Understanding Cyberspace Cartographies :

A Critical Analysis of Internet Infrastructure Mapping

Martin Dodge

Centre for Advanced Spatial Analysis
University College London

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Chapter 1

Introduction

> Now when I was a little chap I had a passion for maps. I would look for hours at South America, or Africa, or Australia, and lose myself in all the glories of exploration. At that time there were many blank spaces on the earth and when I found one that looked particularly inviting on a map (but they all look that) I would put my finger on it and say, 'When I grow up I will go there'.
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> -- Joseph Conrad, *Heart of Darkness*, 1902.

> I want to investigate in what ways this cartographic imaginary proliferates spaces and the ways in which we can live in them.
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> -- John Pickles, *A History of Spaces*, 2004.

1. Aims

This thesis is one of the outcomes of an ongoing, ten-year long, cybergeography research project focused on critically describing the various socio-spatial forms of cyberspace, analysing their supporting material infrastructures and their implications for the geographical organisation of everyday living. The epistemological and philosophical approach I have taken is centred around the map as a process of knowledge construction and as social-material site for critique. The goal of the thesis is provide an analysis of the practical 'workability' and political 'imaginings' of cyberspace cartographies through a critical reading of maps of Internet network infrastructures.

To understand the power of maps, particularly in contemporary Western capitalist contexts, one must grasp how they stir both the imagination and work instrumentally in the exploration and exploitation of new spaces. As Joseph Conrad's narrator Marlow makes clear in the *Heart of Darkness*, mapped representations open up space to the imagination. This cartographic imaginary, according to theorist John Pickles, is more than looking, it inspires action, it beckons space into being and needs to be understood in relationship to living within and through cyberspace.

Cyberspace is often portrayed as the pre-eminent 'blank' space of twenty-first century, an alluring virtual *terra incognita*. The fact that its digitally-mediated territories are composed of software code rather than vast deserts or impenetrable jungle does not weaken the desire for exploration or the potency of the cartographic imaginary. Cyberspace cartographies are opening up unique ways to visually understand the complex, multivalent and intangible nature of virtual spaces. Yet, just like in *Heart of Darkness,* the opening up of cyberspace through particular cartographic gazes also closes down the potential of virtual space at the same time. A mapped space becomes a known place, a controllable territory that can be more effectively exploited by certain interests and groups over and above others.

Many different aspects of cyberspace have been mapped, ranging from the physical infrastructure, the logical layers of data links, the protocols frozen in software code, traffic flows, user demographics, hyperlinks structures of the Web, the emergent patterns of social interaction, along with new interactive spatialisations[1] to navigate in the myriad of online forums and information resources (See Dodge 2005 for examples). The maps cover a range of different scales from individual local area networks and single websites up to global scale visualisation of vast topological grids and the graphical data-mining the daily interactions of millions of people. Some of the maps and spatialisations adhere to established conventions of cartographic design, but many more use quite different visual vocabularies. Many are beautiful and many more are really rather ugly in terms of normative aesthetic values. A few are actually quite useful as practical cartographic tools for navigating new virtual space, but many more are not workable at all for route following. However, all the maps provide a fascinating picture of what cyberspace looks like, or rather, what they really provide are insights into how people *imagine* the virtual territory to look in service to their interests and desires. Understanding the cartographies of cyberspace is therefore important because they not only reflects the nature of the virtual world according to the interests of the mapmaker, but also because they play a fundamental role in shaping the ongoing social-material (re)production of those virtual spaces.

This new and diverse emerging domain of cyberspace mapping activities can be usefully conceptualised, following Edney (1993), into three distinct cartographic modes. The first mode, what I term, 'maps <u>of</u> cyberspace' is mapping which describes the material information and communications technologies (ICT) infrastructures and documents the operations of cyberspace itself, as viewed from an external position. (This thesis is focused on this mode through the analysis of Internet network infrastructure maps.) In some senses they can be thought of as the thematic maps of cyberspace and are quite distinct from the other two modes. 'Maps for cyberspace', the second mode, are maps and spatialisations created for navigating within cyberspace; they are expressly designed to be used to 'interface' virtual spaces themselves. The final mode, 'maps in cyberspace' involves putting existing forms of terrestrial mapping online to widen access and add user interactivity. This mode is far and away the most evident in terms of the many millions of people using online services like the MapQuest and Google Earth.

2. Defining themes

> Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts…A graphical representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding...
>
> -- William Gibson, *Neuromancer*, 1984.

Cyberspace: Historically considered, cyberspace emerged from the convergence of two sets of technologies: those for the transmission of information and those for the automation of computation. (This convergence is itself premised on the fundamental digitalisation of the operations and products of both of these technologies.) Since the second world war the technologies of computing and communication have grown dramatically in capacity and fallen in per unit cost. As is well noted, they have diffused throughout society and have had a significant transformative agency in the nature of everyday living (Castells 1996), including radically altering space-time relations in complex ways through processes of convergence, compression, and distanctiation (Janelle 1969; Harvey 1989; Giddens 1990). They also give rise to cyberspaces, the conceptual spaces of information flows and social interactions that

[1] Spatialisations are a form of visualisation where a spatial structure and map-like interface is applied to data where no inherent or obvious one exists, They are used to provide an interpretable structure to

are continually beckoned into being *within* the infrastructural ensemble of digital computing hardware, software code and high-speed telecommunications networks.

Cyberspace is not the technology or infrastructure itself (although it cannot exist independently of these), but the *experience* of virtual spaces that these engender. The word literally means 'navigable space' and is derived from the Greek world *kyber* (to navigate). As a description of virtual space it was conceived by William Gibson, in his novel *Neuromancer* (1984), as a three-dimensional 'data-scape' inside the global matrix of computer networks where disembodied users interact with "clusters and constellations of data". As an everyday human experiential phenomena, cyberspace is much more mundane than Gibson's science-fiction imaginary, but is fast becoming as powerful in mediating social relationships and shaping the material world. For example, cyberspace "is the 'place' where a telephone conversation appears to occur. Not inside your actual phone, the plastic device on your desk. Not inside the other person's phone, in some other city. The place between the phones. The indefinite place out there, where the two of you, two human beings, actually meet and communicate" (Sterling 1992, 1). Cyberspace is also the 'space' where your money is (to paraphrase John Perry Barlow) and is fast becoming the primary archive of our memories (through online diaries and blogs, emails and text messages, digital photographs, and so on). The Internet is most obvious element of cyberspace currently.

Cyberspaces are not 'real' in terms of common-sense definitions of material 'stuff' you can touch; they are, in Gibson's phrase, a "consensual hallucination" created by software code and visual interfaces, and made tangible by access devices (screens, keyboards, speakers, mice, joysticks, and so on). However, they are perceived as real in that they can have very real, material consequences (e.g., some money being stolen from your bank account). This is because cyberspace is folded into everyday lived experience more and more, rather than being some exotic, dissociated paraspace (as frequently depicted cinematically in the 1990s). Uses of ICTs are themselves embodied and the experiences of virtual spaces form a complex continuum from purely material spaces to wholly cyberspaces, with many social activities now liminally combining the "virtually real and the actually real" (Madge and O'Connor

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various types of non-geographic data, including Web hyperlinks.

2005). An illustration of this experiential continuum is the extent to which cyberspace explicitly draws on material socio-spatial relations and geographic metaphors to create new spatialities and a sense of place (see also chapter four discussions on role of metaphors to explain the nature of the Internet).

Given this liminality, cyberspaces are always contingent on the time and place of their production. Typically, they are heterogeneous in structure and fast changing. There are a rapidly expanding range of online virtual spaces experienced through different forms of interaction and communication affordances (Figure 1.1). There is also convergence of technologies that allow new spaces to emerge (such as the rapid growth in text messaging on mobile phones, or the emergence of VoIP). Reliable, representative and comparative statistics are notoriously hard to gather and quickly become obsolete. All these characteristics mean it is challenging space to survey and has served as a driver in the development of new techniques of mapping.

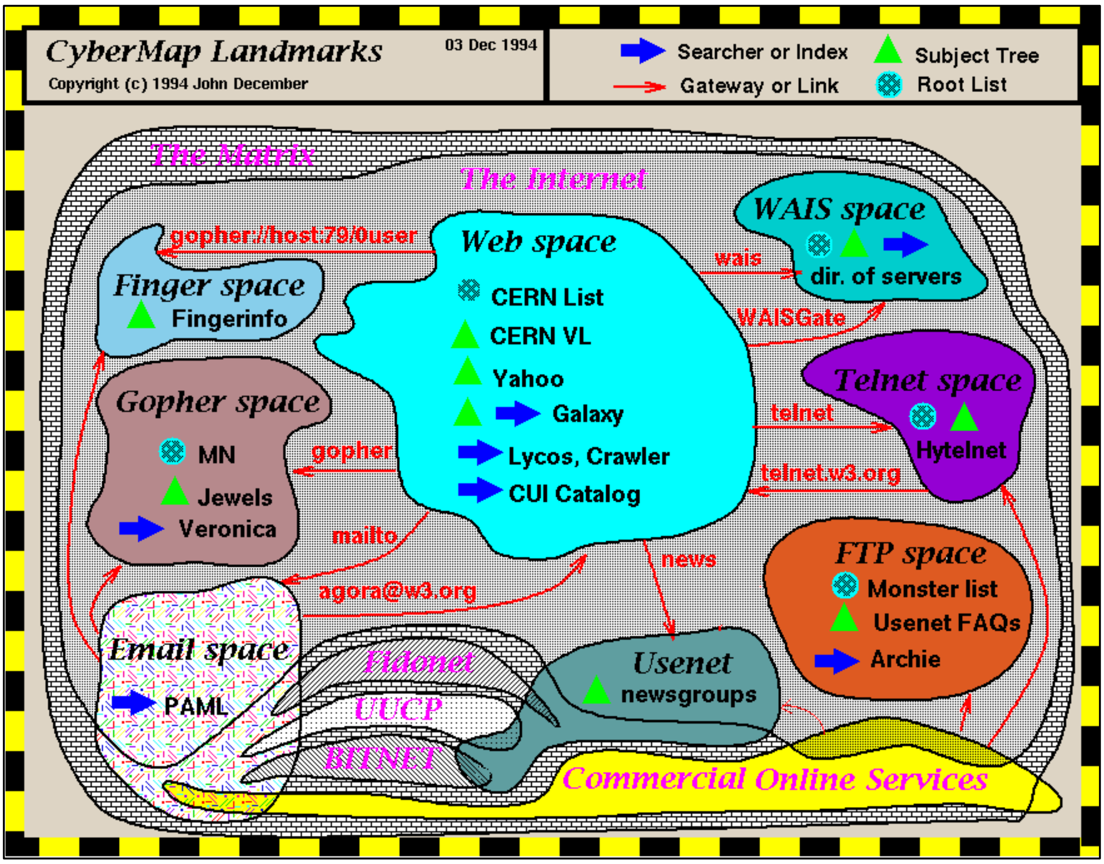

Figure 1.1: An attempt to sketch the principal online virtual spaces of cyberspace, circa 1994. Drawn by John December, it maps cyberspaces as multiple, irregularly-sized domains with fluid boundaries, and many interconnections and overlaps. (Source: December 1995.)

Internet: The focus of this thesis is on just one element of cyberspace, the Internet, a global network of networks that uses TCP/IP protocols to communicate. It burst into the popular imagination in the early 1990s after a twenty year gestation in academic and defence-related research communities. At a conceptual level the Internet is not a material entity, rather it is an agreement between many networks to exchanging data traffic using common protocols. The ease of connecting individual networks together, that is inter-networking, via IP (internet protocol) has been paramount to the Internet's success and phenomenal growth. Importantly, the Internet protocol, Searls and Weinberger (2003, no pagination) note, "doesn't specify what people can do with the network, what they can build on its edges, what they can say, who gets to talk". This openness gives rise to the Internet's three key virtues: no one owns its, everyone can use it and anyone can improve it (Searls and Weinberger 2003). Anyone with a computer, a modem and a telephone can connect to one of the networks and, through it, to the rest of the public Internet[2]. (Note, there are also many private intranets that use TCP/IP but are not interconnected to the public Internet.) The sum of the Internet's nodes and their connections is greater than their parts, forming a network of network that empowers millions of people to communicate and share information with each for the first time in human history.

Built around this agreement is a vast socio-material infrastructure to move data and to provide services. The materiality of the Internet ranges from individual PCs connected via modems, to small domestic LANs up to immense networked assemblages such as undersea cable systems linking continents that cost billions to construct. Given its open architecture no one knows for sure quite how much infrastructure is enrolled in the ongoing production of the Internet, but it is significant. In January 2005, for example, there were some 317,646,000 computer hosts on the Internet according to one of the most creditable 'hardware' metrics[3], an increase of 27% from January 2004.

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[2] Various 'digital divide' issues, notwithstanding, relating to the unequal distribution of the Internet access and production (e.g., see Warf 2001); for example, the cost of access, particularly telephone charges, vary greatly between countries (e.g., Petrazzini and Kibati 1999) along with the freedom to communicate without state censorship (e.g., Reporters without Borders 2003 analysis of Internet surveillance).

[3] The Internet Domain Name Survey, a biannual survey by Network Wizards, <www.isc.org>. A host is a Internet-connected computer assigned a fix domain name, typically they are servers and routers.

The development of the Internet has not been achieved independently and is bound up in the histories of telecommunication technologies, computing and wider social and political-economic histories of media (including easily overlooked and banal infrastructures, such as the ASCII text encoding format). The contemporary Internet is the outcome of a specific set of political-economic relations, most especially to do with the Cold War funding for computing research (see Abbate 1999); the Internet has a particular historical geography that centres it in the U.S., and early Internet development was guided by the military-industrial-academic complex (see discussion in chapter five). It was only later that it became re-appropriated into the public and commercial domain.

The Internet itself is experienced as a variety of different virtual spaces and media channels that are built seamlessly on top of it, including email, instant-messaging, peer-to-peer file sharing, and, of course, the Web. As Castells (2001) rightly points out, the Internet is more than just sum of its infrastructural parts; “it is the technological tool and organisational form that distributes: information power, knowledge generation, and networking capacity in all realms of activity.” It should be viewed as a general purpose technology, much like steam power and electrical current, in that it sets no preconditions on how it is used. As such, the Internet forms the vital motive force for ongoing processes of economic and cultural globalisation. The Internet is it the cardinal infrastructure of the network society (Castells 1996).

Infrastructures: Conceptually, everything that works in the background necessary to effect a certain action or event is infrastructure. Infrastructures work transparently and have innate tendencies to disappear from consciousness (except, of course, when they fail). Multiple infrastructures mesh together into complex assemblages (e.g., air transportation); new infrastructures are often built onto of existing ones (e.g., fibre-optic cables running through old steam pipes). New infrastructures can emerge rapidly, but then quickly become naturalised and taken-for-granted in the landscape of consumption (mobile telephony for example). Many infrastructures, particularly utility networks, are hidden from everyday view being conveyed underground and in unseen service spaces of buildings; further the production of the infrastructural services are often distanctiated from the point of their consumption (especially so with growth of global supply chains). “[U]sers tended not to worry where the electrons that power their electricity came from; how their telephone conversations (or later faxes and Internet messages) were flitted across the city or the planet; how complex technological systems sustained their journey to work; or what distant gas and water reserves they were utilizing in their homes" (Graham 2000, 184). In the context of affluent Western consumer capitalist societies it is easy to assume that some infrastructures, increasingly including the Internet, are spatially ubiquitous and socially universal; while the conveniences they bring become viewed as *necessary* to living.

Given these features, infrastructures, including Internet networks, tend to be understudied within social sciences (except for policy studies focused largely on their regulation). Studying infrastructures is made harder because they are often deliberately 'black-boxed' to keep outsiders from observing (and questioning) their operational logics. (Such ignorance usually serves the interests of the organisations operating them.) Although they can easily appear 'natural', infrastructures are anything but. They are designed and operated in particular ways (e.g., universal service versus cherry-picking through differential pricing), they have politics. Internet network infrastructures, connecting places together at various scales to facilitate efficient data transmission, are no different, they bound up in wide sets of power relations.

One productive route into the study of infrastructures and their politics, I would argue, is through map representations of them. Maps of Internet network infrastructure reveal something of the nature of Internet itself (such as differential ownership patterns and the unevenness of the places served), but more than this they also reveal how the Internet is being conceptualised by the organisation behind the map. Maps then can make the Internet's politics visible for scholarly analysis because they ineluctably make the agenda of the mapmakers visible.

Mapping:

> And this, essentially is what maps give us, *reality*, a reality that exceeds our vision, our reach, the span of our days, a reality we achieve no other way. We are always mapping the invisible or the unattainable or the erasable, the future or the past, the whatever-is-not-here-present-to-our-senses-now and, through the gift that the map gives us, transmuting it into everything it is not … *into the real.*
>
> -- Denis Wood, *The Power of Maps*, 1992.

In this research I take a broad view of what constitutes 'mapping'. Following Harley and Woodward (1987, xvi), I define it as the application of any graphic representation to facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world. The development of cartographic modes over millennia have provided in the Western cultural context uniquely powerful means by which to classify, represent and communicate information about areas that are too large and too complex to be seen directly. Well designed maps are relatively easy-to-interpret within their own cultural milieu, and constitute concentrated databases of information about the location, shape and size of key features of a landscape and the connections between them. More recently, it has been recognised that the process of spatialisation can provide an interpretable structure to other types of non-geographic data. In essence, maps and spatialisations exploit the mind's ability to more readily see complex relationships in images, providing a clear understanding of a phenomena, reducing search time, and revealing relationships that may otherwise not have been noticed. As a consequence, they form an integral part of how people understand and explain the world.

It is now widely recognised that mapping is a process of creating, rather than revealing, spatial knowledge. This applies to cyberspace cartographies as well. Throughout the process of map creation a large number of subjective, often unconscious, decisions are made about what to include and what to exclude, how the map will look, and what message the mapmaker is seeking to communicate. In this fashion, maps necessarily become imbued with the social norms and cultural values of the people who construct them. Commonly these norms and values reflect dominate power relations in the society, especially when individuals and institutions with power commission a great deal of cartographic production.

Maps are used in diverse ways by diverse audiences, as such the work that maps perform is contingent on the times and places in which they are consumed. Maps are situated and selective re-presentations of spatial knowledges. They are not objective, neutral artefacts but a political view point onto the world. This thesis is concerned with understanding the nature of these view points into cyberspace revealed through case studies of Internet infrastructure mapping.

3. Theoretical approach

My researches on the cartographies of cyberspace, their authorship, dissemination and consumption, is embedded theoretically within the sub-discipline of 'critical cartography'. Broadly speaking, the goal of this field of enquiry is to challenge the normative cartographic hegemony of the 'objective' map by employing poststructuralist approaches to deconstruct and denaturalise cartography's scientific truth claims and by demonstrating empirically how maps are socially constructed and historically contingent. The map when viewed critically, is recognised as always partial and provisional ordering of spatial knowledges, and the outcome of processes actively shaped by the choices, intentions and ideologies of mapmakers.

Critical analysis of maps as cartographic texts imbued with power is conceptually aligned to broader cultural re-reading of images following the 'crisis of representation' in contemporary scholarship. New visual methodologies that have emerged for analysing representations are interested in more than just the site of the image itself, seeking to untangle the full web of relationship in the production, dissemination, and interpretations of representations. Based on constructivist approaches, the significance of a visual representations, lies as much in the historical, cultural and political context surrounding the image itself.

Many of the key themes in critical cartography on the ideological meanings of maps can equally be applied to the newly emerging cartographies of cyberspace, as to old paper maps of the 'real world'. Cyberspace maps, for all their cutting-edge graphical sophistication, can be conceptualised as social constructions of power-knowledge that have important, and often overlooked, social implications for how cyberspace is perceived and consumed.

Theoretically, one of the main aims of my research has been to move beyond a empiricist view of cyberspace mapping that simply catalogues and classifies artefacts, and provides an unproblematic technical analysis of their communicative properties. It is also important not to subscribe to technological determinist notions whereby cyberspace cartographies are presented as autonomous and essentially benign agents operating outside of society, and which 'impacts' in predictable and universal ways, ignoring the problematic contingencies of place and social difference Such deterministic notions regarding cartographic technologies are usually bound-up rhetorically with an unquestioned ideology (especially prevalent in contemporary ICTs and Internet discourses), that asserts that new forms of technology will inherently be 'better' and teleological belief that benefits will be realised for everyone simply because they are possible.

If one views cyberspace cartographies through a deterministic and positivistic lens then it can be seen as a logical and even 'natural' evolution of cartographic representation, whose aim is to enhance our knowledge of new virtual spaces, making online navigation (and commerce) more efficient and increasing the 'return-on-investment' in existing geospatial data by facilitating wider distribution on the Web. Making maps of cyberspace will make cyberspace a better place for business. However, I would argue the situation with cyberspace cartographies is much more contestable. Only certain maps of cyberspace get made and they show only certain aspects, in certain ways. They are not inherently 'good' and will certainly not be beneficial to all users and non-users of cyberspace. The mapping of cyberspace is not a benign act, instead particular maps are made to serve certain interests.

Cyberspace cartographies do not emerge by themselves in a political vacuum. They are a product of particular individual endeavours, usually framed with institutional agendas. To really understand cyberspace cartographies, it is necessary to expose the power 'behind' the map. The theoretical tools applied here to achieve this are a combination of social constructivism and political economy, what one might consider deconstruction of both the 'local' and 'global' contexts in which cyberspace cartographies are made and consumed. This theoretical approach to cyberspace mapping is applied to the case studies of maps of Internet network infrastructures in chapters five through seven. The last chapter takes a different theoretical position to reinterpret interactive network mapping techniques through the ideas of performativity to think about possible ways to counter-map the Internet.

The empirical analysis has required a broad, contextual knowledge of cyberspace cartographies, synthesising materials from a wide range of sources, along with multiple interviews with mapmakers to learn about their stated the aims, and their professional and institutional contexts. The analysis is an academic critique and not a personal criticism of individuals or groups involved. It does not seek denigrate or disparage the diverse work of cyberspace cartographers, which I have found tremendously stimulating over the past ten years. The criticism given is not in mould of populist film or music critics (along the lines of 'I like this map, I don't like that map'), where they simply assert judgements of worth based on perceived aesthetic value or likely commercial potential. Furthermore, this thesis does not provide a formal evaluation of cyberspace cartographies in terms of map perception/usability testing, although this is in itself valuable work in regard to new map forms[4]. For my purposes, it does not really matter if they look good or look bad in terms of normative design criteria or if they 'work' or do not 'work' as efficient communication media, they still yield political insights into their social production.

Having said that, I do believe it is important to fully grasp the normative technical scope of the maps, in terms of how they were produced (e.g. what data was used, how it was gathered and processed, and so on.) and how they are designed to be used. I think the critic does need to be fully conversant with the practicalities of the map they are critiquing. A weakness with much of social and cultural 'deconstruction' of technological phenomena is its failure to appreciate the genuine potentialities of the technology and tendency to overstate its technicity.

It is also important here to acknowledge my own positionality as an agent in actively constructing cyberspace cartographies as a coherent research topic over the past ten

[4] E.g., see the work of Sara Fabrikant and UCSB colleagues behaviourist testing perceptions of spatialisations, <www.geog.ucsb.edu/~sara>.

years through a range of print publications and a high-profile webite (see further discussion in second half of chapter three).

Lastly, while this thesis does not attempt to offer alternative or 'better' practice of cyberspace mapping that in some way 'answers' criticisms of critical cartography, it does offer up a positive and productive re-reading of what the Internet is made to look like by challenging the truth claims of its dominant cartographic imaginary and by exposing the power 'behind' these maps and thus the infrastructure itself.

4. Structure of the thesis

The thesis comprises seven main chapters, the first three review relevant literatures and discuss conceptual setting for undertaking a critical analysis of Internet network infrastructure maps. The last four chapters are in-depth case studies critiquing examples from the 'maps <u>of</u> cyberspace' mode. These empirical case studies trace the evolution of the Internet as a social-material network infrastructure by examining how it has been mapped in four time periods using four distinctive genres of mapping[5]: documentary maps, statistical maps; marketing maps and counter-maps.

Chapter two provides a substantive overview of the core elements of the research in terms of defining the nature of the map and discussing contemporary theories of mapping (particularly, the critical cartography paradigm). The third chapter describes the three modes of cyberspace cartography, outlining their distinctive social relations, organisational settings and conceptions of space. I review the literature in the field, paying attention to the varying definitions, taxonomies and research questions relating to the cartographies of cyberspace. This chapter also provides a discussion of my contribution to the cyberspace cartographies discourse in terms of the building of the *Atlas of Cyberspaces* website and the role this has had in interpreting (and in some senses 'promoting') this field of research.

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[5] A genre here is a distinctive type of communicative event or text which is characterised in terms of its central purpose, its prototypical content and form, its being conventionally recognised and labelled as such by the discourse community of which it is a part (Thurlow and Jaworski 2003). Genres are conventionalised, yet their boundaries are always indistinct; they are powerful because they "establish particular ways of organizing and looking at the world" (Thurlow and Jaworski 2003, 584).

Chapter four characterises Internet network infrastructures in relation to the problem of 'invisibility' and considers how they have been imagined using different geographic metaphors. The discussion then considers how the Internet is made in a tangible phenomena for scientific research by particular types of inscriptions of the network infrastructure. Using ideas from science and technology studies I argue that these inscriptions work as a form of 'virtual witnessing' for 'matters of fact' about the Internet.

Chapter five is the first case study chapters. It considers empirically how cartography works as a form of documentary-making by tracing the geohistory of the proto-Internet through an examination of maps of ARPANET network in the U.S. during the time period of late 1960s through to the late 1980s. The principal actors in this mapping genre were scientists, engineers and government technocrats involved in building network infrastructure. The discourse in which the maps were originally disseminated was one in which pioneers were documenting their work as proof of their engineering credentials and as a means to express pride in a job well done. During this time the Internet was unknown (except to a narrow technocratic elite closely involved in its construction), but it was nonetheless a crucial period in infrastructural terms, when the foundations for the Internet today were laid. (These included the design robust standards and protocols for internetworking, the creation of a range of self-governance processes and institutions, and the emergence of a unique 'open access' ethos.) The network maps drawn during this period now provide a valuable 'archaeological' resource for excavating the origins of the Internet.

Chapter six examines the genre of statistical mapping of infrastructure. The time period of the analysis moves forward to consider maps of the global spread of the Internet during the first half of the 1990s. The period was a crucial phase in the maturation of the Internet, when its network infrastructure grew from technical novelty linking thousands of sites to a powerful global communications network connecting millions. The principal actors in this mapping genre were academics and network activists who were working to spread Internet connectivity worldwide. They had distinctly utopian outlook on the progressive potential of computer networking -

getting everyone onto the ‘information superhighway’ - combined with the practical knowledge to get countries wired up as quickly as possible. The map artefacts analysed are a series of conventional choropleth world maps of network connectivity, and they provide a revealing cartographic window into the ‘digitising mission’ of the period and a way to think about the neo-colonialising implications of the Internet.

An alternative view of the evolution of the Internet can be gleaned through the analysis of the commercial genre of mapping by large corporations looking to profit from selling network connectivity. This is the focus of chapter seven, which covers the commercial take-off of the Internet through the second half of the 1990s when the Web spurred a unprecedented levels of hype, culminating in the dot-com bubble at the end of the decade. Hundreds of millions of dollars were invested in new infrastructures for Internet data transport during this period. Marketing maps played a role in the promotional discourses that lead to large speculative, and selective, overbuilding of new fibre-optics lines across the globe.

The last chapter, covering contemporary cartographic practices, is focused on the possibilities of Internet network infrastructure mapping for ‘ordinary’ users. The genre chosen is that of route mapping, considered from the perspective of counter-cartography (i.e. maps which unsettle hegemonic power relations). I consider software tools called traceroutes that allow individuals to make their own route maps of Internet data flows. Traceroutes open-up the meaning of the map as dynamic performance rather than fixed artefact, and also have the potential to enfranchise people with knowledge about their own place in cyberspace.

Chapter 2

Delineating the Map

A map is, in its primary conception, a conventionalized picture of the Earth's pattern as seen from above.

-- Erwin Raisz, *General Cartography*, 1938.

Every map is someone's way of getting you to look at the world his or her way.

-- Lucy Fellowes, Smithsonian curator (quoted in Henrikson 1994).

1. Introduction

Mapping provides a uniquely powerful means to classify, represent and communicate information about places that are too large and too complex to be seen directly. Importantly, the places that maps are able to represent need not be limited to physical, geographical spaces like cities, rivers, mountain ranges and such like: maps can be used to represent virtual spaces of cyberspace and their supporting network infrastructures. This chapter seeks to delineate the nature of maps and outline the major theoretical perspectives that have been used to understand and critique cartography in Western academia in the last fifty years.

The ability to create and use maps is one of the most basic means of human communication, at least as old as the invention of language and, arguably, as significant as the discovery of mathematics. The recorded history of cartography clearly demonstrates the practical utility of maps in all aspects of Western society, being most important for organising spatial knowledges, facilitating navigation and controlling territory. Some have gone further, to argue that mapping processes are culturally universal, evident across all societies (e.g., Blaut *et al.* 2003), although the visual forms of the resulting map artefacts are very diverse. At the same time, maps are also rhetorically powerful graphic images that frame our understanding of the human and physical world, shaping our mental image of places, constructing our sense of spatiality. So, in a very real sense, maps make our world.

Conventionally, maps are material artefacts that visually represent a geographical landscape using the cartographic norms of a planar view - looking straight down from above - and a consistently applied reduction in scale. However, it is impossible neatly to define maps according to the type of phenomena mapped or the particular mode of presentation, or their medium of dissemination (Dorling and Fairbairn 1997). Maps have traditionally been used as static storage devices for spatial data and usually printed on paper, but now they are much more likely to be interactive tools displayed on a computer screen. (Some national mapping agencies are contemplating discontinuing the printed topographic map products as customers increasingly use digital geospatial data[1]). Today, we live in a map-saturated world (Wood 1992), continually exposed to conventional geographic maps, along with many other map-like spatial images and media (e.g. animated satellite images, three-dimensional city models, MRI scans of the brain).

Maps have long been used in scholarly research into social and physical phenomena. They provide, of course, a primary technique in geography[2] but they are also used widely in other disciplines such as anthropology, archaeology, history, and epidemiology, to store spatial information, to analyse data and generate ideas, to test hypotheses and to present results in a compelling, visual form. Mapping as a method of enquiry and knowledge creation also plays a growing role in the natural sciences, in disciplines such as astronomy and particle physics, and in the life sciences, as exemplified by the metaphorical and literal mapping of DNA by the Human Genome Project. This work is not limited to geographic mapping; many other spatial visualisation techniques, often using multi-dimensional displays, have been developed for handling very large, complex spatial datasets without gross simplification or unfathomable statistical output (e.g., volumetric visualisation in atmospheric modelling, three-dimensional body imaging in medical diagnostics). 'More mapping of more domains by more nations will probably occur in the next decade than has occurred at any time since Alexander von Humboldt 'rediscovered' the earth in the eighteenth century, and more *terra incognita* will be charted than ever before in

[1] For example in Canada, see "Ottawa plots making maps without paper" Globe and Mail, October 4, 2005, <www.theglobeandmail.com/servlet/story/RTGAM.20051004.wxmaps104/BNStory/National/>.

[2] Although denigrated methodologically in some quarters; see Perkins (2004).

history" (Hall 1992, 22). Cyberspace cartographies form one of the most significant new domains of this mapping activity.

Mapping processes

The production of geographic maps and spatial visualisation involves a whole series of mapping processes, from the initial selection of what is to be measured to the choice of the most appropriate scale of representation and projection, and the best visual symbology to use. The concept of 'map as process' is useful methodologically because it encourages particular ways of organised thinking about how to generalise reality, how to distil inherent, meaningful spatial structure from the data, and how to show significant relationships between things in a legible fashion. Mapping provides a means to organise large amounts of, often multi-dimensional, information about a place in such a fashion as to facilitate human exploration and understanding. Yet, mapping practices are not just a set of techniques for information 'management', they also encompass important social processes of knowledge construction. As scholars have come to realise, maps and culture are intimately entwined and inseparable.

Mapping not only represents reality, it has an active role in the social construction of that reality. Mapmakers should be seen as creators rather than copyists of the landscapes represented. However, most people are not conscious of this constructive role when they use maps. Sparke (1998, 466) calls this the 'recursive proleptic effect' of mapping, "the way maps contribute to the construction of spaces that later they seem only to represent". The power of maps comes from the fact that they are both a practical form of information processing and also a compelling form of rhetorical communication.

Maps work, essentially, by helping people to see the unseen. This is achieved through the act of visualisation, premised on the simple notion that humans can reason and learn more effectively in a visual environment than when using textual or numerical description. Maps provide graphical ideation which renders a place, a phenomenon or a process visible, enabling our most powerful information-processing abilities - those of spatial cognition associated with the human eye-brain vision system - to be brought to bear. Visualisation is thus a cognitive process of learning through the interaction with visual signs that make up the map and it differs from passive observation in that its purpose is to discover unknowns, rather than to see what is already known. Effective cartographic visualisation reveals novel insights that are not apparent with other methods. In an instrumental sense, then, map use is a powerful prosthetic enhancement for the human body: “[l]ike the telescope or microscope, it allows us to see at scales impossible for the naked eye and without moving the physical body over space” (Cosgrove 2003, 137). The ideal of obtaining a reliable capacity to see the unseen is particularly applicable to much of cyberspace cartography, because of the invisibility of the infrastructure and the intangibility of the virtual spaces (see chapter three).

The power of map use as spatial visualisation to elucidate meaningful patterns in complex data is well illustrated by some of the ‘classics’ of pre-digital era, such as Charles Joseph Minard’s ‘Napoleon map’ of 1869 and Harry Beck’s ‘Tube diagram’ of 1933 (see Garland 1994; Tufte 1983). Even though these were hand-drawn on paper, they are nonetheless still powerful today and show the potential of visualisation to provide new understanding and compelling means of communicating to a wide audience. Through their novel visual forms they also demonstrate the extent to which mapping can be a creative practice in and of itself. The way the best maps go beyond merely representing to become a kind of cognitive shorthand for the actual places and processes themselves, is illustrated in Beck’s celebrated diagrammatic design of the Underground which has become such a powerful spatial template for the ‘real’ layout of London in the minds of many visitors and residents. The ‘problem’ is that although Beck’s map works well for underground movement, it can be confusing for surface navigation because it famously sacrifices geographic accuracy for topological clarity.

Map workability is also engendered because they are visually appealing objects. The aesthetic of cartographic representations is central to their success in rhetorical communication and means they are widely deployed as persuasive devices to present ideas, themes, and concepts that are difficult to express verbally. The result, according to Francaviglia (1999, 155) is that “[c]artographers draw maps that have the power to both inform and beguile their users”. Most of the maps encountered on a daily basis (often with little conscious thought given to them) are used in the service of persuasion[3], ranging from the marketing map to the more subtle displays such as states' claims to sovereign power over territory, implicitly displayed in the daily weather map seen on the news. Maps work because they are able to *sell* a particular vision of the world <u>and</u> because people are willing to *buy* into this vision because they believe in the authority of the image as a trustworthy representation.

The persuasive power of 'informative-yet-beguiling' maps is equally applicable to cyberspace cartography projects. Indeed, much of this mapping is used precisely because it has a appealing visual sense of what cyberspace *should* look like, matching the metaphorical preconceptions of the designers, journalists and editors. (See chapter four for discussion of the visual tropes used to spatially imagine Internet infrastructure.) Yet, the lack of established conventions in mapping aspects of cyberspace (what should a website look like?) have provided great scope for aesthetic experimentation. And in this regard, some of the most innovative cartographies of cyberspace are pushing the definitional boundaries of the map (as opposed to a graph or merely a 'pretty picture'). As such, I would argue, cyberspace cartography is one of the few genuinely 'cutting edge' developments in map design practice in the twenty-first century.

2. Cartographic history, mapping modes and the digital transition

Attempts to historise the nature of (western) cartography through categorisations of map forms and taxonomies based on purpose often implicitly use the notion of evolutionary advancement driven by technological development as an explanation. The end result, often conceptualised as a tree (Figure 2.1), narrates cartography as a beneficent pursuit, characterised by improving accuracy and comprehensiveness with each new generation of map. Examples of this conceptualisation are common in the literature, such that "[t]he normative history of cartography is a ceaseless massaging of this theme of noble progress" (Harley 1992, 234). For example, Crone (1953, xi) notes, "[t]he history of cartography is largely that of the increase of accuracy with

[3] Many of these illustrations are what is known as 'popular' maps and they use figurative infographics style (see Holmes 1991).

which ... elements of distance and direction are determined and the comprehensiveness of the maps' content.".

Histories of cartography tend to be written as a history of technique, with an underlying assumption that rational decision-making leads to the adoption of improved technologies and institutional practices when they become available. Cartographers are typically portrayed as benign artisans and later skilled technicians striving to make ever more accurate depictions of space. Technical development is conceived as a continuous path of improvement, punctuated with particular bursts of intense innovation and progress (e.g., John Harrison's 1761 invention of the chronometer and the production of longitude at sea). Within this 'onward march' view of map-making history, distinct phases are conveniently identified: the Eurocentric sequence runs typically through primitive medieval cartography based on religious imagination, followed by revolutions in measurement and projective geometry, flowing from Ptolemaic geography, leading to Renaissance mapping and then moving forward with the scientific formulations of the Enlightenment and geodetic national surveys, ending up with the most 'advanced' digital map-making founded on GIS and GPS technology. Above all else, such 'progressivist' narratives stress the changes in (western) cartography's state from essentially a descriptive art to a thoroughly scientific endeavour embracing the doctrine of objectivism. This 'cartographic reformation' in which map-makers strove for intellectual respectability as 'men of science' was inscribed on the maps themselves in terms of the "decline in florid decoration and the rise of the factual neutrality of white space" (Edney 1993, 56). This 'reformation' marked a shift in authorship from named cartographers (the individual artisan mapmakers) to the anonymised mass-produced maps of print capitalism, paralleled by a economic reorganisation of map production from small-scale, uncoordinated and sporadic efforts to systematic and later industrialised methods of large cartographic institutions working to formalised standards, typically in the service of the state.

<Figure 2.1 about here. Map evolutionary tree.>

The apparent 'naturalness' of this account belies the politics behind the conceptualisation of the progressive development of cartography from a primitive past to the sophisticated present (Edney 1993; Pickles 1999). The underlying goal of this kind of (re)construction of cartographic history - achievable only through a carefully selective reading of extant map artefacts (Edney 1993) - is to ‘prove’ that the objectivity of *current* scientific methods is predestined. It grants an important legitimation to the positivist notion of contemporary professional cartography as the ‘best’ and provides a discursive mechanism to dismiss maps that do not fit ‘acceptable’ scientific standards (e.g., dismissal of non-western mapping practices). Social studies of science have shown that this type disciplinary ‘storytelling’ is a form of scientism, a metanarrative underlying modernist science’s claims to exclusive truth based on the superiority of empirical measurement to describe reality and the privileging of the resulting representations. Scientist worldviews see technological progress almost like a force of nature that somehow operates outside society and beyond the political concerns of money, power, and ego. The way one approaches cartographic history is therefore worthy of consideration, as it is at the heart of the recent political retheorisation of cartography and directly informs our understanding of the nature of the map and contemporary positivistic epistemological foundations of cartography (including much of the work mapping cyberspace).

There are alternative ways to conceptualise cartographic history that are not so wedded to modernist narratives. One of the most useful is provided by Edney’s (1993, 54) theorisation of ‘cartography without progress’, in which mapping is read as “a complex amalgam of cartographic *modes* rather than a monolithic enterprise”. For Edney, a cartographic mode is not simply a time period in a linear chronological sequence, but is a unique set of cultural, social, economic and technical relations within which cartographers and the map production processes are situated. The mode is the milieu in which mapping practices occur. Each cartographic mode gives rise to its own map artefacts that may well look very different from other modes, but this conceptualisation does not assume that one is inherently better than another, or that one mode will inevitably evolve into a ‘better’ mode. As Edney (1993, 58) says: “[t]he mode is thus the combination of cartographic form and cartographic function, of the internal construction of the data, their representation on the one hand and the external *raison d’être* of the map on the other”. Modes are unique to their time and places, and are transitory. There can be multiple distinct cartographic modes operating at the same time, in the same place. Modes can interact and may well overlap, merge or split. The boundaries between modes are likely to be fuzzy and permeable.

Cartographic history, according to Edney's theorisation, is a pluralist and relational network of activities rather than a single linear process. The end result is not the unidirectional evolutionary tree but a complex, many-branching, rhizomatic structure (Figure 2.2). In contemporary cartographic epistemologies, a diverse range of mappings is seen to emerge from a shifting creative milieu rather than in a systematic fashion.

<Figure 2.2 about here. Edney's map modes diagram.>

As stated in the introduction, the theorisation of this thesis is built on modes rather than trees. The development of new forms of contemporary mapping practices and artefacts - what I term *cyberspace cartographies* - is best conceptualised as three distinct modes rather than a new branch at the end of the family-tree of cartography history. The rhizomatic notion of cartographic modes suits the emergent and variegated nature of cyberspace mapping, which has drawn on many disparate ideas, approaches and visualisation forms; it is thoroughly situated in wider socio-technical changes (particularly the diffusion of the Internet throughout map production and the use of the Web as the primary media of dissemination). The empirical analysis (presented in chapters five - eight) unpacks the set of cultural, social, and technological relations which determine cartographic practices one of these modes, the 'maps <u>of</u> cyberspace' mode, using a range of cartographic genres from Internet network infrastructure mapping.

Digital transition and cartography

The development and rapid diffusion of information and communication technologies in the last three decades has affected all modes of mapping, changing methods of data collection, cartographic production, and the dissemination and use of maps. This has been termed the 'digital transition' in cartography (Goodchild 1999; Pickles 1999) and it is continuing apace (for example, developments in location-based services). As such it is a vital component in understanding the milieu in which new modes of cartography are emerging.

While the detailed social and technical histories of the digitisation of the cartographic industry are complex and largely unwritten, it would be fair to say that in the last decade cartography has been wholly subsumed in a rapid convergence of spatial technologies, such that today, professional cartography is seen as little more than an 'end-service' component of the multi-billion dollar GI industry. Nowadays, the majority of maps are digital and created only 'on demand' from geospatial databases for temporary display on screens. The days of the unwieldy folded map sheet and heavy paper atlases are quickly becoming a thing of the past, replaced by the rapid technological development of GIS, spatial databases and real-time navigation systems. The web mapping portal MapQuest.com, for example, has already generated more digital maps than any other publisher in the history of cartography (Peterson 2001); the huge popularity of Google map's API in the summer of 2005 has inspired an explosion of new online mapping tools and hacks.

As the map itself has became a fully digital text, many of its basic properties have changed. The digital map is infinitely copiable, infinitely transportable, and a highly mutable representation (switching thematic layers on and off, easy modification of symbols, the ability to make selections by spatial/attribute queries, and so on). Cheap, powerful computer graphics on desktop PCs, and increasingly mobile devices, enable much more expressive and interactive cartography, potentially available to a growing number of people. The pervasive paradigm of hypertext as a way to structure and navigate information has also influenced digital maps. Increasingly, maps are used as core components in larger multimedia information resources where locations and features on the map are hotlinked to pictures, text and sounds, to create distinctively new modes of map use (Cartwright *et al.* 1999). In design terms, the conventional planar map form itself is, of course, only one possible representation of spatial data and new digital technologies have enabled much greater diversity of forms including pseudo three-dimensional landscape views, interactive panoramic image-maps, fully three-dimensional flythrough models, and immersive VR space (e.g., see Batty *et al.* 1998; Fisher and Unwin 2001; Hearnshaw and Unwin 1994). Developments in computer graphics, computation and user interfaces have begun to fundamentally transmute the role of map from the finished product to a situation where the map is displayed within a visual tool to be used interactively for exploratory data analysis (typically with the interlinking of multiple representations such as statistical charts, three-dimensional plots, tables, etc.). This changing conceptualisation of the map is at the heart of the emerging field of geovisualization, which in the last five years or so have been at the leading edge of applied cartographic research (MacEachren and Kraak 2001; Dykes *et al.* 2005).

As well as making maps more interactive, ICTs are also helping to give many more people access to cartography as map-makers themselves, be it via the 'map charting' options in spreadsheets to produce simple thematic maps of their own data or through desktop GISs such as ArcView or MapInfo. As more and more people 'by-pass' professional cartographers to make their own maps as and when required, it is likely that the diversity of map forms and usage will expand. Of course, access to 'point and click' mapping software itself is no guarantee that the maps produced will be appropriate and effective. Mapmaking still takes skill and thought, requiring considerable effort to make *workable* maps.

Developments in networking and computer-mediated communications, and the rise of the World-Wide Web in the mid 1990s, means that digital maps are now very easy to distribute at marginal cost and can be accessed 'on demand' by many (see Kraak and Brown 2001; Peterson 2003; Plewe 1997). One of the first examples was the Xerox PARC Map Viewer[4] online in June 1993 and the threshold of online mapping continues to rise (e.g., in June 2005, Google Maps service provided seamless satellite image coverage of the world). These Web mapping services are free at the point of use and are encouraging the casual use of cartography[5].

The provision of web mapping and online GIS tools is significantly shifting the accessibility to mapping and spatial data, as well as altering the user perception of what a map should be. There are clear signs that cartography will be seen as simply one of many available 'on demand' web services. As the digital map display becomes more flexible and much more accessible, it is also, in some respects, granted a less

[4] Created by Steve Putz, <www2.parc.com/istl/projects/mapdocs>. No longer online.

[5] Although, there are many much thornier, political, issues about access rights and intellectual property, especially so in the UK; see for example Dodson 2005).

reified status than analogue map artefacts of the past. Maps are increasingly treated as transitory information resources, created on demand, and discarded immediately after use. In some senses, this devalues the map as it becomes just another form of ephemeral media, one of the multitude of screen images that barrage people everyday. Cartographic knowledge itself is just another informational commodity to be bought and sold, and endlessly circulated[6].

The production of cartographic knowledge has always been dependent, to large degree, on the available methods of data collection. These are being greatly augmented in the digital transition. The wide-spread importance of new digital measurement was noted recently by US National Science Foundation Director Rita Colwell (2004, 704): “new tools of vision are opening our eyes to frontiers at scales large and small, from quarks to the cosmos.” Cartography’s ability to ‘capture’ the world has been transformed by digital photogrammetry, remote sensing and GPS-based surveying. Cartography can not only ‘see’ the world in greater depth (Pickles 2004b), but it can also ‘see’ new things, including virtual spaces, and with new temporalities (see also chapter eight).

Vast geospatial databases underlie the modern digital topographic maps, such as the Ordnance Survey’s Digital National Framework comprising over 400 million features.[7] These are growing as part of the ‘exponential world’, being fed in particular by high-resolution imagery from commercial satellites. Interestingly, in the future, much of this growth will come from people gathering geospatial data as they go about their daily activity, automatically captured by location-aware devices that they will carry and use. From this kind of emergent mobile of spatial data capture it will be to ‘hack’ together new types of maps rather than be dependent on the map products formally published by governments or commercial firms. Such individually-made, ‘amateur’ mapping may be imperfect in many respects (not meeting the positional accuracy standards or adhering to the topo-96 surveying requirements for example), but could well be better fit-for-purpose than professionally produced, general map

[6] The emergence of open-source cartography, as exemplified by the OpenStreetMap project are challenging the commercial commodification of cartography by developing a ‘bottom-up’ capture infrastructure that is premised on a volunteerist philosophy.

[7] Source: <www.ordnancesurvey.co.uk/oswebsite/media/news/2001/sept/masterchallenge.html>.

products. There is also exciting scope for using locative media to annotate our maps with ephemeral things, personal memories, messages for friends, that are beyond conceptual governmental cartography or the commercial cartography industry.

In some respects, then, the outcome of the digital transition can be read as a democratisation of cartography, widening access to mapping and breaking the rigid control of authorship by an anonymised professional elite. However, if one looks more closely (and sceptically), the freedom for people to make their own maps with these types of software tools is strongly inscribed in the design and functionality of the software itself. The maps one can make in Excel or ArcView are only the maps the program allows one to make. The majority of people still do not have the time or skills to break free from the functional constraints that the software imposes[8].

Furthermore, interpreting the digital transition should not merely be about plotting technical 'impacts', but should also involve assessing the political implications of changing social practices in data capture and map authorship. Being wary of linear narratives of progress, one should not read the digitisation of the map as seamless, unproblematic or inevitable (Pickles 1999; 2004a). Technological change is always contested, driven by competing interests and received in different ways and at different speeds in particular institutional settings. Technology is never a neutral actor. It is shaped by social forces and is bound up in networks of power, money, and control of new institutional practices in the processes of cartographic digitisation - and the benefits and costs are never felt evenly. "The mappings of the digital transition have their own geographies" Pickles (2004a, 149) argues, which are intimately bound-up with "new Americanism, a thorough-going post-Fordism, and a resurgent geopolitics of global hegemony." Government agencies and large commercial mapping firms have invested heavily in digitalisation not from enlightened ideals to improve cartography but because it serves their interests (such as to maximise efficiency, to reduce costs by de-skilling production, and to boost revenues). The popular discourses of digitisation in cartography and elsewhere are often shamelessly uncritical, driven in large part by the boosterism of the vendors of hardware, software

[8] See Fuller's (2003) analysis of the framing power of Word on writing and Tufte's (2003) trenchant critique of PowerPoint on presentation.

and IT consultants offering ‘solutions’. The reality of the ‘messy’ social aspects of digitisation are glossed over in techno-utopian fantasies.

As such, the transition has made it more urgent to expose the social worlds in which maps are produced and disseminated, because as Harley (1992, 231) argued at the start of the 1990s, digital cartography and GIS works “to strengthen its positivist assumptions and it has bred new arrogance in geography about its supposed value as a mode of access to reality.” One needs to realise that the path of digitisation in cartography has been driven in large part by militaristic interests in various guises (e.g., see Cloud 2002). The underlying geospatial technologies and capture infrastructures (such as earth imaging and GPS) are still dependent on state funding and imperatives of territorial security. Rather than becoming more democratic, one could argue that the surveillant power of the cartographic gaze is deepening, particularly after 9/11 (Monmonier 2002), accompanied by a fetishization of the capability of geospatial technologies in ‘targeting terrorism’. The mundane disciplining role of the digital map in systems of computerised governmentality continues to grow, for example in consumer marketing and crime mapping (Crampton 2003). Such surveillance requirements are also a key driver in the development of new mapping techniques for cyberspace (e.g., see Gorman’s (2004) work mapping infrastructure networks in America to assess their vulnerability to attack). In conclusion, Pickles (2004a, 146) notes cautiously: “As the new digital mappings wash across our world, perhaps we should ask about the worlds that are being produced in the digital transition of the third industrial revolution, the conceptions of history with which they work, and the forms of socio-political life to which they contribute.”

3. Cartographic theories

The theoretical perspectives that seek to understand the nature of cartography - both the map as object and wider conceptions of mapping practices - can be grouped into three distinct paradigms, each based on a common set of beliefs about what represents a valid area of research. These respectively conceptualise cartography as (1) a means of communication, (2) a form of visualisation, or (3) an expression of power. These three different theoretical approaches provide a useful way to begin to understand how scholars have interpreted, analysed and read the nature and meaning of the map in recent history.

These theoretical positions have framed the types of 'questions' that are asked of the map and, therefore, the ways of approaching empirical cartographic research, and they have also informed the way cartography is taught. It is clear that scholarly cartography research remains a contested subject, with significant alternative epistemologies, and offers no definitive answers (there is no 'true' nature of the map). As such, I concur with Perkins (2003, 342) when he says "it makes more sense to understand contrasting approaches as representing different knowledge communities telling very different stories." As outlined in the introduction, I employ the 'stories' from the 'power of maps' knowledge community to interpret critically the cartographies of cyberspace as social constructions. Before looking in detail at the ideas from critical cartography, I review the other two paradigms as these also shed light on the work that has been done in cyberspace mapping modes.

3.1 Cartography as communication

> When we *communicate* with someone by describing a spatial relationship, we want our description to evoke a similar image in that person's mind. The best way to be sure that will happen is to provide a visual representation of the image. This graphic representation of the geographical setting is what we call a map. (Robinson *et al.* 1995, 9).

The dominant theoretical paradigm in academic cartographic research in the last forty years or so (1950s-90s) has been termed the 'map communication model'. The goal of this theoretical approach, broadly speaking, was to work to improve cartography by determining how map representations communicate geographic information to the user, primarily through psychological testing. The appeal of such an experimentalist approach was its potential to 'scientifically' determine the parameters of the map user's capabilities in reading, comprehending and remembering information from different types of maps. Such data could, in turn, form the basis for quantifiable, 'objective', rules for the most appropriate cartographic design decisions (such as symbol sizes, colour ranges, classification schemes and so on; see for example MacEachren's (1982) early work on design parameters and complexity in thematic maps). Such striving for objectivity in map design was premised on the positivistic belief that it was possible to produce *optimal* mapping for a given purpose and the acceptance of cartographic history as technologically-driven progression necessarily leading to more ‘accurate’ mapping.

In the communications model there is a clear distinction made between the mapmaker and the map user, with the map representation itself being essentially a neutral medium of one-way information transmission between the two. Accordingly, Robinson and Sale (1969, 18) asserted: “Maps today are strongly functional in that they are designed, like a bridge or a house, for a purpose. Their primary purpose is to convey information or to ‘get across’ a geographical concept or relationship; it is not to serve as an adornment for a wall.” The model was often depicted in a summary flow chart as linear process with distinct entities and a directed flow of information from originator to receiver (Figure 2.3). The role of the cartographer in the model was cast in a non-critical fashion, as someone who essentially works in a technical, impartial way, taking an unproblematic body of geographic ‘facts’ and applying objective rules of functional design, which resulted in a map that works as a ‘scientific’ tool for the visual communication of the information in the public realm. Map users were accordingly afforded a relatively passive role of readers as receivers of a fixed message from the cartographer.

<Figure 2.3 about here. Map communication model.>

The ‘map communication’ paradigm marked a significant epistemological shift in cartographic research and its advocates, led by Arthur H. Robinson, wished to remould cartographic scholarship as a scientific practice, moving it away from its existing interpretative, qualitative and artistic nature. This retheorisation was itself bound-up with rapid quantification and a rush to more ‘scientific’ methods of research in the late 1950s in other social science disciplines, including human geography and psychology. The basic premise of the communications model held sway for decades in Anglo-American academia and was a major influence in cartographic education, as can be clearly seen in the content of leading English-language textbooks such as Robinson’s *Elements of Cartography* (which went through six editions, with various coauthors, from 1953 to 1995) and Dent’s *Cartography: Thematic Map Design* (which went through five editions).

By the 1980s, the dominance of the 'map communication' paradigm had waned considerably, as the focus of scholarly cartography research shifted direction and methods of behavioural psychological testing were discredited as excessively reductionist. Although it contains much of practical value, especially in teaching notions of workable map design, the tide of academic ideas has moved against its positivist agenda, driven in part by rapidly changing technology (many researchers having moved into research in GIS and geographic visualisation), and also the social and cultural turn in theoretical perspectives in the social sciences.

Many of the key concepts of the communication theory have been undermined in the last decade or so by those advocating a deeper and more nuanced cartographic theorisation, in which mapping is conceptualised cognitively as spatial representations that can have multiple meanings and uses, and where the map reader actively constructs knowledge from the representation in relation to their particular experience, skills and circumstances. The role of the cartographer as the sole arbiter of a single message encoded in the map is discredited.

Having said this, the 'map communication' paradigm still has influence (Montello 2002). Much of the recent work on Web cartography, for example, is focused on determining new map-design guidelines for optimum graphical presentation for Internet media (e.g., Kraak and Brown 2001; various chapters in Peterson 2003a). While Jiang and Ormeling's (1997; 2000) analysis of 'cybermaps' is premised on the notion of optimising map design (drawing on Bertin's system of visual variables), in which they claim: "in long standing cartographic practice, maps have been considered as communications tools" (page 112).

3.2 Cartography as visualisation

> The map is examined here…. not as a communications vehicle but as one of many potential representations of phenomena in space that a user may draw upon as a source of information or an aid to decision making and behaviour in space. (MacEachren 1995, 12.)

A new paradigm has risen to prominence in the 1990s in academic cartography, which according to one of it leading practitioners, is focused on researching "human-centred methods and technologies that make it possible for scientists and decision-makers to solve scientific, social and environmental problems through computer-supported, visually-enabled analysis of the growing wealth of geospatial data" (Peterson 2003b, 441). To a large degree its research questions and methods of work have been driven by computer technology, with the digital transition of the map and rise of GIS being the crucial catalysts for new research questions. In this sense, it has very much a tool-driven epistemology.

The central focus of the 'visualisation' paradigm has been to examine the potential of interactivity and multi-modal computerised graphic displays of geographic information and how this can facilitate so-called 'knowledge discovery' by users. Consequently, the strict separation of reader from cartographer inherent in the communication paradigm collapses. Map users make their own map; they are actively engaged using their innate cognitive capability, combined with interactive displays, to analyse geographic patterns and visually explore spatial relationships in the data. The map is not a fixed communicative artefact for public presentation, but an element in a process of individual exploration in private environments (Figure 2.4). The research goal is no longer to produce the optimum map, but to develop better visualisation 'toolboxes' that can most effectively support 'visual thinking' - "the generation of ideas through the creation, inspection, and interpretation of visual representations of the previously non-visible" (DiBiase 1990, 4). A great deal of this work is influenced by ideas, techniques and experiences from scientific visualisation and computer science research in interactive graphics and virtual environments.

<Figure 2.4 about here. DiBiase's 'swoopy' diagram.>

Proponents of mapping as a form of geographic visualisation (so-called geovisualisation), have argued ebulliently that it represents "the most important development in cartography since the thematic mapping 'revolution' of the early nineteenth century. For map users, [it] represents nothing less than a new way to think spatially" (MacEachren 1995, 460). The direction of this paradigm through the last five years or so has been set, in large part, by the work of International Cartographic

Association (ICA) Commission on Visualization and Virtual Environments[9] in developing a comprehensive geovisualization research agenda (see Dykes *et al.* 200). In a distinctly instrumentalist tone, MacEachren and Kraak (2001, 4) argued geovisualisation's agenda should be focused on supporting researchers dealing with data-rich human-environment problems, to "provide 'windows' into the complexity of phenomena and processes involved, through innovative scene construction, virtual environments, and collaboration, thus prompting insight into the structures and relationships contained within these complex, linked datasets." Key issues of concern were providing map-based visualisation tools that could be distributed amongst diverse research teams and used in group working tasks; research into three-dimensional representations and immersive modes of interactions (the 'fly-thru-map'); along with empirically driven work on evaluation and usability of these software tools. In evaluating geovisualisation, the concern has been on the fidelity of representation (often with a fetishistic concern for mimetic 'reality'), issues of scale and level-of-detail on human perception and the potential of 2d-to-3d transformations and linked representations to expose novel spatial data relations. There are also growing linkages with other innovations in representing non-geographic data using spatial metaphors in the field of information visualisation (see Skupin and Fabrikant 2003). Although the geographic map as graphic image is central to the geovisualisation paradigm, there are also wider concerns with facilitating analytical methods within a visualisation environment (such as interactive parameter testing in spatial statistics and simulation modelling). This concern overlaps heavily with the development of GIScience. Whilst distinctly positivist epistemologies underlie the geovisualisation paradigm, some have tried to open up the scope of visualisation in more politically progressive directions, for example Kwan's (2002) use of interactive three-dimensional geographic modelling in the analysis of women's lives.

Many of the most interesting developments in cyberspace cartographies have clear linkages and overlaps with developments in geovisualisation, in terms of using interactive spatial representations – the 'map' – as an interface tool for data exploration and knowledge discovery. Developing new forms of interface and interaction that let the analyst explore and cognise cyberspace in terms of spatial

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[9] Commission's homepage at <http://kartoweb.itc.nl/icavis/index.html>.

patterns and relationships that are not readily apparent in the raw data (very often large databases of automatically logged records); for example, the visualisation of internet infrastructure by three-dimensional visualisation of IP address ownership (Shiode and Dodge 1999)

3.3 Cartography as power

> Robinson tried to describe how maps are, whereas Harley asks why maps are as they are, and how else they can be. It is this latter project which is the political one. (Crampton 2002, 15).

> no sooner are maps acknowledged as social constructions than their contingent, their conditional, their ... arbitrary character is unveiled. Suddenly the things represented by these lines are open to discussion and debate, the *interest* in them of owner, state, insurance company is made apparent. (Wood 1992, 19).

Most cartographers would agree that all maps are, by necessity, selective and that all maps are designed to serve particular purposes. This somewhat innocuous admission, however, can - depending on the theoretical position taken - lead to a significant re-interpretation of the nature of mapping. In the last fifteen years or so, a strongly theoretical strand of cartographic theory has emerged, which takes a fundamentally different viewpoint as to what is the purpose of maps is and the social significance of human agency in mapmaking. The thrust of this perspective is twofold: first, the acknowledgement that the map is a form of power-knowledge, and second, the rejection of the cartographic orthodoxy of representational objectivism and communicative efficiency. The concern of this paradigm, as Crampton alludes to in the quote above, is not to accept normative cartographic discourses, but to "subvert the apparent naturalness and innocence of the world shown in maps both past and present" (Harley 1992, 232).

Scholars advocating a critical theory concerning the 'power of maps' argue that maps are social constructions that reflect the ideological structure of their production and work actively in the ongoing reproduction of these structures. Maps are never neutral 'scientific' representations, instead they are powerful heuristic devises serving particular interests. Furthermore, the consequences of what Wood (1992) conceptualises as the ‘interested selectivity of cartography’ flow well beyond the graphic symbols of the map image itself. These consequences of map power on human lives have been consistently ignored by earlier academic cartography discourses. To reverse this, critical scholars sought to bring concerns for cultural, social and ethical issues into the centre of the discipline. The most strident advocates view the map with deep suspicion, seeing it as a hegemonic object in struggles for social domination, and regard cartographers as guiltily implicated in the production of social difference (such as governance of populations, enforcement of property rights, imperial conquest and colonial exploitation, and military violence and environmental destruction). Mapping, then, is a deeply politicised process.

Yet the politics of mapping have been consistently denied in the majority of mainstream (technical) discourses and the socially constructed nature of contemporary cartography itself is usually concealed because the reader shares, often at the subconscious level, the same values as the mapmaker. Unsurprisingly, most conventional map representations are ‘in-step’ with norms of the society in which they are made, agreeing on what is and is not important. Occasionally, however, the mapmaker’s social values will be at odds with the reader’s, so that the map will be viewed as unconventional or controversial (e.g., the ‘alternative’ atlases produced by Kidron and Segal). Similarly, maps from earlier historical periods, when viewed from the perspective of contemporary cultural norms, often seem ‘wrong’ (people can see them as social constructions). Today, many politically-motivated counter-cartographic projects set out to produce maps that reveal ‘truth’ by deliberately unsettling the pact of shared social values between reader and mapmaker.

To begin to understand the politics of cartography, one must ‘deconstruct’ and ‘demystify’ the implicit and explicit power relations imbedded in map images, questioning why the map was made, who paid for it to be made, exposing who gains from the map, and, equally, who loses from the map’s work in the world; it is necessary to expose what point-of-view the map takes while it assiduously pretends to be a ‘view from nowhere’. As Harley (1992, 232), set out in his seminal article, *Deconstructing the Map*:

> “What I am seeking to do ... is to show how cartography also belongs to the terrain of the social world in which it is produced. Maps are ineluctably a cultural

system. Cartography has never been an autonomous and hermetic mode of knowledge, nor is it ever above the politics of knowledge. My key metaphor is that we should begin to deconstruct the map by challenging its assumed autonomy as a mode of representation."

This critical paradigm emerged in academic cartographic research, particularly from the sub-discipline of the history of cartography, in the late 1980s, propelled in large part by the influential work of Brian Harley and Denis Wood, and it can be seen as a significant epistemological break from the dominant positivistic position of the 'communication theory of mapping. It can seen as one particular aspect of a much broader critical 'project' across the social sciences, focused on rethinking the nature of representations within contemporary visual cultures. Harley, and other cartography theorists, drew on a range of poststructural ideas to problematise the Cartesian surety of the map as a 'natural' representation of reality, particularly the influential work of the social theorists, Barthes, Derrida, and Benjamin in analysing texts, sign systems and the political economy of images. Besides such semiotic deconstruction, other concepts have been drawn from feminism (particularly the work of Haraway) and governmentality (especially the work of Foucault).

The 'crisis of representation' as it pertains to maps, undermines the truth claims of scientific cartography in several ways. First, it questions modern (western) science's privileging of representations of real-world phenomena based on empirical observation, while consciously and consistently overlooking the social and cultural conditions within which such representations are grounded. Fundamental to this privileging is the ontological dualism of observer and subject, which is replicated in cartography as the separation of the map from the territory it represents. As Edney (1993, 54) put it: "[t]here is a world of geographic facts 'out there' - separate and distant from the observer - which are to be 'discovered' by the explorer and surveyor". If there are errors in the map, these are technical and do not effect the representational essentialism of cartography, i.e., maps can capture faithfully the details of the landscape, they are 'mirrors of nature' (Rorty 1980). Second, critics dispute the possibility of producing 'mirrors of nature', arguing in many ways that the map *precedes* the territory. As Pickles (2004, 145) asserts: "[f]ar from being a mere representation of private property, cadastral mapping gave legal and material form to the new territories and landscapes of private property".

Third, the fallacy of modern representationalist logics has been highlighted by alternative measurement methodologies. From a philosophical point of view, the application of fractals analysis to geographic features, for example, breaks the faith in being able measure 'facts' with certainty. Mandlebrot's simple question about 'how long is the coastline of Britain?' exposed the scale-dependency in capturing cartographic data. While the increasing diversity of data sources, from surveys, sensors, and satellite imaging, means the appearance of empirical unity and universality in state-produced topographic representations dissolves. The ease with which aerial photographs can now be directly compared to topographic maps on Google Maps is powerful exemplar (Dodge and Perkins 2006). Ultimately, the technologies of cartographic measurement are dialectical, as Turnbull (2004, 209) argues: "Our devices for measuring the world frame our understanding of nature but cannot by themselves lead to greater correspondence with reality, rather they require the proliferation of evermore sophisticated technical devices and social strategies to keep our conceptions and nature in line."

(i) The influences of critical cartographers

Over the last fifteen years a number of critical human geographers, cartographers and allied scholars[10] have worked "to problematise mapping and visualisation as a social practice [and] to dissect the relationships between mapping and the exercise of power" (Perkins 2003, 341). Critical ideas on the politics of mapping have also informed a number of substantive, theoretically-driven 'archaeologies' of cartographic knowledges in specific contexts[11].

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[10] Key works include, Cosgrove 1999a; Crampton 2001, 2002, 2003, 2004; Curry 1998; Edney 1993, 1996; Henrikson 1994; Jacob 1996; Pinder 1996; Pickles 1992, 1995, 1999, 2004a; Rundstrom 1991; Sparke 1998; Turnbull 1993, 1996; Yapa 1992. Some of this work, especially by Curry and Pickles, critiquing spatial representations, is more focused on GIS technologies than on cartography *per se*, but remains very relevant to the critical reading of cyberspace mapping.

[11] Examples include, Schulten's (2001) in-depth study of U.S. mapping institutions, focused on popular world maps and atlases produced by Rand McNally and National Geographic, and their role in the social construction of modern American geographical perspective. Edney's (1997) detailed study of British colonial mapping in India; Winichakul's (1997) examination of the role of cartography in the construction of national identity of nineteenth century Thailand; Herb's (1997) reading of map use in Weimar and Nazi Germany.

The focus of critical reinterpretation has been principally historical in character, rather than focused on contemporary mapping practice (although, see Pickles 2004a, chapter 8). There has been little published research that has applied the 'power of maps' theoretical perspective to begin to understand the ideologies of cyberspace cartographies (although, see Crampton 2003, chapter 2; Dodge and Kitchin 2000b; Harpold 1999).

While this body of critical writing on cartography has been forceful (and sometimes polemical), it is not without its problems, inconsistencies and critics (e.g., Andrews 2001: Belyea 1992; Godlewska 1989). Ideologically-driven cartographic deconstruction has been seen as unproductive in that it offers little in the way of an agenda for mapmaking *practice* to carry forward (Crampton 2001). Indeed, the influence of the critical retheorisation within academic discourse is in marked contrast to the work of the large majority of cartographers in practitioner communities in university drawing offices, government departments and commercial design firms. The profession has not followed this new epistemological line and continues along an essentially positivist pathway[12]. Equally disappointing in terms of effecting progressive change in the nature of cartography is the failure of human geographers to make critical *use* of maps in their researches. Accordingly, Perkins (2004, 385) laments: "Despite arguments for a social cartography employing visualizations to destabilize accepted categories most geographers prefer to write theory rather than employ critical visualization". The humanistic cartography of Danny Dorling, discussed below, is a notable exception to this.

Other accusations levelled at critical cartography include: a misreading and superficial misusing of social theories, of simply jumping on the cultural 'bandwagon' of deconstruction and the foisting of a false 'conspiracy' view of cartography through biased sampling of empirical evidence (Black 1997). "In contrast to Harley's experience of cartographers", Godlewska (1989, 97) notes, "I have found that most have a subtle and critical sense of the nature of their work and do not perceive

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[12] Much the same situation pertains to the case of GIS research and the 'Ground Truth' debate.

cartography as an objective form of knowledge". Of course, the critical scholars themselves had an agenda in their attacks on mainstream cartography, being "propelled by an odd mixture of cynicism and idealism" (Lemann 2001, no pagination).

It is also worthwhile noting, that besides the ideologically-driven 'deconstructionists', this paradigm includes other socially-informed and politically progressive scholarship. One might term this work 'map scepticism' rather 'map criticism'[13]. It is significant as it has tried to move mapping *practice* forward in addition to commenting on the politics of map-making. The position is highlighted best by Mark Monmonier's (1996, 2) book *How To Lie With Maps*, in which he argued that "maps, like speeches and paintings, are authored collections of information and are also subject to distortions arising from ignorance, greed, ideological blindness, or malice." Besides this book, Monmonier's other works (e.g., 1995, 2002 and 2005) have coherently pointed up the social implications of mapping across a range of pertinent topics. His work is also valuable as it is consciously written to reach beyond the confines of academia to inform a wider readership. In addition to Monmonier, the work of quantitative social geographer Dorling (1995 and 1998) is noteworthy in questioning conventional statistical mapping practices and also offering up a range of alternative, more 'democratic' visualisation techniques (especially the use of cartograms). Dorling (2005), for example, produced socially-informed mapping applicable to educating the next generation of geographers and also to influence public policy by more effectively highlighting the extent of social inequalities across space; "[m]aps are powerful images", acknowledges Dorling (1998, 287), but this can be exploited in a progressive way, "[f]or people who want to change the way we think about the world, changing our maps is often a necessary first step".

[13] This kind of realist conceptualisation of cartography as an imperfect enterprise has a long pedigree, for example geographer J.K. Wright's paper, *Map makers are human: comments on the subjective in maps*, published in 1942.

(ii) The scales of map deconstruction

a. Power on the map: "Maps are stories we tell about ourselves, but they are stories with political payoff" notes Crampton (2004, 41) and "the question for map criticism is then to expose who is getting the payoff and how it is achieved." To begin this work, one needs to focus on the power exerted on the map in its production. Maps are embedded within a relational network of power/knowledge. The mapmaker is not a lone individual or organisation, but encompasses a whole set of actors - explorers and surveyors, designers and printers, publishers and politicians - all with interests and particular agendas working in ongoing processes. The map necessarily emerges from this milieu, as a codified and conventionalised text that stabilises the network into visual form at a particular point in time. Within the network geometry of the map's production there are unequal relationships, with much power resting on the patrons (be they the military, local government, commercial firms or the patronage of kings and princes of times past)[14]. The power exerted in the network of cartographic production leave visible traces, to varying degrees, in the actual content and graphic form of map text itself. Power resides within the map's image. Critical analysis seeks to reveal the traces.

b. Power in the map: The application of epistemological tools from social theory can provide a new reading of map artefacts as texts. This analysis looks beyond the aesthetic connoisseurship of the map collector or the Tufte-type rules of good design and focuses on the 'second text' of the map. As such, deconstructing the map means exposing the reasons underlying the selectivity of what is displayed and demystifying the origins of the signs used. Everything about the look of a map is subjective and to some extent arbitrary in semiotic terms, but people usually ignore this because they read modern maps as 'natural', having been thoroughly indoctrinated into the conventions of cartographic sign systems (i.e., a blue line for a river). This has important implications because "[o]nce it is accepted that certain conventions are

[14] When talking critically to individuals at Ordnance Survey (the epitome of professional mapmakers in many respects) one often discovers the severe limits on their freedom of action in terms of what gets mapped and what is left unmapped by the 'government'. Much of this is a useful smokescreen to deny their hegemonic role.

‘natural’ or ‘normal’, the danger is that they acquire a coercive and manipulative authority.” (Harley 2001, 202).

The power in the map text through the conventionality of sign systems can be deconstructed in terms of ‘rules of cartography’ (Harley 1992). These rules enable certain map texts to be conceived and made, whilst at the same time making other maps unacceptably unconventional and, therefore, unmade. The rules are generally not openly acknowledged and many operate in unspoken and unconscious ways (i.e. ‘this the way we always represent rivers’). Traditions, customary working practices, professional standards, institutional cultures, all help to simultaneously mask the rules and enforce the rules, as well as ensuring their perpetuation. The ways of ‘policing’ the rules become more overt, with external threats (the reaction by the mapping establishment to the Peters projection, for example). Even though these rules are very powerful, they are never universal and are also contingent on the time and context of production. Such rules also provide opportunities for resistance by exposing conventionality.

Harley (1992) advances two exemplars of these subtle yet powerful cartographic rules: the ‘rule of ethnocentricity’ and the ‘rule of social ordering’. The first rule is premised on the tendency for any society to place itself (its territorial base or metropolitan heartland) at the centre of its maps, thereby, granting more significance to itself and ‘pushing’ other peoples and places to the periphery. The subliminal geometry of the map image is used to achieve this. For example, it is evident in the choice of orientation and projection used on world maps. Eurocentric dominance in cartography means a map of the world conventionally centred on the Atlantic, with north at the top (Figure 2.6). While Mercator ‘biases’ in relative apparent sizes of nations are long-lasting in the cartographic imaginary and as Stewart (1943, 589) noted more than sixty years ago: “Children studying elementary geography should be warned that a Mercator map of the world, .. is *not* a picture but a representation in code; specifically, the ‘Mercator code’.” Breaking the convention on world maps (such as ‘upside down’ maps) shows just what a powerful hold the ‘rule’ of Eurocentricism has on cartography.

<Figure 2.6 about here. Projection of heads diagram.>

In the second rule, the sign systems employed on maps encode an implicit hierarchy of space based on social power rather than objective measures of importance. So, the "distinctions of class and power are engineered, reified and legitimated by means of cartographic signs" (Harley 1992, 237). The palace, cathedral, and castle have, historically, been most prominently represented on maps because they are classified as significant (i.e. powerful). The rule of thumb is that the more powerful you are, the more visible you will be on the map. A stark example of this is the urban mapping in apartheid South Africa, where small typefaces were used to label large black townships, while much larger, more prominent labels were used to show white settlements which often had far fewer inhabitants (Stickler 1990). However, there are many other more subtle examples, such as the prioritising of mapped landscapes for car drivers in almost all general cartography, at the expense of other forms of mobility (Perkins and Thomson 2005).

Another important concept elaborated by Harley (1988b) to deconstruct the power in the map was the theory of cartographic silences. The idea that what is *not* shown on a map can be as revealing to the implicit agenda as what *is* shown. The absence of a feature on a map that one would normally expect to see (i.e. it is technically possible to survey and represent it at the nominal scale of the map) is read as a *positive* statement in the mapping process, rather just a passive gap in representation. There is a range of intentional and deliberate silences, where geographic information is suppressed and censored from maps - for example, due to strictures of security or exigencies of commercial confidentiality. So, for example, it is well known that certain military bases and security installations are absent from contemporary maps even though they are evident on aerial photographs (Dodge 2004). Increasing paranoid fears of terrorism following 9/11 have led to a much wider definition of 'sensitive sites', including various infrastructure networks, and the 'chilling' of previously published map information on these (see Zellmer 2004 for the perspective of librarians).

Beyond such wilful censorship there is a range or subtle and insidious silences that operate as a 'hidden' rule. Certain aspects of the material landscape of society are silenced because they are not appropriate – they are 'not the things we put on our maps'; "objects outside the surveyor's classification of 'reality' are excluded" (Harley 1988b, 65). These objects might be inconvenient, embarrassing or deemed insignificant and are made to disappear figuratively from the map. The active denial of indigenous place-names on colonial cartography is one of the best examples of the power of silencing, whereby "[w]hole strata of ethnic identity are swept from the map in what amount to acts of cultural genocide" (Harley 1988b, 66). In contemporary cartography, poor people's lives tend to be unmapped (Bunge 1975), except when they are classified as a 'problem' to be fixed (for example, in crime mapping). Silences also work to produce gendered representations through masculinist mainstream cartography that ignores women's interests. The 'God's eye view of the world' is male, as Donna Haraway's (1991) analysis has shown. Yet, the extent of social silencing of the diversity of human experiences in mainstream state cartography also leaves many spaces open to counter-mapping (Pickles 2004) - for example, Kwan's (2002) feminist visualization.

c. Power through the map: The power relations encoded semiotically within the map text do not exist in isolation, they (re)project outward from the image onto the space and social lives they purport to represent. The map can create power itself - just like the power of a photograph, film or song - by changing opinions, stirring the emotions and inspiring and enabling action in the world. As such, cartographic knowledge has often been jealously guarded because it is perceived to be so powerful (Harley 1988b).

"Cartographers manufacture power: they create a spatial panopticon" (Harley 1992, 244) and Western cartography's record shows very clearly the map to be a pre-eminent device of social domination by manufacturing not just visibility over space but also legibility throughout the social-material landscape, "rendering the broad swathes of worldly complexity and enormity in miniature form for a discrete purpose" (Pickles 2004a, 80). Detailed maps are expensive to create and they are most effectively employed by elites, be they kings and princes, bishops, governments, militaries, land owners, or corporate interests.

Clear examples of the hegemonic power exercised through the map can be seen in the conduct of wars, delineating and enforcing property boundaries (at all different scales), counting and locating people, maintaining law and order, commissioning the extraction of natural resources, legitimating the existence of nation-states. Some of the earliest surviving map fragments etched into clay tablets are believed to have been for taxation (Dorling and Fairbairn 1997).

The instrumental role of Western mapping in imperial exploitation through the erasure of indigenous peoples from the colonisers' maps provides perhaps the strongest evidence of the malignant power of cartography. In the partition of India, the annexation of Palestinian land or the '*terra nullius*' of Australia, cartography been integral to colonial practices, providing both spatial justification and an rationalising tool for colonisers, past and present. For example, Bassett's (1994, 333) analysis of maps made by European imperial powers at the end of the nineteenth century demonstrates how effectively they "promoted the appropriation of African space under the rhetoric of commerce and civilization."

The state also actively uses cartography in the formation of national identity. The map provides one of the most potent images of unity between people, territory and the government (Biggs 1999). Anderson's (1991, 175) thesis of nationalism as imagined community, for example, highlights the extensive symbolic power of 'map-as-logo', deployed in an "infinitely reproducible series, available for transfer to posters, official seals, letterheads, magazine and textbook covers, tablecloths, and hotel walls. Instantly recognisable, everywhere visible. Maps showing space divided according to political authority are a powerful assertion of state sovereignty and have become so ingrained as 'natural' template that such borders are present even in maps which are not explicitly political (e.g., weather maps). The symbolic power of cartography to make borders is endlessly exploited in the 'grand games' of geopolitics between states, where the "maps provided the master image of the nation's superiority and centrality in global affairs" (Vujakovic 2002, 198), such as Halford MacKinder's cartographic articulation of the 'Eurasian heartlands' thesis at the height of British imperial power.

An important way that the power of the 'cartographic gaze' works, is by dehumanising the landscape, allowing powerful groups to exercise power at a distance, "removed from the realm of face-to-face contacts" (Harley 1988a, 303).

Maps are foundational to modern systems of governmentality, as evidenced in the extensive use of statistical mapping by state bureaucracies. These cartographies are designed to produce a “rationality of calculability of populations” (Crampton 2004, 43), where people can be managed *through* the map more easily because action can be taken without witness to human consequences. Indeed maps come to symbolize the governmental processes of regimentation, in which particular places, individual homes, and complex lives are rendered as mere dots. This kind of de-socialisation of space through cartographic abstraction is seen most brutally in the military. Modern war making is now frighteningly like a map game in which death is played-out on digital geospatial interfaces that render human landscapes into an impersonal terrain of targets and threats that can be engaged by so-called precision-guided weapons.

The myriad ways that the state has come to rely on ‘power through the map’ to govern means that it is far and away the largest patron of cartography, but mapping is also integral in the iniquitous processes of capitalist accumulation by (re)ordering lived lives into markets, potential markets or obstructions to markets. For example, geodemographic mapping reductively profiles individuals, fitting them into idealised consumer types, fixing them into a spatial grid of quantifiable economic value and ranking them based on ‘worth’ or ‘risk’ (see Curry 1997; Goss 1995). This easily leads to discriminatory practices of ‘redlining’ - the term is derived from the mapping practice - where whole communities deemed unprofitable or high risk and are denied services.

While the potent role of cartographic power in social domination by the state and corporation is unquestioned, such hegemonic mapping is dialectical because it must also open up new ways to resist by mapping differently. The practical and rhetorical power of maps to articulate alternative perspectives is always available (see chapter eight). The power of the map can be used to re-frame the world in the service of progressive interests and to challenge inequality (such was the goal of the Peters Projection project), while the logo-map used to bolster the state can re-imagined as a potent emblem in anti-colonial struggles (Huggan 1989). Cartographic power has also been exploited by environmental pressure groups and anti-globalisation activists to counter the dominant corporate discourses, using the authority of the map against itself. This kind of counter-hegemonic cartographic potential is evident in the work of radical geographer Bunge (1975, 150) and his expeditionary geography, mapping socially-polarised urban America, to "depict a region of super-abundance adjacent to a region of brutal poverty" (e.g., Figure 2.7).

<Figure 2.7 about here. Bunge's rat bite map.>

In many examples of counter-cartography, the actual maps themselves are not alternative in design terms, making use conventional cartographic signs (e.g., Bunge's (1975) dot maps or Kidron and Segal's (1995) use of choropleth mapping). The distinction that marks these mapping projects as 'subversive' is that they exploit the authority of cartography to ask difficult questions by mapping the types of human phenomena (war, poverty, violence against women) and landscape features (toxic waste sites, rat bites) that are usually deemed insignificant, inappropriate or otherwise 'difficult' by mainstream government and commercial cartography and therefore left unmapped. They confront the norms of society by using the conventional signs of the society's elite. Another significant tactic in counter-cartography is changing scale and opening up authorship, for example in eco-mapping, which stresses the importance of mapping local areas by local people (Aberley 1993), and the empowering of marginalised groups, such as having physically disabled people map their experiences of hostile streetscapes (Kitchin 2002).

4. Conclusions

In conclusion, one might ask to what extent can the ideas from the 'power of maps' paradigm be productively applied to cyberspace cartographies? To answer this, I would argue that the concepts from critical cartography can and should be connected to understanding these new modes, not least because the hegemonic work of cartography is being replicated to a large degree in cyberspace. Many of the implicit purposes of today's maps of cyberspace are the same as those of maps from earlier times – to control space and exert sovereignty, to legitimate private property rights, to surveil people, to defend social difference, to make a profit.

The luxury of hindsight and the distance of time seem to make the political agendas and social consequences of old maps more apparent, such as the colonial mappings of Africa. I would argue it is more urgent to critically read contemporary maps because they are the ones directly affecting people’s lives today and shaping the ongoing production of the social-material landscape. The most ‘modern’ of today’s digital maps, geovisualisations and cyberspace mapping systems have many more layers of accuracy, sophistication, and ‘science’ that help to mask and deny their ‘interested selectivity’ (Wood 1992). The latest immersive, interactive three-dimensional map of the World-Wide Web is as much a provisional and contingent form of cartographic imagination as Waldseemuller's map of the world from 1507. They are still social constructions that serve particular interests, working to further particular sets of power relations.

The ‘critical cartography’ paradigm can challenge the positivistic notions that underlie much cyberspace mapping and lead to analytical questions that focus on revealing the selective nature of new maps, their ethics, the agendas and social practices of the mapmakers, the wider social interests served, and how they work as cartographic imagination shaping the perception of cyberspace for users. The theoretical ideas, such as rules of ethnocentric geometry and social ordering, the concepts of mapped silences, spatial governmentality and dehumanisation through cartographic abstraction, along with the focus on authorship and contested practices, can open up cyberspace cartographies critically and as shown in the following empirical chapters (five-eight) help reveal the ideology of the maps of Internet infrastructures. Thinking critically also opens the terrain for counter-mapping (see chapter eight). Lastly, this paradigm acknowledges that there can never be a ‘best’ map of cyberspace and that no one representation is inherently privileged over another.

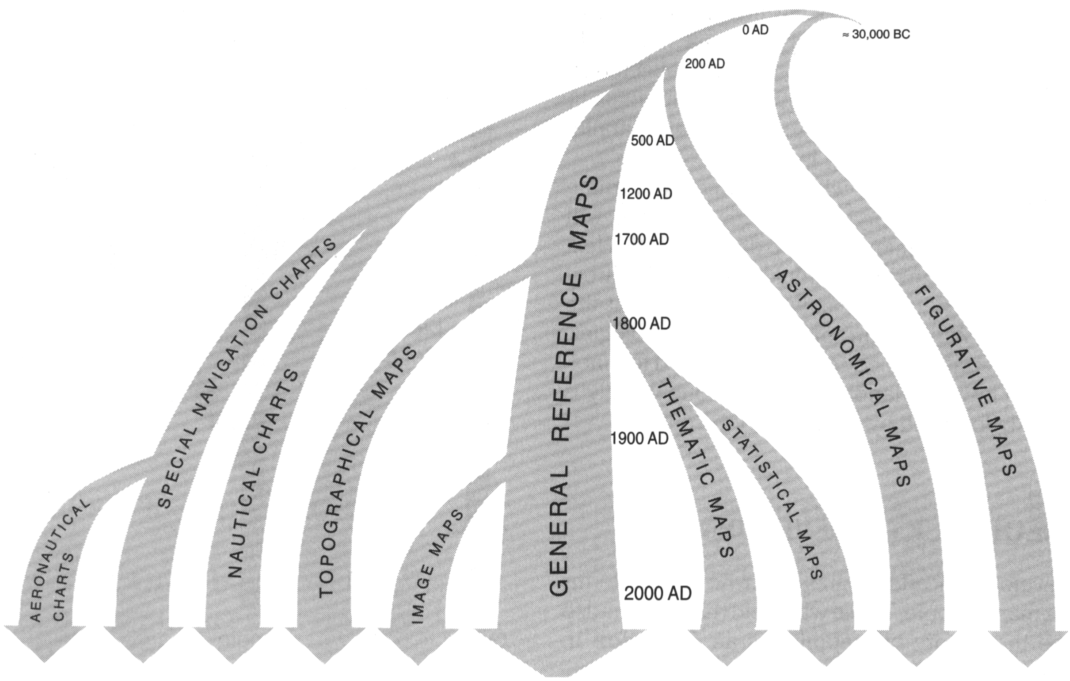

Figure 2.1: Cartography explained as a 'story of progress'. Mapping is shown to evolve over time with the development of increasingly complex forms. (Source: Robinson *et al.* 1995, 22.)

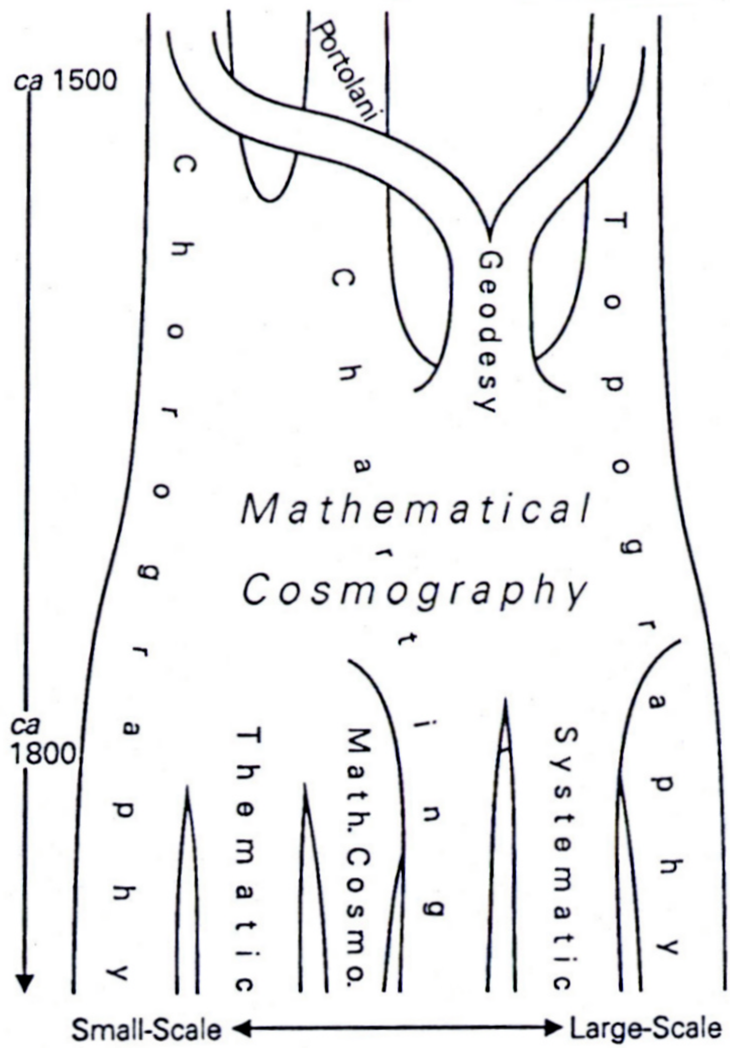

Figure 2.2: Cartography alternatively characterised as rhizomatic network of competing and overlapping modes of mapping. This example shows the post-Renaissance convergence of modes into mathematical cosmography and then the gradual bifurcation into several more distinctive modes following the Enlightenment. (Source: Edney 1993, 59.)

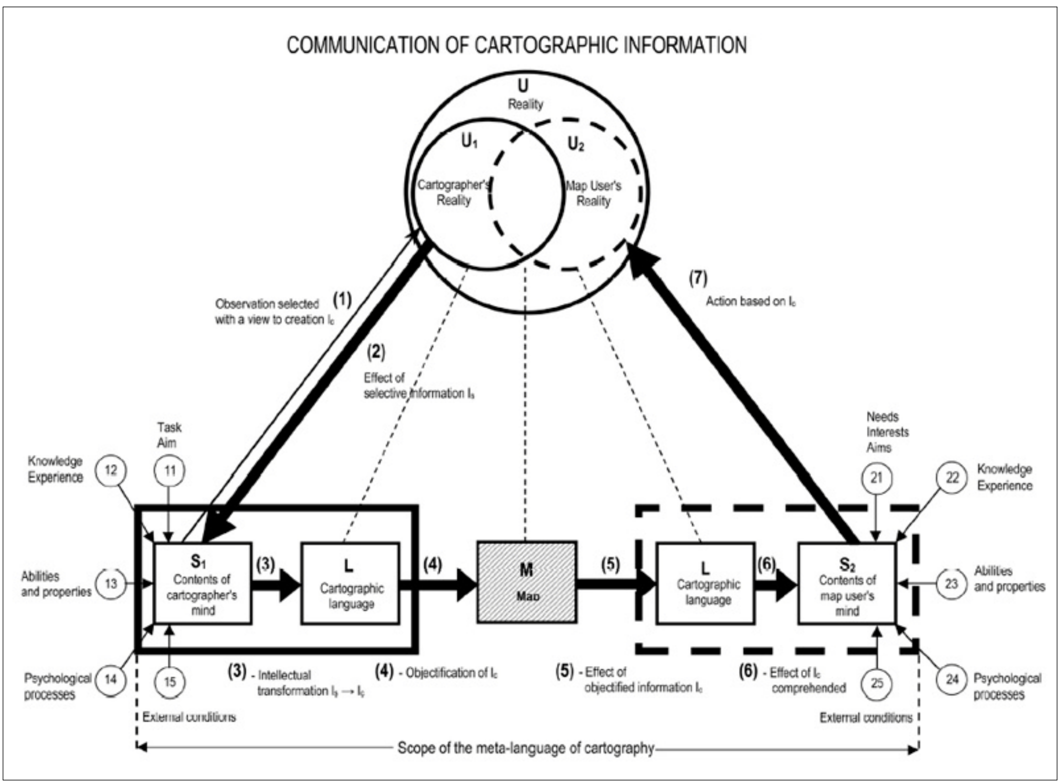

Figure 2.3: Flow chart view of the map communication model, conceptualising cartography in terms of stages in the transmission of spatial data from cartographer to reader via the map. (Source: original diagram by Koláèný, 1969, reprinted in Montello 2002, 292).

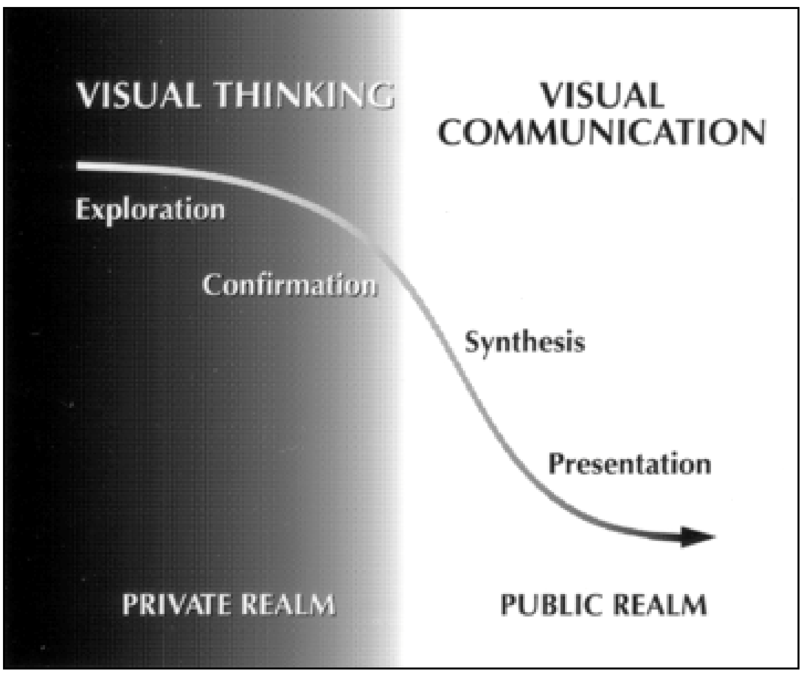

Figure 2.4: DiBiase's conceptualisation of role of cartography in the research process. The focus of the 'map communication' paradigm was on optimising cartography for use in the right hand side of the diagram, more recent work under the rubric of geovisualisation is concerned with developing cartographic tools for use in the left hand part of the process. (Source: DiBiase 1990.)

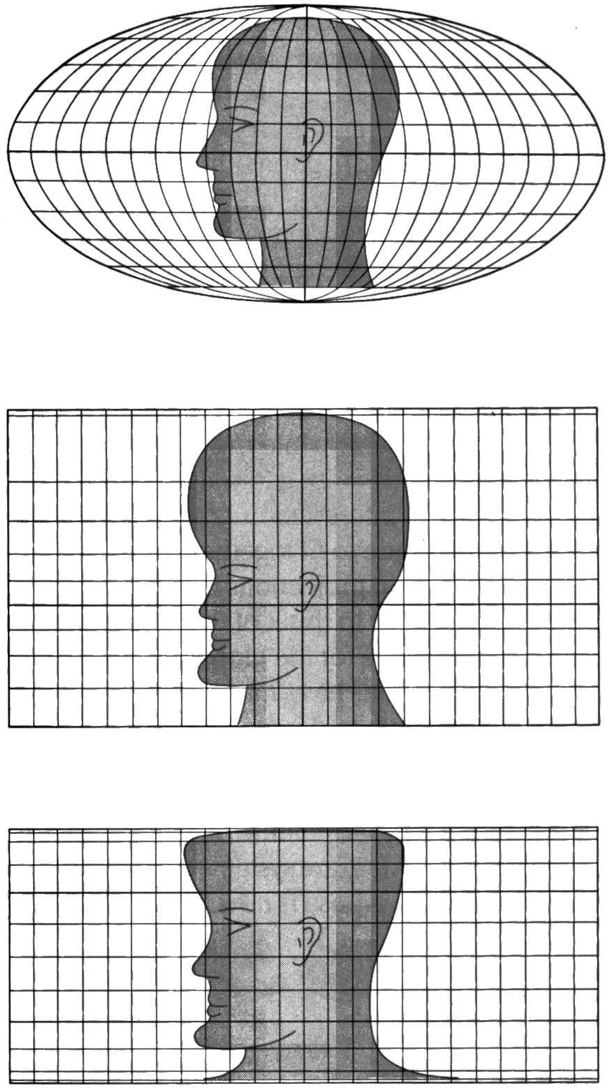

Figure 5.7 **A head drawn on the Mollweide projection (top) has been transferred to Mercator's projection (center) and to the cylindrical equal-area projection with standard parallels at 30° (bottom). Just because the profile looks most natural on Mollweide's projection, that projection is not necessarily "better." The natural profile could have been drawn on any projection and then plotted on the others.**

Figure 2.6: A textbook illustration of the impact of projection selection in shaping the world. (Source: Robinson *et al.* 1995, 69.)

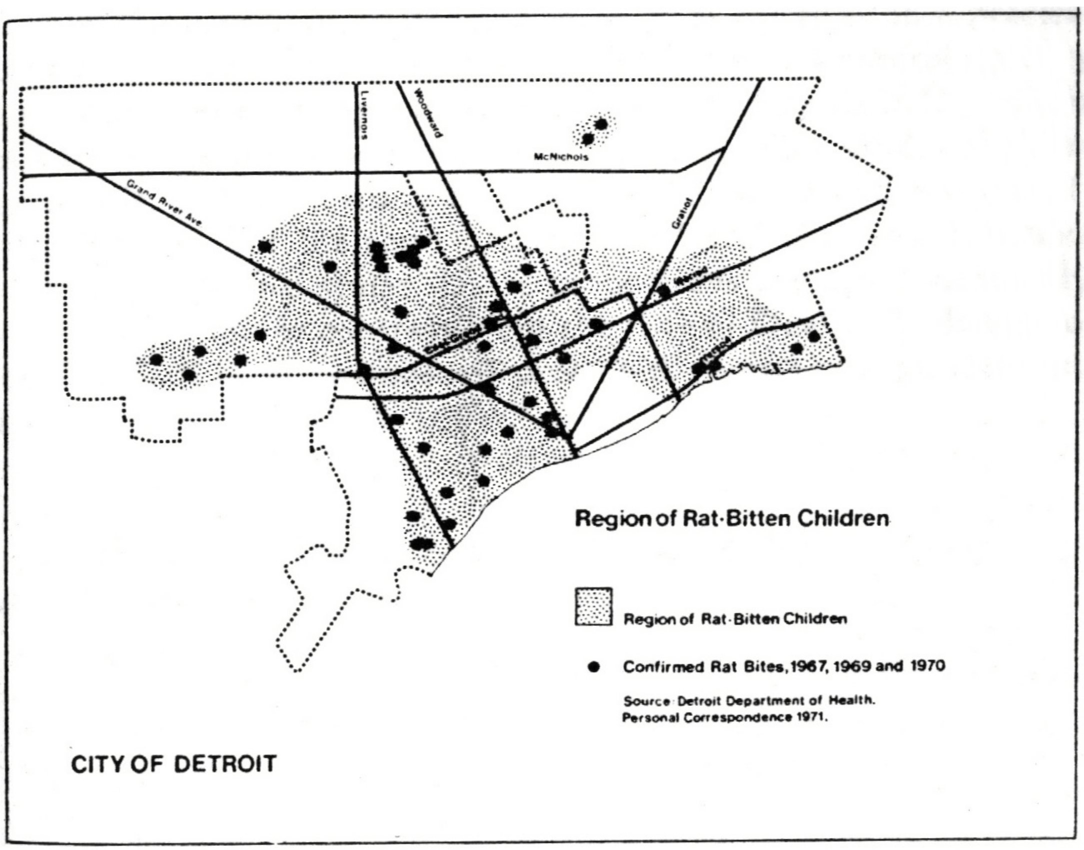

Figure 2.7: Example of the counter-cartography of William Bunge showing the rhetorical power of thematic maps to challenge the status-quo. (Source: scanned from Bunge 1975, 161.)

Chapter 3

Cyberspace Cartographies

[N]ow we have the emergence of cyberspace … It is largely invisible to conventional methods of observation and measurement … We need to begin to map this space, to visualize its architecture, and to show how it connects to and transforms our traditional geographies. The task before us is urgent, baffling, and exciting…

-- Michael Batty, *The Geography of Cyberspace,* 1993.

The mapping of that vast territory known as cyberspace has begun in earnest ... They range from glorious depictions of globe-spanning communications networks to maps of Web information. Many have no geographic references, instead turning to nature, the cosmos or neuroscience for spatial models.

-- Pamela Licalzi O'Connell, *Beyond Geography: Mapping Unknowns of Cyberspace*, 1999.

1. Introduction

A major part of my interest researching cyberspace cartographies has been to learn about the authorship of the new map representations produced outside of the mainstream mapping industry . Who are the new mapmakers and what motivates them to tackle the challenge of mapping aspects of cyberspace? Over the past thirty years many different mapmakers, from a diverse range of academic, technical and institutional backgrounds, have mapped different aspects of cyberspace. It is readily apparent that the cyberspace cartographies are one of the significant areas of creativity in mapmaking, with a great deal of experimentation with new visual metaphors, new survey methods and data source, and above all new forms of users interaction with map artefacts. Indeed, as cyberspace is lacking established conventions of representations, it is ripe domain for real cartographic innovation and a flourishing of counter-hegemonic, 'bottom-up', mapping activity. As such cyberspace cartographies need to be studied in greater depth.

This chapter, therefore, begins by offering a substantive review of cyberspace cartographies using a three-fold classification defined in the introduction. This is followed by a short review of relevant theoretical literature focusing on how other scholars have defined the domain of cyberspace cartographies and the types of social implications they highlight. The review also considers briefly of some more significant media coverage of the field revealing how these new mapping modes have been presented to the general public. The chapter concludes by outlining my personal research into the cyberspace cartographies focused on my contribution to scholarly knowledge in relation to building and maintaining the Atlas of Cyberspace

2.1 Cyberspace and the new modes of cartography

The cartographic imagination in Europe was profoundly changed during the 'age of discovery' in the fifteenth century as the bounds of geographic knowledge expanded. Now, at the digital 'fin de siecle', a new and diverse range of mapping activities has emerged in concert with the 'age of information', giving rise to new cartographic imaginings encompassing cyberspace. As discussed in chapter two there are a range of ways to theorise such cartographic change and innovation and here I follow Edney's (1993, 54) non-progressive genealogical approach in which mapmaking is composed of a number of *modes*, that are historically contingent sets of "cultural social, and technological relations which define cartographic practices and which determine the character of cartographic information". Modes of cartographic practice are related to the continual emergence of new knowledges, problems, methods, and institutions, driving developments in both the 'look' of map representations and roles that cartography serves in society. Contemporary mapping practices for the information age - what I term cyberspace cartographies - can be categorised into three distinct modes:

- maps of cyberspace,
- maps for cyberspace,
- maps in cyberspace.

The first mode of 'maps <u>of</u> cyberspace' is focused on mapping that describes the structures of networks and documents the operations of cyberspace itself, as viewed from external positions. In some senses they can be thought of as the thematic maps of cyberspatial infrastructures and user demographics. (The thesis is focused on this mode through the analysis of four different genres of Internet network infrastructure mapping.) The scope of this mode is therefore primarily defined by the subject of the maps rather than the spatial conception of the map representations or the tasks undertaken with them. The resulting maps encompass a multitude of graphic forms, some of which appear quite un-cartographic in a normative sense, such as topological network graphs (see also chapter four).

The second mode produces maps to be used for navigating through cyberspace, their purpose is to guide users within the virtual spaces themselves. They are mostly created through the spatialization of non-geographic information structures to produce a visual map-like interfaces to virtual space that can be support interactively browsing and searching. As such this mode is primarily defined by the task to which the maps are put rather than their subject or spatial conception. Many of the maps from this mode are experimental interfaces and produced in different institutional contexts to the other modes.

The final mode, 'maps <u>in</u> cyberspace' involves putting existing forms of terrestrial cartography online to widen access and add user interactivity. Whilst somewhat more prosaic than the other two modes, work in this area to distribute existing map information in new ways, and to new audiences, has undoubtedly had the widest impact on the discipline of cartography (e.g., many millions of people use web mapping services daily to create custom maps). Maps in this mode are characterised by their spatial conception based exclusively on conventional geographic frameworks. In institutional terms, the established cartographic industry is at the centre of these developments (although being seriously challenged by new players, e.g., Google Maps).

The formal nature, and wider cultural meanings and social implications, of these three modes of cyberspace cartography is a novel area for scholarly research. It has received relatively little consideration within academic cartography and geography (although, the ‘maps in cyberspace’ has been subject to a sizeable amount of technical analysis). While this framing of cyberspace cartographies into three modes is to some extent arbitrary, I think it does provide a useful conceptual aid to analysis. It is useful to try to group social-technical innovations into a new modes to see the overlaps between them, to identify the distinctive themes (in terms of ‘what’ to map and ‘how’ to map it) that divide them, and to mark out their particular relationships to wider ‘information age’ discourses (e.g., neoliberal marketisation, the rise of corporate power, increased securitisation and the fear economy, the deepening cultural globalisation).

2.2 The ‘maps in cyberspace’ mode

The work in this mode has already produced demonstrable utility and commercial viability in putting ‘real-world’ cartography online through developments in web mapping portals and Internet-based GIS services. Much of the innovation in this mode has research links into the cartographic visualisation paradigm, however, the large-scale deployment is very much commercially driven, often through joint ventures between established mapping organisations and newer Internet-focused companies with e-commerce experience (e.g. Google launching its impressive online mapping service in the summer of 2005 with topographic data from Tele Atlas and imagery from its purchase of Keyhole). GIS software vendors are also active in this mode, developing platforms for customers to distribute maps via the web (e.g., Figure 3.1 shown below was built using ESRI’s ArcIMS software; see French and Jia 2001). Many in the mapping industry see the future as one in which they provide cartographic information as a bespoke Web service rather than publishing general-purpose map products.

This mode has received much greater attention from cartography practitioners and academic researchers because it is represents an obvious continuation of their ongoing activities. Nearly all the work examining this mode is technical in scope, concerned with adapting existing mapping practices for the new media and adopting new technological solutions for user interactivity (e.g., Kraak and Brown 2001; MacEachren 1998; Peterson 2003; Plewe 1997). The edited volume by Kraak and Brown (2001, 1) for example delineates web cartography simply and instrumentally as maps “presented in a web browser” and is primarily concerned with design and presentation issues in relation to the constraints and opportunities of the new medium of publishing. Two notable exceptions to the focus on the 'engineering' side are Crampton's (2003) useful genealogical analysis of distributed mapping and Monmonier's (2002) consideration of some of privacy implications of making cartographic information widely available online.

One of the more sophisticated research efforts to understand this mode of cartography is lead by Fraser Taylor and colleagues at Carleton University in Canada, under the project they call 'cybercartography'. He argues that the Internet as a new publishing media is "revolutionising cartography" and that the map reconceived as interface tool will be "key to navigation in the information era, as both a framework to integrate information and a process by which that information can be organized, understood and used" (Fraser Taylor 2003, 405). His research agenda in many respects sets of the techno-cultural imperatives underlying this mode of cartography. It comprises seven core elements aimed at creating new maps which:

- are multisensory (vision, sound, touch and leading to smell and taste),
- are multimedia format, exploiting new media,
- are highly interactive and engages user in new ways,
- are applied to a wide range of topics of interest to society,
- are integrated with analytical capability rather than a 'stand-alone' products
- are compiled by teams of individuals from different disciplines,
- involves new research partnerships among academia, government, civil society and the private sector.

(following Fraser Taylor 2003, 407).

The agenda clearly remains wedded to a communicational view of cartography with the focus on designing better map artefacts for representing data about geographic spaces rather than as a immersive navigation tool to information space (hence it should be seen as distinctive from the second mode of cyberspace mapping, 'map <u>for</u> cyberspace'). If this research agenda is achieved - and much is being actively pursued by geovisualisation researchers (see Dykes *et al.* 2005 for latest review) - the nature of mapping as experienced by a general audience will likely be profoundly changed in the next decade. One might argue that Google Earth is already delivery much of this.

2.3 The 'maps of cyberspace' mode

A straightforward working definition of the 'map of cyberspace' mode is any visual image that facilitates the spatial understanding of the materiality of cyberspace itself. Their distinctive subject matter is to show what cyberspace 'looks like' by mapping how it is produced, revealing unseen details of its technical geography, operations and the users demographic patterns. There are overlaps between this mode of cyberspace cartography and the 'maps in cyberspace' mode outlined in the preceding section. For example, the commonality of practice and visual form in online mapping techniques used to produce interactive telecommunications atlases (Figure 3.1). One of the key denominators of the 'maps of cyberspace' mode from the other modes is, therefore, its narrowly-focused subject matter. While its 'external' descriptive approach distinguishes it from the 'maps for cyberspace' mode that are designed to be used 'internally'.

<Figure 3.1 about here. Georgia telecom atlas screenshot.>

The 'maps of cyberspace' mode encompasses a broad range of representational genres: geographic maps, abstract diagrams and charts and graph visualisations (chapter four details examples relating specifically to Internet network infrastructures; see also Dodge and Kitchin 2001 for examples). It is, therefore, difficult to taxonomise this mode based on graphic form or spatial conception of representations.

Many of the maps produced in this mode do look familiar in that they use semiotics of mainstream cartography – for, example mapping the routes of cables as colour-coded line symbols on a general geographic base map in the Georgia Telecommunications Atlas (Figure 3.1 above). A large number draw directly on the practices of thematic mapping to spatially represent statistical data on cyberspace's production, such as mapping telephone calling patterns as proportional circles (see Figure 3.3 below), while chapter six analyses a series of conventional choropleth maps, produced at the world scale, to track the national diffusion of Internet connectivity in the 1990s. However, other products of the 'maps of cyberspace' mode go beyond what many people (including 'traditionalist' cartographers) would think of as 'maps' in their use of non-geographic forms of representations. For example, non-Euclidean visualisations of the topological structure of network infrastructures (e.g., see Figure 4.9). These abstract graphs focus on showing the connectivity between nodes rather than their relative position in geographic space. (In some cases such non-geographic visualisation is undertaken because of the difficulty in meaningfully and reliably geo-coding data objects, e.g. problems of locating IP addresses; see discussion in Shiode and Dodge 1999).

In terms of map use, a good many 'maps <u>of</u> cyberspace' move beyond the static two-dimensional representational norms of mainstream cartography to provide interactive multi-dimensional visualisations. There are overlaps in this case with research work being undertaken in the visualisation paradigm in cartography (discussed in chapter two). The lure of sophisticated three-dimensional graphics and virtual reality interfaces to produce mapping with the requisite 'cyber'-look has been a recurrent feature of this mode. The Earth globe aesthetic has proved to be a particularly popular backdrop onto which infrastructural data can be mapped. For example, Lamm *et al.* (1995) visualising web server traffic as 'skyscrapers' on VR Earth. (The striking images from this research proved to be suitably iconic that one was used as the major illustration of the 1999 *New York Times* story on cyberspace cartographies (Figure 3.6 below). (See the discussion in chapter four of power of the 'arc around the globe' metaphor for imagining the Internet). Eschewing the globe and restrictions of terrestrial referencing, others have produced immersive three-dimension visualisations of cyberspace operations in abstract space, such the Walrus system used to interactively display huge graphs of routing topologies in a hyperbolic space (Figure 3.2). In some respects these types of interactive three-dimensional visualisations are the most innovative for cartographic practice by pushing outwards the boundaries of the map users experience. However, most also suffer with poor workability in actually conveying useful information (what I term the 'eye-candy' trap of cyberspace mapping) and are unsuitable for general audiences.

<Figure 3.2 about here. Walrus graph.>

Many of the mapmakers creating 'maps <u>of</u> cyberspace' would not class themselves as 'cartographers'. They are diverse collection of individual explorers/programmers, academic research groups (typically from the computer science domain), market research companies, the marketing departments of networking / telecommunications corporations, and government statistical and regulatory agencies. Unsurprisingly, they tend to come from fields that are most involved in the daily production of cyberspace, having the need for maps to accomplish particular immediate goals (e.g., engineers analysing network traffic and planning new building, market researchers tracking the growth, industry regulators monitoring competitiveness of service provision and so on). Those directly responsible for building and operating the data networks underlying cyberspace are the most prolific single group of mapmakers in this mode, however much of their work is for internal use and is never made public.

In some senses then, many of these people were compelled to become cyberspace mapmakers because the basic maps they needed to do their jobs did not exist within the normal cartographic information supply-chain. There is no coverage of cyberspace in major world atlases for example and the national mapping agencies, like USGS and Ordnance Survey, completely ignore the Internet as an infrastructure in their standard mapping products. Even the basic telecommunications infrastructures is only partially recorded in small scale topographic mapping; it is very much the poor cousin to other infrastructures, like railways, that are mapped in much greater depth[1]. Historical inertia in what is deemed important to be recorded on national topographic maps partially explains this. A further reason is the ‘invisibility’, of much of the Internet’s infrastructures, relative to other networks like rail or roads (see discussion in chapter four).

In terms of authorship, the ‘maps of cyberspace’ mode has offered a renewed scope for dedicated individual endeavour to make an impact. In much of conventional commercial and state-sponsored mapping, cartographic authorship is firmly professionalised and largely anonymised. This is not the case with mapping the Internet, for example, because the network infrastructures open up new opportunities to be used to map themselves in really quite innovative ways and at very low costs (see chapter eight). This allows novel opportunities for what might called ‘super-empowered individuals’ to chart vast swathes of cyberspace with minimal resources,

[1] The UK’s ‘Digital National Framework’ (dominated by Ordnance Survey’s MasterMap product), for example does not contain coherent coding of telecommunications network features suitable for spatial analysis.

utilising some clever software to automate the surveying process and reduce the burden of charting huge volumes of data. The work of undergraduate physics student Stephen Coast[2] is a telling example. Individually he mapped the core topology of the Internet as a summer internship project in the Centre for Advanced Spatial Analysis in 2001 using software 'bots' to scan the network and report results to database (in much the same way that search engines monitor the Web). Coast's work highlights also the 'death of distance' in this mode of mapmaking where whole territories can be remotely sense from a single location.

Given the diversity of institutions and individuals producing 'maps of cyberspace' it is not surprising that they serve multiple normative purposes. At a basic level, most of the maps in the mode provide a visual census of where cyberspace nodes are located, and in very few cases the traffic that flows between them. (The 'where' in this case can be plotted in geographic space or according to some other topologic framework). 'Maps of cyberspace' at the level of infrastructures can show clearly how computers are physically wired together to create complex networks that operate over several spatial scales, from individual buildings up to global scale systems. Depending on scale, these maps can be used by engineers to install and maintain the physical hardware of the networks, by system operators to manage networks more effectively, and by marketing and business development departments to demonstrate the size and penetration of networked services.

Many of the 'maps of cyberspace' serve as significant components in the market-driven development of cyberspace fostered by global capital. They are produced as cartographic propaganda by companies and consultants who have vested financial interests in the expansion of cyberspace. Maps are deployed as persuasive devices (Tyner 1982) because they provide authoritative support to the rhetoric of expansionism, helping to visually assert the globalists positioning of corporations and as a means to exert sovereignty of private capital over public electronic spaces (Dodge and Kitchin 2000b). A cursory examination of most ISP web sites, for example, will reveal the presence of 'high-gloss' marketing maps showing a generalised and simplified view of the company's network. They are usually a bright,

[2] Results of the project are available at <www.fractalus.com/steve/stuff/ipmap/>.

colourful, and visually effective maps drawn on a familiar template of real-world geography. As such they have many design commonalties with the airline route maps displayed in the back of in-flight magazines and are part of an established cartographic lineage of marketing maps used to highlight the advantages of the latest communications technology to prospective investors and potential customers (see chapter seven).

Beside selling cyberspace, another motive is census-mapping cyberspace in support of academic and policy analysis (see the analysis in chapter six for detailed empirical discussion). The results, with varying degrees of reliability and impartiality, are fed back into business strategies and government policy formulation, thereby directly effecting the future production of cyberspace. An pioneering example of this kind of mapping in academic analysis is found in the work of geographer Jean Gottmann (1961) who display inter-city telephone call patterns as part of the assessment the emerging ‘informatisation’ of the U.S. economy (Figure 3.3). More recently, much of policy analysis work using census type mapping focused on explaining the exponential growth in Internet infrastructures, connectivity and usage. Visual summary presentation using statistical charts and geographic maps is common; for example, Batty and Barr’s (1994) quantitative spatial analysis of Internet diffusion used a sequence of simple choropleth world maps.

<Figure 3.3 about here. Gottmann telephone map.>

Some of the more innovative examples of cyberspace census mapping come from TeleGeography, a market analysis firm based in Washington DC. They measure and map telecommunications traffic flows and Internet bandwidth between countries, and provide one of the most important and credible data source for the growth of cyberspace. The company grew out of the pioneering work by telecommunications lawyer Gregory Staple in the late 1980s, who gathered telecom traffic flow data between countries for the first time (see Staple and Dixon 1992). Staple’s goal was to map out the structures of telegeography; his motivation in doing this was simple: “At the time, I was a few streets away from one of London's best stocked book stores and I had had the same frustrating experience; the information society was everywhere, but you couldn't find a map of who was connected to whom to save your job.” (quoted in Dodge 2000e). While much of Staple's output used conventional statistical cartography templates (for example, see TeleGeography's wall posters[3]), he is also interested in more innovative visual vocabularies for 'maps of cyberspace' as evidenced by his publication of the 'The Whole Internet' maps[4] (based on the graph projection by Hal Burch and Bill Cheswick, see Figure 4.9).

There are several reasons why 'maps of cyberspace' are important beyond their normative roles in planning network construction, in selling network access or network census-taking for policy-making. Firstly, taken as a whole the output from this mode has significant pedagogic utility in challenging the misconception cyberspace as a paraspace and the naïve notions that virtual interactions spells the 'death of distance' and somehow renders geographic location meaningless. As noted in the introduction these notions were prevalent in cyberspace discourses, particularly in much of the business-orientated coverage in the 1990s, and stem in part from simplistic, techno-utopianist fantasies of transcendence of the physical constraints of embodied human lives and democratising dreams of borderless worlds.

The seemingly magical ability to surf virtually through an ocean of online information, moving from website to website at a single click, belies the scale and sophistication of the socio-technical assemblage of protocols, hardware, capital and labour that makes this possible. Despite the virtualised rhetoric, this infrastructure assemblage remains embedded in real places and 'maps of cyberspace' have real utility in revealing the intersections between virtual space and geographic space. Geographical mapping is therefore significant, as it can provide insights into who owns and controls the supporting infrastructure, how and from where cyberspace is being produced. In addition, geographical maps are especially useful for communicating this to public audiences because they use a familiar template of countries and continents.

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3 <www.telegeography.com/products/maps/cable/index.html>

4 Four iterations of this striking poster were sold by Staple's company Peacock Maps, <www.peacockmaps.com>. Note, I worked for Peacock Maps in 2001 and participated in the publication of last version.

Understanding the 'where' and 'how' of the physical embeddedness of data networks and information flows through geographic mapping is also important because of the uneven geographical distribution of cyberspace and the consequent socio-spatial implications in terms of access and inequalities. The location and structure of infrastructure is a key determinant in access to cyberspace, affecting cost, speed, reliability, and ability to connect (Holderness 1998; Warf 2001). Maps in this cartographic mode can illustrate how, on a global scale, infrastructure is concentrated in certain countries (such as the USA, UK, Scandinavia), and at the national scale how it is concentrated in certain regions (e.g. Silicon Valley, the London-M4 corridor, the Helsinki metropolitan area), and even very localised neighbourhood clustering within 'high-tech' cities like San Francisco or New York (see for example Zook's (2000; 2005) cogent economic analysis and mapping of dotcom domain name ownership). Accessing cyberspace is fragmented along traditional spatial and social divisions with infrastructure density and variety being closely related to areas of wealth (see Warf 2001).

Despite much innovation and effort from the range of mapmakers, in terms of a normative evaluation, the available 'map of cyberspace' gives only a partial view of the production of cyberspace. Mappable information is still limited in many areas, for example, the inability to measure information flows between and within cities. In some important respects, mappable information of cyberspace is actually diminishing. The growing diversity, size and privatisation of cyberspace are making it harder to survey and map legibly compared to say ten years ago. This has been acerbated with recent post-9/11 'chilling' (Zellmer 2004) in which details on cyberspace infrastructures operating procedures are kept from public purview for 'security' reasons; for example, the Georgia Telecommunications Atlas (Figure 3.1 above) is no longer online. Visitors to the site looking to produce maps of network infrastructure are now informed: "Due to security concerns from telecommunications providers, the Georgia High-Speed Telecommunications Atlas is no longer available."

Yet 'maps of cyberspace' remain also politically important, not because they can tell us things about the production of cyberspace itself, but because they tell us things about how certain people, groups and organisation perceive and (re)present cyberspace to themselves and to the outside world. All the 'maps of cyberspace' reveal the interests and agendas of the people who make them: for example, Is cyberspace being presented as a dangerous, threatening place needing to be controlled? or as a new digital 'public square' for invigorating community and democracy? or a new market ripe for economic exploitation? The ideological agendas in 'maps of cyberspace' are made apparent in chapters five - eight.

2.4 The 'map for cyberspace' mode

The extent and usage of cyberspace has grown very rapidly in the last decade. With so many distinct virtual spaces and users online, cyberspace has become an enormous and often confusing entity that can be difficult to cognise and navigate. The 'maps for cyberspace' mode focuses on helping people understand the structures of online spaces of information and social interaction, rendering them into visual form and enabling people to then navigate through them. These are cybermaps designed purposefully as a means to explore 'inside the wires', rather than see how than the 'wires' themselves are produced.

It may seem surprising, in the first instance, that a worthwhile case can be made to use cartographic maps to navigate cyberspace. This surprise is based on two false assumptions: firstly, that cyberspace has no meaningful spatial structure and is somehow 'unmappable'; and secondly, that maps can only represent geographic phenomena in relation to the surface of the earth. Both these assumptions are incorrect, maps are not just geographic and cyberspace has meaningful structures to be surveyed (and calculated) and mapped, such as semantic similarity between content, affinity ties of differing strengths in online social networks, turn-taking in mediated conversations. The self-evident answer is that it *is* possible to make 'maps for cyberspace' - as many researcher have indeed done (see Dodge and Kitchin 2001, chapters three and four, for myriad examples) - although as yet mapmakers in this mode have largely failed to produce workable maps suitable for widespread public usage.

In terms of authorship, the range of work in this mode is undertaken by a surprisingly diverse group of mapmakers, including graphic designers, sociologists, new media artists, physicists, information scientists, librarians and interface engineers.

Contributions by cartographers or geographers has been minimal (excepting the notable work by Andre Skupin and Sara Fabrikant). The bulk of the work is being done within academic context, particularly in U.S research labs and universities. Also, quite a number of start-up companies spun-out from a academic research to develop a novel interface concepts into products[5], particularly in the heady days of the dotcom bubble when venture-capital was readily available. Sadly, few survived the subsequent technology market crash and none has achieved large scale success in the commercial market.

A number of computer science specialisms interested in the 'engineering' aspects of new interactive visual representations have also been heavily involved in the 'maps <u>for</u> cyberspace' mode, including researchers in computer graphics, human-computer interaction, visual data-mining, and virtual reality areas. Many of these fields are share common goals of being able to better understand information navigation and thereby create more efficient means of human-computer interactions. In some respects online spaces, such as the Web, simply provide a conveniently accessible, large-scale testbed for this work. In addition to these fields, within computer science an allied research community has grown up in the 1990s under the banner of information visualisation[6] which provides many of the most innovative 'map <u>for</u> cyberspace' exemplars because of its specific emphasis on development dynamic interfaces to large volume of textual data (see Card *et al.* 1999; Spence 2001).

Outside of computer science and technically-focused visualisation research, the information design community, with direct responsibly for architecture of the online content has been most active within the 'maps <u>for</u> cyberspace' mode; for example in terms of site maps on websites (e.g., see Kahn 2000). Valuable and very eclectic contributions have also come from new media artists, who are developing interactive maps as works of art (see reviews in Anders 1998; Holtzman 1997; Paul 2003) and as virtualised architectural spaces (e.g., Benedict 1991; Spiller 1998). One especially

[5] For example, Visual Insights, Perspecta, Inxight Software and Cartia were spins-off from cutting-edge research at Bell Labs-Lucent Technologies, MIT Media Lab, Xerox PARC, and Pacific Northwest National Laboratories respectively.

[6] It has been defined by three of leading academic computer science researchers as follows: "The use of computer-supported, interactive, visual representations of abstract data to amplify cognition" (Card *et al.* 1999, 2).

interesting group here, working at the intersection between online art installations and software computation, are the so-called 'data-viz' artist programmers including Ben Fry at the MIT Media Lab and Martin Wattenberg at IBM Research (see Dodge 2001c, 2001d).

The power of information mapping:

Cartographic mapping has utility since it can render the intangible virtual media, composed of immaterial code (in essence just software algorithms manipulating database records) into visually tangible spaces[7]. Even though one cannot 'touch' hypertext, for example, it is possible to plot its structures on screen to aid navigation. Depending on their scale and design, information maps can give people a unique sense of a space difficult to understand from navigating alone (Dodge 2000a). As such cartographic mapping of information space offers three distinct and interlinked advantages over other interfaces to cyberspace:

- Creating a sense of the whole information space,
- Supporting ad-hoc, interactive user exploration,
- Revealing hidden connections between data object.

In a metaphorical sense information maps enable users to get 'above' the virtual space. In terms of the Web this kind of 'birds-eye view' function has been described by David D. Clark, Senior Research Scientist at MIT's Laboratory for Computer Science, as the missing 'up button' on the browser. Such overview visualisation, displayed on a single screen for cognition at a glance, is particularly important when combined with support for interactive exploration given the nature of much of online information seeking is via unstructured and poorly formulated browsing and foraging techniques. "[A] user may be unable to say exactly what they are looking for in a collection of documents because they may not *know* exactly what they are looking for. They may want to discover *roughly* what is available in the collection and then, by exploration, gradually refine their inquiry" (Spence 2001, 179, original emphasis). The maps should also be able to show, in an intuitive and meaningful fashion, the

[7] Of course, there are many of visual interface approaches beside cartographic mapping - the most common is the temporally ordered list of items, which underlies the experience of email for example.

structures of the information space in terms of direct relationships between documents (via citations or hyperlinks, for example), but also similarity in terms of shared themes, semantic connections and common usage. These structures and relationships are usually completely hidden in the presentation of conventional interfaces, like the web browser. Yet this is often where we find insight and answers, in the visual-cognitive assimilation of how the mosaic of available information fits together. As carto-theorist Bertin (1981, 64) reminds us: "Items of data do not supply the information necessary for decision-making. What must be seen are the relationships which emerge from consideration of the entire set of data. In decision-making, the useful information is drawn from the overall relationships of the entire set." The effective power of 'maps <u>for</u> cyberspace' comes from showing these relationships to users to enable them to make better decisions.

Developments in the field of information visualisation in last decade have proved particularly fertile in creating novel visual metaphors for navigating high-dimensional information spaces through processes of spatialization (see Couclelis 1988; Fabrikant 2000; Fabrikant and Buttenfield 2001). These are map-like interfaces that "rely on the use of spatial metaphors to represent data that are not necessarily spatial" (Fabrikant 2000, 67-68). According to Couclelis (1998, 209) "true spatialization go beyond the conversion of information into general visual patterns to reproduce aspects of the kinds of spaces that are familiar to people from everyday experience ... Spatializations work by allowing the establishment of metaphors linking a particular task domain with a familiar domain of experience in such a way that the modes of thought and action appropriate in the familiar domain area also appropriate in the task domain."

Spatialization renders large amounts of abstract data (usually textual corpus) into a more comprehensible, compact visual form by generating meaningful synthetic spatial structure (such as distance on the map display scaled according a metric of lexical similarity between data items) and applying cartographic design concepts from topographic mapping and thematic cartography (Skupin 2000). Some of the most map-like examples have used the conventions of hill shading and contouring from terrain mapping to create browseable virtual 'information landscapes' (Wise 1999; Dodge 2000f) (Figure 3.4). Skupin and Fabrikant (2003, 113) have called for much greater involvement of cartographers in information visualisation to develop improved spatializations for non-geographic data, arguing that "it may lead to a renewed interest among non-cartographers in how our community has managed to not only represent the infinitely complex geographic reality within a limited display space, but also do it in a manner that enables people to recognize their world within it."

<Figure 3.4 about here. Themescape Newsmap screenshot.>

Challenges in information mapping:

Given these potential advantages, actually creating workable spatializations, however, faces real challenges. This is particularly the case, firstly, because cyberspace is new and diverse. It is not a single, homogenous and continuous phenomenon, but a myriad of rapidly evolving digital databases, channels, and media, each providing a distinct form of virtual interaction and communication (as shown in Figure 1.1 in the introduction). Secondly, many virtual spaces are overlapping and interconnected, but often in ad-hoc and unplanned ways, giving rise to complex rhizomatic structures that can not easily be surveyed and mapped. Cyberspace, composed of infinitely malleable software code that can produce numerous media forms - including web pages and their hyperlinks, social interactions as text in synchronous chat rooms and asynchronous mailing lists, three-dimensional VR environments, huge distributed file corpuses on peer-2-peer networks - all with "their own sense of place and space, their own geography" (Batty 1997, 339).

Some virtual spaces can be highly mutable and in continual informational flux as content is refined, expanded and deleted in unpredictable ways - the average life span of a Web page in 2000 was reported to be only 44 days (Lyman 2002). These are inherently transient landscapes, but where changes are 'hidden' until one encounters them. Change can happen instantaneously, for example deleting a web page leaves behind no trace (unless archived elsewhere previously). The lack of reciprocity in relations means an information node can vanish without notice or notification to any other party (hence the problem of 'dead-end' hyperlinks on the Web). The harsh programmed logic of cyberspace – presence or absence, zero or one – makes for a hard landscape to map.

Furthermore, these issues of information mutability and transience are likely to grow, and become obfuscated by increasing use of encryption and ad-hoc distributed architectures (e.g., P2P and WI-FI mesh networks) making mapping even harder[8]. The task of generating even a basic index of parts of cyberspace for example, continues to tax the largest corporations and government agencies. The Web search engines, for example, have failed to keep pace with the growth and mutability of just this one part of cyberspace (see Lawrence and Giles 1999). Of course, issues of data currency and change management are well known in cartography (e.g., the revisions cycles of paper topographic maps). However, the surveyed environment represented on conventional topographic maps is really quite a stable place (change tends to be gradual in relation to human perceptions; most things stay the same, and when they do change, they typically leave evidence behind in the material landscape.) The physical fixity, friction and inertia of geographic space means the 'shelf-life' of most maps is quite long (most of the information on an OS Landranger map remains valid for decades). There is no such friction or inertia in cyberspace and the 'shelf-life' for many cyberspace maps is terribly short. What is really needed are 'maps for cyberspace' that are capable of dynamically mapping out virtual space in real-time, much like a radar map for tracking weather patterns (see chapter eight for further discussion in relation to mapping Internet data routes in real-time).

A third set of challenges in mapping relate to the nature of the space. Cyberspace offers media that at first, often seem contiguous with geographic space, yet on further inspection it becomes clear that the space-time laws of physics have little meaning online. This is because virtual spaces are purely relational. They are not 'natural', but are solely the productions of their designers and, in many cases, users. They adopt the formal qualities of geographic (Euclidean) space only if explicitly programmed to do so, and indeed many media such as email have severely limited spatial qualities. Significantly, many virtual spaces violate two principal assumptions of modern (Western) cartography making them difficult to map legibly using conventional

[8] Some counter that the growth and complexity of online information resources can be more effectively managed with application of XML to encode semantic meanings and the use of collaborative user tagging and rating. Additionally, the wholesale automatic geocoding of information objects, as they are created and transmitted, opens up interesting possibilities for spatial indexing, filtering by distance and searching by geographic location.

techniques[9]. The first of these are the Cartesian properties of space as continuous, ordered and reciprocal; there are no sudden gaps or holes in the landscape, everything is somewhere, and the Euclidean notion of distance holds true, i.e. the distance from *A* to *B* will be the same as from *B* to *A* (Staple 1995). Yet parts of cyberspace are discontinuous, lacking linear organisation and in some cases elements can have multiple locations.

The second assumption is that the map is not the territory but a representation of it, (i.e. the territory has a separate, ongoing existence and meaning beyond the map.) Yet there are examples of virtual space where in a literal and functional sense the map *is* the territory. Cartesian logic collapses and there is no reality independent of the representation. (See chapter eight in relation to the performance of mapping and the production of virtual space by traceroutes) This conflation of the map and the territory is most obviously seen in hypertext spaces when the structuring of the data is the both the space and its map. This can be experienced in the experimental three-dimensional 'fly-through' spatializations of hypertext, such MIT Media Lab's Perspecta system (Holtzman 1997) or Apple's HotSauce navigation map-interface (Figure 3.5) (Dodge 2001a). Staple (1995, 71) comments: "In a very real sense the session is the map. Or paraphrase Marshall McLuhan, the medium is the map." Interestingly, none of the experiments in 'fly-thru' map-interfaces that emerged in the 1990s gained widespread usage despite great hope by some pundits that they would overturn the page-by-page view of the Web (the book paradigm) ingrained in browsing software.

<Figure 3.5 about here. Hotsauce screenshot.>

At present, it is probably fair to say that in relation to the challenges of producing workable 'maps <u>for</u> cyberspace', the current mapmakers are at the same stage as the cartographers at start of Renaissance period. Although armed with a knowledge of traditional mapping and sophisticated computing, we are lacking the vital 'blueprints' that Ptolemy provided for European cartographers in terms of a projective grid for plotting the knowledge of vastly expanded territories that the New World explorations brought back. At present we do not really have a equivalent world-making grid of

[9] Of course, a number of geographers have undertaken work on non-Euclidean geographies using relational metrics of distance (e.g., Gould 1991).

latitude and longitude for cyberspace. As a consequence, many cyberspace cartographers have generally resorted to extending methods.

One productive route forward for this mode is to draw upon the mapping epistemologies of non-western, aboriginal cartographies, which are markedly different from the dominant conventions and norms of Western cartography, and might well provide insights for future cyberspace mapping projects. Much of the focus in indigenous cartography is on the non-textual visualisation of conceptual links, pathways and relationships between space rather than the geometric grids and locational accuracy emphasised in modern (Western) cartography. These ideas are explored further in chapter eight in relation to conceptualising mapping network flows using the Aboriginal notion of songlines.

Ethical mapping:

'Maps <u>for</u> cyberspace' have also been applied to visualise the patterns of online social spaces (such as virtual worlds), to give researchers useful new insights into users behaviour (e.g., Börner and Penumarthy 2003). However, one must question how far these kinds maps can be useful to the participants of the spaces to augment and enhance their experience. Will seeing a social mapping of the community help inform the social life of the community, helping it grow through additional positive feedback or might such maps actually be detrimental to community life? Mapping social interactions that were previously invisible to participants and service providers, hidden in unused log files and databases, is a kind of cartographic surveillance which raises the ethical dimension in visualising cyberspaces?

In ethical terms the act of mapping itself may constitute an invasion of privacy. If the appeal of some online social spaces is their anonymity, then users may object to it being placed under wider scrutiny, even if individuals are unidentifiable on the maps. Here, public cartographic display may well represent an infringement of personal rights, especially if the individuals were not consulted beforehand and have no means to opt out. In some senses, these maps may work to shift the spaces they map from what their users consider semi-private spaces to public spaces, and thus the maps may actually change the nature of the space itself. Thus, it is important to consider the ways, and the extent to which, ‘maps for cyberspace’ are responsible artefacts, that do not destroy what they seek to represent or enhance.

Furthermore, as noted in chapter two, maps have proved to effective governmentality tools when the cartographic gaze is harnessed by the state to discipline people and this could well prove to be more true in cyberspace than ‘real-space’. The frictional constraints in material space limit the tracking, observing and recording of people and help maintains a fairly robust degree of geographic privacy. This friction evaporates in electronic space where all interaction and conversation are observed (mediated by software) and can be recorded (saved automatically to log files). Web browsing activities, for example, through their technical architecture leave detailed digital data trails that reveal everywhere a user has ‘been’ and what they read (Bennett 2001). The resulting ‘clickstream’ can be mined and visualised (Dodge 2000a). As an illustration, consider monitoring a ‘real’ bookstore against an online one and one can see how easily the ability to browse and read anonymously can disappear in cyberspace. ‘Maps for cyberspace’ then have wider social implications in terms of surveillance and potential discriminatory impacts because of the panoptic nature of the virtual spaces they chart.

Furthermore, digital traces of online activities and interactions in cyberspace can be kept for a long time and become available to wider audiences than originally intended. Figure 3.8 below is a banal, but telling, example of this surveillance power. It is an exact copy of a message I posted to a Usenet newsgroup in 1997 that had been archived unbeknownst to me at the time and now circulates for anyone to read through a simple search on Google. The ways such trails and traces are used to build data profiles is particularly threatening because it opens many new axis of discrimination for the powerful interests of the state and corporations. The role of visualisation technologies, including the work of ‘maps for cyberspace’ cartographic mode, in shifting the power balance between watcher and the watched needs rigorous examination (see also Monmonier 2002). The discriminatory impact of ‘maps for cyberspace’ also arises as the degree to which they become a means of censorship by curtailing the freedom of online movement. As tools for navigation they can be designed to direct user in particular directions (for example to serve commercial interests) and actively shape access to knowledge. After all the history of commercial cartography is replete with tourist mapping in which hotels and restaurants buy a prominent visual position (Monmonier 1996). The form of the map, and who controls their content, will then be vital to what people see and do in cyberspace. Critiquing the politics of 'maps <u>for</u> cyberspace' is vital because of their apparent 'naturalness'[10]; they deny their power and agency by presenting a seemingly transparent and innocuous interface, a mere window in cyberspace.

3. Literature on the cartographies of cyberspace

There is a substantial body of critical analysis on the history of cartography, and on contemporary digital mapping and the practices of GIS, yet there has been little scholarly work examining cyberspace cartographies *per se.* While examples of cyberspace maps crop up frequently in different literatures, such as network maps used as illustrations in technical guide books (e.g., Quarterman 1990) and histories of the Internet (e.g., Abbate 1999; Hafner and Lyon 1996; Salus 1995), but without systematic comments on their semiotic properties or their wider social significance.

To begin the summary of relevant literature on cyberspace cartographies, I want to consider Gregory Staple's papers , *Notes on Mapping the Net: From Tribal Space to Corporate Space* (1995). (Staple is a lawyer and the founder of TeleGeography, described above.) Although it is a non-academic in some regards, and was published in grey literature, the paper provides a valuable perspective on the emergence of cyberspace cartographies from one of the pioneers in the field. Staple argues firstly that cyberspace is significant in extending the centuries old debate about 'what are maps' and starts by drawing direct parallels to the explorative drive from the 'age of discovery' to define contemporary cartographic motivations. He notes that effective maps of cyberspace are rare because "[f]ew among this frontier fraternity" of hackers and webmasters, "have both the navigational and drafting skills of a Ferdinand Magellan or a James Cook" (p. 66). He then provides a role call of 'issues' that make cyberspace mapping challenging, including the lack of a established mental

[10] Many new users of the Internet assume that the Web browser and the default homepage is the 'natural' view of the Internet itself and not an ordered, conventional and socially-constructed media interface. It might appear to be just a technical piece of software, but the Web browser is in software manifestation of particular sets of power relations that inherently frames actions of the people who use it.

conception of what cyberspace *should* look like: "Ask a communications engineer to draw a picture of cyberspace and you are likely to get a sea of clouds each representing a different network" (p. 67) (see also chapter four). The confusion in how to represent cyberspace calls for a clear separation of the "hardware and software side of the on-line world." (p. 67), matching partially the mode conceptualisation used here.

Staple's principle interest is in 'cybermaps' to represent information spaces for user navigation (what I define as the 'maps <u>for</u> cyberspace' mode). To achieve this, he notes, new maps will likely be cartographically unconventional (i.e. breaking Euclidean conventions of most Western maps) and he draws on ideas from tribal mapping as a source for such alternative conceptions. Importantly, connectivity rather than continuity of virtual spaces of cyberspace need to be represented to users and he cites American Indian and Aboriginal Australian mapping as a useful model for this: "Cybermaps like tribal maps may ... dispense with conventional perspective to conserve connectivity. They are true to the land, not to the theodolite" (p. 68). Staple's paper concludes by discussing the social implications of cybermaps in relation to the changing forms of cyberspace evident in the mid 1990s with the start of rampant commercialisation, arguing that initial exploration mapping will open up cyberspace to the controlling cartography of "a more mercantile genre" with universalising grids capable of locating all virtual territory. "Tomorrow's cybersmaps" he concludes "will record the boundaries of corporate space on the Net even as earlier ones illustrated its tribal origins" (p. 72).

In terms of writing by academic cartographers, there are two descriptive papers by Jiang and Ormeling (1997 and 2000) which do engage cyberspace cartography directly, although they do not attempt any theoretically-informed critique on their social implications. The lead author is heavily involved in visualisation paradigm of cartographic research and the papers were both published in the *Cartographic Journal*, the house journal of the British Cartographic Society which speaks to 'mainstream' practitioners and researchers. Both papers review a range examples of 'cybermaps' with an explicit 'call to arms' to cartographers to lend their skills and experience to make improved maps, asserting that: "cartographers with a long standing tradition of mapping geographical space, can make an important contribution to mapping cyberspace" (1997, 111).

Jiang and Ormeling's first paper, *Cybermap: The Map for Cyberspace* (1997), defines the nature of the 'cybermap' elliptically as a "special map for cyberspace" (p.112) that encompasses representations of both the physical network and the information spaces. Drawing on theories of maps as communication tools, they set out a three-fold 'functional classification of cybermaps': navigation maps, maps for cyberspatial analysis, maps for persuasion. The short paper includes five colour cybermaps as illustration, but these are not politically critiqued. The authors use them in the affirmation of 'establishment' cartography, somewhat snobbishly noting that "[a]s many cybermaps are produced by non-cartographic professionals, it is unavoidable that some low quality maps are created."

Jiang and Ormeling's second paper, *Mapping Cyberspace: Visualizing, Analysing and Exploring Virtual Worlds* (2000), covers similar ground to the first, with the map again normatively defined as "a visualisation tool for understanding and perception of space" (p. 118). They set out a somewhat modified conceptualisation of cyberspace mapping as being concerned, firstly, with analysing the geography of the "physical anchorages" of Internet following the "principle of traditional thematic mapping" (p. 118), secondly, a typology of network forms in which the Internet is visualised as non-geographic trees and graphs (they cite the Cheswick-Burch visualisation as an exemplar; see Figure 4.9). Lastly, they argue cybermaps are means to produce "general purpose maps for virtual worlds" (p. 118) as an aid to user navigation through three-dimensional space.

Geographers Michael Batty and Harvey Miller (2000) bring concepts from quantitative modelling of accessibility into their analysis of representations of different types information space. They are concerned with developing a research agenda for understanding the nexus between material and virtual spaces, the hybrid space that they argue will be the "focus for a new geography of the information age" (p. 134). Attempts to directly map out virtual spaces using tradition techniques developed for Euclidean landscapes, they argue, may well not be applicable because of the ease with which 'rules' of geographic space are broken and the unsuitability of the existing tools: "current GIS software does not treat non-Euclidean space in an appropriate way" (p. 136) they point out. An alternative, to map the real-world locations of the physical and logical components of virtual space, is again viewed with caution by Batty and Miller because "[t]he spatial/geographical metaphor may not be appropriate, particularly since information flow in most networks apparently does not correlate with geographical space" (p. 136). One route forward, they suggest, might be to look beyond mapping the 'surface' morphology of cyberspaces towards an analysis of the structural process underlying cyberspatial production by modelling interactions using measures of latency instead Euclidean distance to "see whether or not the frictionless world that has emerged has any parallel in traditional geographic spaces" (p. 139) or by applying the notion of power laws and small world networks to understand the emergent properties of information objects (such as Web sites and their hyperlink structures). By way of conclusion they set out a fourfold research program for representing hybrid space (p. 144) focused on (1) visualisation of connections between material and virtual geographies by augmenting existing measures of accessibility and developing new ones; (2) researching information flows and costs in relation to existing market, social and institutional processes; (3) mapping activity spaces by extending time geography theories to take account of network flows; (4) developing tools for cyber-navigation. This agenda has clear overlaps to my conception of cyberspace cartography, with the first two items aimed at advancing the 'maps of cyberspace' mode and the other two items come within the remit of the 'maps for cyberspace' mode.

Castells' (1996) sophisticated sociological theorisation of the network society was founded on the power of informational flows to reconfigure time-spaces of material places. In his latter book, *The Internet Galaxy*[11] (2001) he analyses in more depth the material production of the Internet with a review of the geography of the infrastructure with descriptive statistics and census-type mapping. He sets out a three-fold schema for analysis that in many respects correlates to major types of 'maps of cyberspace' mode outline above. The first element in schema is the "technical geography" by which Castells' refers to "the telecommunications infrastructure of the

[11] As an interesting side point, the book's cover features a version of the Burch-Cheswick Internet graph as its central motif. Clearly this image conjured up, both, in the space of networks as well outer (galactic) space in the mind of the designer (see discussion in chapter four).

Internet, the connections between computers that organize Internet traffic and the distribution of ... bandwidth" (p. 208). The second element is the user demographics, especially concerning the uneven geographic distribution of access and usage. The final element in Castells' schema is the economic geography of Internet production, which has a much more spatially concentrated pattern that usage. Drawing heavily on the work of Matthew Zook, the chapter includes seven illustrative thematic maps of Internet statistics that show very much the conventional face (and normative utility) of cyberspace cartographies to make intangible spaces seem tangible to a non-technical audience.

Outside of academic geography, the most theoretically sophisticated work on cyberspace cartographies is the paper by Harpold, titled *Dark Continents: Critique of Internet Metageographies* (1999). Coming from the cultural studies domain, Harpold provides a cogent postmodernist critique of maps of global-scale Internet infrastructure, richly illustrated with relevant empirical evidence. He views much of the output of the 'maps of cyberspace' modes as a pernicious new 'metageography'[12] sustaining the information society. "[T]he inherent selectivity and social subjectivity makes a map", Harpold (1999, 18) argues, "a problematic construct for describing the heterogeneous conditions and practices of the emerging the global telecommunications networks." He is particularly concerned with the politics of silence and the iniquitous *under* representation of the peripheries of cyberspace as evidenced in the blank spaces of the African continent on most infrastructure maps. He draws direct ideological parallels here to the colonial mappings of the nineteenth century, arguing "[t]he blank region is 'empty' only in relation to the comparable fullness of the rest of the map" (3). He proceed to trace out the implications of using nation-state boundaries as the 'natural' background to represent Internet diffusion, bandwidth and access, when the motive forces behind the processes are operating in a multi-scalar networked political economy. The result, he agues is these kinds of 'maps of cyberspace' are deeply deceptive, overstating the extent of Internet diffusion because fundamental they are unable to "account for the extreme local obstacles

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[12] Harpold's concept of metageography, following Lewis and Wigen (1997), is defined as "sign systems that organize geographical knowledge into visual schemes that seem straightforward, but which depend on historically- and politically-inflected misrepresentation of underlying material conditions." (5)

which must be overcome before anything like a viable African Internet is possible, at least as netizens of digitally-saturated, liberal-democratic nations understand the Internet." (12)

In Harpold's opinion, too many 'maps of cyberspace', by opting for conventional geographic projections, statist borders and signs systems of thematic cartography, produce mythologies that reduce Internet into categories of "on/off, traffic/no traffic, wired / unwired" (17). Thus the maps work, Harpold asserts, as a display of "counterfeit ubiquity and technological reasonableness" that masks the unevenness of the process of Internet diffusion and the extent to which the network will further acerbate social difference between places. He ends his analysis with a call to map the Internet using a different cartographic imagination, with "new schemes for representing the archipelagic landscapes of the emerging political and technological world order." (18). It is not clear whether these have been drawn yet or, indeed, whether they can be drawn at all by mapmakers cultured with conventional Western metageography. (See also chapter eight for discussion of counter-mapping the Internet.)

The field of cyberspace mapping has also received coverage from the mainstream media in many parts of the world. Notable articles where the journalists provided a useful analysis includes Bodzin (1999), Forde (2000), Johnson (1999) and O'Connell (1999). The last of these was a substantive review in the *New York Times* entitled *Beyond geography: Mapping Unknowns of Cyberspace* and provides a coherent frame to the field, noting that cyberspace cartographies encompass a diverse range of representations and are being "produced by geographers, cartographers, artists and computer scientists" (p. G1). The story was illustrated prominently with five colour examples from both modes with the front page dominated by earth globe from the visualisation research of Lamm *et al.* (1995) (Figure 3.6). Two other well known Internet visualisations are used, firstly a fragment of the Burch-Cheswick topology graph (Figure 4.4 bottom) and the 'arc across the world' map by Stephen Eick. O'Connell argues that cyberspace cartographies stretch the "definition of a map in their effort to capture, sometimes fancifully, what is sometimes referred to as the ‘common mental geography’ that lies beyond computer screens.” (p. G1). Defining the field, she divides cyberspace cartographies into two types, infrastructure and traffic maps on one side, and “those addressing the content and social spaces of the electronic world.” (p. G1) on the other. The quotes she includes from experts in the field create an impression of an nascent field with few practical maps available, but an upbeat prognosis about future developments; as she notes: “The maps hold the potential to change, subtly or perhaps more directly, the relationship of the average person to cyberspace.” (p. G1).

<Figure 3.6 about here. Scan of NYT cover.>

4. Building the Atlas of Cyberspaces

at-las *n., pl.* **at-las-es**. **1.** a bound collection of maps. **2.** a bound volume of charts, plates, or tables illustrating any subject.

“They enlisted polygraphs, photographs, and a host of other devices in a near-fanatical effort to create atlases - the bibles of the observational sciences”
-- Lorraine Daston and Peter Galison The Image of Objectivity 1992, 81.

Daston L, Galison P, 1992, “The image of objectivity” *Representations* 40 81-128

The greatest part of my academic research time over the last few years has been focused on the understanding the geographies of cyberspace, what I have termed cybergeography[13]. The primary areas of concern in this research has been on analysing the spatial forms of the Internet and its supporting material infrastructures. The epistemological and philosophical approach I have taken is centred around the map as a process of knowledge construction and as social-material site for critique. The key analytical tool to achieve this has been the *Atlas of Cyberspaces* (Figure 3.7), a comprehensive web catalogue of the best available cyberspace maps. Examples are drawn from both the ‘maps of cyberspace’ and the ‘maps for cyberspace’ modes; the ‘maps in cyberspace’ mode is not covered. The catalogue began largely as a personal

[13] I began investigating this field in 1995 while a research assistant at Cardiff University and the research flourished subsequently at the Centre for Advanced Spatial Analysis, University College London with the support and encouragement of Mike Batty.

set of visual bookmarks to guide my research, but subsequently became a widely used and well known public resource that has helped to define the scope of cyberspace cartographies. Over the first six months of 2005, for example it was receiving an average of eleven thousand visitors a week and according to the Google database it has 532 incoming hyperlinks (Web citations)[14].

The *Atlas of Cyberspaces* web site has been freely and continuously published online for over eight years[15]. It was publicly announced in spring 1997 (via messages to various newsgroups and mailing lists; Figure 3.8) and has since grown in scope as many new sections have been added to index the diversity of available maps. It currently comprises seventeen thematic sections, cataloguing xx[?] different cybermap examples[16]. Each item in the Atlas contains representative visual image(s) of the map, a short descriptive text and hyperlinks to further reading/relevant web pages. The whole resource has been translated by volunteers into French, Italian, Spanish and Portuguese[17]. In 2001 a 270-page long 'coffee-table' book version of the *Atlas of Cyberspaces* was published, co-authored with Rob Kitchin; whilst it drew heavily from the Web Atlas, it had many fewer examples and a simplified taxonomy.

<Figure 3.7 about here. Screenshot of the Atlas homepage.>

<Figure 3.8 about here. Usenet announcement of the Atlas.>

[14] These figures exclude mirror sites and foreign language translations for which usage statistics were not obtained.

[15] The primary URL for the site is <www.cybergeography.org/atlas>, with mirror sites provided by the Department of Geography, UCL <www.geog.ucl.ac.uk/casa/martin/atlas/atlas.html> and for the Australian / Asia-Pacific region at <http://cybergeography.planetmirror.com/>.

[16] The current thematic categories are as follows: conceptual maps and diagrams, artistic representations, geographic visualisations, cables and satellites maps, traceroutes mapping tools, census maps, topology visualisations, information maps; information landscapes, information spaces, ISP maps, weather maps, wireless visualisations, web site maps, surf maps, muds and virtual worlds, historical maps. This classification mixes form and function, and reveals the evolutionary nature of the Atlas as a research tool.

[17] The French language mirror site is maintained by Nicolas Guillard <www.cybergeography-fr.org/atlas/atlas.html>. Italian language mirror was initially created by Paolo Cavallotti and is now maintained by Giuliano Gaia and Stefania Bojano, <www.mappedellarete.net/>. Rodrigo Nóbrega maintains the Portuguese language mirror site, <http://cibergeografia.org/atlas/atlas.html> and Emiliano Rodriguez Nüesch translated the Spanish language version <www.cybergeography.org/spanish/atlas.html>.

My contribution to the analysis of cyberspace cartographies through the *Atlas of Cyberspace* Web catalogue has been primarily as a curator, surveying the diversity of examples, classifying and interpreting them and then assembling a selection into a structured typology for public display. The resulting atlas presentation is, I believe, the most comprehensive one produced and has significantly greater value as a curated whole than the simply the sum of its parts (given as an unedited bibliography or set of bookmarks). As well as curating the *Atlas of Cyberspaces* on the web, I have described, interpreted and critiqued a wide range of cyberspace cartographies using various theoretical approaches. The results of these interpretative analyses have been disseminated to diverse audiences in a range of publications and presentations (see below).

Collecting the cartographies of cyberspace materials required extensive fieldwork given the diversity of authorship in these two modes and the fact that no other catalogues or classifications existed when the project began in the mid 1990s. To a large degree this was a new type of fieldwork comprising many, many hours spent in front of the screen exploring cyberspace itself, trawling through search engines results, monitoring new corporate websites and homepages of individual researchers, as well as numerous other online resources. In addition, conventional library research and literature reviews were undertaken, along with a more limited amount of archival research of primary historical materials at the British Telecom corporate archives in Holborn and in the British Library map collection. In total over xx[?] hundred different maps (or interactive mapping projects / software systems) have been researched to date that fit the criteria of 'maps <u>of</u> cyberspace' or 'map <u>for</u> cyberspace' modes[18]. The majority of these are archived and not displayed in the *Atlas of Cyberspaces*. Besides archiving copies of the cyberspace maps themselves, relevant supporting papers, descriptive web pages, and biographic details on the creators were also kept. As part of the fieldwork process I have also built a significant professional knowledge network, making personal contact with many of the mapmakers and other

[18] I have been limited to collecting *published* maps, i.e. those that are available in the public domain. It is certain that they are many, many more maps of cyberspace are created by individuals, corporations and governments are never released into the public domain, either because of reasons of confidentially and security, lack of resources or interest, or a belief that the maps are too technical and will, therefore,

interested parties through email, mailing list discussion and individual interviews. Twenty-two mapmakers were interviewed via email by myself between 1999 - 2003 and the findings written up and published as ‘map of the month’ articles[19]. In totality, this collection of materials arising from the fieldwork represents a unique and valuable contribution to the history of cartography.

Building the *Atlas of Cyberspaces* has been personally rewarding and academically successful. As a information resource, the site has had an impact within human geography discourses, for example it was highlighted by AAG president Duane Nellis in the *AAG Newsletter* (November 2002, 3) as a prime example of innovative new research which “documents the worldwide infosphere fostered by the internet that will surely be of growing importance as the millennials further transform the ways we interact within geography”. While cartography theorist John Pickles (2004a, 194) in his recently published key text ‘A History of Spaces’ cites the *Atlas of Cyberspaces* in the conclusion arguing that it reveals the “conceptual flexibilities and political possibilities” of new cartographies that have “de-ontologized whatever we ever meant by modern cartography in ways that we are perhaps only beginning to recognize.” Further, in a recent book chapter Pickles (2004b, 184) notes: “The [*Atlas of Cyberspaces*] is rich and varied, and the maps illustrate well the geographically uneven nature of access, connectivity and interaction in this new ‘world in the wires’”. More importantly, the website has proven to be a productive medium to disseminate my research beyond the confines of geography, becoming visible in many other disciplines and outside academia. The website is also used as a teaching resource for many courses, across disciplines. The *Atlas of Cyberspaces* has also been cited frequently in the press (e.g., *The New York Times*, see Figure 3.6 above). Lastly, it has acted as a catalyst in informing different groups about each others work, cross linking ideas and maps between library science, network engineering, artists, and designer, as well geography/cartography of course.

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be of no practical use to the wider public. In addition, my researches have been largely restricted to English-language materials.

[19] These majority of these articles were published in *Mappa.Mundi Magazine* and usually involved a detailed examination of a specific example map that best represents a particular genre of cyberspace cartography, and, where possible, an interview the mapmaker to determine their aims and intentions. All the articles are accessible from <www.cybergeography.org/map_ofthe_month/index.html>.

In addition to the web catalogue, I have actively disseminated ideas about cyberspace cartographies to a diverse range of audiences through invitations to give talks at conferences, in departmental seminar series and to industry[20]. For example, in 2001 I spoke in the Department of Architecture, Princeton University; in April 2000 I participated in a symposium at the Department of Design and Media Arts, UCLA; and most recently I gave a keynote presentation for a workshop on 'e-social science' at the School of Social Sciences at the Australian National University and the Ordnance Survey in Southampton. I also participated in significant disciplinary workshops including Project Varenius, E-Space and VR and Geography and subsequently contributed chapters in edited books that arose from these meetings. Key published output also included two books, both co-authored with Rob Kitchin. These have been well received and cited; the first, *Mapping Cyberspace*, currently has 62 citations according to ISI data. I have also written a number of other articles and book chapters considering different aspects of cyberspace cartographies, in which I have tried to meld together a technical understanding of their formal properties with some consideration of their wider social implications and cultural meanings (see Dodge 1998, 2000a, 2000b, 2002a; Dodge and Kitchin 2000b). I have also fostered a network of researchers, scholars and practitioners from across the world and across multiple disciplines interested in cyberspace cartographies by publishing a regular email bulletin[21] and as the moderator of the mapping-cyberspace listserv[22].

In conclusion, the *Atlas of Cyberspaces* acts as one of the key international knowledge hubs for virtual geographies. My researches as a whole have helped to define cyberspace cartographies as a coherent and legitimate field of academic enquiry.

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[20] My curriculum vitae located at <www.cybergeography.org/martin/> provides a complete list of presentations and publications.

[21] Located at <www.cybergeography.org/register.html>. It has been running since June 1997 and currently has 6,100 subscribers.

[22] Located at <www.cybergeography.org/discussion.html>. It currently has just over 500 subscribers.

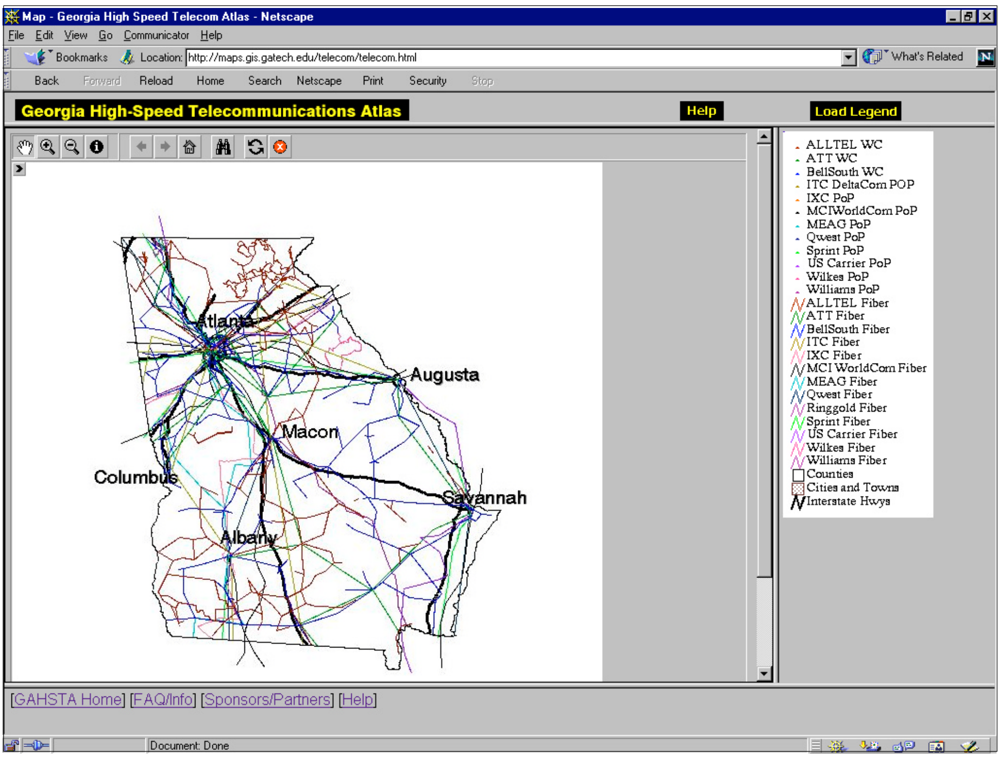


Figure 3.1: A telecommunications atlas of network infrastructure in Georgia, USA is an example of 'maps <u>of</u> cyberspace' mode. However, it is disseminated using web mapping technology that is characteristic of the 'maps <u>in</u> cyberspace' mode. The atlas was produced by university researchers at Georgia Tech as an information resource for regional economic development. (Source: Center for Geographic Information Systems, originally located at <http://maps.gis.gatech.edu/telecomweb/index.html>, no longer available online.)

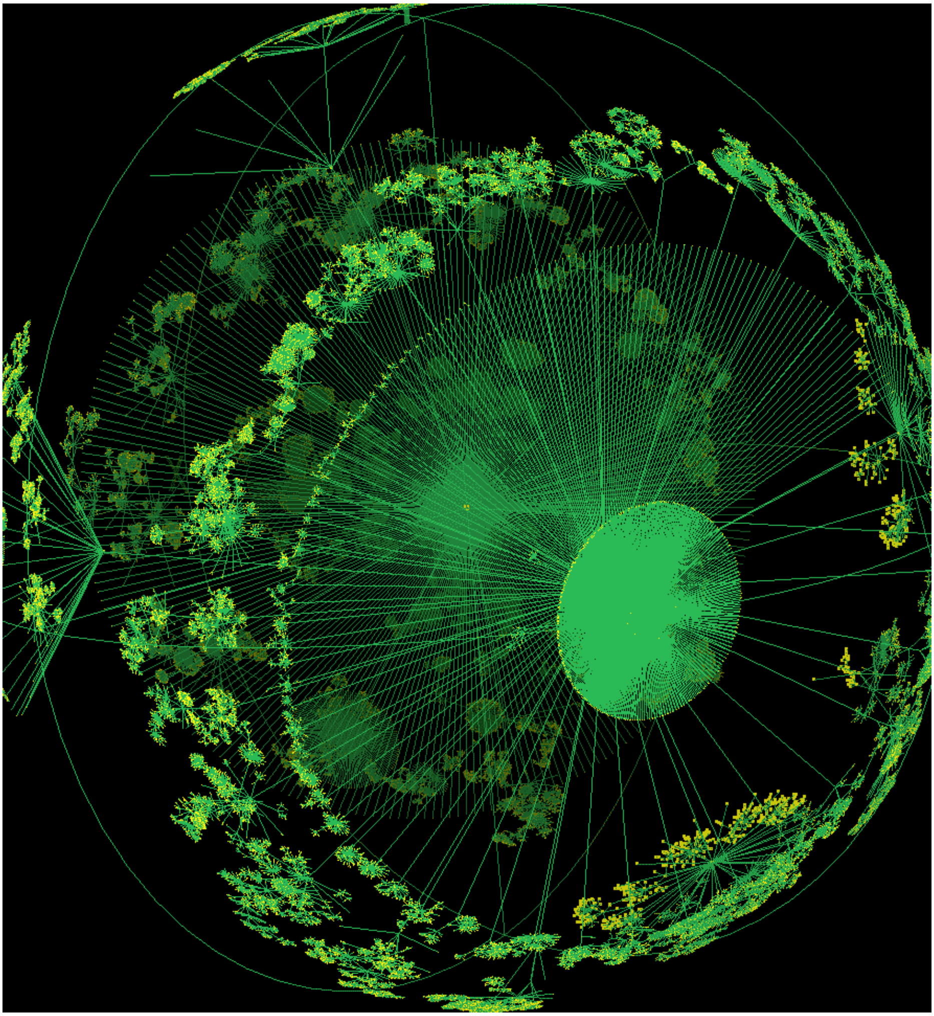


Figure 3.2: A screenshot of a three-dimensional hyperbolic visualisation of Internet topologies created by Young Hyun (Cooperative Association for Internet Data Analysis) in 2000. It produced using custom-written hyperbolic graph viewer called Walrus design to allow researchers interactive browse huge graphs (greater than 100,000 nodes). (Source: Courtesy of Young Hyun, CAIDA, <www.caida.org/~youngh/walrus/walrus.html >.)

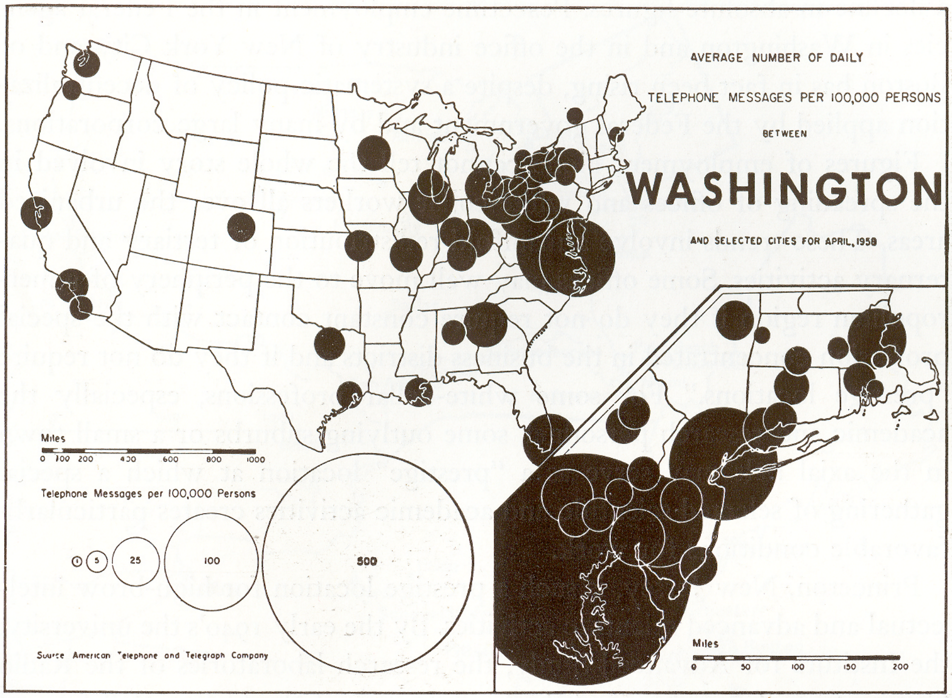


Figure 3.3: Statistical map of telephone calling patterns from Washington DC. This is a typical example of 'maps of cyberspace' mode presenting results of cyberspace census-taking in the context of academic analysis. (Source: Map originally produced by Neil C. Gustafson and reproduced from Gottmann 1961, 593.)

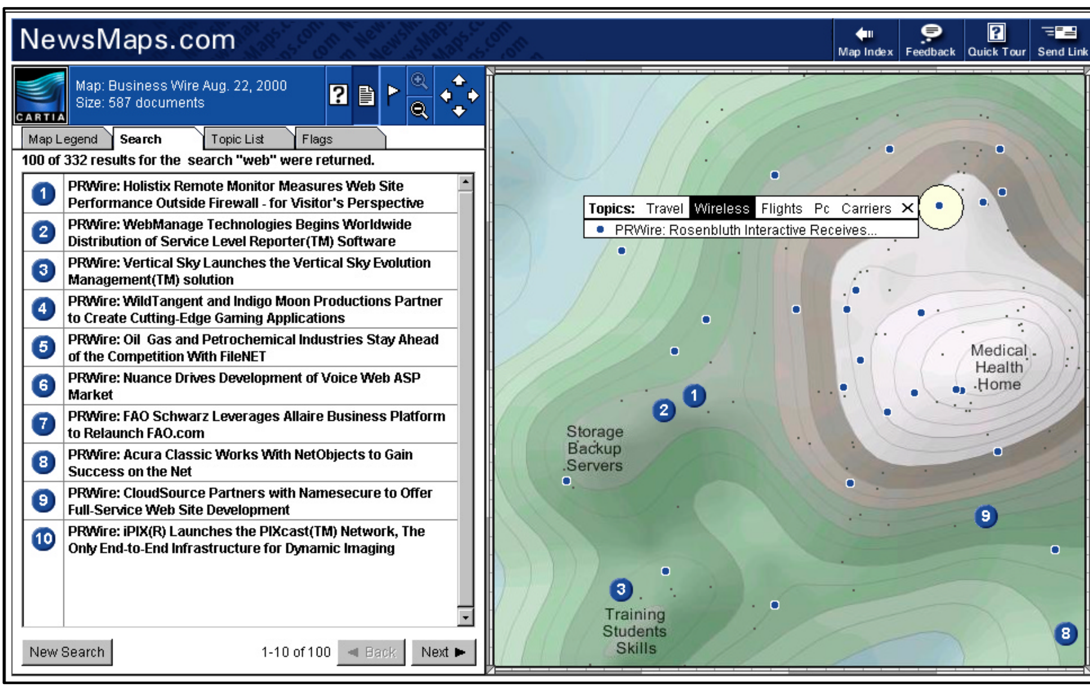


Figure 3.4: The NewsMaps interface was navigable information terrain where the hills and valleys to represent the volume of textual information. The white peak represents a large number of news stories discussing the same topic (labelled with keywords).The interface was based on Cartia's Themescape spatialization system and was one of the more effective 'maps for cyberspace' produced in the late 1990s. (Source: author screenshot.)

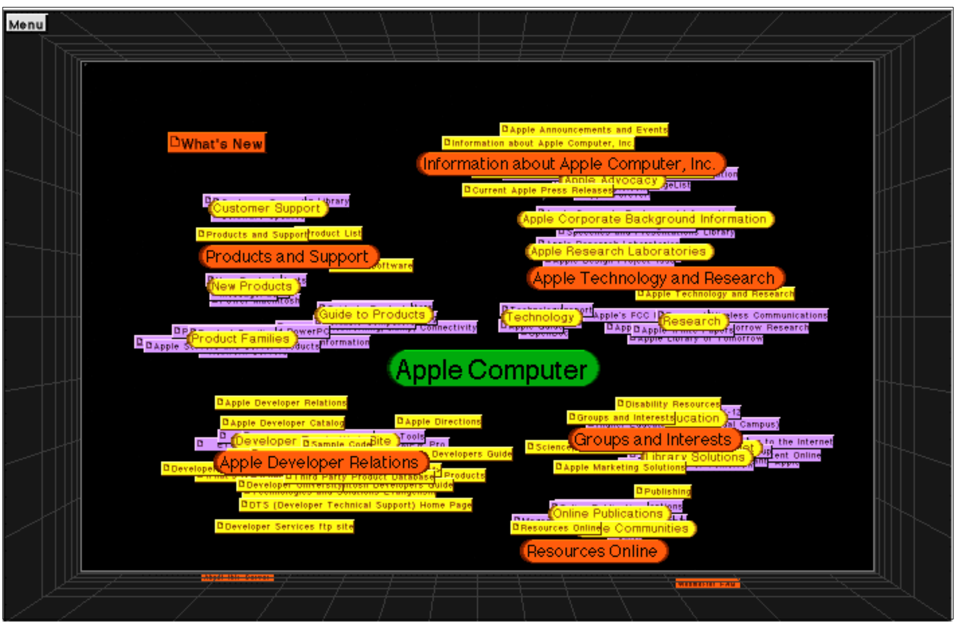
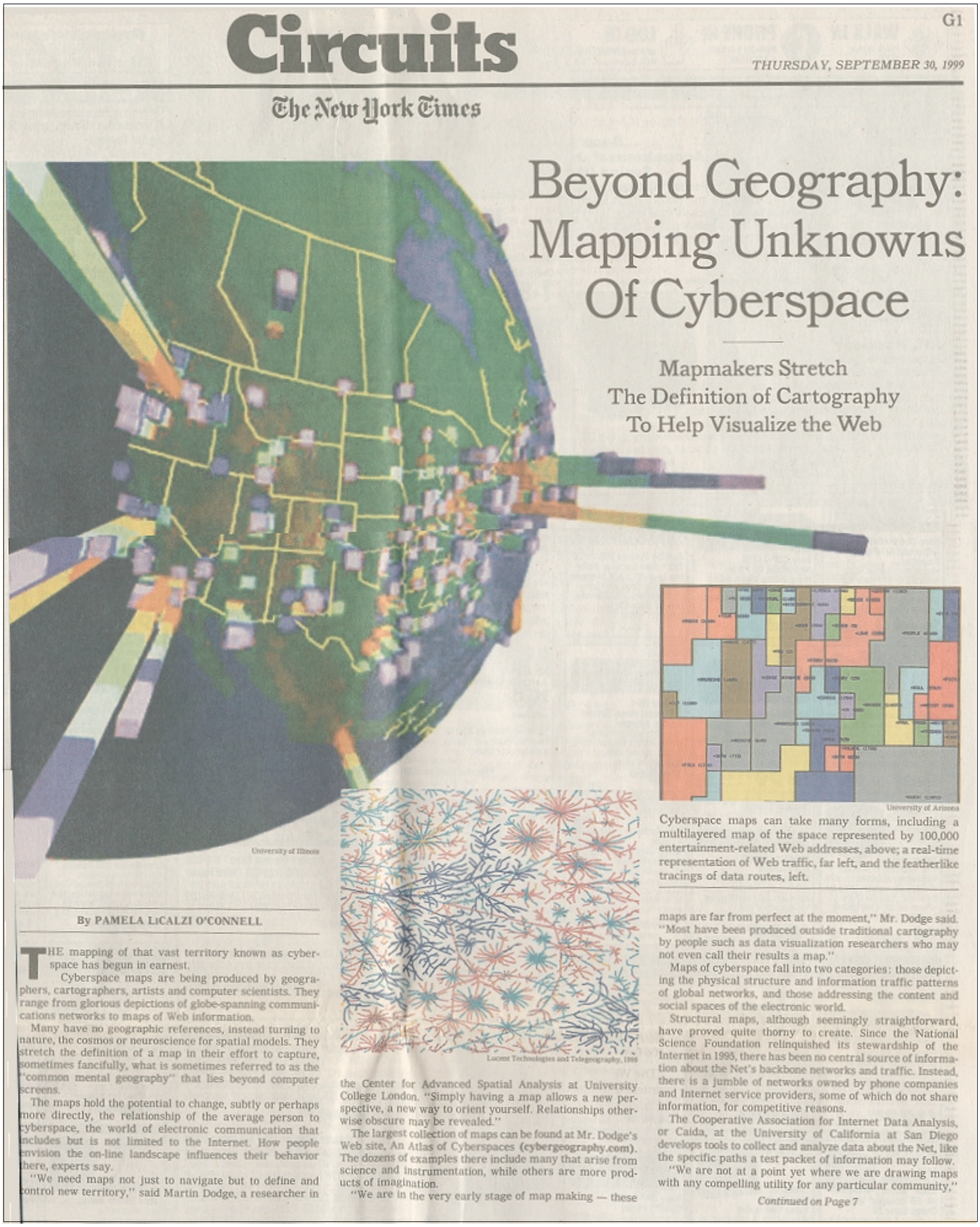


Figure 3.5: A screenshot of the Hotsauce fly-through interface to web sites produced in the mid 1990s by Ramanathan V. Guha while working at Apple Research. It was an experimental three-dimensional abstract representations and illustrates the degree to which 'maps for cyberspace' mode stretches beyond cartographic conventions. As a workable navigation map it was a failure. (Source: author screenshot.)



G1

Circuits

THURSDAY, SEPTEMBER 30, 1999

The New York Times

Beyond Geography: Mapping Unknowns Of Cyberspace

Mapmakers Stretch The Definition of Cartography To Help Visualize the Web

University of Illinois

Lucent Technologies and Telegeography, 1999

University of Arizona

Cyberspace maps can take many forms, including a multilayered map of the space represented by 100,000 entertainment-related Web addresses, above; a real-time representation of Web traffic, far left, and the featherlike tracings of data routes, left.

By PAMELA LiCALZI O'CONNELL

THE mapping of that vast territory known as cyberspace has begun in earnest.

Cyberspace maps are being produced by geographers, cartographers, artists and computer scientists. They range from glorious depictions of globe-spanning communications networks to maps of Web information.

Many have no geographic references, instead turning to nature, the cosmos or neuroscience for spatial models. They stretch the definition of a map in their effort to capture, sometimes fancifully, what is sometimes referred to as the "common mental geography" that lies beyond computer screens.

The maps hold the potential to change, subtly or perhaps more directly, the relationship of the average person to cyberspace, the world of electronic communication that includes but is not limited to the Internet. How people envision the on-line landscape influences their behavior there, experts say.

"We need maps not just to navigate but to define and control new territory," said Martin Dodge, a researcher in the Center for Advanced Spatial Analysis at University College London. "Simply having a map allows a new perspective, a new way to orient yourself. Relationships otherwise obscure may be revealed."

The largest collection of maps can be found at Mr. Dodge's Web site, An Atlas of Cyberspaces (**cybergeography.com**). The dozens of examples there include many that arise from science and instrumentation, while others are more products of imagination.

"We are in the very early stage of map making — these maps are far from perfect at the moment," Mr. Dodge said. "Most have been produced outside traditional cartography by people such as data visualization researchers who may not even call their results a map."

Maps of cyberspace fall into two categories: those depicting the physical structure and information traffic patterns of global networks, and those addressing the content and social spaces of the electronic world.

Structural maps, although seemingly straightforward, have proved quite thorny to create. Since the National Science Foundation relinquished its stewardship of the Internet in 1995, there has been no central source of information about the Net's backbone networks and traffic. Instead, there is a jumble of networks owned by phone companies and Internet service providers, some of which do not share information, for competitive reasons.

The Cooperative Association for Internet Data Analysis, or Caida, at the University of California at San Diego develops tools to collect and analyze data about the Net, like the specific paths a test packet of information may follow.

"We are not at a point yet where we are drawing maps with any compelling utility for any particular community,"

Continued on Page 7

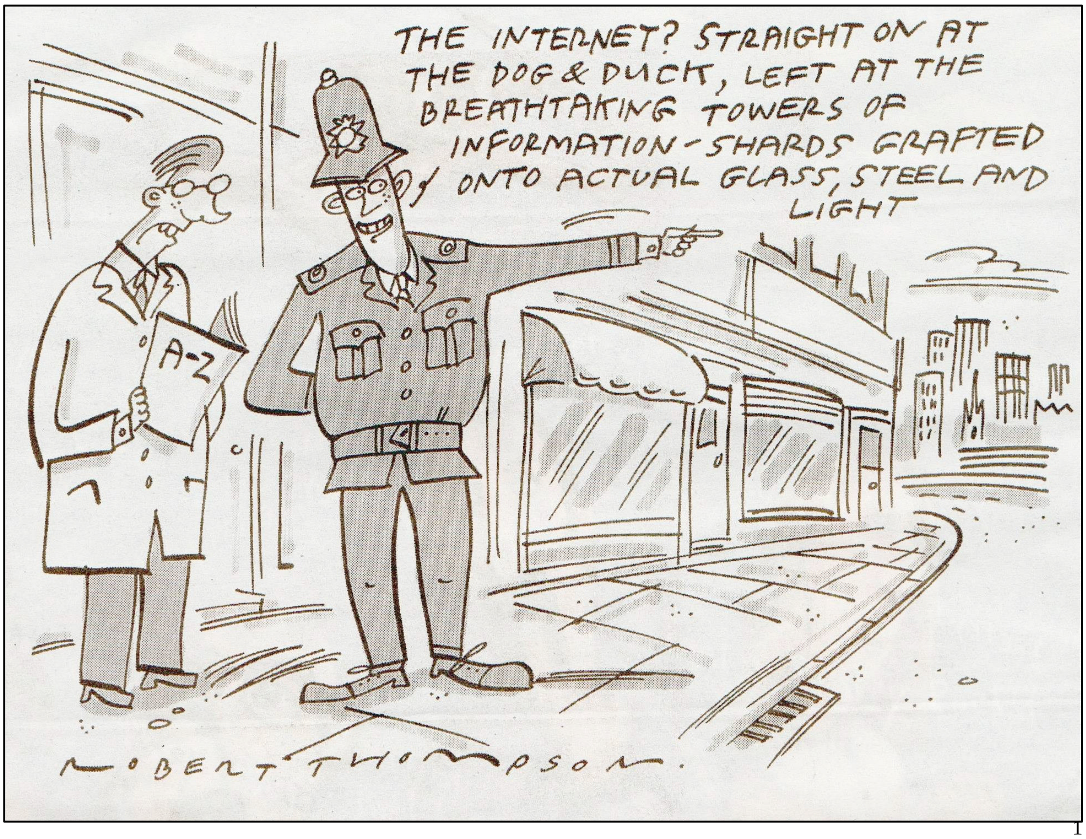
Figure 3.6: The first page of a major story in the *New York Times* Circuits section that publicized the notion of cyberspace cartographies in September 1999. (Source: O'Connell 1999.)

Figure 3.7: The front page of the *Atlas of Cyberspaces* web catalogue. The links on the left-hand side represent the high-level taxonomy of cyberspace cartographies presented on the site. (Source: <www.cybergeography.org/atlas>.)

Figure 3.8: An archived version of the original public announcement of the *Atlas of Cyberspaces*, posted to the comp.infosystems.gis newsgroup in March 1997. Note, the URL given for the site on the UCL Geography Department's server is still valid as one of mirror version of the Atlas. (Source: <www.google.com/groups>.)

Chapter 4

Imagining Internet Infrastructures: Geographic Metaphors and Scientific Inscription



[1]

1. Introduction: Explaining what the Internet looks like

There are several kinds of spatial imaginings that has been exploited to establish the Internet as something 'real', to prove the 'matter of fact' existence of its infrastructure to different audiences, by explaining 'what the Internet looks'. These are significant in how they work to overcome the problem of invisibility of the Internet as an infrastructure. How do you explain the Internet when you cannot touch it?

Imaginings of infrastructures were particularly prevalent in the first half of the 1990s when the Internet emerged rapidly as a new social-technical phenomena in advanced capitalist countries and needed to be 'explained' in an accessible ways to majority of

[1] (Source: Robert Thompson, *The Guardian*, Online section, 29 March 2001, page 4.)

people who had not experienced it for themselves. This was especially so because the Internet as a entity has no singular, manifest representation. Unlike transportation and telecommunications there is no one material object that unambiguously signifies the Internet. Further complicating the matter, the Internet is often typified as a place rather then an object or media (as illustrated by the cartoon above). Early in the Internets' entry into the public consciousness, it had an imaginal malleability as people had no fixed conception of what it was, how it worked, whether it was valuable to them, or whether they could trust it. As a result the influence of particular spatial metaphors, geographic representations and scientific inscriptions in shaping perceptions was strong.

In this chapter, I consider how different types spatial imaginary of the Internet have been deployed to overcome infrastructural invisibility and work to forge the disparate and fragmented networks into a unitary entity that could be trusted. This imaginary is are examined in two broad categories, firstly, for the general audiences, the range of verbal and visual geographic metaphors deployed is considered. Secondly, for the research-engineering audiences, I examine the role of scientific inscriptions in constructing facts about the Internet's structure and operations. To begin, I unpack the nature of Internet's invisibility.

1.2 Internet 'invisibility'

There are several dimensions to the invisibility of the Internet: firstly, the unseen, ignored and hidden materially of the wires and computers; secondly, the transparency of network activities and lack of tangible experience for users; thirdly, issues of rapid social naturalisation and the 'taken-for-granted' banality of technical systems; and lastly, the conscious occlusion through institutional normalisation within the wider neo-liberal political economy. I outline each of these dimensions in turn.

(i) Materially unseen:

The first dimension of invisibility is that network hardware for data transmission is largely unseen in the everyday urban landscape, especially in comparison to the materiality of other communications systems (roads, railways, airports, postal mail and the like). The Internet as infrastructure is very briefly visible as fibre-optic cables are rolled out in the streets, but is quickly subsumed beneath roads and pavements.

The ‘wires’ of the Internet are almost universally routed subterraneously (Figure 4.1). The Internet is also dematerialising further as the actual wires are replaced by wireless transmission using electromagnetic spectrum that invisibly carries data unfelt through buildings and bodies.

<Figure 4.1 about here. Utility graffiti photo.>

The infrastructure at the ends of the wires, the network switches and computer servers, have a small physical footprint, and are usually hidden away in unmarked service spaces and anonymous secure, windowless buildings. Other supporting hardware elements vital to ongoing Internet production, such as air-conditioning and backup power supplies, are separated from people by being located in basements or on roof tops. For all the hype surrounding the Internet it has remarkably little impact on the industrial landscape. Beside vision, the infrastructure of the Internet is ‘unseen’ in other ways. For instance, tangible or noxious externalities are minimal - the Internet as an infrastructure does not produce noise pollution or olfactory offence[2].

In addition to being out-of-sight and relegated to non-human serving spaces, other elements of the network hardware that are manifestly visible in the landscape are effectively made invisible because they are mundane (‘invisibility by being ignored’) or because they are not associated with the operation of the Internet (‘invisibility by misconception’). For example, the wiring cabinets[3] aggregating customer telephone lines, which are vital to ‘last-mile’ Internet distribution, are a common sight on pavements but are an anonymous and unmarked part of street furniture.

The material invisibility of the Internet is being actively encouraged in some quarters as part of more recent cybersecurity initiatives in which critical and vulnerable elements of the infrastructure are thought to be best protected by being kept anonymous and secret (Gorman 2004). Such ‘security through obscurity’ by leaving

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[2] Also, the negative externalities of manufacturing I.T. hardware are concentrated and distanctiated from the affluent places of consumption as a consequence of global supply chains. The disposal of computing equipment is also highly polluting, but again is hidden from view of most people (see BAN 2002).

[3] In the UK, British Telecom has some 90,000 such ‘primary cross-connection point’ cabinets. They are usually painted an unassuming green colour, see <http://www.btplc.com/Thegroup/Networkstory>.

important places deliberately undocumented has a long tradition, including in the production 'rules' of state cartography (see Harley 1988b).

It is not only the ongoing hardware production of the Internet that is unseen, at the infrastructural level what is carried by data networks is entirely invisible in a phenomenological sense. Unlike, cars on the road, trains on the track, or letters in the mail, the packets of data flowing through the Internet do not exist at the analogue scales of human senses. Bits (binary digits) of data are composed of discrete states of energy propagated at various wavelengths (light, radio, microwave, and so on) and have "no colour, size, or weight, and can travel at the speed of light ... [they are] a state of being, on or off, true or false" (Negroponte 1995, 14). While the bits are easily interpreted by software, they must be rendered through interfaces for people to comprehend. It is, therefore, not possible to observe the operation of the Internet unmediated.

(ii) Transparent in use:

At a higher level than traffic flows, the Internet is also 'invisible-in-use' because data networks are intangible in terms of consumer experience. In conventional transportation infrastructures, passengers and drivers have innate and phenomenological knowledge of the networks through the journey experience. They comprehend the materiality of the infrastructure by kinaesthetic interaction with cars, trains and planes - the direct 'seat of the pants' feel of the network. Telecommunications, in their inherent virtuality, are completely lacking such experiential comprehension. The *lack* of human touch defines *tele*-communications.

No knowledge of the Internet as infrastructure is gained from browsing the Web for example, it gives off no physical sensations. The majority people on the Internet are never aware of the vast infrastructure they are utilising because it is consciously hidden from them, behind software interfaces. Such infrastructural concealment is seen as a good thing by the industry - it is described as the 'network being transparent to the user'[4]. A key part of the technicity of the Internet has been its ability to provide seamless, end-to-end, communications services so that users do not have to worry about the structure of the underlying networks and the complex ways traffic is transmitted. Indeed, one might argue that the Internet could only become such a successful and widely used media of communication once its arcane technicalities were rendered sufficiently invisible to novice users, through developments such as the Web browser.

Moreover, a large cadre of computer science researchers, engineers and industrial designers are striving to greatly increase the degree to which computers and the Internet fade in the fabric of everyday activities. Working under the banner of pervasive computing they striving for systems that are "so imbedded, so fitting, so natural, that we use it without even thinking it" (Weiser 1991, 94). Scholars in this area (e.g., Norman 1998) argue that current ICT use, is in fact, far from transparent, requiring too much cognitive effort to achieve the desired results. The promise of nomadic, always-on access through wireless mesh networks will, advocates argue, make the Internet as invisible and ubiquitous as air.

(iii) Disappearance by social naturalisation:

> The conduct of daily life surely demands a tactical lack of curiosity! But that lack of curiosity carries costs and overhead expenses as well as benefits.
>
> -- Wieve E. Bijker and John Law, *Shaping Technology/ Building Society*, 1992.

As well as being materially unseen and intangible in use, probably the most effective way that Internet infrastructure is made invisible is through the subtle disappearing from people's consciousness. As is well noted by scholars interested in the social shaping of technology, once an infrastructure becomes commonplace, people do not much care for how it was produced, they exhibit "a tactical lack of curiosity" according to Bijker and Law (1992, 2). It becomes a 'taken-for-granted' feature, fading into the background of everyday life.

[4] Transparency in this sense means that infrastructure "does not have to be reinvented each time or assembled for each task, but invisibly supports those tasks" (Star and Bowker 2002, 152); the archetypal of this in developed countries is domestic electricity supply.

From being a ‘novelty’ in the mid 1990s, the Internet has quickly become culturally naturalised, with email addresses and websites part of common vernacular. Concerns about ‘digital-divides’ notwithstanding, many businesses and government agencies now presume that *all* people have Internet service and are conversant with it to obtain information and perform transactions. Such everyday social-cultural familiarity is clearly bound-up with transparency in use. As infrastructures become more transparent, (and more reliable, affordable and universally available) so they morph in character from being novel conveniences to a necessary and naturally-given part the lived environment.

This is often conceived as a process of ‘black-boxing’ in which infrastructures are “treated by users as unproblematic and ‘closed’ sociotechnical artefacts that [can] be relied on without much thought” (Graham 2000, 184). One might argue that the best infrastructures are those that are so ‘black-boxed’ they are not noticed at all; they are also the most powerful, able to affect deeper or wider ranging reorganisations of socio-spatial relationships without scrutiny or resistance (again, electrical power supplies serves as an archetypal case). Indeed, one way of assessing the extent to which technologies, including the Internet, have moved ‘backstage’ and been ‘black-boxed’ is by measuring the degree of dependency people are willing to place on them. Such dependency is exposed in the disruption caused when infrastructures fail, for whatever reason (e.g., the amount of inconvenience to everyday activities caused by power cuts).

(iii) Occlusion through institutional normalisation:

Large infrastructures are produced by institutions and their ongoing production requires huge amounts of easily-overlooked organisational work (construction plans and maintenance schedules, operational staffing arrangements, business processes, technical standards, and so). Internet network are as much outcome of the institutional practices as they are the result of physical wires.

Yet institutional work tends to become normalised, bureaucratic and anonymous. Infrastructure invisibility is manufactured institutional then, by the obscure regulatory structures that makes it hard to discern sources of decision-making power, by complex pricing models that hide real costs, deliberately opaque ownership structures which make it unclear who controls companies. Ultimately, the complex institutional power structures underlying the supply of Internet into peoples home work to make it invisible.

Institutional working is itself is bound within prevailing political economy structures. Through much of the twentieth century utility infrastructures (electricity, water, telephone, transportation networks) were operated within monopolistic state ownership structures. Generally, these had clearly established remits and strong public identities for the infrastructure they managed (even if they were not well liked, e.g. British Rail). Since the 1980s this institutional unity in provision has been deliberately broken apart - so called ‘unbundling’ - through processes of marketisation, privatisation and regulatory liberalisation. Graham and Marvin (2001) characterise this shift as a ‘splintering urbanism’, arguing that it is giving rise to “‘premium networked spaces’ that are customised precisely to the needs of powerful users and spaces, whilst bypassing less powerful users and spaces” (Graham 2000, 185). Internet provision is a prime example of such premium networked spaces. Furthermore, there is a lack of constituted, agreed institutional identity for the Internet - whose job is it to keep the Internet running?

Another significant element in this invisibility of institutions owning and running the infrastructures of the Internet is the obscurity of the workers who do this work. The skilled labour force required to build and operate Internet is largely invisible, and when acknowledged they are often denigrated as just ‘technicians’ in comparison to other more attractive occupations associated with new media. This aspect of ‘hidden’ workforce in information technology is not new (see Downey 2001).

(v) Implications of infrastructure invisibility

> Infrastructure can be dullest of all topics. It can also be the most important. Infrastructure defines the basis of society; it is the underlying foundation of the facilities, services and standards upon which everything else builds.
>
> -- Donald Norman, *The Invisible Computer*, 1998.

These dimensions of infrastructural invisibility have consequences, both pragmatic and political, for understanding the nature of the Internet. Firstly, from a practical point of view it means infrastructures tend to be understudied within social sciences. They are easily overlooked by scholars and deemed to be insignificant elements in wider analysis or are seen as 'mere' technicalities without scope for socially informed research. Hillis (1998), for example, argues that infrastructure invisibility across several registers has been the key reason why communications has received scant attention by the human geography discipline[5]: "[f]or a discipline firmly rooted in an empirical and visually dependent understanding of the facts, too often, if it can't be seen 'it's not geography'." (1998, 544).

The failure of social sciences to take a serious interest in infrastructures is compounded by the lack of published and comprehensible documentation of them. This is particularly the case with the Internet, which is fragmented and often held to be commercially confidential. As an infrastructural entity the Internet is essentially made intractable because of its undocumented in major standard government statistics and general reference mapping. For example, terrestrial fibre-optic cable systems, which sustain the Internet, because they physically buried are not present as a layer in published topographic mapping (e.g., in Ordnance Survey's MasterMap product in the UK)[6]. Being unmapped in this way is, in many respects, tantamount to be invisible.

From a political perspective, critical studies infrastructures are made harder because of the ways institutions deliberately kept them as 'black-boxed' systems. The easier to keep people from easily observing (and questioning) their design and operational logics. Invisibility of the infrastructure provides an effective cloak under which dubious or iniquitous practice can be safely carried by institutions owning and operating them. The lack of critical studies of Internet infrastructure mean that can bias the ongoing production of networks in ways that widen social difference and inequalities across space. It also precludes informed discussion of ways to build and operate infrastructure differently; as Bijker and Law (1992, 3) argue technologies "might have been otherwise".

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[5] There have been some noteworthy attempts to understand the materiality and geographical embeddedness of network infrastructures, in spite of the varying dimensions of invisibility (Mitchell 1995; Graham and Marvin 1996, 2001; Townsend 2003).

[6] Utility engineering departments do have facilities maps showing pipe and cable routes but these are typically not available to the public and in many cases are incomplete and of varying degrees of accuracy.

2. The role of verbal and visual metaphors

The generation of popular explanations of the Internet involves the classification and conceptualisation of an unfamiliar phenomenon (i.e., extensive but invisible infrastructures which support novel forms of interactive media) into a set of well-known categories. This process can be effectively accomplished using metaphors, which constitute an important and pervasive form of figurative speech, fundamental to human language and which structures cognitive experience (Lakoff and Johnson 1980). Here I consider verbal metaphors first, followed by a discussion of common visual spatial metaphors, used to represent, imagine and 'explain' Internet infrastructure, and thus, at least in part, overcoming its multidimensional invisibility.

2.1 Spatio-linguistic metaphors

> The expanding lexicon of the Internet ... is not only replete with, but actually *constituted* by, the use of geographical metaphors.
>
> -- Stephen Graham, *The End of Geography or the Explosion of Place?*, 1998.

Metaphors are linguistic tools that facilitates understanding of a unfamiliar subject by bringing another, more familiar, concept in conjunction with it. According to Lakoff and Johnson (1980), metaphoric schemas ground the conceptual structures of a novel domain (target) to a known, physical one (source). The metaphor works as a transfer of concepts from source to target, in which the transferred, familiar concepts interact with the new unfamiliar context, highlighting its nature and producing effects in terms of potential shifts in meaning. As Sawhney (1996, 292) argues, metaphors "create a 'stereoscopic vision' which allows for simultaneous viewing of an idea from two or more points of view." The unfamiliar motorcar when it first appeared in 1880s, for example, was explained as a horseless carriage; grounding the unknown by proposing that it seen as being like the known. The insight generated by a well chosen metaphor comes from the point of *interaction* between the familiar and unfamiliar concepts. Metaphors create an image that usually far from the actuality of the subject - for example the reality of Internet access via dial-up in the early 1990s modems was at odds with 'highways' metaphors - and yet effective metaphors can pervade the popular imagination through reproduction in the media, being endlessly circulated and refined, so that they become a natural and invisible part of language. Further metaphors become part of the defining cultural contexts of communication and play a major role in the legitimisation of certain social values and denial of others. The choice of metaphor can reveal as much about the speaker as what they are actually talking about.

Metaphors can work as self-fulfilling prophecy in which the phenomena so described gets progressively remade to fit its dominant metaphor. “The metaphors that are used to study an emerging technology”, Sawhney (1996, 293) notes, “usually end up influencing the shape it takes.” This can be seen for example in the legal frameworks enacted to regulate Internet based in significant part on metaphors from a transportation context relating to physical movement of goods (see below). The conceptual framework from which particular metaphors are drawn is important because they impart certain properties and favour certain implications. Contrast, for example, conceptualising Internet infrastructure as a media with incumbent range of broadcasting metaphors instead of the more utilitarian transportation one.

Metaphors must, therefore, be read as political because their linguistic power can effect social change in how a new phenomena is perceived in the service to certain interests. Adams (1997, 156) calls this effect a “cognitive jolt” that makes people stop and think in a new way, and it can be used to destabilise accepted norms. Metaphors can are also deployed persuasively to contain and normalise threats to powerful interests from new phenomena, such as a disruptive technology like the Internet. Metaphors then are a contested domain of political action because they effect how people talk about the world which effects how they relate to it.

Internet ‘explained’ through spatial metaphors

In circumstances where there is “high uncertainty, missing data, unclear goals and poorly understood parameters” (Klein 1987 quoted in Sawhney 1996, 292), the most productive means of explanation of a new technology can often be through metaphors and analogies. This was the case with the Internet in the early 1990s when the Internet was in its social ‘discovery’ phase of development in Western consumer societies. It is important to think about the politics laying behind the work metaphors were being asked to do at this time.

Metaphors from many different conceptual frameworks have been actively deployed to characterise the Internet. For example, the Internet as a living organism (such as a tree, a body or brain); the Internet as a city (with streets, towns halls and suburbs); the Internet as a market (with online shops, virtual money, and e-trading); the Internet as writing (with its letter metaphors of email, addresses and signature files); the Internet as an archive (the ultimate book of knowledge). The map and mapping practices related to navigation were themselves a prime source of metaphors for explaining the Internet. Metaphors from multiple domains were employed simultaneous, often in competition to dominate a discourse. The result was a confusing ecosystem of metaphors and analogies (see Palmquist 1996), being combined together and clashing against each other in interesting, sometimes creative ways (e.g. the notion of information presented as a ‘Web page’ combines the organic framework with a book bound analogy).

Each of these metaphoric domains highlights certain aspects of the Internet, downplays others and hides others. Some clearly owe allegiance to Americentric domination of the Internet’s infrastructure development and media-driven popularisation; for example the large number of ‘frontier’ related metaphors. (This metaphoric domain is seen as foundational to American cultural myths, pregnant as it is with complex connotations of social autonomy and political conquest, see Adams 1997.)

Besides, the ‘frontier’ metaphors, another noteworthy collection of spatial metaphors applied to the Internet use familiar architectural places (e.g., library, shops, farms, etc). Others characterise the Internet in terms of container-like space (e.g., rooms, sites, malls, communities, cities, spheres, worlds and, of course, cyberspace itself). The metaphors in the container-spaces framework are somewhat more abstract than others, but have nevertheless proved to be particularly potent in defining the Internet as a territorial system, with discrete locations and a bounded sense of inside / outside.

Metaphors built around architectural places are also very common, subtly suffusing throughout Internet imaginary. Familiar domestic environments of the home and work have been metaphorically co-opted to give concrete cognitive forms to invisible Internet infrastructures and its intangible media (homepages, digital libraries, virtual classrooms, server farms and so on). There are almost endless combination of them and they have been nested together by function or linked thematically. Internet evangelist Howard Rheingold, who was the lead propagator of the 'virtual communities' (itself a potent metaphor), gave a vivid description in the early 1990s, of the social forms of part of the Internet by layering together multiple architectural-place metaphors:

> "… a place for conversation or publication, like a giant coffee-house with a thousand rooms; it is also a world-wide digital version of the Speaker's Corner in London's Hyde Park, an unedited collection of letters to the editor, a floating flea market, a huge vanity publisher, and a collection of every odd special-interest group in the world." (Rheingold 1993, 130)

A thorough application of architectural imaginary to metaphorically 'explain' the nature of Internet infrastructures is given in the writings of William Mitchell (dean of the architecture school at MIT). His influential book *City of Bits* (1995) published in the midst of the Internet 'take-off' was one of the first to analyse the significance emerging Internet infrastructures for the built environment. Mitchell's (1995, 107) thesis claimed that "[c]omputer networks [will] become as fundamental to urban life as street systems. Memory and screen space become valuable, sought-after sorts of real estate." The highpoint of such urban-centred metaphors came in the mid 1990s with popularity of 'virtual cities', some of which were 'grounded' with real-world equivalents while others were purely imaginary (Graham and Aurigi 1997).

The widespread application of such architectural and city metaphors clearly has utility in making foreign media-based environments feel familiar, yet they are not innocent (mere convenient linguistic device). The over-reliance on such metaphors, Graham (1998, 167) argues "actually serves to obfuscate the complex relations between new communications and information technologies and space, place and society". How far is a digital library really like a 'real' library for example, in relation to issues of access, usability and privacy. More subtly, these metaphors bring with them the oppressive potential of manmade environments, with their established power geometries of ownership and rules of access and exclusion. As Adams (1997, 167) notes: "We might worry that the primary function of virtual architecture would be a kind of containment, in which there were no longer an 'outside' and populations were everywhere contained and subjugated."

Beside place-based 'nouns' to describe the forms of the Internet, the action of using the network is frequently described using spatial 'verbs' of physical movement and embodied travel. The lexicon of such metaphors includes: surfing, navigating, exploring, homesteading, settling. (They are quite different from ways of describing other media use, e.g., book reading.) These metaphors of movement also encompass spatial notions of following paths, getting lost, hitting dead-ends and the discovery of new places. Online activity draws from "every imaginable environmental situation, suggesting not simply a virtual place but an entire virtual geography" (Adams 1997, 155).

Closely allied with the spatial metaphors of movement used to explain participation in computer networks, are the transportation oriented metaphors of pipes, routes, rails and, especially, roads used to analogise data flows. Transportation metaphors conceptualise the wider effects of the Internet infrastructure not as a virtual territory but as a means to *traverse* real territory, typically at great speed. The implication of this metaphoric approach to infrastructure, is that Internet's role is primarily about improving efficiency in shipping data. (Data itself is treated as a bulk commodity to be rapidly moved from point-to-point.) The most common of these traversal metaphors is, of course, the 'information superhighway' which coupled the nascent Internet directly with ingrained American notions of automobility. At the end of 1993 the highway metaphor was invoked directly as a political ideal of what the Internet should become, as then U.S. Vice President Al Gore asserted: "Today, commerce rolls not just on asphalt highways but along information highways" (Gore 1993, 3).

Coming from a strongly techno-utopianist perspective, Gore championed a vision of universal public access to Internet, explaining that a helpful way to think about such an infrastructure was as "a network of highways -- much like the Interstates begun in the '50s. Highways carrying information rather than people or goods" (1993, 5). Although these new 'information highways' would be built by private capital, the clear analogy with road infrastructures of the past implied that the government had a positive social remit to oversee development of the Internet to ensure equality of provision. Furthermore, the government had a duty to set the framework of the market (equivalent to the highway code) to insure "there will be a 'public right of way' on the information highway" (Gore 1993, 10), rather than a private networks such as cable television.

The 'information superhighway' metaphor proved to be a potent choice and it quickly grew to be one of the dominant metaphors applied to explain the Internet infrastructure in the mid 1990s, endlessly promulgated in media coverage and in government reports[7]. While the socially progressive goals of Gore's vision were clearly articulated, the choice of the highway metaphor itself imposed distinctly instrumental notions on the future shape of network infrastructure: it would essentially be a flat hierarchy, accessible only at certain junctions, with people as passive drivers only able to go in certain directions[8]. Highways are, after all, built for efficiency and this has been paralleled in the Internet's subsequent development As such the 'superhighway' had a "strong aura of linearity" (Sawhney 1996, 304) and can be read as an extension individualistic economic model over the communitarian one that dominated much of the Internet's development in the 1980s (emphasised, for example, in Rheingold's deployment of the 'virtual community' metaphor). Sawhney (1996, 307) argues that at its heart, the highway metaphor is reductionist - "[t]he ritual or the communal aspect of human communication is almost totally neglected" in favour of maximising the transfer of information.

The subsequent demise of the 'superhighway' as a meaningful explanation of the Internet shows how metaphors are contingent, partial and contestable[9]. By the end of the 1990s the 'superhighway' had become thoroughly cliché moniker and was being used most often in a derisory sense. It was also deployed counter-factually as commentators pointed up the reality of network 'dirt tracks' outside the developed core in discussion of digital divides (see chapter six). As Sawhney (1996, 300) notes:

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[7] The British Library catalogue lists 71 books which contain the phrase 'information superhighway' in their titles. Thirty-four of these books were published in 1995.

[8] Interestingly, this passivity was itself subverted metaphorically when commentators argued users should be allowed the freedom to 'go off road'.

[9] Of the 71 books with 'information superhighway' in their title catalogued by the British Library, only four have been published since 2000.

“The initial metaphors basically function as provisional hypotheses which can be held only as long as the facts permit”. As more people experienced the Internet first hand, and used it productively for everyday tasks, the appeal of the ‘highway’ metaphor waned to be replaced by organic metaphors of Web environments and social software.

2.2. Visual metaphors for Internet infrastructure

Metaphors are not just verbal constructs, they can equally be fabricated through visual imagery. Given that much of modern experience is constructed ‘second-hand’ through visual media and marketing imagery in print and on screen in many respects visual metaphors enjoy even greater political significance in defining ‘what the Internet is like’ than their verbal counterparts. This is well realised by designers of advertising (see De Cock *et al.* 2001; Goldman *et al.* 2003).

As noted in the introduction the Internet lacks a single, obvious, physical representation that people experience for themselves which could be moulded into its defining visual metaphor[10]. Metaphoric uncertainty on the ‘natural’ visual shorthand for the Internet for a general audience is apparent, for example, in newspaper coverage in the 1990s that juxtapose different image types. A significant proportional of these visual metaphors called upon explicitly spatial constructs to make the Internet appear as a tangible entity or to place it within familiar geographic contexts. Here, I present a interpretative analysis of significant types of visual metaphor that imagined the Internet infrastructure as (i) a network of wires, (ii) as flow around the globe, (iii) as machines for moving objects, and lastly, as (iv) abstract clouds and organic-looking graphs.

(i) Wiring visions:

The commonest visual analogy to explain the Internet as a spatially extensive infrastructure is a physical network of wires. Very often this imagery uses arc-node route lines plotted on top of a geographic base map. As such they are part of a lineage

[10] Here, I am distinguishing the Internet as an infrastructure, from the consumption of particular Internet services. The Internet as a service is typically represented visually screenshots of media interfaces, such as websites ‘in action’ (e.g., e-commerce was often ‘explained’ metaphorically by a visual image of Amazon.com’s homepage).

of sketching the pathways of human movement stretching back throughout cartographic history to the earliest maps scratched in the sand. Route maps have been applied to telecommunication systems since they emerged in the mid nineteenth century. As a visual analogy they demonstrate the material reality of the infrastructure in relation to a familiar and trusted geographic backdrop.

The ‘wires-on-the-world’ visual analogy also underlies many ‘maps of cyberspace’ produced (see chapters five). They can be produced at different scales, from local maps in the form of wiring schematics for a neighbourhood or an individual corporation, up to global maps of transcontinental cable systems (e.g., see Figure 7.3). National and global scale maps of infrastructure are frequently produced as part of network marketing (see chapter seven). The level of realism in plotting the routes of lines can also vary. In many network maps the routes are logical links between end nodes and bear no relation to the pathway of the cable on the ground. Increasing the degree of generalisation of route lines morphs the Internet from conventional geographic network mapping into variable scale-distortion subway maps and non-geographic circuit diagrams (Figure 4.2).

<Figure 4.2 about here. InterRoute European subway map>

Attempts have also been made to increase the visual impact of Internet infrastructure maps by stringing the wires in three dimensions. One the best known example is the NCSA visualisation of the NSFNET network backbone (Figure 4.3 top). The network is imagined glowing white hot with pulses of data-light in the inky dark sky, a powerful presence radiating connectivity down to the nation. This striking image has been widely circulated and reproduced.

The NCSA visualisation is also interesting as it blends together the iconography of the engineers node diagram with thematic display of statistical mapping. The connecting lines from ground to network in the sky are colour coded to indicate the volume of traffic flowing from individual sites onto the network. Showing flows rather than just the wire routes of a network opens up many possibilities for metaphoric invention.

Another visualisation from the mid 1990s illustrates well the potency of visual imaginary to capture the essence of the Internet by displaying real flow data in three-dimensions (Figure 4.3 bottom). The ‘arc-trans’ map of global traffic flows imagines the Internet as a set of fountain-like arcs of light traversing the world. The colour, link style and height of the arcs encode statistical information. It important to realise the arcs are not network links but cartographic symbols plotted between capital cities to represent inter-country traffic flows.

Of all the maps and diagrams catalogued in the *Atlas of Cyberspaces*, the ‘arcs-across-the-world’ metaphor at the heart of this image is far and away the most requested one for reproduction. In this manner, a few of most the visually impressive and compelling maps begin to define how the actual infrastructure of the Internet is perceived. Yet, it is not an innocent image, as Harpold (1999, 5) points out, the underlying metaphor draws its energy from “visual discourses of identity and negated identity that echo those of the European maps of colonized and colonizable space of nearly a century ago.”

<Figure 4.3 about here. Top - NCSA visualisation; Bottom - Eick Arc Trans map.>

(ii) Global visions:

The earth globe is a dominant visual metaphor in Western contexts. The capability to command global vision is intimately associated with modernist culture. The globe has symbolic power because “we all assume for ourselves the position that most peoples have historically reserved for God. No longer confined by the local worlds of our direct experience, the conception of the globe allows us to make geography, for us to predict and then to discover new spaces, new worlds, new peoples” (Cosgrove 1989, 13). The globe has become integral in the imagery of many elements of corporate capitalism (e.g., aviation, telecommunications), as well as the key icon for the environmental movement (the ‘Whole Earth’ idea) (Cosgrove 1994). Universally displayed, often to the point cliché, it is *the* iconic symbol of a business or institution with world-wide operations or aspirations. The global perspective, derived directly from the arms-race technical capacities in satellite monitoring, is also bound up with militaristic gaze of command and control.

The globe as a visual metaphor is immediately recognisable[11]. It has become a staple visual metaphors for the Internet with network arcs or data flows being wrapped around the world (good example from visualisation literature include Cox *et al.* 1996; Lamm *et al.* 1996; Munzner 2000). Globes were used on a poster called Internet World, produced by Peacock Maps in 2001. Three views on the Earth show curving lines between capital cities to represent the available Internet bandwidth. The height of the arcs above the surface of globe is a function of distance. The imaginary view of Internet, as if seen from a God-like position, with a dense mesh of arcs criss-crossing the USA from coast to coast, along with higher, longer transcontinental tunnels curving around the globe. The points on the globe *without* arc are evident as well. [MORE?]

<Figure 4.4 about here. Peacock Maps Internet World poster>

(iii) Machinic visions:

In a very different mode to maps and globe, the Internet has also been spatially envisioned as a machine with working parts which handle and transport items of data. Representing the Internet through such mechanical metaphors can be helpful in an educational context (e.g., see Gralla 2003). The simplest of these approaches use of photographs of actual network hardware cables or iconic images of equipment. These visual elements are sometimes presented as a systems model showing conceptually how a message is transported - what I call a ‘tin cans and string’ diagram (Figure 4.5).

<Figure 4.5 about here. Tin cans and string diagrams.>

More elaborate machinic metaphors imagine a ‘world-in-miniature’ inside the Internet. For example *Warriors of the Net*, a short animated film, shows in a jovial, non-technical way, how the Internet works internally by following the journey of data packets through different parts of the infrastructure (Elam 1999). Its underlying

[11] It is also highly functional in graphic design terms because it can be rendered in myriad forms from an naturalistic ‘blue planet’ to a very stylised image conjured forth by a sparse grid of curving lines.

metaphor shows an industrial environment of grimy metal and of noisy machines - a 'steampunk'[12] imaginary, rather than slick, clean cyber-infrastructure of digital electronics and fibre-optics (Figure 4.6).

<Figure 4.6 about here. Warriors of the Net stills.>

Rather than just imagine infrastructure spaces in mechanical terms, others have actually created physical machines to model the Internet's concept. For example, Japanese media artist Kouichirou Eto created 'a hands-on model of the Internet' that simulates physically the form of digital bits and data routing. As he succinctly notes: "Balls roll, and the workings of the Internet are revealed."[13]. Infrastructure is thus made tangible as an analogue clockwork model, a real spatial metaphor of the Internet that people can see, hear and touch (Figure 4.7).

<Figure 4.7 about here. Japanese physical internet.>

The metaphoric use of the movement of real machines to suggest the invisible workings of the Internet is also common. The power and speed of flows of data through network has often been suggested by visual images of blurring vehicle lights on highways or a soaring flight over a city at night for example. The feeling of physical movement experienced by the viewer captures the idea of flow through networks. For example, Goldman *et al.* (2003, no pagination) highlight a MCI WorldCom advert using this kind imagery, noting: "Here is the cyber-scape of the moment, not simply a symbol of a future that is upon us, but a functional conduit, the veins of a network that like a river flows through us, connecting us." Intertwined with evocative imagery of movement and the power of raw speed is the utopian message of transcendence over the tyranny of place and time, commonly used in promotional rhetoric of the 'New Economy' (De Cock *et al.* 2001).

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[12] The visual aesthetic of 'steampunk' (named after the cyberpunk genre of science fiction) imagines advanced societies based on machinery (usually steam powered) rather than micro-electronics. A classic steampunk novel, *The Different Engine* (Gibson and Sterling 1992), imagines a world with computers built from mechanical parts rather than silicon chips.

[13] Source: <http://eto.com/2001/PhysicalInternet/>.

(iv) Abstract visions:

The last category of spatial metaphors envision the Internet's infrastructures in a very much more abstract way. They draw on naturalistic iconography of organic structures (fractal branching of trees and leaves, structured lattices and webs, the fine filigrees patterning of brains or lunges) and emergence aesthetics redolent of meteorology and astronomy (cloud patterns, glowing gas nebulas and star clusters).

The simplest and most common genre of abstract visual metaphors is the cloud (Figure 4.8). Curiously cloud diagrams are ubiquitous in the Internet literature as a visual shorthand for infrastructure, particularly favoured in technical 'explanations' as they allow the author to signify the Internet as a object without needing to spell out the detail. As such they are a useful envisioning metaphor precisely because they obscure the infrastructure's heterogeneity and topological complexity: "the cloud's main usefulness lies in its vagueness, like cyberspace" (Gibson quoted in Scanlon and Wieners 1999). Clouds can be quickly sketched and are instantly recognised, and "[a]sk the founders of the Net about the cloud, and it quickly becomes apparent that the Net cloud is as old as the Net itself" (Scanlon and Wieners 1999).

<Figure 4.8 about here. Montage of clouds.>

Computer scientist and network researchers have produced many other abstract visual representations of the Internet that try to show the full complexity of the infrastructure rather than hide it inside cartoon clouds. These images, created by and for technoscience elites, tend to be amongst the most elaborate and visually dramatic representations of the Internet (e.g., Figure 3.2). They use graph-like network representations to show the topology of connections and are distinct from the wiring metaphors using geographic 'arc-node' links examined above. Even though their construction and use are avowedly technical, some have resonated with wider publics as 'artistic' renderings of the Internet.

The outstanding example of this genre emerged from the research of Bill Cheswick and Hal Burch[14]. Their technoscience visualisation is noteworthy in normative

[14] Begun in 1998 as a research project at Bell Labs - Lucent Technologies and subsequently continued as a part of commercial venture Lumeta, <www.lumeta.com>.

aesthetic terms, but also politically, in terms of the impact it has had on how the infrastructure has subsequently been imagined. Automatic surveying of the topology of thousands of interconnected Internet networks provides raw data that is visualised as huge, complex, multi-coloured graphs (Figure 4.9). The layout algorithm uses simple rules, with forces of attraction and repulsion jostling the nodes into a stable configuration that looks distinctly (Branigan *et al.* 2001); and this is done within abstract space because as Cheswick notes: “We don't try to lay out the Internet according to geography ..... The Internet is its own space, independent of geography”.

<Figure 4.9 about here. Cheswick - Burch graph.>

Indeed, the power of the metaphor underlying the Cheswick-Burch graphs derives directly from this evolved, organic look - this is what people in some senses *expect* the Internet to like now. Their results have been variously described as a peacock’s wing, a human lung or a coral reef. These graphs have been widely circulated, including being sold by Peacock Maps as large wall posters proclaiming to show the ‘Whole Internet’[15], used on book covers[16] and featured in art galleries and as exhibits in science museums (Branigan *et al.* 2001).

Another interesting point in terms of the wider implications of these graph metaphors is the number of people who assume that they shows the endogenous characteristics of the Internet infrastructure itself. In fact all the visual properties of the graphs (geometry of the lines, their spatial arrangement, colours, etc) are exogenous to the phenomena being mapped, they are in that sense purely technical artefacts. Changing parameters of the graph layout algorithm, even slightly, can produce a radically different looking Internet. While its possible to make the Internet look like something from nature, there is nothing natural about the graph’s appearance.

Typically, when this types of graphs are employed as ‘eye-candy’ images there are no instructions as to how this image may be interpreted, or even that careful

[15] See <www.peacockmaps.com>. I worked for Peacock Maps in 2001 and contributed to the publication of the final ‘Whole Internet’ poster.

[16] For example, Manual Castells’ *Internet Galaxy* (2001), William Mitchell’s *ME++: The Cyborg Self and the Networked City* (2003).

interpretation is necessary. The image's main function is metaphor for the sublime complexity of the Internet and as a demonstration of the technical prowess of its creator.

[THIS NEXT SECTION IS INCOMPLETE]

3. Overcoming Internet invisibility via scientific inscription

> Instead of being a figment of one's imagination ..., it will become a 'real objective thing', the existence of which is beyond doubt.
>
> -- Bruno Latour & Steve Woolgar, *Laboratory Life: The Social Construction of Scientific Facts*, 1979.

Using ideas from science and technologies studies (STS) concerning the construction the objective authority within technoscience working practices, particularly Steven Shapin's (1984) theory of virtual witnessing, I consider how infrastructure invisibility is overcome by computer scientists and network engineers who are studying the structure and operation of Internet network infrastructure. For this technical community, a distinctive mode of representation - 'scientific inscription' (Latour and Woolgar 1979) - is enacted to render the Internet 'factually' as opposed to the 'impressionistic' envisioning produced through visual metaphors for lay audience. Scientific inscriptions, including schematic diagrams, statistical charts and tables, equations and topological graphs and network maps, are derived from empirical measurement and have the capability to make the invisible and intangible Internet in a "real objective thing" (Latour and Woolgar 1979, 241).

According to STS, the natural sciences do not discover 'laws of nature', but socially construct knowledge by stabilising particular experimental findings as widely agreed 'facts'. Because the phenomena to be experimented upon are usually undetectable to human senses, they require measurement techniques and inscriptions to make them visually apparent. Ethnomethodological studies[17] have demonstrated the almost obsessive preoccupation of scientists and engineers with inscription (Lynch and

[17] These seek to understanding scientific epistemology by looking at what scientists and technicians actually in everyday working practices, rather than accept the formally published 'discoveries' as sufficient explanation of the production of knowledge.

Woolgar 1990), producing a bewildering array of “traces, spots, points, histograms, recorded numbers, spectra, peaks and so on” (Latour and Woolgar 1979, 88). Indeed, Latour (1990, 42) characterised laboratory work as fundamentally a “cascade of inscriptions”. As visual re-presentations of ‘nature’ they are constructed from direct empirical measurement, then cleaned, redrawn, smoothed, transformed, and finally displayed prominently in publications to the bolster the truth claims made in the text.

The potency of inscription is due, in large part, to the ocularcentric nature of Western scientific practices. Since the Enlightenment, vision has been the dominant mode of understanding of the material world: ‘seeing is believing’. Reflecting this primacy of vision, most geographical research, until recently, was a matter of ‘looking’ at the landscape as best way of obtaining truthful knowledge (Sui 2000). It has been argued that the scientific revolution itself depended significantly on Renaissance development of new ways of seeing, such linear perspective, able to create much more mimetic inscriptions of reality (Edgerton 1975). Many ‘technical’ illustrative approaches in engineering drawing, that are now taken-for-granted modes of inscription, were invented at this time, such as the orthographic projection depicting three views of an object, the exploded view to show how complex mechanisms were assembled, and the cut-away view to show internal workings. While contemporary scientific endeavour, in response to modern media driven agenda, has realised the power of inscription for public communication and promotion; as Heller (2003, 57) wryly notes: “Scientific disciplines with good pictures are rich in resources that keep them ... moving forward.” This equally applies to Internet science [define?].

Inscription are usually produced by measuring devices, specialised machines or an assemblage of apparatus designed purposefully to “transform pieces of matter into written documents” (Latour and Woolgar 1979, 51). Inscription devices come in all different sizes and work in myriad of different ways - from a simple weighing balance up to an sophisticated radio telescope - but their end result is always the same - inscriptive markings written out to paper. For Internet science, the inscription device is typically a dedicated computer with custom measurement software that writes out the markings to data files or statistical graphs. The markings are invaluable to scientific endeavour because “scientists themselves base their own writing on the written output of the [inscription devices]” (Latour and Woolgar 1979, 51). Moreover, Latour and Woolgar (1979, 245) argue that the importance of inscriptions lies “not so much as a method of transferring information but as a material operation of creating order.”

Inscriptions work to ‘create order’ within in the social practices in technoscientific settings in several ways. Firstly, they define objects of interests. They are seen as having a direct relationship to reality, providing the focus of discussion about the properties of the phenomena that are otherwise invisible. The pattern of peaks on the graph is itself analysed as a legitimate object of scientific study. Secondly, they are a means for organising collaborative effort between scientists and of agreeing ‘what is happening’. As such, Roth and McGinn (1998, 217) characterise inscriptions as conscription devices, noting they are so importance in many discussions that “scientists and engineers will stop a meeting to fetch a design drawing, produce a more or less faithful facsimile on the whiteboard, or render a diagram in a gesture.” Inscriptions are also a most effective means of forging unity of effort across different communities of practices, which may well be distributed geographically and in time; they work here as ‘boundary objects’ (Star and Griesemer 1989). In this way that inscriptions work publicly in the production of ‘matters of fact’, that is discrete elements of knowledge that have been verified by the scientific community and enjoy widespread assent.

However, a significant problem in the production of such ‘matters of fact’ is the limited access to experimental activities and the inner working of inscription devices for independent verification. Science strives to solve this verification problem through what Shapin (1984) termed ‘virtual witnessing’, a way that a experiment can be validly observed via a particular kind publication rather than by being physically viewed in the laboratory. Assent that an inscription constitutes a valid ‘matters of fact’ is thus manufactured remotely and, infinity using ‘literary technology’. This is now recognisable as the austere and avowedly ‘objective’ style of scientific writing but had to be invented[18]. It involves a necessarily functional, dispassionate prose and puritan type of diagrammatic inscription - the result should be readable as far as possible as a

[18] Developed in relation to the contested emergence of experimentalist natural philosophy in the mid the seventeenth century, particularly Robert Boyle’s studies on the nature of vacuum using air-pumps.

factual and impersonal record work done. Accordingly, Shapin and Schaffer (1985, 62) argue that Boyle's approach "served to announce, as it were, that 'this was really done' and that 'it was done in the way stipulated'; [it] allayed distrust and facilitated virtual witnessing." Objectifying matters of fact through the denial of human agency. They have to appear to 'discovered' from nature rather than being man-made artefacts.

For this kind of literary technology to be successful in virtual witnessing it also requires that scientists themselves be 'modest witnesses' - "the author as a disinterested observer and his accounts as unclouded and undistorted mirrors of nature." (Shapin 1984, 497). Modest witnesses describe facts objectively for the advancement of science, not for personal rewards; and they willingly admit weaknesses in methods and failed results. "Such an author gave the signs of a man whose testimony was reliable." (Shapin 1984, 497). They produce descriptive and systematic work and do not indulge in overly theoretical and speculative writing.

The CAIDA AS-level graph as virtual witnessing of Internet infrastructure

The notion of virtual witnessing has utility in understanding how invisibility of Internet infrastructures are overcome in terms of the scientific practices of computer science/network engineering researchers.

Computer network infrastructures have been an object of 'scientific' study since the very beginning. The engineers and computer scientists involved the designing ARPANET in the 1970s, for example, produced detailed analysis of its topology and performance from direct measurement of network traffic flows (e.g., xxxx; see also chapter five). Their goal was to discern the underlying 'facts' of wide-area computer communication by experimental study of real dynamics of a working packet-switching network.

A sizeable interdisciplinary 'Internet science' community now exists that undertakes experimentally-driven studies solely on the Internet using positivists scientific approaches and by building complex inscription devices (usually, large-scale software monitoring/scanning tools to measure the real status of the network from multiple sample points.) (see Murray and Claffy 2001; Spring et al. 2004). They have also come to see the Internet as a natural phenomena suitable for study. 'Internet science' self-stated pragmatic aims is aid future engineering efforts to achieve more optimal design of protocols and hardware routing equipment.

One of the leading 'Internet science' centres, combining both academic and industrial researchers, is CAIDA[19], and I use an example of one of their inscriptions as a case study of virtual witnessing of Internet infrastructure. [MORE?]

Internet science is marked by a fetish for measurement, generating large data volume and complex inscription (principally through statistical charts) characterises the work in the 'Internet science' field. This is perhaps unsurprising given the depth of empiricism underlying most engineering practice associated with networking. (Indeed, the necessity of measurement is deeply ingrained across most scientific practice.) Inscribing ever greater data volumes is a signifier of machismo in modern scientific endeavour and explains, in part, the compulsive desire for ever more realistic statistical models of Internet by building large and more sophisticated software scans of the infrastructure. The experimentalist practices within in Internet science involves construction and operation of inscription devices to measure the network. These are typically written in software and use the protocols and infrastructures to measure itself. In one sense then, there is nothing to see in Internet science laboratories, apart from computers working as inscription devices (the inscriptions are output of software code.) A great deal of research in Internet science involves simply trying to get the instruments to work, and convincing others that the inscriptions that are produced are acceptable 'evidence' of the underlying infrastructural reality.

[Outline CAIDA skitter measurement and AS-level topology graph]

<Figure 4.10 about here CAIDA AS Core Internet Graph>

[19] The Co-operative Association for Internet Data Analysis <www.caida.org>, based at the San Diego Supercomputing Center, the University of California at San Diego (UCSD).

This inscription makes use of several techniques to achieve the dispassionate ‘scientific look’ need for successful virtual witnessing; these are all evident in CAIDA AS-level Internet graph (Figure 4.10).

(a) Employing objectives Viewpoints and perspectives, Kress and van Leeuwen ‘objective images’.
(b) Blank space and end of embellishment. “decline in florid decoration and the rise of the factual neutrality of white space” (Edney 1993, 56). Blank spaces on graph Lynch Q p59, “The emptiness is infused with moral significance inasmuch as it involves the tacit claim of scientific integrity, with motives assumed to be beyond reproach, and is offered with an unstated presumption that, if anything significant should have been said about the operational history of the graphic line, it will have been stated.”
(c) Sensible pictures. Lynch- geomatizied and mathematized nature. Denial of situatedness of data - plotted on idealised abstract space. Importance of ‘correct’ graphs - labels, suitable scale, numbered classes etc
(d) Denial of subjective authorship. silence the voice of the artist. “A fact is nothing but a statement with no modality ... and no trace of authorship” Latour and Woolgar 1979, 82

Conclusions

While these visual metaphors can be considered semiotically in their own right, they have wider significance as imaginary tools, giving a source of inspiration and conceptual ‘blueprints’ for designers, programmers and creators of the software code and network hardware that produced the Internet. Some of the spatial imagery is powerful and visually arresting, providing a vision that fulfils people’s imaginative expectations of what the Internet *should* look like. Visual metaphor are typically chosen deliberately to reinforce existing preconceptions, thus it is easy to understand how people willingly accept certain kinds of maps and diagrams as ‘natural’ pictures of the real Internet, rather than entirely contrived images (just like many people accepted the Mercator projection maps as the ‘real’ view of world).

This negotiation over metaphors is a negotiation over visions of how the Internet will be financed, governed, regulated, consumed and experienced. One must study visual representations of reality, because those representations are adopted and legitimated, those representations become the reality.

Ultimately, the choice of how to visually represent the Internet infrastructure is a far from simple question. Over time many conceptions have dominated. Implicit in any approach are the underlying power geometries of the metaphors used (verbal, visual, numerical) regarding what the Internet is, and more important, what it could be. None of these conceptions can really be said to be ‘wrong’ The metaphors and diagrams can be seen as explorations of what the Internet is ‘at its essence’. Ultimately, the exploration phase has ended, various metaphors having been tried and rejects, while a few dominant ones are legitimated. Indeed, the Internet itself has become a metaphor of its own, for example used to describe new forms of decentralised, distributed organisations.

These images not only make visible the invisible infrastructures of the Internet, they can dramatise the dull and banal nature of the network lacking in striking physical motifs of soaring airliner or giant spans of a railway bridge. Thus they explain visually what the Internet looks like, but they also delude by equal amount as this is never a view of the Internet one could see naturally.

I argue that scientists studying the Internet are practising a modern form of virtual witnessing as a way to authenticate their experimental results and produce ‘matters of fact’ about the structure and performance of the Internet. The value of these numbers and the inscriptions produced from them is not in what they show so much as in how they show it, to make the Internet a plausible, a known, a measured artefact. Such inscriptions enable the Internet to be ‘matter of facts’ without ever having been witnessed directly by the wider scientific community. It is this that makes scientific inscription of the Internet so powerful - able to convince others ‘at a distance’ of the matters of fact reality of the infrastructure.

Figure 4.1: A road junction outside the One Wiltshire building, an internet hub in downtown Los Angeles, that is heavily marked with 'utility graffiti' signifying the location of underground cable routes leading into the building. Such markings are a kind of 1-to-1 map of the complexity of what lies unseen just beneath the surface. (Source: Varnelis 2002.)

Figure 4.2: Internet infrastructure explained using the subway maps metaphor. This example was produced by Interoute in 2000 to promote its European network. (Source: http://www.interoute.com.)

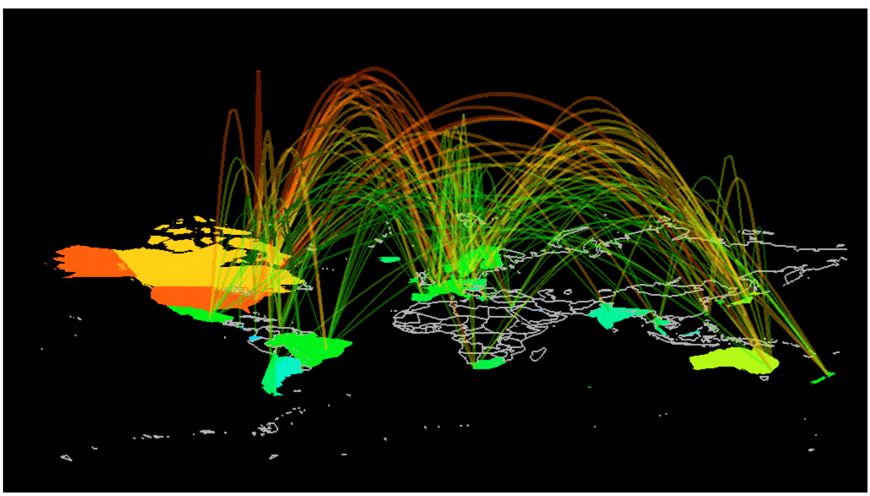

Figure 4.3: Top: A dazzling wire network provides the central metaphor for a visualisation of NSFNET infrastructure produced by Donna Cox and Robert Patterson, National Center for Supercomputing Applications, University of Illinois Urbana-Champaign in 1994. The figure itself is a single frame from a short movie of the growth in traffic on the NSFNET backbone (Source: NCSA 2005.) Bottom: The metaphor of 'arcs across the world' creates a visually arresting image of Internet traffic flows between fifty countries as measured by the NSFNET backbone for a two hour period in February 1993. It was produced by researchers Stephen Eick, Ken Cox, Taosong He and colleagues at Bell Labs-Lucent Technologies in 1996 as part of a project to create compelling 2D and 3D visualisations to understand network data flows. It is a screenshot of an interactive visualisation tool they developed called SeeNet3D. (Source: Cox *et al.* 1996.)

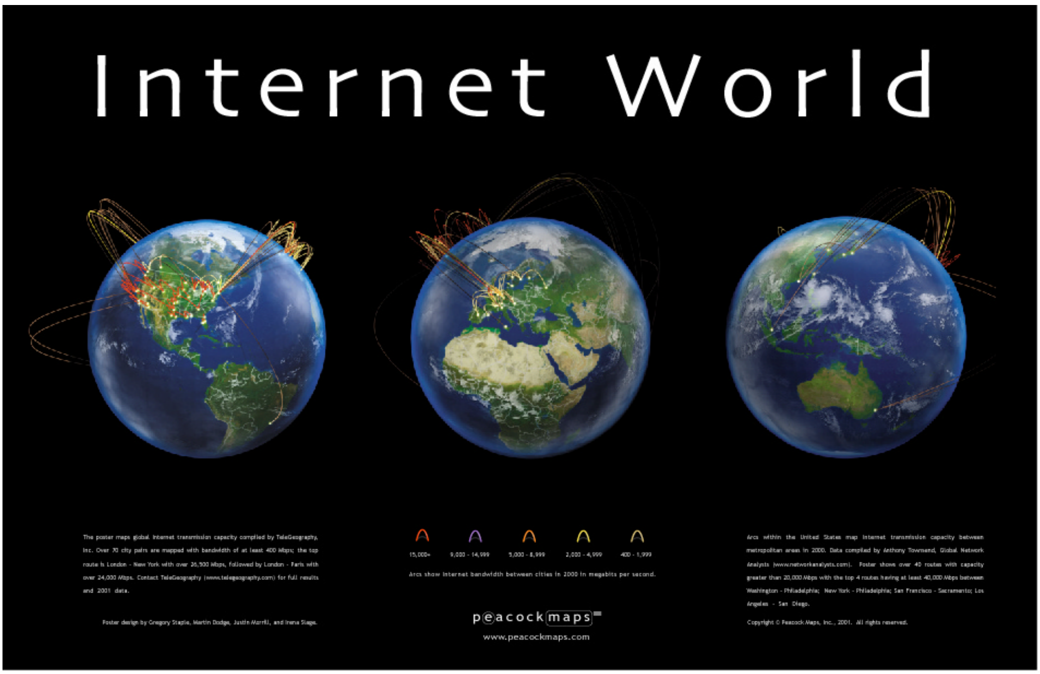

Figure 4.4: An effective example of the globe metaphor used to visualise three-dimensionally Internet bandwidth statistics. It was conceived by Greg Staple and Martin Dodge for a commercial poster in 2001 (source: Peacock Maps).

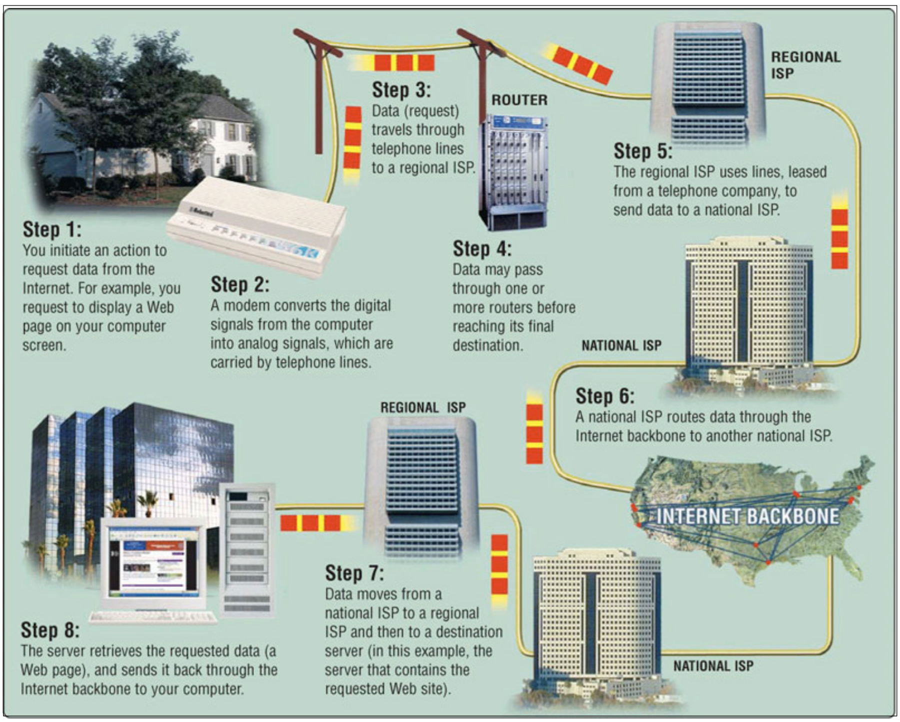

Figure 4.5: An exemplar of machinic diagrams using photographs of hardware and building to illustrate explain basic Internet networking concepts. (Source: Not known.)

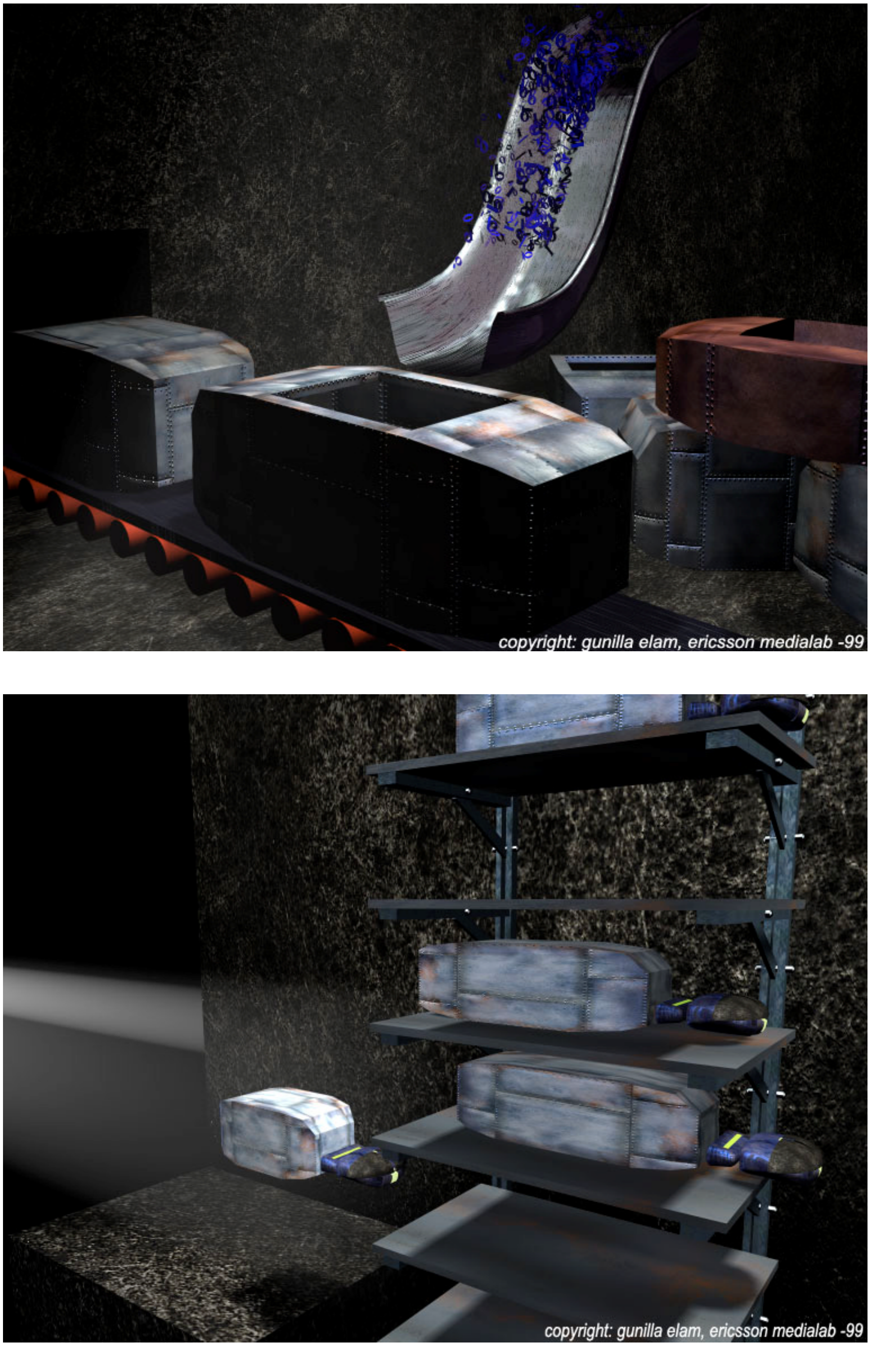

Figure 4.6: Stills from *Warriors of the Net* using a machinic metaphor to explain the inner-workings of the Internet. Empty IP data packets, represented materially as large steel trucks, are filled with loads of data (top). They are then carried aloft in a freight elevator for entry onto the LAN (bottom). (Source: Elam 1999.)

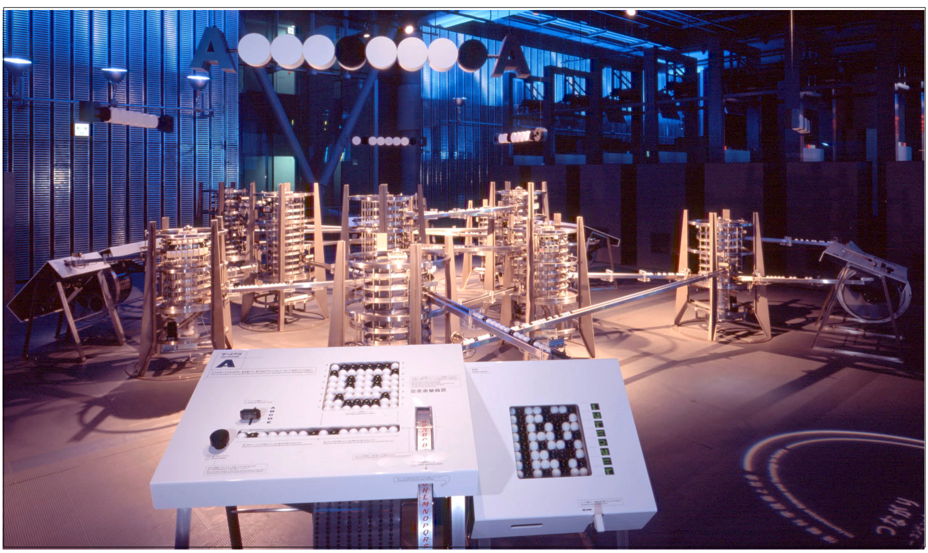

Figure 4.7: Kouichirou Eto’s physical model of the Internet exhibited in National Museum of Emerging Science and Innovation in Tokyo. The control panel in the foreground is used to compose messages by hand using black and white balls to encode letters as binary zeros and ones. Users can then watch their message move through the machine, accompanied by suitably machinic sounds of clanking metal and clinking of ceramic balls. (Source: <http://eto.com/2001/PhysicalInternet>.)

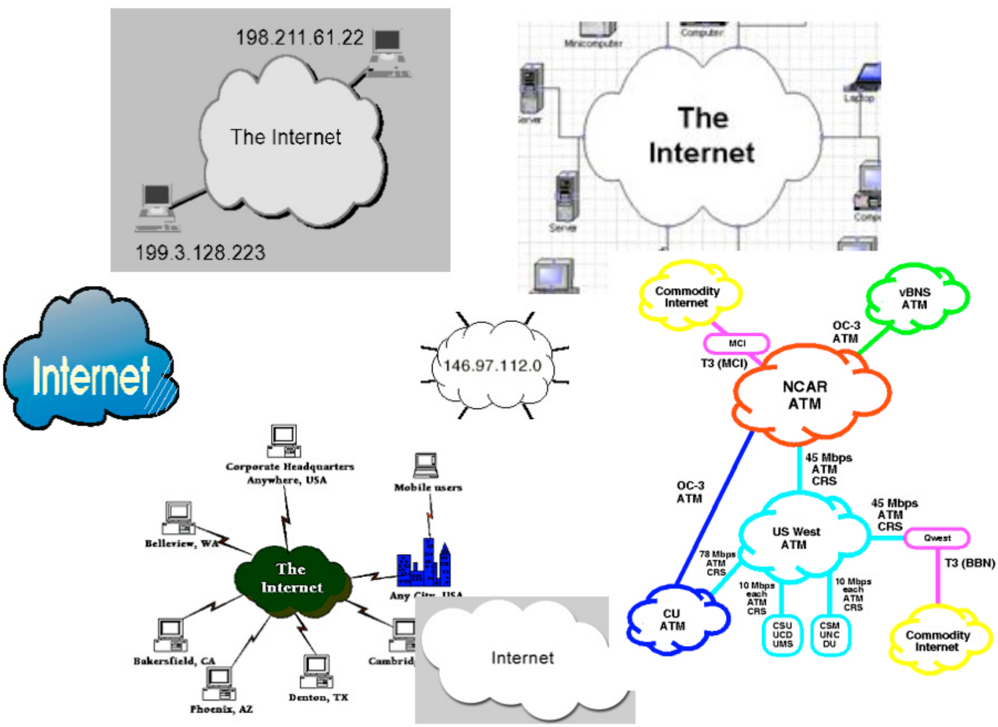

Figure 4.8: A montage of typical examples of the cloud metaphor. Some of these also use simple machinic icons to represent particular sites at the edges of the cloud. (Source: various, images gathered from the Web through Google image search.)

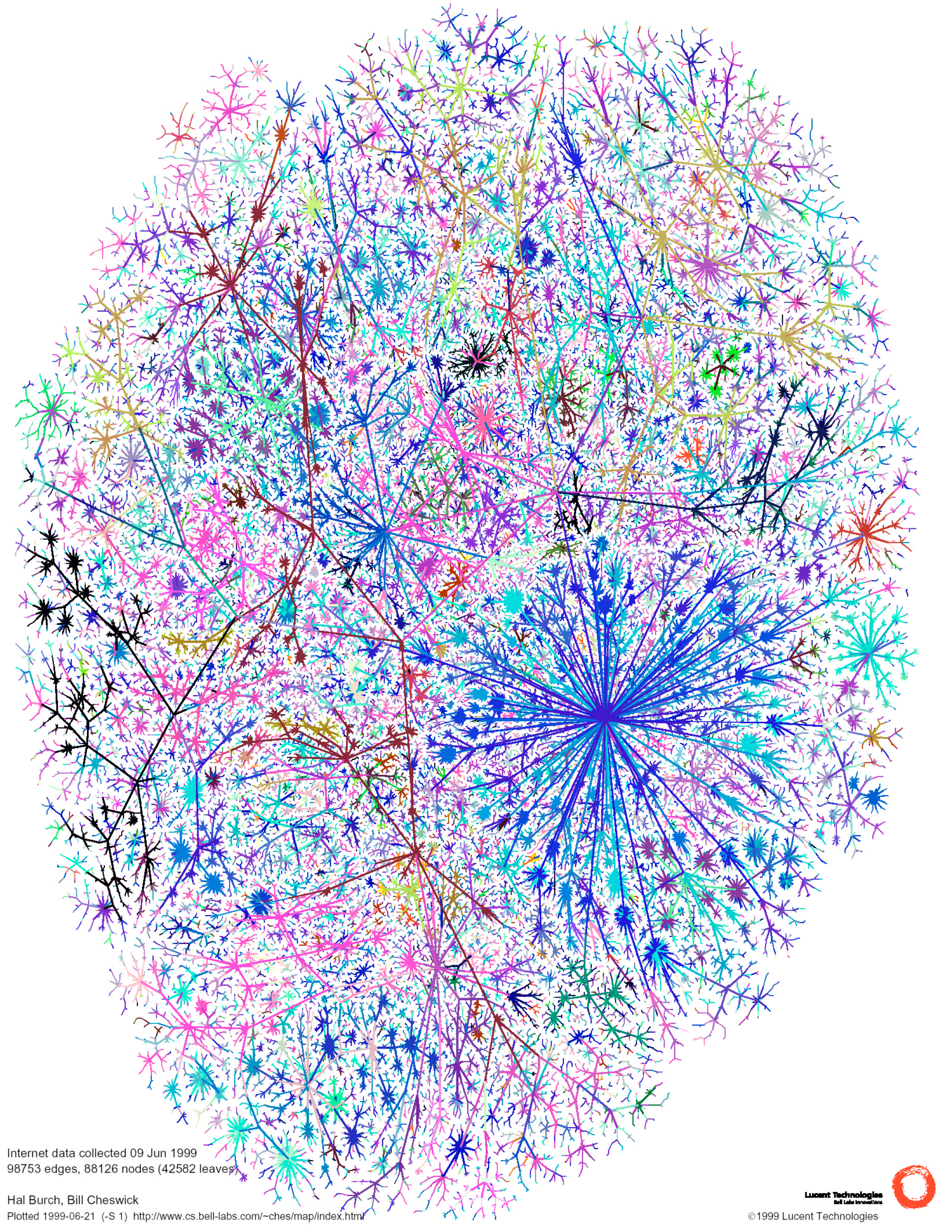

Figure 4.9: Internet connectivity graph created by Hal Burch and Bill Cheswick. This particular example from their ongoing Internet Mapping Project to visualises the core of the 'cloud' in topological terms, colour coding nodes according to the IP address, seeking to highlight zones that share common network addresses. The most striking feature of this graph is the large, dark blue cluster which represents a key hub owned by Cable and Wireless (formerly MCI) - Cheswick describes this as "the magnetic north of the Internet". (Source: Courtesy of Bill Cheswick, Lumeta, <http://www.lumeta.com>.)

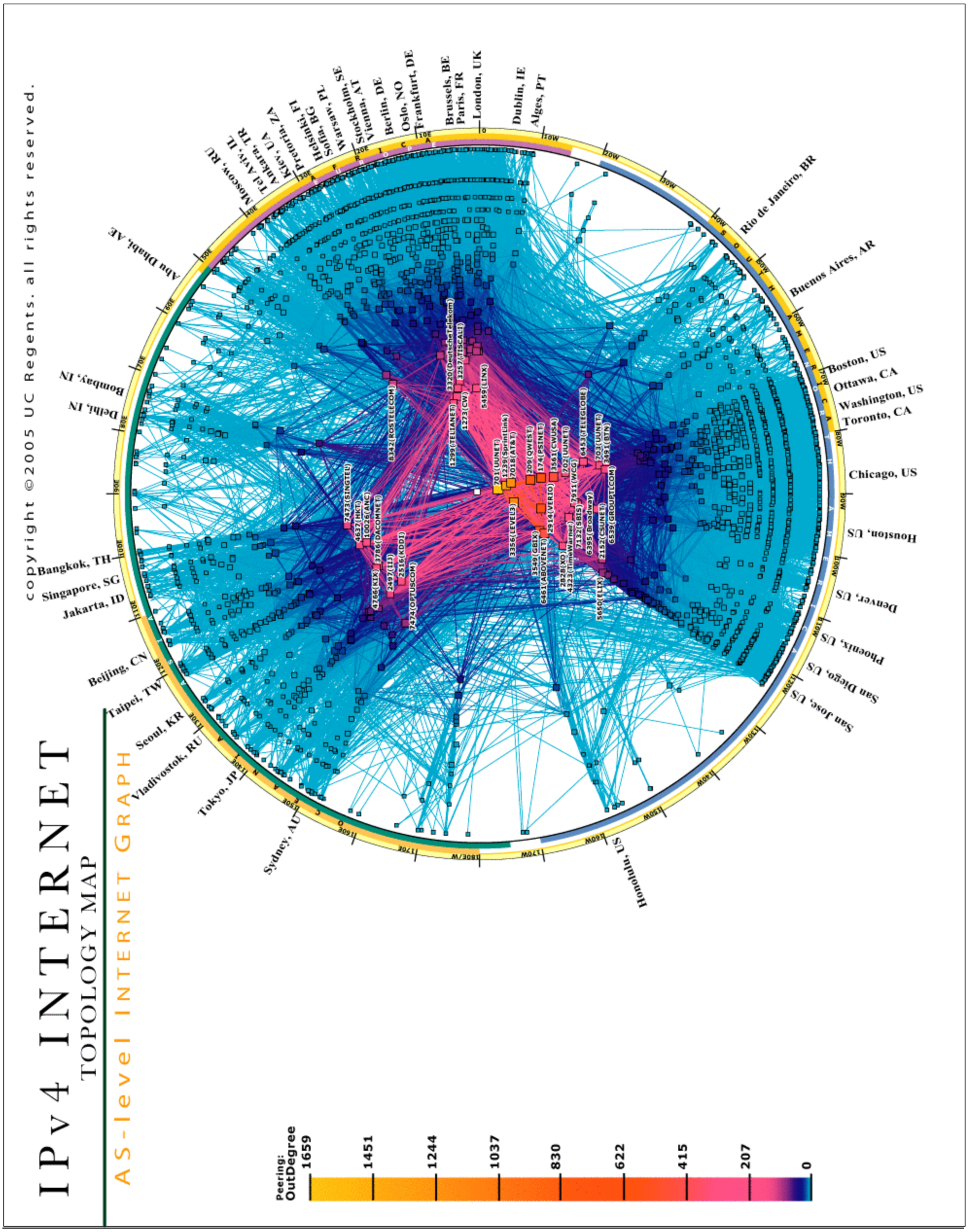

Figure 4.x: An example of a scientific inscription of the Internet.

Chapter 5

Spaces of History: Documentary Network Mapping and Internet Archaeology

When people do their informational work 'at the console' and 'through the network', telecommunications will be as natural an extension of individual work as face-to-face communication is now. The impact of that fact … will be very great – both on the individual and on society.

-- J.C.R. Licklider and Robert W Taylor, *The Computer as a Communication Device*, 1968.

While highly survivable and reliable communications systems are of primary interest to those in the military concerned with automating command and control functions, the basic notions are also of interest to communications systems planners and designers having need to transmit digital data.

-- Paul Baran, *On Distributed Communications*, 1964.

1. Introduction

This chapter is concerned with the early history of the Internet covering the period from the late 1960s through to the end of the 1980s and the role that extant maps from this time can play as primary source documents for network archaeology. The empirical evidence drawn upon is from the development of the U.S. Department of Defense's Advanced Projects Research Agency (ARPA) network - ARPANET - and the series of maps of its evolving network structure.

As well as tracing the imaginative geography of the network infrastructures, I also discuss the underlying discourses which spurred the development of novel computing networking technologies from the late 1960s. One of these was a concern for command and control in the time of war. Governments, and the military in particular, have seen the strategic value of rapid and reliable communications networks since ancient times and have often been the prime movers in their development. Similar governmentality motivations, it has been argued, were instrumental in the conception of the Internet with the support of United States government, notably via R&D funding from the Pentagon. However, strategic concerns were not the sole motive, or even the dominant concern, and others have argued that the goal of enhancing scholarly productivity through intellectual networking forms the real heart of Internet genesis. I use these two primary discourses - facilitating scholarly collaboration between scientists and the need to produce survivable communications systems - as the discursive framework in the cartographic analysis Internet archaeology.

1.2 Networks and history

Over the centuries a number of different media have been employed as transmission technologies in long-distance communications, including fire beacons, smoke signals, reflecting mirrors, semaphore flags, pigeons, and, of course, humans messengers. It is easy to assume that the emergence of large-scale communications networks are a product of twentieth-century technological prowess. In fact, several nation-wide networks were built two hundred years ago, predating the invention of the electric telegraph by many decades. At the end of the eighteenth century, a number of European nations, including France, Britain and Sweden, had extensive optical telegraph networks linking major cities and militarily important locations (Holzmann and Pehrson 1995). The speed of data transmission, while much faster than the physical carriage of a message, was still quite slow. Transmission was also labour-intensive, limited to daylight hours and prone to interference by the weather.

The real revolution in communication came with the application of electricity for rapid message transmission. The electric telegraph was the first communications technology able to transmit messages between distant places *instantaneously*, regardless of time of day or weather conditions. Morse’s telegraph system was developed in the late 1830s and public funds from the U.S. Congress enabled a 37 mile test line between Baltimore and Washington DC to be built in 1843. The famous demonstration of the first practical telecommunication system - marked by the exchange of the message, ‘What hath God wrought!’ - took place in May 1844. Telegraph technologies and their supporting networks of wires quickly spread (e.g. see Figure 4.2 for their extent in North America by 1853). By 1861, the first telegraph link across the continent from San Francisco to New York city was opened and just five years later the first effective transatlantic cable was laid. There is much to be said on the spatial development of telegraphic systems, which could be analysed, in part, through extant network maps, however this is largely overlooked in technological histories (although, see Hugill 1999).

In some senses, then, the antecedence of the Internet can be traced back to the development of telegraph networks in the second half of the nineteenth century. These networks were the first to permanently connect distant places together to allow the instant communication of data. Standage (1998) aptly describes the telegraph as the 'Victorian Internet' and argues persuasively that most of the advances in telecommunications made since have been incremental improvements rather than revolutionary breakthroughs[1]. There are also obvious parallels in the funding and organisational development between the telegraph and the Internet, "the government started the ball rolling, and rapid capitalization and growth followed in the private sector" (Press 1996, 12).

1.3 ARPANET case study

To understand the network archaeology of the Internet and how it has been mapped, in this chapter I examine in detail the ARPANET network in the United States, which operated from 1969 to 1990, with military research funding. It provides a strong case study for Internet archaeology for three reasons[2]:

- ARPANET is widely acknowledged in the literature as the most important progenitor of the Internet (Abbate 1999; Hafner and Lyon 1996). It pioneered wide-area computer networking and laid much of the foundations of the Internet in terms of both the technical and social infrastructure of internetworking. Understanding the geo-history of ARPANET is important, therefore, to understanding the Internet as a whole.
- The development of ARPANET is well documented. Even though its development was funded by the military, it was an unclassified project and the results were widely published in technical literature.
- Lastly, and most importantly in the context of this analysis, is the fact that from the very beginning, and throughout its life, ARPANET was mapped[3]. The consistency

[1] Standage (1998) also points out that much of the rhetoric and hype regarding the benefits and dangers of the Internet in the 1990s were directly paralleled by the earlier boom in the telegraph.

[2] Of course, there were number of other important networks that made valuable contributions to early development of the Internet (c.f. reviews by Quarterman and Hoskins 1986; Salus 1995).

[3] Besides the ARPANET maps considered here, the surviving infrastructure maps of other historical data networks from the 1970s and 1980s (e.g., Usenet, UUCP, Bitnet) are much more fragmentary. See LaQuey (1990), Quarterman (1990) and Salus (1995) for reproductions of extant examples.

of mapping means it is the best exemplar network to study in regard to the role of infrastructure maps in a historical context.

A large number of maps of ARPANET were created at regular intervals throughout its operation and have survived in published records, reports and scholarly articles. I assembled a collection of over 150 maps as part of this research, from a range of sources[4]. In addition to the maps themselves I conducted email interviews in August 2004 with Alex McKenzie and Bob Brooks, the two key people primarily responsible for ARPANET map production at Bolt Beranek and Newman (BBN), the contractor that built and operated the network for ARPA. The sample maps that I analyse in this chapter are scans of original reproductions and are not redrawn versions.

In terms of cartographic design, these maps look like quite crude, being simple black and white line drawings using purely the functional form of the arc-node representation (Figure 5.1). In many respects, however, their ‘look’ matches the requirements for engineering inscriptions that are deployed in virtual witnessing to scientific experiments (see chapter four). Furthermore, the aesthetic limitations of the maps are far outweighed in contemporary analysis by their value as historical records. They are unique visual artefacts, charting the imaginative geography of a network that has completely disappeared as a material culture (except for a very few pieces in museums and personal collections). In normative terms, the most revealing feature of these maps is that they demonstrate how ARPANET’s growth delineates the geography of military installations and elite research universities involved in defence contracts in the United States.

<Figure 5.1 about here. Geographic and logical ARPANET maps.>

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[4] The main secondary sources reproducing ARPANET maps are: CCR (1990) and Salus (1995). The key primary sources I have located are ARPANET documents held by the Internet Archive and The Internet Completion Report (published as Heart *et al.* 1978).

It is important to note that these maps show the ARPANET at the level of data linkages (termed ‘level 2’ in terms of the hierarchical layer model of communications protocols). They do not show the details on the geographic routes of the cables (so called ‘level 1’ facilities). While the nodes are relatively accurately positioned, the paths are merely relational, designating a link between sites. Hence the acceptability of generalising transmission paths between nodes to straight lines in the maps. Two distinct classes of maps were produced by the BBN drawing office: geographic maps and logical diagrams (Figure 5.1). The focus of the analysis here is on the geographic maps.

On the logical diagrams (a typical example is shown in Figure 5.1, bottom) the network topology is represented in a rectangular fashion with crossing branches and looks much like a circuit wiring diagram (which, on a conceptual level, it is). This infrastructure visualisation approach was obviously inspired directly by the operational network diagram on the wall in the control room (Figure 5.2). The layout of the map is semi-geographic, as the position of the nodes corresponds roughly to the left-right, west coast-east coast division of the United States. The map is perhaps most revealing of the design of ARPANET as a distributed network with no topological centre.

One key addition to the logical diagrams over the geographic maps is the recording of the host computers connected to each network node. These are shown as rectangular boxes and acronyms of the make of mainframe computer. In some respects these diagrams are most useful as a visual census of the virtual space potentially accessible through the network. It is apparent that several sites had multiple hosts connected and as a consequence could be regarded as the more significant network hubs (this is not apparent on the geographic maps where each ARPANET node is given equal graphic weighting.)

<Figure 5.2 about here. Control room operational map.>

The presentation of the territorial base itself in these maps as an empty canvas is also noteworthy. The United States is represented by a simple border line which has the effect of creating an inert container, an archetypal *terra nullius* ready to be made into a modern networked space. Indeed, for those involved, the ability to draw the network on a blank map parallels the unencumbered construction of the infrastructure itself: "the ARPANET did not have to interconnect with other existing and/or decrepit communications systems; it was possible to establish … standards *de novo*, in the best ways that could be devised" (Heart *et al.* 1978, III-111). Fitting into the U.S. tradition of Manifest Destiny, ARPANET could literally be mapped out over a blank landscape.

2. Network genesis: Computer collaboration or nuclear war proof communication?

Before looking at the a selection of the maps in the context of ARPANET's geo-history, first I examine two discourses of computer collaboration and network survivability that need to be understood to grant a wider context to narrow cartographic analysis. These discourses were integral to developments in the 1960s that led to the funding and building of ARPANET and they remain very much alive in contemporary debates on the value of the Internet and its implications for social and economic relationships.

Today, it is taken for granted that computers should be networked together and that much of their technicity derives from the communication facilitated, rather than their computational ability. However, the possibilities of computer-mediated communication (CMC) were practically unknown in the 1950s. Then, computers were too important and far too expensive to be on wasted on what were perceived as frivolous activities such as exchanging messages.

This viewpoint began tentatively to change in the 1960s when some of the first significant analysis on the possibilities of social interactions through the networking of computers was undertaken by JCR Licklider. Although he was not a computer scientist (his PhD was in psychology) he is widely acknowledged as a visionary for interactive computing, passionately believing in the creative power that would be unleashed when scientists could 'talk' directly with computers in a real-time dialogue rather than the existing batch job paradigm. He pioneered radical ideas of human-computer symbiosis and he envisioned a global network of interconnected ‘thinking centers’ through which people could access programs and collaborate (Licklider and Taylor 1968). Critically for the history of ARPANET, unlike many farsighted scholars, Licklider was able to realise his vision because of the large amounts of research money the United States government devoted to computer research under his direction and of his successors (Abbate 1999). This investment was spurred by the ‘Sputnik shock’.

On October 4, 1957 the Soviet Union launched the first satellite and ratcheted up the Cold War rivalry to a new level of intensity. Scientific research became increasingly viewed as more than just academic – advances in science and technology were a matter of national defence, and ultimately, a proof of the supremacy of American ideology. One of the practical responses from the Eisenhower administration to Sputnik’s dramatic challenge to American technological superiority was the creation of Advanced Research Projects Agency (ARPA) in 1958 as part of unprecedented peacetime growth in defence-related research spending. The role of ARPA was ‘high-risk, high-gain’ projects that included major investments in fundamental computer science research as well as more applied computer engineering (including networking). In 1962 Licklider went to work at ARPA as the first director of the Office for Information Process Techniques (IPTO). The original research agenda for this office was to produce more flexible military command and control systems but Licklider used the position to direct funds to support the nascent computer science departments in a select few universities focused on research in time-sharing, interactive computing, and computer graphics.

Although Licklider ran IPTO for only two years, he was able to set the agenda for the following decade and inspired in succeeding directors the importance of computer networking concepts. The practicalities of designing and building a workable network for ARPA were managed by Larry Roberts from 1967. Some of the first design concepts and performance goals for an experimental ARPA network were published by Roberts in October 1967 in a paper entitled ‘[m]ultiple computer networks and intercomputer communications’. The paper stressed the potential of networks for sharing data and resources, noting in a section on scientific communication that ‘[a] network would foster the ‘community’ use of computers.’ (p.2) Additionally, this paper is historically interesting as it provides probably the first published map of a computer network, a simple schematic showing the “tentative layout of the network nodes and communication paths” (p. 3) of the planned ARPA network (Figure 5.3). Although roughly geographic in node layout, it is primarily a topological diagram as “most of the communications will be dial-up, the paths are just hypothetical” (Roberts, 1967, 3). This paper therefore gives an early illustration of the way maps and diagrams were used as persuasive visual tools to convey to audiences some sense of the tangibility of what were very abstract notions of networking and virtual communications spaces.

<Figure 5.3 about here. Roberts 1967 schematic diagram.>

Robert’s 1967 paper, among other documents from that time, shows that planning in the late 1960s for the ARPA network was conceived as a method for linking together several incompatible computer systems located at various points across the USA so that resources could be shared. Linking distant computers together to eliminate distance would bring economic efficiency and also improve research productivity. The key design parameters articulated by those involved in planning the network were for an efficient and reliable system.

Parallel to the discourse of resources sharing networking, a second thread underpinning the archaeology of Internet is the idea of *survivability* of communication in the time of war. Being able to engineer superior infrastructure that was invulnerable to attack, thereby negating Soviet atomic threats, lies at the heart of the ‘closed world’ of American Cold War paranoia and its generous military R&D funding (Edwards 1996). The creation of survivable communications systems to ensure the military chain of command and the continuity of government was, unsurprisingly, a particular concern of the power elites who authorised profligate funding.

A prime example of this survivability technoscience mentality, and of direct relevance to history of the Internet, is the work undertaken in the early 1960s by Paul Baran at the RAND Corporation[5]. Baran produced a significant theoretical analysis of the design of

[5] A key Cold War think-tank, privately run but funded by Pentagon contracts. It had a particularly controversial involvement in terms of ‘thinking the unthinkable’ for nuclear war strategies.

computer networks that could provide the basis of a new kind of communication system capable of surviving serious damage, such as would result from a nuclear attack. The work was funded by the U.S. Air Force, who had responsibility for the strategic nuclear arsenal, were spending billions on continental air defence systems and needed survivable communications to insure the delivery of vital ‘Go / No Go’ launch messages in the event of a Soviet ‘first strike’.

Baran’s (1964) detailed 11 volume report, entitled *On distributed communications*, advanced two particular architectural innovations to insure survivability of end-to-end communication even when large parts of the network were destroyed. Firstly, the structure of network must be distributed, with each node interconnected to several neighbouring nodes, to create a redundant mesh of possible data pathways. Secondly, messages are broken into small units that would be independently routed through the network, each following the best available route and then reassembled at their destination[6]. This combination of distributed pathways and adaptive routing was radically different from the existing engineering conventions employed in telephone networks of that era. They remain fundamental to the architecture of the Internet today.

While significant in technical terms in the history of telecommunication theory, Baran’s network design remained a concept on paper and was never developed into an operational network. While his work became known to key ARPANET instigators, including Lawrence Roberts, it had little direct influence on the basic concepts they implemented, and, crucially, it was *not* the design blueprint for the network that was actually built (Hafner and Lyon 1996). Despite this historical fact, Baran’s work is vitally important in understanding Internet archaeology because of the ways its ‘survive-a-nuclear-war’ notions were subsequently co-opted into discourses in the 1990s as one of the founding narratives of the Internet.

The myth that the Internet was *purposefully* built by the American military with the goal of nuclear war survivability has been widely reported as ‘fact’. To quote just one

[6] This is basically the notion of ‘packet switching’ network, although Baran did not term it thus. The ‘packet’ terminology was conceived independently by research by Donald Davies at the National Physical Lab in England at about the same time (Abbate 1999).

example, William Mitchell in his influential book *City of Bits* asserts that the "original ARPANET was, in fact, explicitly designed to withstand nuclear attack" (1995, 110). The power of this kind of techno-genesis myth is in the ways it becomes enacted to advance certain interests by providing a compelling and easily-comprehended moral story. Such stories quickly gain authenticity through repeated retelling. "Whether the story is accurate or has actually happened is beside the point when looking at such morality tales, because their truth lies in the message they convey, not their accuracy" (Jordan 1999, 34). The nuclear survivability myth seemed quite plausible during the popularisation of the Internet in the mid 1990s, given the undoubted military basis of Baran's work, along with the Pentagon funding of ARPANET, and the relative technical obscurity of the real design motives expressed in the late 1960s. One can imagine how journalistically easy it is to conflates together notion of *reliability* with that of *survivability*.

What interests were served by the nuclear war survivability myth? The myth is potent because it proved useful for popularising discourses, adding a trace of militaristic glamour to dull infrastructure and helping to demonstrate that the Internet was *special*, having been born of superior Cold War technology. In particular, it showed that the Internet was different from existing 'top-down' networks owned by telecommunications corporations because it was deliberately decentralised. This conceptualisation of a network without a controlling centre also fitted well with the counter-cultural, anti-establishment notions of the Net, with cyberspace as a new and fundamentally progressive media that could not be censured or shut down. (Such notions are aptly captured in John Gilmore's oft-repeated phrase: "the internet treats censorship like damage, it routes around it".) Mitchell (1995, 110) claimed: "Because its electronic underpinnings are so modular, geographically dispersed, and redundant, cyberspace is essentially indestructible. You can't demolish it by cutting links with backhoes or sending commandos to blow its electronic installations, you can't even nuke it."

The architecture of the global Internet imbued with unique properties from Cold War 'boffins', makes it the ideal media to subvert the rigid hierarchies of the territorially-bounded governments and big corporations and their attempts to stifle the open exchange of information between users. The myth resonates further: the ironic twist that "military funding to prosecute the nuclear arms race resulted in the ultimate weapon of libertarian, grass-roots free speech is one enjoyed by many on the net" (Jordan 1999, 35). The discourses deployed in the fierce intellectual property battles currently raging over the rights and wrongs of file-sharing on peer-to-peer networks and the fundamentally uncensorable nature of the Internet provide an intriguing contemporary recycling of this myth.

In fact, the novel architectural design of packet switching and adaptive routing that makes the Internet so robust (and thus gives it some properties of un-censorability) was chosen by ARPA IPTO scientists for their network because it was judged to be a technically superior method to produce a *reliable* and high performance network and *not* because it would make the network resistant to nuclear attack. The benefits of packet-switching were confirmed in published academic studies by Donald Davies and Leonard Kleinrock in addition to the work of Baran (Abbate 1999). There is no mention of nuclear survivability as a design criteria in the initial ARPANET program plan entitled 'Resource sharing computer networks' drawn up in June 1968; the stated objectives "were to develop experience in interconnecting computers and to improve and increase computer research productivity through resource sharing" (Salus 1995, 26).

Additionally, the cartographic records showing the structure of ARPANET as built provide some of the most powerful evidence dispelling the myth. The ARPANET maps (e.g. Figure 5.1) reveal that the topology of links actually built was insufficient to withstand a nuclear war. Quite simply, there were not enough wires between each computer. To achieve the level of survivability specified by Baran's work would require *all* nodes in a communications network to have a minimum of three separate links. The result is a fully redundant mesh network, yet it is apparent from the maps that most ARPANET nodes had only two links, while a fair number are only singly connected. According to data given in the ARPANET Completion Report, the average connectivity of the network never reach three, the highest was 2.45 in July 1976 (Heart *et al.* 1978, page III-91). Consequently ARPANET was not distributed enough in its structure to produce a nuclear attack-proof network.

The popularising of the Internet in the mid 1990s and writing of the histories of computer networking has seen a degree of active resistance to the nuclear war survivability myth by some of the influential scientists and engineers involved in the design and building of ARPANET. For example, Bob Taylor, who served as IPTO director from 1966-69, recently commented: "The creation of the ARPAnet was not motivated by considerations of war. The ARPAnet was created to enable folks with common interests to connect to one another through interactive computing even when widely separated by geography"[7]. Many people involved in the genesis of the Internet never did and still do not consider themselves 'cold warriors' but as Quarterman (1999, no pagination) argues, "[b]oth versions can be and probably are true simultaneously: the roots of ARPANET and the Internet are in the Cold War, but many of those working on the ARPANET doubtless were doing it for regular research or academic reasons."

While the military origins of funding and direction in the ARPANET can not be denied, it is more important that the values of its operations, enshrined in the open architecture of protocols, came from scholarly traditions of the research communities of major universities. The real legacy from ARPANET to Internet is about opening up new spaces for communications and not surviving wars.

3. Cartographic geo-history of ARPANET

In this section I will examine in some detail a number of ARPANET maps, discussing their cartographic form and what they can reveal about the structural development of the network over the two decades of its operation. The focus in the analysis is, for the most part, on the geographic maps and the spatial patterns of connected sites. The narrative couples the mapped representations of ARPANET network structure with some of the key events in its socio-technical development, to produce a geo-history.

(i) The 4-node experiment (1969):

In material terms, the archaeological origins of the Internet are usually sited in an experimental network built in 1969 in the western United States linking together computers at universities in California and Utah. This network was ARPA's initial test-

[7] Posting on the *Internet People* mailing list, 'An insightful look at the 'facts'', October 2004.

bed for a multimillion dollar project to build a nation-wide packet-switching network for resource sharing.

The first node in the experimental network – in material form it was a refrigerator-sized computer known as an Interface Message Processor (IMP)[8] - was installed at the Network Measurement Center, run by Leonard Kleinrock, at the University of California, Los Angeles (UCLA) in September 1969. A month later, the second node was instigated when an IMP was delivered to the Stanford Research Institute (SRI) outside San Francisco. The SRI research group was led by Douglas Engelbart, a pioneer in interactive computing and the inventor of the mouse, and was designated the Network Information Center, with responsibility to catalogue the available online resources on the new network.

The first message transmitted over ARPANET between UCLA and SRI nodes took place on the 29th of October 1969. It comprised the typed command: 'lo', the first two letters of 'login'; however, the SRI host crashed before the command was completed[9]. While 'lo' may lack the resonance of Samuel Morse's famous 'What hath God wrought?' or even the practicality of Alexander Graham Bell's 'Mr. Watson - come here - I want to see you', it nonetheless does represent a significant milestone in the history of communications.

The next two nodes linked were mainframe computers at the computer labs of the University of California, Santa Barbara (UCSB) and the University of Utah. All four of the first sites on the network were academic institutions undertaking significant ARPA-funded computer science research. One of the earliest surviving Internet network maps shows this ARPANET's four-node trial network (Figure 5.4). It is a crude hand-drawn black and white sketch, reminiscent of a 'back-of-an-envelope' wiring diagram. The authorship is not recorded, but it is likely to have been one of the scientists or engineers

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[8] IMPs were hardened Honeywell minicomputers and were dedicated to efficient routing the data; they were expensive pieces of equipment, costing about $50,000 dollars each, upwards of £800,000 today (Kirstein 1999, 39).

[9] The scientists were able to successfully transmit the full login command a few hours later. See <http://www.lk.cs.ucla.edu/LK/Inet/1stmesg.html> for interesting historical details on the first message.

involved in the start of the ARPANET project. Despite its crudity, Figure 5.4 marks an important development in the history of the proto-Internet and it has been reproduced a number of times in recent years because of its potent emblematic quality[10] (see discussion in section 4). It could be argued that its rough, hand-drawn appearance actually adds to its appeal, giving it the right visual 'feel' as a shorthand image in 'birth of the net' narratives. The circular symbols in the diagram represented IMPs at each site, which were initially connected to a single mainframe computer, represented as boxes labelled with the particular model of computer used (Sigma 7, PDP 10, [IBM]360, [IBM]940). The data links between the nodes, shown as straight lines on the sketch, ran over existing long-distance telephone infrastructure on dedicated circuits leased from AT&T. The speed of the links was around 50 Kbits, about the same bandwidth as home dialup Internet connections today.

<Figure 5.4 about here. The 4-node sketch.>

The design for ARPANET consciously used standard IMPs as gateways to the network, to enable the easy interconnection of different, and often incompatible, types of computers produced by competing manufacturers with very different operating systems software. The ability to connect together all types of communications devices in a shared network space and have them seamlessly 'talk' to each other is a significant part of ARPANET's legacy to the Internet. It is part of the reason why the Internet can be considered a 'general purpose' technology, like electricity, that is neutral to the particular form of the artefacts plugged into it.

(ii) ARPANET's 'childhood' (1970-72):

Following the success of the four node experiment, ARPANET grew rapidly in the next three years as new nodes were added to the network at the rate of about one per month (see Figure 5.5). The siting of the fifth node in the network at BBN's offices in Boston in early 1970 created the first connection across the continent. The next site connected was MIT in Boston, followed by RAND in Los Angeles. By January 1971 the network

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[10] E.g. Salus 1995; Wurman 1999. In addition to books, it has been used on posters, including the *First Maps of the Internet*, 2001, Peacock Maps, Arlington, VA, <www.peacockmaps.com>. A search on Google image service for 'arpanet' shows this image to be the most prevalent cited.

had expanded to thirteen nodes and in April 1972 it linked together twenty-three sites. By summer 1972 ARPANET had three separate cross-continental routes and links to twenty-nine locations across the continental United States as evident in the original map from this period (Figure 5.6).

<Figure 5.5 about here. Growth chart.>

The number of host computers on the network was expanding and traffic growth on the network greatly outpaced the simple numerical increase in the number of sites. In September 1971 the total traffic throughput was recorded as 6,013 packets per day, growing to 970,455 packets per day in less than a year, by August 1972 (Heart *et al.* 1978, page III-91). Despite this rapid overall expansion, the actual geographical diffusion of the network was not nearly so impressive. The bulk of nodes were heavily concentrated in a select few regions of the United States, evident in the August 1972 maps (Figure 5.6). Of the twenty-nine ARPANET sites in August 1972, thirty-eight percent were in the Boston - Washington D.C. metro areas and another thirty-five percent in the two Californian metropolitan centres of Los Angeles and San Francisco Bay area. The rest were scattered across the centre of the continent.

In the map (Figure 5.6), the sites on the network are shown by small black circle symbols, labelled by site name, not by the actual computers connected (the hosts were shown only on the logical diagrams). The actual design of the map in terms of the layout of the nodes and their large labels makes the continent seem better covered by ARPANET than was really the case. The location of some nodes is approximate - for example, the USC node is the University of Southern California, which is in Los Angeles but is drawn virtually in Nevada on the map.

<Figure 5.6 about here. August 1972 map.>

By 1972 the ARPANET was being used for real work and there was a need to operate the network less like a research experiment and more like a utility. This necessitated much more professional management of the network by BBN, along with the establishment of a dedicated network control centre (Figure 5.2), manned permanently, for continuous network monitoring and troubleshooting, as well as routine software upgrade. While ARPANET was not a classified military project, it was not widely known about and access to it was very limited. People in technical circles and in the computer science community knew about it through numerous publications in the early 1970s by BBN scientists and academics at the lead university sites (see extensive listing of many papers given in Heart *et al.* 1978 for example), but it had yet to prove itself in action to a wide audience and many in the telecommunications industry were deeply sceptical of the novel packet-switching approach. In October 1972 ARPANET received a crucial debut with a 'hands-on' demonstration to the telecommunications community at the First International Conference on Computer Communications, held in Washington DC. Many new programs were created to 'show-off' the potential of the network for real-time interaction to around 1,000 attendees. "It was the watershed event that made people suddenly realize that packet switching was a real technology" (Robert Kahn 1990, quoted in Abbate 1999, 79). As well as making its public debut, the August 1972 network map (Figure 5.6) can also been seen to mark the transition of ARPANET from 'childhood' into 'adolescence'. The most important element in this maturation was the emergence of email.

Email was the unplanned, and largely unforeseen, 'killer application' for ARPANET (Abbate 1999). It was implemented in a semi-official fashion, and has been characterised as one of the first network 'hacks'. It is, in many ways, an apposite example of how users do not just adopt but *adapt* technology to suit their needs. The open architecture of ARPANET also meant that it could easily accommodate new applications being added to the network without the need to be formally planned and authorised. The surprising result of building a network for resource-sharing was that its users actually found most benefit from communicating with each other. Quite quickly the bulk of network traffic on ARPANET was for email. Thirty years later, and despite many new applications becoming available, email remains the single most important reason for people to use the Internet.

Another notable event marking the end of the initial experimental 'childhood' phase of ARPANET was the beginning of efforts to commercially exploit packet-switching technologies. In July 1972 three BBN engineers quit the company to start a commercial networking business called Packet Communications, Inc. In 1973, Larry Roberts, ARPANET's chief architect, left ARPA to run Telenet, the first of a number of official commercial 'spin off' ventures by BNN. ARPA was itself was also looking to divest management responsibility by selling the government's interest to a commercial firm. The obvious candidate was AT&T, the dominant commercial telecommunications carrier in the United States but the company declined - perhaps, thereby, missing a chance to 'own' the future Internet. The switch in management of ARPANET would come a few years later.

(iii) ARPANET 'adolescence' (1973-76):

A major part of ARPANET's legacy in the genesis of the Internet was the development of software architecture for transporting data, known as the network protocols. In computer science, protocols are the defined set of rules that allow devices to communicate with each other without ambiguity. Computer networks succeed or fail based on the quality of their protocols. It can be argued that the prime reason for the success of the Internet in the last thirty-five years rests on the quality, and openness, of its protocols.

In 1973 the key protocol which would come to underlay the Internet was written by network researchers Vinton Cerf at Stanford University and Robert Kahn at ARPA[11]. Called TCP (transmission control protocol), it allowed separate networks to connect together so that the users would see a single transparent space, offering seamless end-to-end communication. TCP was formally published in the following year as a 'protocol for packet network intercommunication' (Cerf and Kahn 1974), in which they described "a simple but very powerful and flexible protocol which provides for variation in individual network packet sizes, transmission failures, sequencing, flow control, and the creation and destruction of process-to-process associations" (page 648). TCP was split into TCP/IP in 1978, forming the basis of internetworking of hundreds of millions of machines today.

[11] Cerf and Kahn won the 2004 Turing Award for this, the equivalent of the Nobel Prize in computer science.

<Figure 5.7 about here. June 75 map.>

The geographical extent and growing topological complexity of ARPANET in the middle of the decade is detailed in the June 1975 map (Figure 5.7). While it was plotted on the simple geographic base as in the 1972 map, it also employed an obvious design innovation in the use of the magnifying circles to enhance legibility in the four core ARPANET regions in northern and southern California, and the Boston and Washington D.C. . The scale distortion makes the maps look fuller than they are. In reality, many sites were clustered geographically (e.g. the sites in the Washington DC area were all within a few miles of each other.)

In total fifty-six network nodes are shown on the June 1975 map, supporting ninety-four host computers (located geographically at fifty different places). There was a marked growth in the number of military sites on the network, compared to the earlier map. The hardware infrastructure of the network had also become more complex as there were now two different types of routing computer employed, represented on the map by the circle and square node symbols.

It is also apparent from the June 1975 map that ARPANET had become, tentatively, international in scope, with sites overseas connected via satellite links, represented by the two wavy lines projecting out beyond the continental coastline (Figure 5.7). Interestingly, the first links went towards the east and the west, rather than perhaps more obvious north or south direction to the United States' immediate continental neighbours. One satellite link towards the west, crossed the Pacific connecting the network research group at the University of Hawaii. The link east crossed the Atlantic to an ARPA-funded seismic monitoring facility near Oslo, Norway (called NORSAR). This link then went via undersea cable to London, with the IMP actually located in the computer science department at University College London[12]. ARPANET's international linkages

[12] The UCL node actually joined ARPANET on the 25 July 1973. Apparently, the hardest part of the initial years of transatlantic networking was the shaky state of research finances in Britain! An initial funding proposal to the Science Research Council was rejected as "being too speculative and uncertain" (Kirstein 1999, 40). The link was a success technically and became quite widely used by British academics by the mid 1970s. It achieved a measure of respectability when it was formally opened by the Queen in February 1976; "...the first involvement of a head of state with any computer network" (Kirstein

were not just limited to Britain and Norway: later overseas connections reached researchers in Korea and Germany in 1983, for example (Salus 1995).

The June 1975 map also marks another transition in the long-term management of ARPANET, with the transfer of operational responsibility from ARPA to the Defense Communications Agency (DCA) in July 1975. The result of the management change was stricter access controls and less openness to ‘frivolous’ uses, as Brian Reid noted: “The agency [DCA] generated a blizzard of memoranda from colonels and generals about things you were and weren't allowed to do” (quoted in Hafner and Lyon, 1996, 233). Despite the change of overall management responsibility, the operation of the network was still undertaken by BBN and hence the mapping of the network configuration continued.

Although, ARPANET was a decentralised network to in terms of topology, on the ground the network infrastructure was not really distributed. The location of nodes remained geographically concentrated, with the majority of sites (62%) in the four metropolitan areas: Los Angeles, San Francisco, Washington DC and Boston. This geographic clustering is clearly apparent in the June 1975 map (Figure 5.7) Outside California and the Northeast U.S., the maps shows continued sparse scattering of ARPANET sites through the Midwest. At this point in time there were still no ARPANET sites in the Pacific Northwest, none in Texas and only two in the southern states[13].

Another anomalous feature in the distribution of ARPANET infrastructure, apparent from close inspection of the maps from the 1970s, was the dearth of network nodes in America's two largest, primary commercial cities, Chicago and New York. In June 1975 there was just one node in New York, at NYU in Manhattan and none at all located in Chicago (the closest was at Argonne, a national defence laboratory located in Illinois). The ‘under-performance’ of Chicago and New York would continue throughout

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1999, 41).

[13] On Figure 5.7, the Gunter node was at the air base in Alabama and the AFWL node was at the Air Force Weapons Laboratory, located in Kirtland air base near Albuquerque , New Mexico.

ARPANET's operational life and was symptomatic of the larger mismatch in the allocation of ARPANET sites in comparison to the distribution of populations across America. The selection criteria that ARPA management applied in deciding which organisations were joined to their network produced a specific geographical configuration quite different from other transportation and communications networks that are designed to serve the maximum numbers of people as efficiently or profitably as possible; hence they almost always link together the largest cities first. As a consequence, seven of the ten largest U.S. cities in 1970 had no ARPANET node[14] .

The distinctiveness of ARPANET's geographical architecture becomes even more apparent when one compares it to maps of the Interstate and Defense Highways system from this era[15]. The vast network of motorways connects, by as direct a route as possible, all principal metropolitan areas and significant industrial centres as a requirement of national defence. The result is a much more uniform coverage of the United States than the network produced by invocation of ARPA managers. Townsend (2001, 44, emphasis added) goes further and argues, "ARPANET evolved throughout the 1970s into a *highly deurbanized* and decentralized communications network, linking remote centers and military bases throughout the United States." So ARPANET, as revealed in the 1975 map, had grown to be a network spanning the nation, but it was far from being a national network.

Another interesting point of contention is the degree to which the distinctive architectural structure of ARPANET in serving some cities and by-passing many other economic centres had a lasting legacy on the spatial form of the Internet industry into the 1990s. Did participation in ARPANET in the 1970s set up advantageous dependent pathways in economic development that favoured certain regions in the latter years when the Internet became a mainstream commodity? Analysis of the impacts of earlier communications revolutions, such as canals, railways and roads, shows that the

[14] These were Chicago, Philadelphia, Detroit, Houston, Baltimore, Dallas and Cleveland. The other three largest cities with ARPANET nodes were New York (but only 1), Los Angeles, and Washington DC.

[15] This was ambitious physical networking scheme, conceived in the Eisenhower era of the Cold War and built by the Federal government over succeeding decades. It would become the biggest single civil engineering program in the world and transform the space economy of the United States (Lewis 1999).

changing accessibility between certain places resulting from new network links tends to spur novel topologies of land-use and economic development[16]. The July 1975 ARPANET map shows a pattern of heavily networked regions (those with density of military research establishments, agencies and university labs with large percentages of defence-funded research) but the real archaeological significance in terms of future spatial development is hard to fathom.

Statistical analysis by Zook (2005, 74) demonstrated that the "early history of ARPANET involvement is positively and significantly correlated with a region being the location of Internet firms in 2000". Certainly, the four core ARPANET regions, represented by the magnifying circles on the maps, were at the forefront of the commercial take-off of the Internet in the mid 1990s and remain powerhouses of the global Internet today, being dominant centres of technology innovation (Boston, Bay area), content production (LA, Bay area) and network infrastructure (Washington DC). Townsend (2003, 70) argues that "[t]he siting of early nodes on these networks laid the seeds of supply and demand for IP networking which drove the creation of commercial Internet hubs." However, there are many confounding factors in a realistic model of the economic geography of the Internet in the United States and it is clear that these city regions may well have been at the forefront of technology-driven regional development, regardless of the ARPANET presence. (Washington DC's case is perhaps strongest for the ARPANET legacy). The real archaeological significance of the study of ARPANET is then probably not the specific spatial-economic legacy shown in the geographic maps, but the more intangible cultural capital of internetnetworking and the model of governance based the 'rough consensus and working code'.

(iv) ARPANET 'maturity' (1977-1981):

In extent, ARPANET remained static over the next few years as no more sites were connected, however the number of hosts coming online grew. Figure 5.1 earlier provides examples of the two different map styles for March 1977. By now, the network is known by the shorthand of 'ARPANET'. Three different types of nodes are evident

[16] The rapid transit around the edges of cities enabled by motorways for example, has contributed significantly to sprawling urbanisation that has become such distinctive feature of the American economic landscape in last forty years.

(although there appears to be only one of the new Pluribus IMP at the SDAC site in Washington DC). The legends also contain a couple of caveats for the reader. The overall ‘neatness’ of the network link representation in the geographic map is disturbed by more crossing lines than in the 1975 map (a particular offender being the new connection from CCA in Boston to DCEC in Washington DC which crosses over five other lines.) There is no great change in the network geographic topology over that time - a few sites lost their connection and a few others gained one, so preserving the equilibrium. Subtle changes are evident by close comparison, for example the addition of few more links to create a fourth transcontinental link from Harvard University, Boston to Scott air base in Illinois and then to FNWC (Fleet Numerical Weather Central) in the Monterey, California. Other notable additions are nodes in Texas and a link to the Pentagon itself.

The summer of 1977 marked another technical milestone in *inter*networking with the successful exchange of messages across three distinct networks and around the globe using TCP. The experiment started in San Francisco Bay with a message generated on a packet radio net from a moving van to BBN, transferring to ARPANET and across the Atlantic to London (UCL) on packet satellite network (SATNET). It was bounced back again on SATNET and then onto ARPANET and ended at the Information Sciences Institute in Marina del Rey, California. “The packets travelled 94,000 miles without dropping a single bit” (Hafner and Lyon 1996, 236). Some commentators cite this as the point at which a genuine global Internet was born, i.e. a network of networks that could provide users with a seamless, end-to-end communications service.

(v) ARPANET evolution: The ‘switch’ and the ‘split’ (1981-1986):

The next milestone in the geo-history comes at the beginning of ARPANET's second decade of operation, the ‘take-off’ point for computer-mediated communication (CMC). This was due, in large part, to the arrival of affordable personal computing. The launch of the IBM PC in 1981 and Apple Macintosh in 1984 brought powerful computers to millions of desktops, which were also being linked to LANs using Ethernet. As a consequence, discussion of the impacts of CMC on work practices starts in earnest (c.f. Newell and Sproull 1982).

The February 1983 map of ARPANET (Figure 5.8) shows the extent of the network during its peak period with nearly one hundred nodes ‘wired’ and nearly 500 hosts online. The topology of the network appears from the map to have ‘filled-out’ somewhat in the centre of the continent with additional nodes in New Mexico (Sandia and Los Alamos national laboratories), Seattle and in Texas. There also seems to be a proliferation of nodes in the Washington DC area, with the circle looking much more crowded than in previous maps. Some sites have also disappeared from the map, including those in Norway and London. (In fact, they had switched to connection via SATNET in 1982.) The types of routing machines on the network had also evolved and the map employed four different types of node symbol. The addition of the corporate logo in the bottom right-hand corner of the map is notable, perhaps providing evidence of more conscious promotion by BBN.

<Figure 5.8 about here. February 83 map.>

The map is also noteworthy as a historical marker as it shows ARPANET one month after a crucial technical transition had taken place - the ‘great switch’. On the 1st of January 1983 all nodes on the network switched protocols, changing from NCP to the newer and more flexible TCP/IP, so the “network could branch anywhere; the protocols made the transmission of data from one network to another a trivial task” (Hafner and Lyon 1996, 249). The switch to TCP/IP for ARPANET and then the Internet would prove vital in battle for global networking standards with OSI in the late 1980s. (The OSI protocol was favoured by powerful European telecoms incumbents - see Salus 1995 for discussion.) The ARPANET also endured a major ‘split’, in 1983 when 45 military sites were separated from civilian network and linked via a MILNET; 68 nodes remained on ARPANET (Salus 1995).

The geo-history presented here is focused on ARPANET but it should be noted that by the early 1980s there were a constellation of other wide area networks emerging (see Quarterman and Hoskins 1986, for an overview). Importantly for Internet history, a good number were outside the USA. They grew out of research and education settings mostly and were focused on meeting the latent demands from academics for email. In

America, many networks took-off initially by offering low-cost connectivity to those universities not fortunate enough to have privileged access to ARPANET, but quickly became valuable in themselves as more colleagues came online. Some of the most important networks to emerge in the 1980s were UUCP (unix-unix copy), BITNET (‘because its time’ network) and CSNET (computer science network). UUCP was a simple store-and-forward network enabled by the spread of the UNIX operating system. It was also used as the transport layer for USENET news developed in 1979 by graduate students in Duke University and the University of North Carolina. BITNET was developed by Ira Fuchs, a professor at CUNY in 1981 and spread quickly across the United States, along with clusters in Canada, Europe and Japan (Kellerman 1986). CSNET began in 1981, spearheaded by Lawrence Landweber, with federal funding channelled via the National Science Foundation, rather than DOD as with ARPANET, and with a much wider remit in terms of who could connect (Cromer 1983). (Landweber was a key figure in the world-wide diffusion of email networking and I consider his cartographic contribution in depth in chapter six.) National education computer networks aimed at delivering the benefits of CMC for a broad user base of academics were also being actively developed in countries outside the USA. For example, JANET (Joint Academic Network) started in the UK in 1984. Eventually, many of these networks came to interconnect, via gateways, to exchange of email, sometimes using ARPANET as the backbone to form a huge common email-space, that Quarterman (1990) called the ‘Matrix’.

Home users were also able to get networked with the availability of affordable modems spurring the growth in dial-up bulletin boards (known as BBS). FidoNet, based on a free DOS-based software written by Tom Jennings in 1983, quickly grew to become the largest co-operative BBS network with some 20,000 nodes (Bush 1993). By the mid 1980s, networks like BITNET and FidoNet had grown to be much larger than ARPANET in terms of extent and numbers of users. (see chapter six on the statistical mapping of the global diffusion of FidoNet, BITNET and UUCP through the 1990s.)

The start of the 1980s also saw the emergence of a distinctive ‘hacker’ culture based on the home computer and BBSs, providing an initiation into new online worlds of cyberspace and later the growth of cyberculture (cf. Levy 1984). BBSs were important as an unregulated digital commons, facilitating the grassroots exchange of software and technical information (see Rheingold 1994, chapter four). The power of networks was also brought to the popular imagination by the release of Hollywood movie, *War Games* in 1983. Science fiction writers, including William Gibson with his novel *Neuromancer* (1984), were beginning to imagine the insides of networks as navigable virtual space where people could interact, which was realised in some senses in the first MUD, written by Roy Trubshaw and Richard Bartle at the University of Essex in 1979, albeit through a textual interface (see Dodge 1999a).

One particular weakness with the geographical mapping of ARPANET is revealed by a significant incident in the mid 1980s. As noted in section 1.3, the maps show only logical network links and not cable facilities location; this can be significant as physical damage at layer 1 renders all other layers above it out of action. One of the more spectacular examples of how multiple, apparently independent, links were disabled by a single event occurred on December 12, 1986, when a construction crew dug through a fibre optic cable running between Newark, New Jersey and White Plains, New York. As it turned out, *seven* different logical ARPANET links, including all of the cross-country links into the Northeast U.S., went through this single cable trench, causing a major portion of the ARPANET to be disconnected. It was not obvious, from looking at a geographic map of the sites connected by those links, that they shared a common point of failure. In fact, no one really knew where the physical communications channels went, because the ARPANET links were just leased from the telephone company. This partition lasted for 11 hours, the time it took AT&T to restore service (Trewitt 1988).

(vi) ARPANET in decline (1987-90):

From the mid 1980s, ARPANET began to decline as sites and users moved over to faster networks. In 1986 the National Science Foundation Network (NSFNET) was built and quickly assumed the role as the core of the growing TCP/IP Internet. Also, within the university research community a number of new regional and national networks were conceived and funded in the 1980s and these were able to offer connections to many more people than ARPANET. As noted, the U.S. military had already split from ARPANET to form MILNET in 1983 for wholly defence-orientated communications. Like the rapid growth in the early 1970s, the gradual shrinking in size of ARPANET was recorded in the BBN network maps (Figure 5.9). The spring 1989 map recorded only 40 sites, which were concentrated almost completely into the four core metropolitan regions. Satellite links connected them across an empty, apparently ‘unwired’ continent. ARPANET was decommissioned in 1990, having been superseded by far faster, more sophisticated networks.

<Figure 5.9 about here. April 1989 map.>

Connections between nations were beginning to take off and by 1989 the number of recorded hosts on the Internet reached 100,000 (Zakon 2004). The fading away of ARPANET also marked the increasing commercialisation of the Internet with the first relays between commercial electronic mail carriers (like MCI Mail and CompuServe) and the Internet (this story is covered in part in chapter seven’s discussion of network marketing maps). In 1991 NSF lifted restrictions on the commercial use of the NSFNET. Crucial to the Internet’s widespread success, a then unknown British research scientist, Tim Berners-Lee, working at the CERN particle physics laboratory in Switzerland, was using it as the platform for a simple distributed hypertext system for information sharing amongst scientists. This system became the World-Wide Web (in 1991). And with that innovation in interface the Internet was quickly propelled into the mainstream, becoming one of the defining technologies of the late twentieth century.

4. Conclusion

The roles to which the ARPANET network maps have been assigned are diverse, depending on the particular discourses they service. Some are well beyond the original intentions of the maps’ initial creation. I have categorised these roles into four distinct types, ordered approximately in succeeding time periods.

The maps’ sparse cartographic design indicates their initial functional role as network documentation. They were produced by BBN as a routine part of its project management and reporting processes; they were not conceived as lasting records. Many were used by ARPA researchers and BBN engineers as useful illustrations in technical papers and presentations given in the early 1970s. The maps were thus significant in the virtual witnessing of ARPANET, supporting the ‘matter of fact’ of novel packet-switching computer networking technology[17]. ARPANET maps worked as a credible form of visual proof of, firstly, the material existence of a network that was beyond the limits of human vision and, secondly, the superiority of the engineering by showing a network that was dominant in size and spanning the nation.

An important distinction in roles can be made between network promotion and out-and-out commercial marketing. The ARPANET maps were not, initially, intended to be used to advertise the network to the general public per se, nor to win new customers from competitors. Indeed, in the early 1970s ARPANET had no competitors. There is none of the overt advertising imagery one might expect and it was only quite late in the day that an unobtrusive BBN logo was added to the bottom right of the maps (see Figure 5.8). This kind of information dissemination and promotional 'pride' role for technical network maps, established as a distinct genre of cartographic discourse by ARPANET, continues today with contemporary research and education networks across the world producing backbone maps that provide virtual witness to their engineering prowess. For example, maps of the Joint-Academic Network, known as JANET, in Britain are frequently deployed in its publications for the technical user community (Figure 5.10). The network is funded by top-slicing funds from the budget of universities in Britain to provide 'free' high-speed network connectivity. Given this monopoly provision, there is not really an explicit marketing role as such for JANET maps, because its customers cannot shop around.

<Figure 5.10 about here. JANET map.>

A subsidiary role for the ARPANET maps in the later 1970s was their strategic deployment by the lead contractor BBN in building a coherent identity for the ARPANET network as part of the processes of proving to ARPA their capability to build and continue to run the network effectively. The ultimate goal for BBN, I would argue, was to establish its own kind of corporate techno-sovereignty over the new

[17] One element of this was to win over traditional telecommunications engineering, which is based on the circuit-switching concept. This debate continued for next two decades. Today packet-switching has won out, as voice telephony is being rapidly being absorbed to become just another service running on IP networks.

territory of packet-switched computer networks so as to affirm their 'rightful' claims to future federal government funding.

An interesting parallel can therefore be drawn between BBN's use of the ARPANET maps and symbolic uses of cartography by governments in similar efforts to establish a distinct national identity by demonstrating their irrefutable sovereign authority over a territory. Maps were forging an imaginative geography of the ARPANET 'nation' that was coterminous with the U.S. and with BBN's corporate goals. As Henrikson (1994, 56-57) argues in his analysis of statist cartography: "...it is noteworthy that one of the first steps of a newly independent country is often to commission a national atlas, to print stamps with a map of the country's outline on them, and to otherwise use the emblem of the map to assert the country's new identity in a new setting."

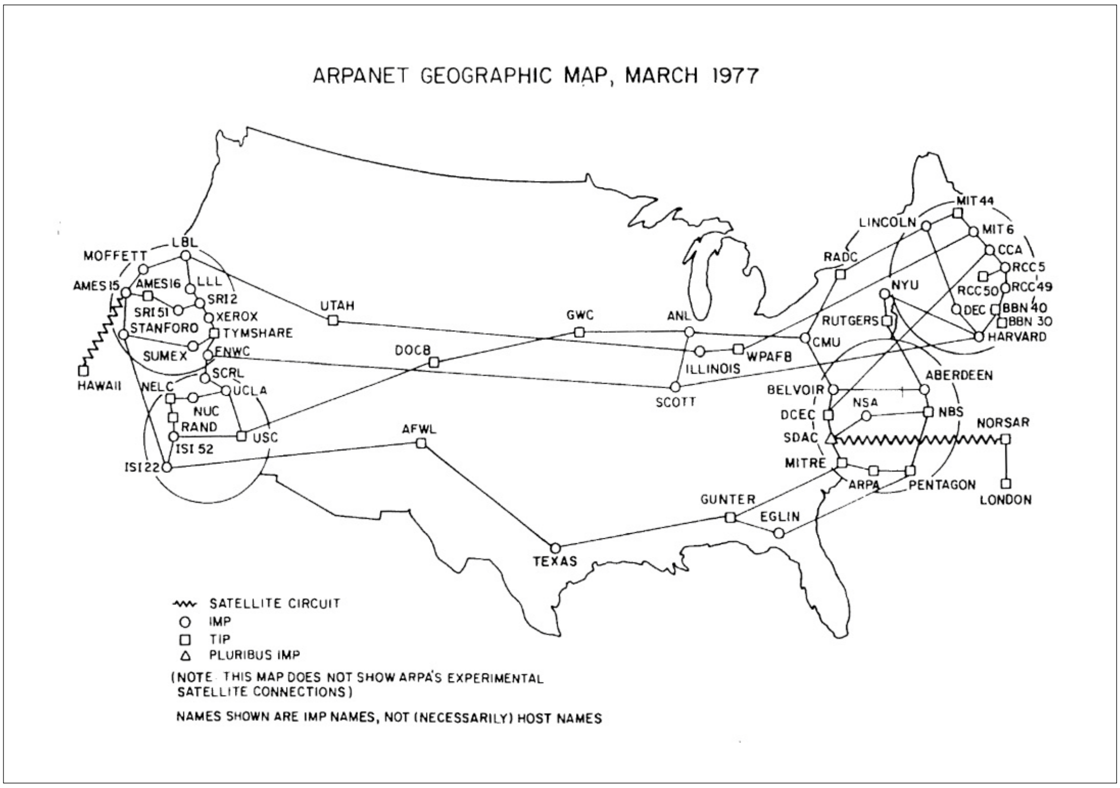
This strategic application of ARPANET maps for claiming network sovereignty is apparent in official documents such as the *ARPANET Completion Report* (Heart *et al.* 1978), produced by BBN in 1978 as part of the fulfilment of its contractual obligations to ARPA. The report was written by four of the key ARPANET engineers and managers at BBN and is a substantive document, running to nearly two hundred pages; it lays out reasons why the ARPANET succeeded and its likely long-term impact, as seen through the strategic corporate interests of BBN. Unsurprisingly, given the authorship, the report gives a strongly upbeat narrative of a thoroughly successfully engineered project: claiming that ARPANET "has created no less than a revolution in computer technology and has been one of the most successful projects ever undertaken by ARPA" (Heart *et al.* 1978, I-2). Cartographic figures completely dominate the illustrative content of the report, with some twenty-seven full pages displays of geographic and logical maps. Apart from the maps, there are only six other figures in the report (two conceptual diagrams, three tables and a statistical graph). The maps serve as obvious artefacts, providing tangible proof of how the network was built and that it really functioned as a successful entity. Clearly, ARPA were more than satisfied with BBN's performance as they continued to fund the corporation to operate the network for another decade. BBN was also successful in gaining further federal networking projects (e.g., Milnet).

The next role for ARPANET maps moves beyond the closed, elite world of ARPA-funded research, to considering how they were deployed in developments in the 1980s to obtain further public funds to network American science more fully. Maps were useful in this regard, as authoritative visual material able to prove the existence of large, nation-wide networks in support of this strategic discourse. An example of how network maps were used in advocacy for further funding can be seen in an article published in *Science*, titled ‘Computer networking for Scientists’, (Jennings *et al.* 1986). The article is only eight pages in length but includes five maps of the different networks - ARPANET[18], CSNET, BITNET, MFENET (Magnetic Fusion Energy researchers network) and NSFnet.

Lastly, the contemporary role of the ARPANET maps, from the mid 1990s onwards, is as emblematic visual symbols of the past. The maps are now perceived as ‘old maps’ and they have became easily packaged into narratives of the Internet’s history. This type of use is common in textbooks, to illustrate otherwise textual historical descriptions. This role is aided graphically, because the ARPANET maps in their extant form have the right look for ‘old’ maps: simple, almost crude, line-drawing, black and white.

Yet, while the maps of ARPANET might look primitive in terms of cartographic design, they are nonetheless historically significant documents; they provide one of the best records of a crucial period of networking history, revealing the growth and evolving geographic structure of one of the most important parts of the early Internet. Indeed, they are one of the few tangible traces of the network left as there is very little physical evidence of ARPANET to be found.

[18] The map (p. 945) shows the configuration in 1985 and the design is clearly based on BBN source material with its distinctive four magnifying circles, but the map has been simplified and all the labels have been removed.



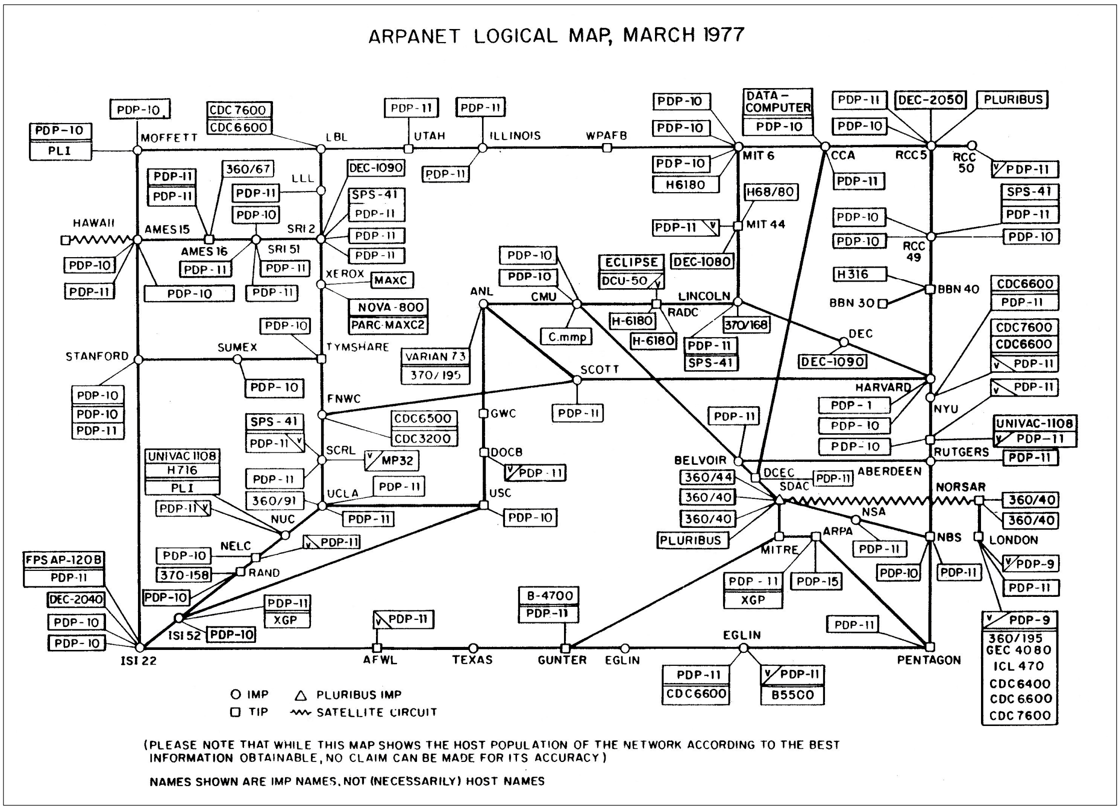


Figure 5.1: Typical examples of the ARPANET network mapping. Both were drawn by Bob Brooks and the BBN graphic design department. (Source: (top) Internet Archive 2000; (bottom) scanned from Heart *et al.* 1978.)

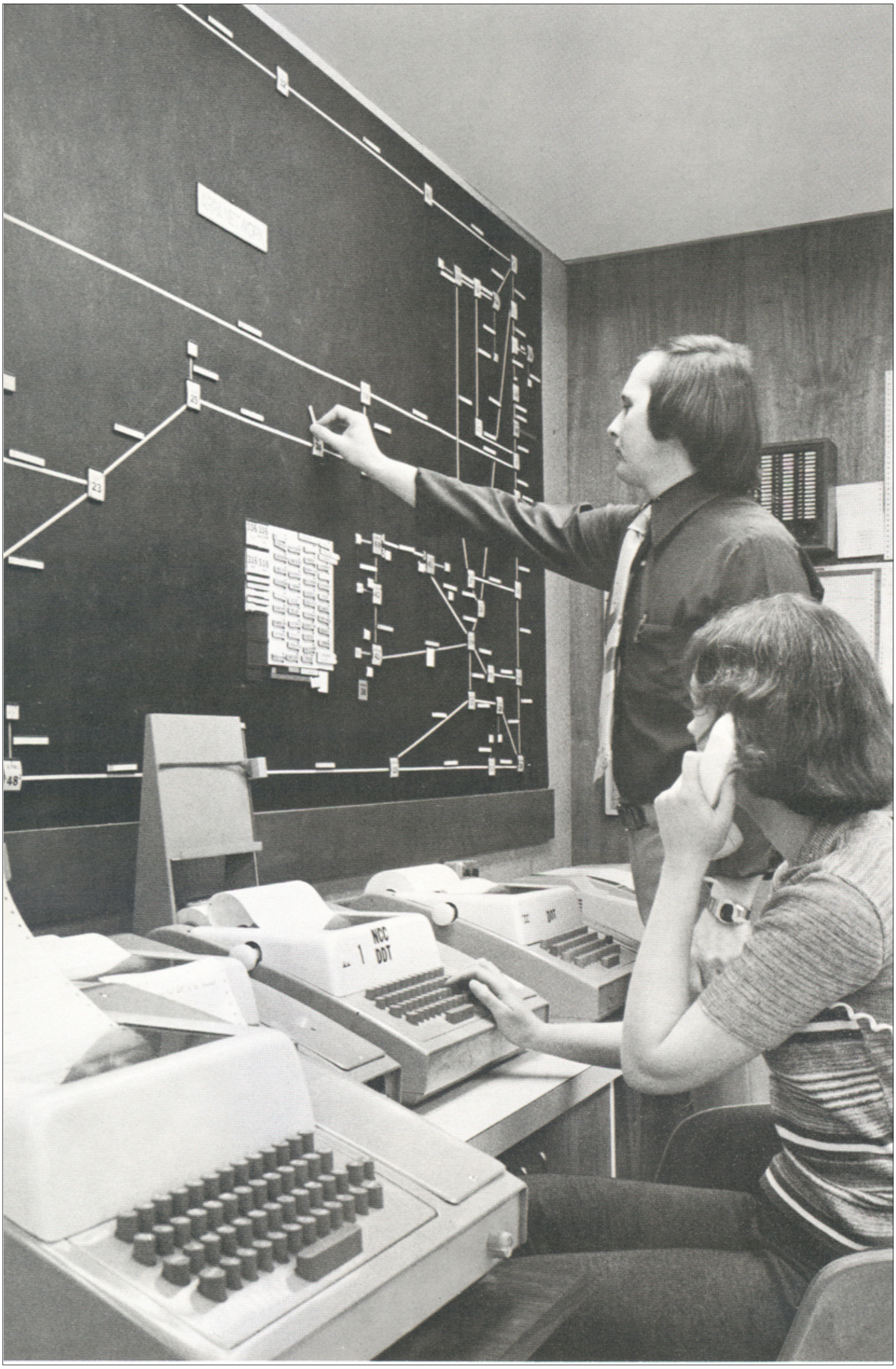


Figure 5.2: The ARPANET network control centre at the BBN headquarter in Cambridge, MA. The topological configuration and status of the network was recorded manually on a large wall map by operations staff using magnetic strips and markers. (Source: Alex McKenzie, photo undated.)

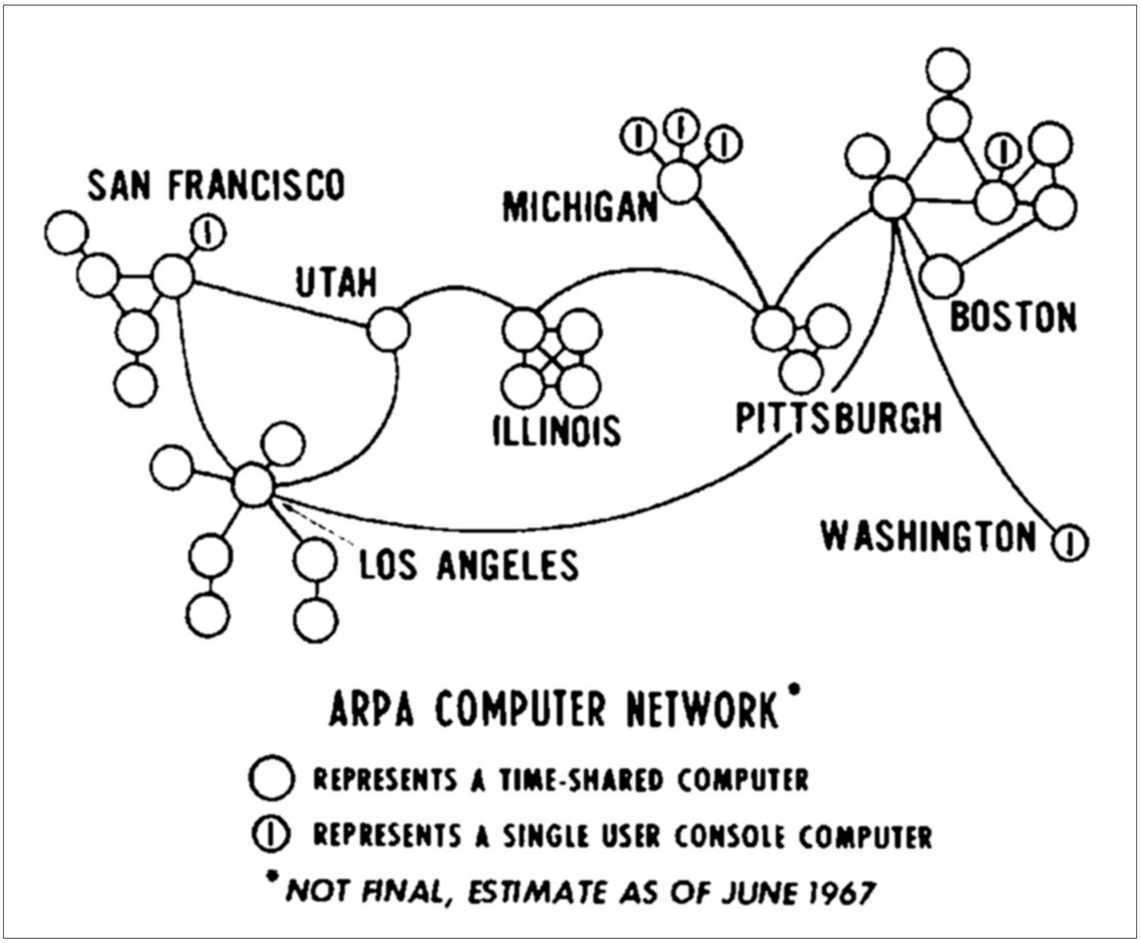


Figure 5.3: Schematic map of the proposed layout of the proposed ARPA network used as an illustration in paper by Larry Roberts, ARPA IPTO manager. (Source: scanned version from Roberts 1967, 6.)

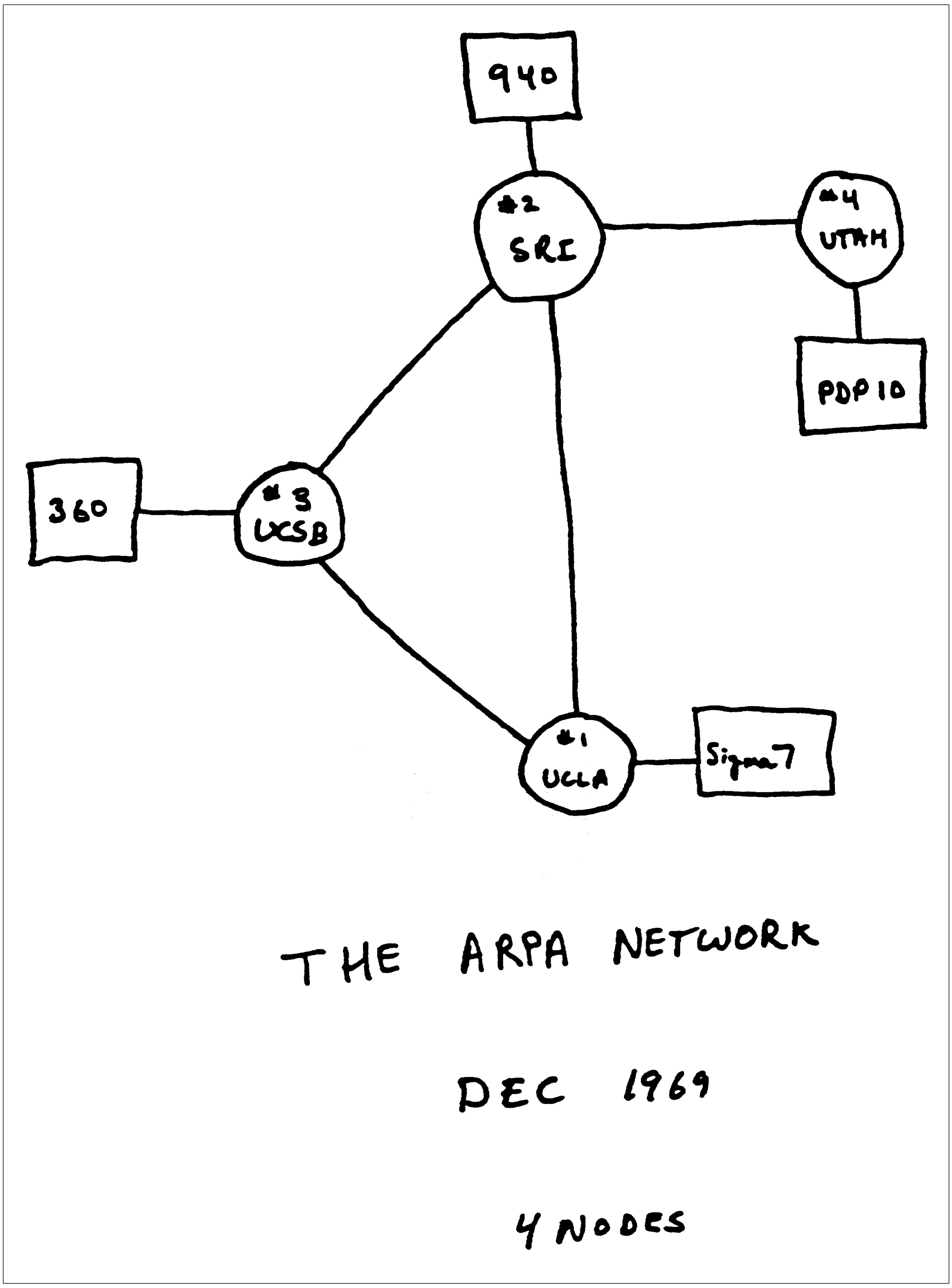


Figure 5.4: Original sketch map of the first four sites connected to ARPANET in December 1969. Author unknown. (Source: scanned from CCR 1990, 83.)

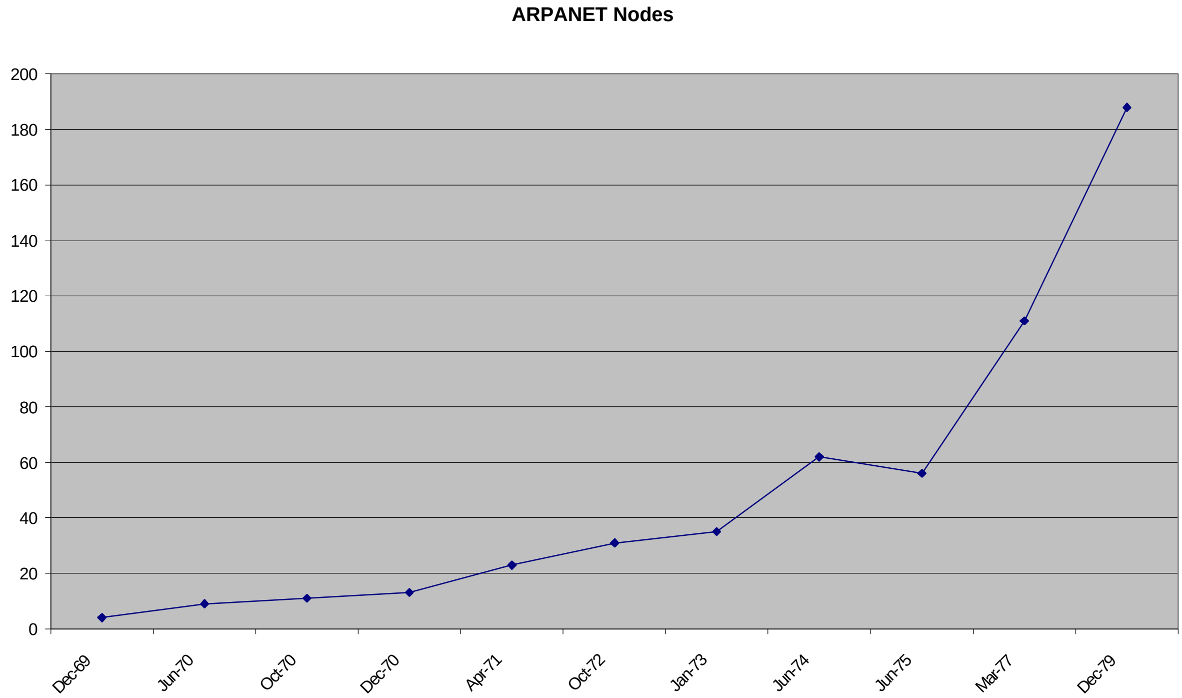


Figure 5.5: The growth of ARPANET during its first decade of operation in terms of connected nodes. (Source: Data derived from analysis of the ARPANET maps.)

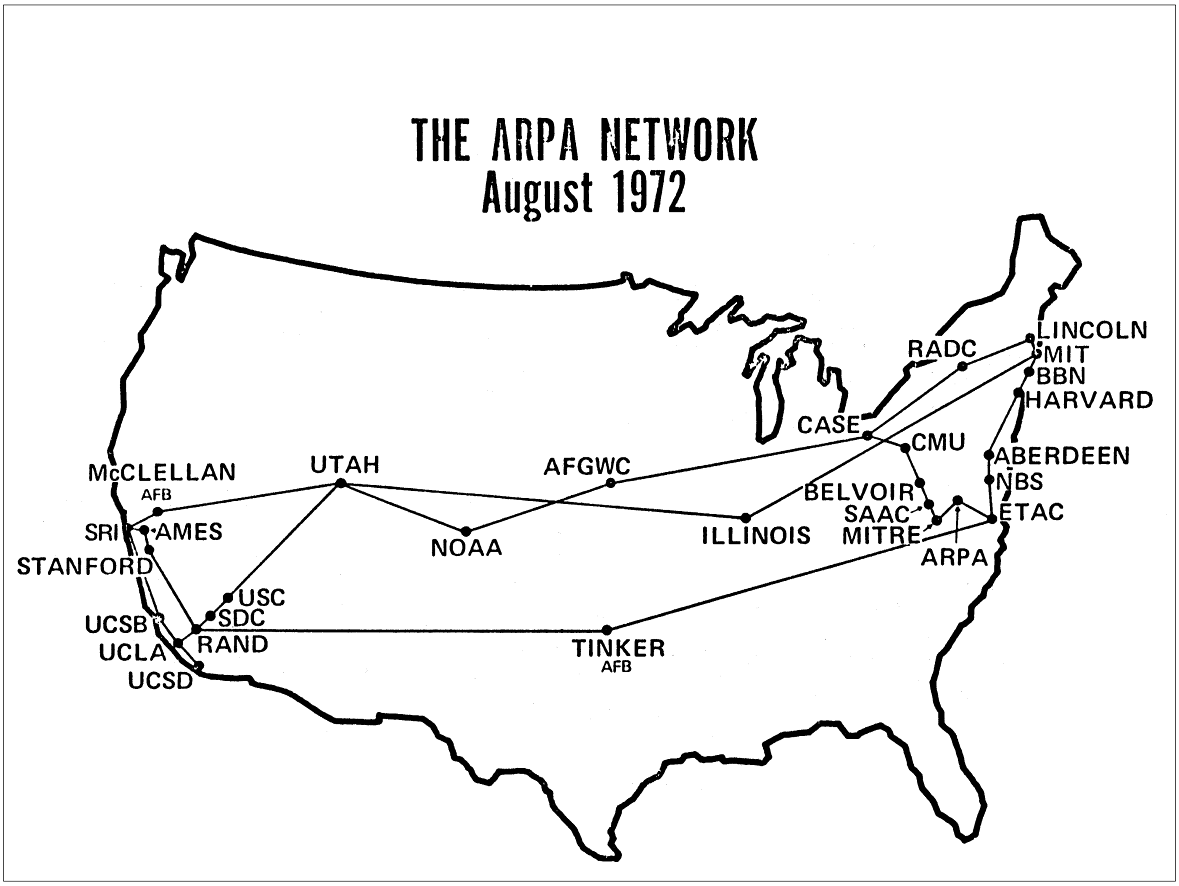


Figure 5.6: The extent of the ‘ARPA Network’ towards the end of its experimental phase of growth. The network connected nearly thirty sites and had three different cross-continent routes. Drawn by the BBN graphic design department. (Source: scanned from CCR 1990, 86.)

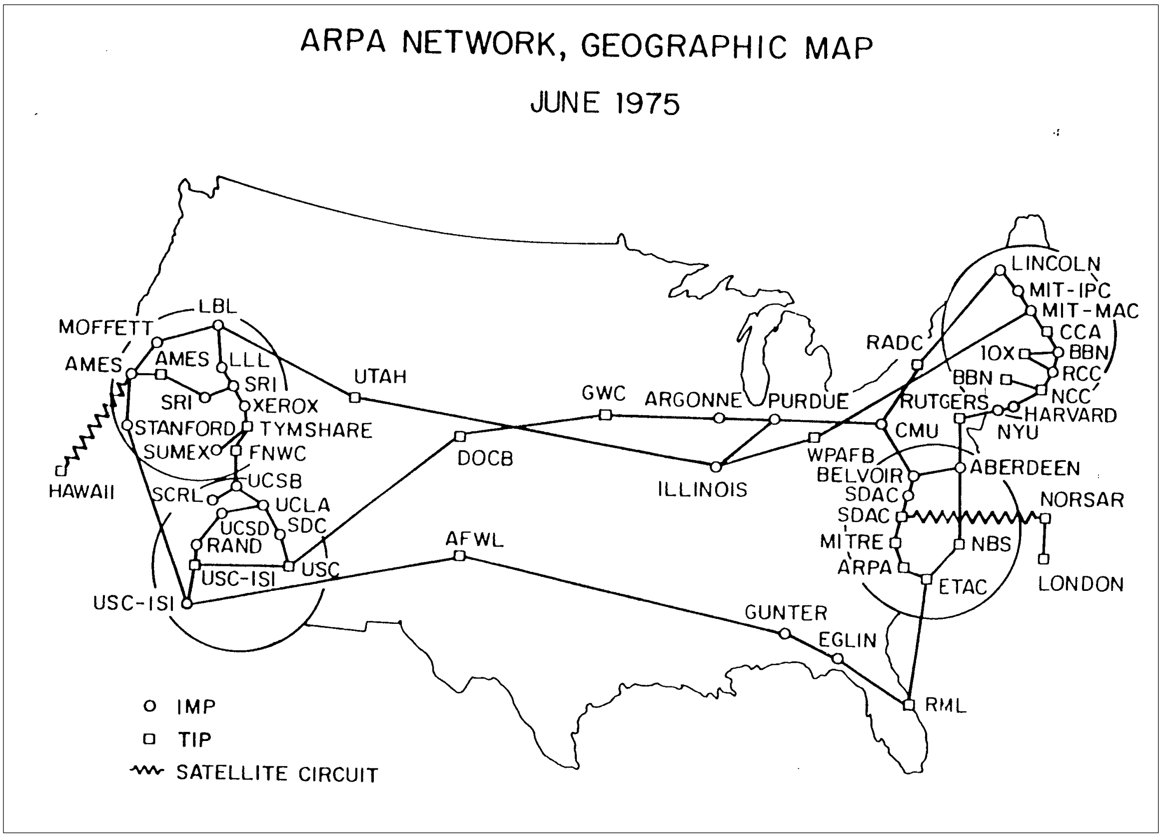


Figure 5.7: Geographic map of fifty-six nodes on ARPANET network in June 1975. Produced by Bob Brooks and drawn by the BBN graphic design department. (Source: scanned from CCR 1990, 87).

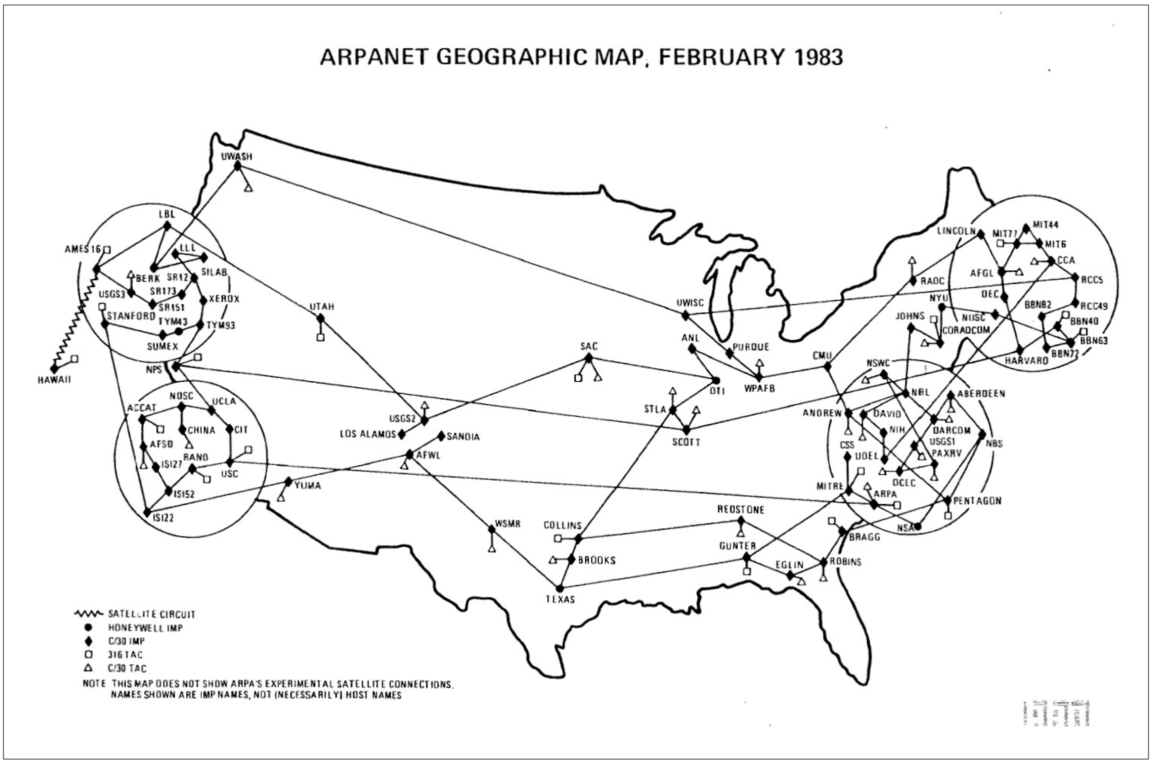


Figure 5.8: Geographic map of ninety-four sites on the ARPANET network in February 1983. Drawn by Bob Brooks and the BBN graphic design department. (Source: scanned from CCR 1990, 99.)

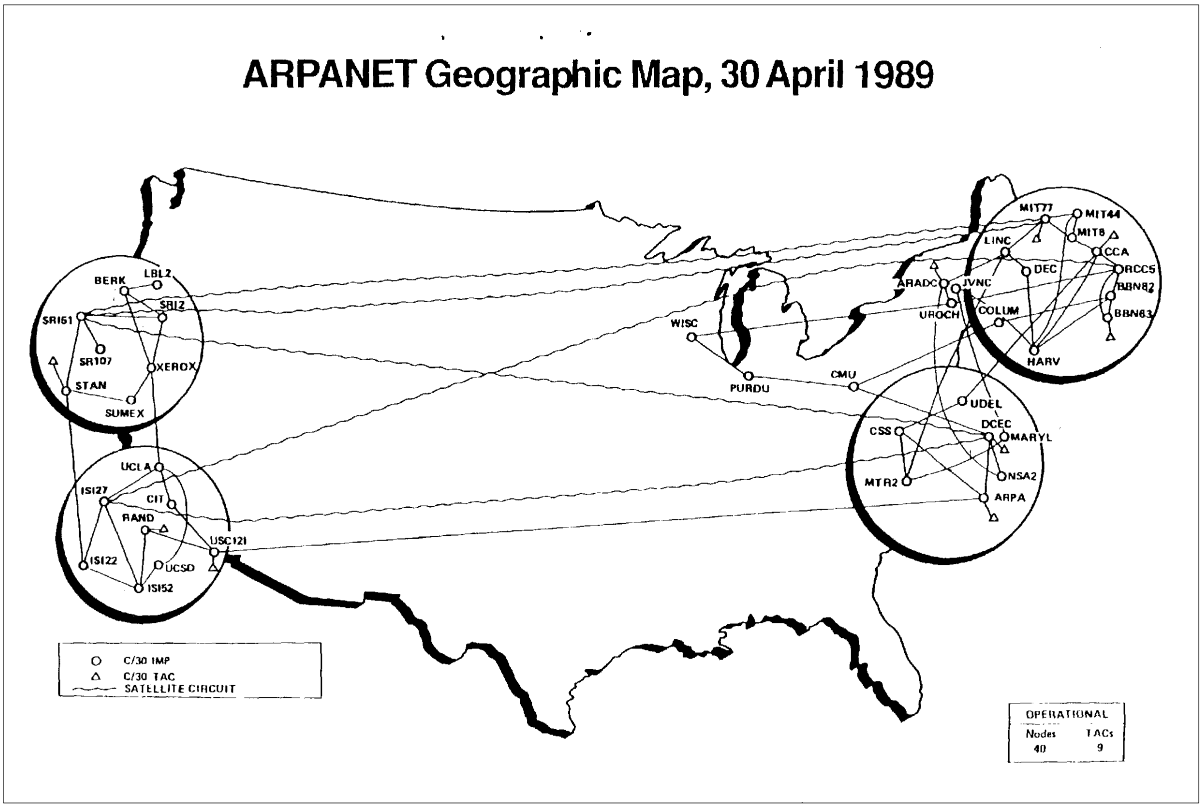


Figure 5.9: Geographic map of the shrunken ARPANET network as of April 1989, shortly before the network was decommissioned. Drawn by the BBN graphic design department. (Source: scanned from CCR 1990, 109.)

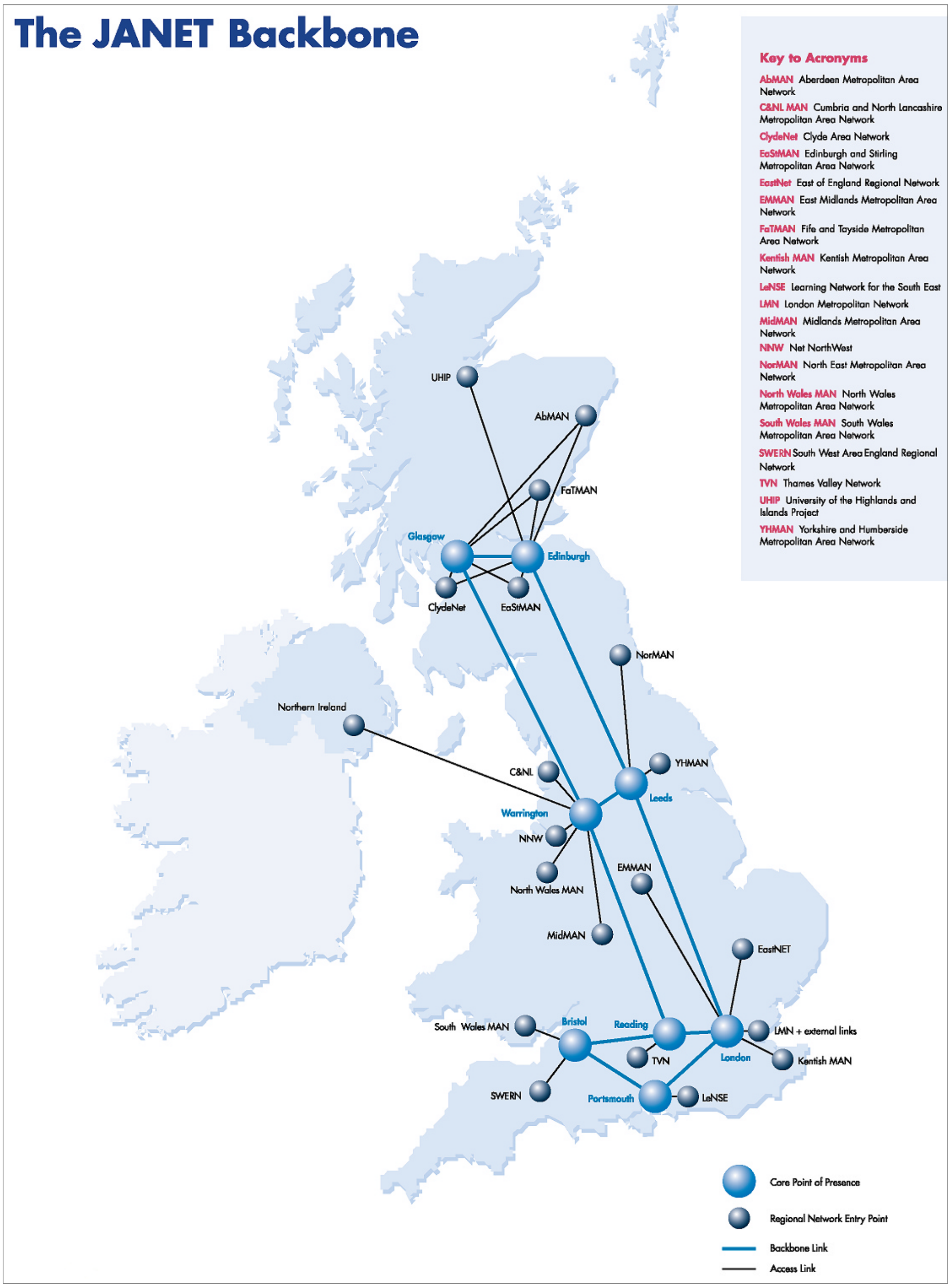


Figure 5.10: An example of a contemporary network map produced to promote a non-commercial research and education network. Shown is the geographic topology of the core of the SuperJanet3 network in Britain, circa 2000 (source: <www.ja.net>).

Chapter 6

Spaces of Diffusion and Division: Statistical Mapping of Internet Globalisation

Jobs, knowledge use and economic growth will gravitate to those societies that are the most connected, with the most networks and the broadest amount of bandwidth.

-- Thomas L. Friedman, *The Lexus and the Olive Tree*, 1999.

Almost the whole world, it seems from a casual inspection of this map, has turned Internet-coloured. The sun never sets on the Internet; it appears to reach everywhere except some war-torn corners of the world.

-- Mike Holderness, *Who are the World's Information Poor?*, 1998.

1.1 Introduction

The 'old' maps of ARPANET analysed in the previous chapter constructed an image of the Internet as wires linking computers together across the United States using arc-node network representations. In this chapter I consider maps that provide a synoptic picture of the evolving geographical structure of Internet at the global scale using choropleth map representations. The analysis moves forward in time to the more recent history of the Internet, covering the first half of 1990s, the period of mainstream 'take-off' of the Internet in most developed nations and subsequent widespread diffusion of network connectivity across the world. The critique focuses on the workability of a series of statistical world maps from this era produced by U.S. academic Lawrence Landweber to track the extent of global diffusion of the Internet and, at the same time, to examine the ways they serve politically to produce a particular imaginative geography that masks the extent of 'digital divides'. The ideology and partiality of Landweber's particular choropleth maps of Internet globalisation is then revealed through the consideration of a range of alternative cartographic representations and different metrics for the geography of the Internet at the global scale.

1.2 Connecting the world: Tales of Internet diffusion and digital divides

The Internet grew tremendously during the 1990s. One of the most impressive elements in this growth was the speed by which countries across the world became connected (Figure 6.1). The first half of the 1990s, in particular, can be conceptualised as the 'globalisation' of the Internet, starting from an U.S core, spreading throughout the reminder of the developed world and then linking to poorer, peripheral nations, so that by the end of decade most countries had at least some form of connection to Internet. The rapid globalisation of the Internet was facilitated by a number of technological developments, as well as wider political and economic factors which benefited new forms of low-cost international networking.

The most significant technological factor was developments in long-haul fibre-optic transmission systems, particularly undersea cables linking continents, made in the 1980s. This led to an order of magnitude growth in available bandwidth[1] and concomitant decline in circuit costs in the 1990s. (See also chapter seven for more discussion of the boom in fibre-optic infrastructures in relation to network marketing maps.) The majority of investment in new undersea cable systems, however, was on a select few routes linking together already well-connected industrialised regions and major cities (Graham 1999), beneficially reinforcing existing transportation routes (Arnum and Conti 1998).

Demand for this new bandwidth was driven by exponential growth in Internet traffic in the early 1990s resulting from many new users, new interfaces to navigate online information spaces and wholly new applications (see analysis by Coffman and Odlyzko 2000). One of the first user-friendly, 'point and click' Internet interface tools to gain widespread use was Gopher (launched in 1991). Gopher was usurped in quick succession by the World-Wide Web with the release of the Mosaic browser in 1993. Web traffic growth for next three years was explosive, growing at several thousand percent per year and quickly outstripping all other protocols (Odlyzko 2000). By helping to make it a mass medium, the Web was also a critical element in the

[1] This growth was reified by techno-pundit George Gilder in his 'law of telecosm', which states: "The world's total supply of bandwidth will double roughly every four months - or more than four times faster than the rate of advances in computer horsepower [Moore's law]." (Rivlin 2002, no pagination).

commercialisation of the Internet industry. Netscape's Navigator browser was commercially released in 1994 and the company's IPO the following year is now commonly regarded as marking the starting point for the 'dot-com' boom that propelled the Internet into the public consciousness as one of the defining technologies at the *fin de siecle*.

<Figure 6.1 about here. Growth chart.>

The underlying economics and governance structures of the Internet also evolved significantly in the early 1990s to facilitate the global spread of the network. At the end of the 1980s the Internet largely retained its 'research & education' ethos, being run in a co-operative, not-for-profit way based on informal consensus reached by a small cabal of 'techies'. It was dominated by the quasi-academic[2] National Science Foundation Network (NSFNET) in America. NSFNET was the largest and fastest network and thus formed the effective central 'backbone' of the Internet from the late 1980s. The 1990s saw the transition of the Internet core in America from a public to a fully privately managed and financed infrastructure. In 1991 commercial traffic was allowed and soon the major proprietary online services - including AOL, CompuServe and Delphi - provided gateways to the Internet to allow exchange of email. An increasing number of commercial ISPs emerged, creating an affordable dial-up Internet access market for domestic users in several developed countries. In 1995 the Internet backbone itself was 'privatised', as NSFNET was decommissioned. One noteworthy symptom of commercialisation and changing management of the Internet was a transformation in online culture, to the chagrin of many long-time users[3].

Beyond the network, so to speak, the world-wide spread of the Internet was facilitated by significant broader geopolitical changes at the start of the 1990s, announced by the

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[2] It was government-funded but run by private corporations under an agreement with the National Science Foundation. It had an operational charter forbidding transmission of commercial traffic for the first five years.

[3] Feelings about this time are nicely summarised by Guédon's (2002, no pagination) reminiscence: "I remember the dismay of old-time users like myself when the AOL crowd showed up, with no manners, no understanding of the community spirit that had developed quietly in the '80s, no comprehension of the sharing and give-and-take quasi-utopia that had grown somewhat confidentially in their midst."

fall of the Berlin Wall and the collapse of Soviet hegemony. Many states, particularly in Eastern Europe, became more open to external trade, investment and media flows, often accompanied by marketisation of industries. The liberalisation of telecommunications monopolies in many developed countries also opened up 'market space' for new businesses to start providing commercial Internet access services. In complex ways, then, the spread of the Internet was greatly *aided* by wider globalisation 'project' that many see as characterising the 1990s (Dicken 2003). Yet at the same time the Internet was itself playing a key part *enabling* this economic and political globalisation - for example, by easing data flows, flattening hierarchies of communication and, above all, lowering transaction costs.

Unsurprisingly, interpreting the nature of the Internet's global growth was the subject of intense and competing analysis through the 1990s, focused in particular on the implications for economic and social development likely to flow from connectivity. In binary terms, the debate around the meaning of Internet globalisation can be conflated into two viewpoints: what I label here 'diffusion' and 'division' perspectives[4].

On one side there was a broad 'diffusionist' coalition of scholars, activists, techno-pundits and network builders who viewed the Internet as essentially a progressive tool for social empowerment and development. For example, then U.S. Vice President Al Gore (1994) in a utopian call to create a global information infrastructure, asserted: "I see an new Athenian Age of democracy forged in the fora the GII [Global Information Infrastructure] will create." Connectivity was seen as a potent eraser of economic difference between regions of the world. The rapid diffusion of access, particularly of personal email communication, would connect people in the less developed regions directly into the core, and the mutual flows of information, ideas and knowledge engendered would be beneficial to all, fundamentally overturning power differentials.

The alternative, 'divisionist' discourses, focused on the hegemonic power of technologies, were deeply sceptical of the progressive potential of networking and

[4] Obviously, this characterisation is a simplification for purposes of current discussion, but it resonates with many other debates about the 'impact' of ICTs which tend to deterministic arguments, split along utopian or dystopian lines (see Graham 1998).

typically viewed the Internet as simply adding another layer of inequality between nations. Far from being economically empowering, the Internet was likely to *widen* divisions, enabling the developed regions to exploit the weak more effectively. In the future, the Internet promised, so the argument went, “the distinction between developed and non-developed countries will be joined by distinctions between fast countries and slow countries, networked nations and isolated ones” (Baranshamaje *et al.* 1995, quoted in Holderness 1998, 37). The winners of world-wide Internet growth - much like other dimension of globalisations in the 1990s - would be those select few switching points able to direct the flows and extract surplus value. Besides economics, the potential of Internet to level social differentials in power was also questioned: “Despite the assertions of the people at *Wired* and other end-of-politics theorists, class stratification and oppression have not been eliminated by computers or any other technology” (Surman 1995, no pagination).

Fundamentally then, the ‘diffusionists’ and ‘divisionists’ disagreed on the extent to which the Internet could make the world a ‘better’ place. Assessment of the undoubted unevenness of Internet penetration was a key element for both sides, with concerns being most publicly articulated in ‘digital divides’ discourses. The digital divide emerged as a distinct ‘problem’ for academic analysis and political action in the mid-1990s with major international summits held and the formation of high-profile task forces (such as the G8 Dot.Force). At the global scale, the African continent was often highlighted as needing special attention; for example, a *New York Times* article from this period stated: “From the White House and the World Bank to international business and academic circles, analysts warn that unless Africa gets online quickly, what is already the poorest continent risks greater marginalization” (French 1995, 5). For the advocates of the ‘diffusionist’ positions, the evidence of digital divides was useful for highlighting where extra effort was needed and, anyway, these differentials in access were just a temporary ‘blip’ that would be quickly ironed out. The same kind of evidence was used in a more incriminating fashion in ‘divisionist’ discourses to puncture the utopian hype of the ‘diffusionists’ and point up the absurdities of the ‘global information society’ rhetoric.

Both sides sought to create particular imaginary geographies of the Internet to suit their agendas, deploying potent metaphors, statistical evidence and graphic representations (particularly ‘growth’ charts and scattergrams) to aid their case (Dodge and Kitchin 2000b; Harpold 1999). In terms of spatial metaphors, the most prevalent one seen in the mid-1990s drew a direct analogy between computer networks and road networks, with the ‘diffusionists’ proclaiming the Internet as the coming ‘information super highway’. This was pointedly countered by the ‘divisionists’ camp who said it was clear that most of the world would be left to struggle along ‘digital dirt tracks’ (see chapter four). In this chapter, I analyse the role of statistical world maps played in this debate on the ‘true’ nature of Internet globalisation in the 1990s.

1.3 The emergence of statistical mapping

Robinson (1982, 16) defines the thematic map essentially as one that “focuses on the differences from place to place of one class of feature, that class being the subject or ‘theme’ of the map”. The communicative goal of thematic maps is to make apparent to the reader the *spatial* distribution or structure of the theme itself and the underlying geographical base map is simply the backcloth to support this. The spatial description of data revealed by the thematic map can be a useful aid in determining underlying causal processes and then demonstrating the plausibility of an explanation to others (e.g. spatial diffusion patterns in epidemiological studies). An almost infinite range of possible themes can be mapped, using a wide range of representational techniques (Dent’s 1995 text book provides a comprehensive overview). Statistical maps commonly use choropleth techniques which shade areal units of enumeration to represent classified interval data, although several other approaches, such as isopleth and proportional symbol maps, are also prevalent.

Today, thematic maps are one of the most widely-seen forms of cartography, being deployed in all manner of discourses and distributed in all media, the ubiquitous television news weather map being the most obvious. Yet, attempts at understanding the nature of the human world in terms of the nomothetic mapping of environmental, social and economic phenomena came quite late in the history of cartography. Until the late seventeenth century, cartography had focused solely on representing idiographic knowledge, with maps used predominantly as a topographic reference recording the location of unique features in the landscape, for delineating property boundaries and as a tool for navigation. The development of a distinctive new mode of cartographic representation - the thematic map - focused on the *generalised* description of a single aspect of place or human activity came to the fore in the beginning of the eighteenth century and became firmly established as an outcome of dramatic changes of the Enlightenment era and later industrialised modernity (Robinson 1982).

It is now widely acknowledged that the Enlightenment and the shift into a modern society gave rise to more systematic means of managing and governing populations. People became increasingly viewed as components in larger systems: as labour commodities, as problems to be solved (e.g. ill-health, illiteracy), and as citizens. The development of ‘population thinking’ by centralised State institutions depended, crucially, on generating both a depth and a breadth of new statistical knowledge about society as a whole. This period saw the creation of systems of universal civil registration, standardised observational methods in morbidity, the enactment of large-scale social surveys (on education, poverty and other aspects of ‘moral’ status) and, ultimately, the total enumeration of the population through censuses (the first British census was held in 1801) (c.f., Hacking 1990). The concern was to gain a uniform understanding of the human resources available to the State and also to create “unitary national identities via the production of statistical measures that levelled differences, and suppressed local and ethnic identities” (Higgs 2004, 20).

This wholesale ‘quantification’ of society required new kinds of representation to make sense of wholly new classes of economic and demographic data being generated. Indeed, Cosgrove (2003, 133) argues that “statistics had their greatest social impact through graphic expression - graphs, charts and maps”. A range of thematic maps, along with many other chart types, such as Playfair’s pie charts, were invented at the start of the nineteenth century in a burst of graphic creativity (see Friendly and Denis 2003 for review). William Smith produced his geological map of England and Wales in 1815 and two years later the pioneering geographer Alexander von Humboldt produced the first known isoline map showing temperature patterns. The origination of the choropleth map itself has been traced back to 1823 and work of the political economist, Charles Dupin, who was concerned with mapping the demographic capacity of the French nation (Robinson 1982, 156-57). In representational terms, choropleth maps were a significant advance in visually communicating complex socio-spatial patterns, as they replaced the accepted practice of simply writing numeric values onto the map.

The emergence of thematic mapping also had political implications (Crampton 2004). Choropleth maps in their visual form and application tend to dehumanise the spaces they purport to represent. They are intimately involved in the production of a particular kind of governmentality, in which their instrumental rationality aggregates unique places and generalises individual human experience into easily mappable averages, rates and scores. The orderly representation of statistical knowledges offered by thematic maps are powerful, I would argue, not because of what they show, but because they can mask so well the complex, contingent social reality. The social worlds viewed through statistical mapping are thus de-socialised and rendered more easily governed by powerful institutions, as the human effects of their policy decisions remain safely opaque, hidden behind the neat tables of numbers and uniformly shaded enumeration areas.

2.1 The 'International Connectivity' map series, 1991-97

The world-wide diffusion of the Internet during the 1990s was tracked by the American computer scientist, Lawrence Landweber, and charted in a series of statistical maps. In total, Landweber produced twelve maps over a period of six years, providing a unique visual census of the spread of international connectivity via a range of different computer networks, including the Internet[5]. The first map Landweber produced displayed the diffusion of network connectivity in September 1991 and the last one in the series was created in June 1997 (Figure 6.2). The first map (labelled version 2; there is no version 1) is the earliest published map that attempted to represent the geography of the Internet in a nomothetic fashion. By making a simple visual comparison of his maps through time, it becomes clear that a large swathe of the world's nations *appeared* to have become connected to the Internet in the first half of the 1990s. As such, Landweber's maps, and the associated data tables (see Figure 6.4), are one of the most

[5] A quite similar effort, the 'FAQ: International E-Mail Accessibility', was also undertaken in the 1990s by Olivier MJ Crepin-Leblond (see <www.nsrc.org/codes/bymap/ntlgy/>). It is not examined here, as it does not add substantively to the arguments made.

accessible and well-used sources of longitudinal data on Internet globalisation during a crucial period of growth.

<Figure 6.2 about here. Landweber maps.>

(i) Map semiotics:

In terms of symbolisation, Landweber's maps are firmly embedded in the conventions of statistical cartography. They use a choropleth approach, based on a four-fold nominal classification, to represent network connectivity at the national level (Figure 6.2). The first class, 'No Connectivity', is represented by yellow shading; the two intermediate categories of connectivity - 'EMail Only' and 'BITNET but not Internet' - are symbolised by green and red shading respectively; and the 'top' category of 'Internet' connectivity is represented by a purple colour. The world base map of countries is wholly conventional, taking a familiar Robinson-type projection centred on the prime meridians. Countries are rendered as black outlines, easily filled with bright, solid colour. No countries, oceans or other features are labelled; there is no geographic context shown beyond the country containers for the statistic. Clearly, it is assumed that the readership will know the conventions of world maps.

The classification scheme is set out in the large legend box that dominates the centre of the map layout. The legend box also gives the title of the map, 'International Connectivity', along with revision details. The title itself is somewhat ambiguous if the maps are read out of context. Connectivity to what? The word 'international' in the title must also be noted so the reader understands what is being shown and what is *not* shown (see discussion below regarding Landweber's data collection methodology). The labels for classes in the legend are also rather cryptic for readers without prior knowledge of computer networking. What, for example, are BITNET and UUCP? It is also not explained what the significance is of the difference between the classes of connectivity. How is BITNET different from Internet? What does it mean for a country to be shaded red rather than green in terms of online access for people living there? There is no explanation on the map artefacts themselves, although further details are given in associated data tables (Figure 6.4; see discussion below).

Besides the legend box, there are two other textual elements in the map layout. These give background information on the map in terms of authorship and distribution. They also work in a connotive sense to grant additional authority to the statistics on the map. On the right hand side is a formal sounding copyright statement that says of the work: 'this map is formally published'. *De facto* credibility is also bestowed on the map's validity by citing the *Internet Society (ISOC)*[6]. The left hand text 'opens up' the map to the world in a sense, by proclaiming it to be freely and *anonymously* available online. This text also subtly exudes technocratic power by the statement of the ftp access method and the URL; particularly so as the first of the maps were published in 1991-93, pre-Web mainstream, when only the cyber-*cognoscenti* would have been able to meaningfully decode this text.

Taken as a whole, the textual elements of the map promote the work as a quasi-official statement on Internet globalisation. A techno-scientific aesthetic can also been seen in the overall map composition: the unadorned, sparse and perfunctory style of scientific representation. This outward 'matter-of-fact' simplicity in design results mainly from expediency in production. However, the effect - I would argue - is the production of an *authoritative* looking map and one that epitomises the *authoritarian* imposition of the 'statistical' vision *onto* the world, *ordering* Internet globalisation by country and by classes. Landweber's maps display perfectly the prevailing de-socialising *modus operandi* of most thematic mapping.

(ii) Mapping out Internet globalisation

How, then, do Landweber maps imagine the geography of global Internet diffusion through the 1990s? A casual inspection of the first map from 1991 presents a world where pretty much all developed countries were connected to the Internet (most had been linked to NSFNET during previous three years), but at the same time a large number of the world's nations were shaded yellow, indicating that they had no international network connectivity. In fact, this category included about half of the world's countries, though these were clearly concentrated in the less developed regions

[6] This is a significant U.S.-based lobby group working to support the 'progressive' development agenda for the Internet. In the mid 1990s it enjoyed considerable influence as the 'voice of the Internet' in policy debates with the U.S. government and international forums. Today, its influence in shaping the structure of the Internet has diminished considerably.

of Africa and central Asia. Jumping forward in time to Landweber's final map from June 1997, the vast majority of the nations of the world were shaded purple. The Internet, measured according to Landweber's survey methodology and classification scheme, was so widespread that by 1997 the *exceptions* really stand out on the map. It was at this point that tracking diffusion at this scale became largely redundant and, hence, this was the last map in the series produced by Landweber[7].

By 1997, then, this imaginative mapping of Internet globalisation showed a pristine purple-coloured world, pockmarked with bright yellow spots. These remaining 'unwired' spots were nations suffering from extreme poverty, war and civil conflicts (such as Afghanistan, Bhutan and Somalia) or from geopolitical isolation (e.g. Libya, North Korea, Burma, Iraq and Syria). More than six years after Landweber produced this map, most of these yellow 'No Connectivity' countries are still marginal to the Internet world. Indeed, in some globalisation discourses they are stigmatised as 'failed' states, with a number being actively demonised as part of an (illusory) 'axis of evil'. These 'unwired' places are being shifted from a moral *problem* of underdevelopment to a security *threat* to globalised peace.

A particularly pernicious example of such a construction of new threats of the 'unwired' is set out in the 'Pentagon's New Maps', a provocative template of twenty-first century American geopolitics produced by defence analyst, Thomas Bennett[8]. In his mapping, he asserts that "disconnectedness defines danger" as the ".. new security paradigm that shapes this age" (Bennett 2003, no pagination). Unsurprisingly, Saddam Hussein's Iraqi regime was cited as the prime example of a nation that was seen as "..dangerously disconnected from the globalizing world, from its rule sets, its norms, and all the ties that bind countries together in mutually assured dependence" (Bennett 2003, no pagination). This new security challenge for America, therefore, *justifies* pre-emptive action to re-connect the disconnected nations, by military means if necessary.

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[7] An amended map was created a year later by activists Mike Jensen to show the updated networking situation in Africa, see <www3.wn.apc.org/africa/afstat.htm>.

[8] See Roberts *et al.* (2003) for an incisive critique of Bennett's aggressive neoliberal re-mapping of the world.

(iii) Map authorship

Unlike most statistical maps, the 'International Connectivity' series has a clearly identified author. The maps were solely the work of Lawrence Landweber, whilst a professor in the computer science department at the University of Wisconsin-Madison, where he worked for over thirty years. Initially, Landweber's research interests lay in theoretical computer science but from the late 1970s he become one of the pioneers in the development of academic networking in the U.S., being the prime mover in the building of TheoryNet in 1977 and CSNET at the start of the 1980s (for details, see Cromer 1983). These networks complemented developments then taking place with ARPANET (discussed in chapter five) and were themselves significant milestones along the road towards the modern Internet. The success of CSNET, in particular, was an important factor in securing government funding for NSFNET (Randall 1997). Landweber's breadth of professional work over two decades clearly demonstrate his genuine commitment to spreading the benefits of computer networking as widely as possible: "Starting in 1982" Landweber notes, "we made contact with CS [computer science] groups in other countries and held workshops with people from around the world who were building national networks. The networking idea was awakening everywhere in the world" (quoted in Randall 1997, 120). He was involved in founding the Internet Society and he served as the society's President for two years. He was instrumental in founding the society's Developing Country Workshops, beginning in 1993 - a vital element in Internet 'bootstrapping'.

Why did Landweber track and map the global diffusion of network? Given his academic background, the desire to inform and educate the wider community of interest through the free, timely dissemination of accurate information; and given his commitment to the 'diffusionist' cause, the maps were not purely academic productions, they were created also as tools of persuasion to encourage greater efforts to connect up the 'unwired' nations. This last motivation is partially articulated in a revealing comment Landweber made in a 1995 *New York Times* article: "Everyone realizes that Africa is lagging .... you look at the map of Africa and you see huge gaps all over that will prevent this continent from participating in so many aspects of life on this planet as it is developing" (quoted in French 1995, 5). Importantly, his efforts in this regard, should be read as altruistic rather than commercially-driven promotion for personal gain.

(iv) Data collection methodology

To understand the maps and the perspective on Internet globalisation they produce, it is important to have a sense of what they are measuring and how the measurement was undertaken. Essentially, Landweber was enumerating the availability of computer networks according to two key characteristics: that connections were international in nature and that they were publicly accessible. 'International' chiefly meant connected to the U.S. and 'public' effectively meant that some institutions (most often universities) were reachable to general users outside the country. (The degree to which connectivity and public reachability in *both* directions was verified by Landweber is not clear.) Landweber was solely concerned the *presence* of an international link, with no recording of the capacity, cost or reliability of the links. Further, measurement did not enumerate the extent of internal networking provision and intentionally did not register private networks (such as military links or proprietary business networks like the airline reservation system). The data was collated and presented in summary form at the country level at regular intervals (Figure 6.3). Like any survey methodology, Landweber's was a compromise; as Press (2000, no pagination) points out: "[k]eeping track of only one easily defined variable allowed [Landweber] to maintain a global perspective at a reasonable cost, but this system was limited by the fact that differences among and within nations were hidden."

<Figure 6.3 about here.>

Data on the changing state of network connectivity in different countries were returned to Landweber's 'centre of calculation' (Latour 1987) at the University of Wisconsin-Madison, from a human network of knowledgeable 'locals' across the world. The maps were thus built by many hands from voluntarily submitted data (explicitly acknowledged in the data tables; e.g., see Figure 6.4). Besides collecting data from the field, Landweber was also an 'insider', with intimate knowledge of ongoing networking activities, particularly those related to NSFNET's international connection scheme (see Goldstein 1995) and he was able to exploit technical information and statistics published by the MERIT consortium that ran the NSFNET backbone. Once the 'International Connectivity' maps began to circulate he also received feedback from readers (again, this was explicitly encouraged in the header of the data tables - see Figure 6.4). Overall, it is clearly the only practical way of assembling such global information at a low cost (remembering this project was very much a 'one man' effort), although others tried direct technical measurement methods, using the Internet to scan itself (e.g., see Quarterman *et al.* 1993 and discussion in chapter eight).

The actual network connectivity data that underlies each of Landweber's maps was also published in tabular form. Figure 6.4 presents an illustrative portion of the December 1991 (version 3) table. The table of data is another representational form that deliberately exudes orderliness, objectivity and an air of authoritative accuracy. Landweber's Internet census tables list all countries as 'present and correct' - the ideological "fiction of the census is that everyone is in it, and that everyone has one - and only one - ... place. No fractions." Anderson (1991, 166). The tables themselves are interesting to the present discussion, primarily, because they reveal a more sophisticated classification system for connectivity than was represented in the maps, as they contain a basic 'intensity of use' measure[9]. Besides the data classification, the table headers also contain some useful information for contextualising Landweber's project, including acknowledgement of sources and often succinct remarks on the precision (or otherwise) of the data (e.g., 'Information on Slovenia/Croatia/Yugoslavia and former Soviet Republics may be incomplete.', from April 1992 survey table). The admission of potential faults in the data can contrasted with the cartographic certainty of presentation by the maps. An orderly visual presentation does not only reveal, it can most effectively hide a multitude of sins in the data[10].

<Figure 6.4 about here. Example data table.>

[9] Countries were categorised into the 'minimal' use class if they had fewer than five known sites connected and this was indicated with a lower case letter. Countries with more than five sites were classed as 'widespread' and this was denoted by a capital letter.

[10] The capacity to show statistical uncertainty is an active area of cartographic research (e.g., MacEachren *et al.* 2005).

(v) Map distribution

Landweber's maps are some of the most widely seen geographic maps of the Internet. There are several factors that can be advanced to explain why they have enjoyed such wide distribution:

- Easy to get: All of Landweber's materials were and remain publicly accessible online via anonymous ftp (and now through http) from his department at University of Wisconsin-Madison. The location is widely disseminated and cited. Further, the URL has remained active since the project started in 1991.
- Easy to read: The file formats used by Landweber for the maps and data tables mean that they are still all readable today on pretty much all computing platforms without the need for specialised software. The avoidance of proprietary formats (e.g. a particular spreadsheet format for the tables or GIS package for the maps) has been important for long-term accessibility. The file sizes for the materials are also small, making downloading possible for people with slow Internet connections (a more significant issue, of course, for much of the world when Landweber began his project back in 1991).
- Easy to understand: The materials are clearly named and quite straightforward to understand in a normative sense. As stated earlier, the choice of choropleth mapping provides an ostensibly familiar and comprehensible cartographic design. The materials are all labelled with dates and it easy to work out which is the most up-to-date version.
- Free to use: Explicit permission is granted for unlimited reproduction of the materials in the copyright statement on the maps and tables. This is a small, but important, factor. By removing the hassles in obtaining formal copyright release, Landweber was encouraging the widest possible dissemination of his maps. Free access and dissemination clearly stems directly from Landweber's academic position, founded as it is on the open publishing model with results distributed non-commercially. This model also underpins much of the rest of Internet documentation (such as core standards published as RFCs - see Salus 1995), but is in marked contrast to other valuable Internet statistics, which are available only in expensive reports for the corporate market (e.g. those produced by IDC and TeleGeography).
- Authoritative source: There are several interlocking factors that work to promote the trustworthiness of the materials, such that people are confident in using them that

they are factually accurate. Firstly, the authorship of the materials is clearly stated and this lends considerable weight to their probity. The author, Landweber, is a respected professor, well known in the field of research and education networking, and affiliated with a major American university. As noted above, the endorsement of the Internet Society was also overtly employed.

- ‘Scarcity breeds success’: A last reason for the success of Landweber’s maps is that there was little in the way of competition, especially in the early 1990s. There were very few other maps produced which offered as synoptic and simple - and perhaps one might say seductively simple - view of the Internet on a single map. Most other maps tended to be more technical in nature, showing specific networks or specific countries using link-node graphs. Even today, very few ‘high-level’ statistical maps of the ‘whole’ Internet are produced to match the workability of Landweber’s output.

2.2 Truth claims and the influence of Landweber’s maps

Together, the semiotics of the images, their authorship and distribution mean that Landweber’s ‘International Connectivity’ maps are apposite examples of what Latour (1987) called ‘immutable mobiles’. Truthful, scientific knowledge on the extent of networking across the globe was constituted at a ‘centre of calculation’ from various pieces of survey data. This knowledge was purposefully inscribed into maps and tables to stabilise the knowledge in fixed, conventional forms. The maps are said to be ‘immutable’, remaining the same wherever and whenever they are read. The maps as graphic files on the Internet were very easily ‘mobile’, freely circulating online and in print and being usable in a wide range of contexts across the globe. Lastly, the maps were combinable in many ways and many discourses.

Seeing Landweber’s maps as ‘immutable mobiles’ is useful because it starts to unravel the underlying truth claims they are working to establish. As Cosgrove (2003, 136) asserts, maps work because they “permit scientific discourse to sustain its claims of empirical warranty and repeatable truth in the absence of eye-witness evidence.” Most people have no means of assessing first hand the globalising of the Internet. They had to rely on Landweber’s maps to establish the *truth* of the Internet diffusionists’ viewpoint by showing that country x was connected. Landweber’s maps are powerful ‘immutable mobiles' because so many people seemed willingly to accept the map as truth, as can be seen in the extent that they were cited and used. If Landweber had failed to secure immutability, then the maps would not be able claims to be anything "more than an imaginative picture" (Cosgrove 2003, 137).

Landweber's maps have been reproduced numerous times in newspapers, popular books, academic papers and policy-related reports in the last decade, contributing to a range of discourses on the 'state of the net'. Apparently, they were "displayed triumphantly at the various Inets [ISOC conferences] to mark the fact that the Internet was gallantly going global; this was exciting!" according to Guédon (2002, no pagination). The data tables were widely posted to mailing lists and Usenet newsgroups throughout the 1990s. Long after the end of Landweber's updating of the maps (in June 1997), they still continue to attract interest[11].

In the majority of cases Landweber's maps and data tables have been deployed as unproblematic and objective evidentiary material, which supports the 'truthfulness' of rapid Internet diffusion: maps of a successful Internet, successfully spread across the world.

In terms of more scholarly works, the 'International Connectivity' materials have been employed by several academic authors in a number of contexts (e.g., Leiner 1993; Crampton 1999). A typical example was the use of a connectivity map by Manuel Castells in the third book in his 'network society' trilogy, *End of Millennium* (1998), as the sole illustration for the section titled 'Africa's technological apartheid at the dawn of the Information Age' (pages 92-95). (Indeed, it is the only map in the whole book.) The discourse expounded by Castells' here is diffusionist one about 'failing Africa' and the need to quickly counteract technological underdevelopment. The citation to the map in the text follows this clear articulation of the 'failure' line of argument: "Connection to the Internet is very limited because of insufficient international bandwidth, and lack of connectivity between African countries. Half of the African countries had no connection to the Internet in 1995, and Africa remains, by and large, the switched-off region of the

[11] For example, a search of the web as indexed by the Google service in December 2004 returned 405 'hits' to pages containing links to for Landweber's maps.

world” (page 93). The map itself is presented in landscape orientation, filling a whole page; it is reproduced in black and white and has been edited (simplified legend, removal of copyright notice and distribution text). There is no commentary about the map or the patterns shown in Castells’ text. The reader is assumed to accept it as ‘truthful’ and to be able to decode it sufficiently to support his line of argument. In this way Landweber’s map is a ‘factual’ representation, able to demonstrate with the aid of cartographic authority, how badly-off Africa is in relation to rest of the world.

Diffusion studies are an enduring topic of interest to academics in a range of disciplines, with many focused on explaining the temporal and/or geographic waves of innovations in technologies. Unsurprisingly, describing and explaining the global spread of the Internet through the 1990s sparked a number of studies (e.g., Arnum and Conti 1998; Batty and Barr 1994; Elie 1998; Hargittai, 1999). These studies commonly used country-level analysis of per capita measures of Internet availability in some form of regression modelling to find explanatory ‘independent’ variables and to fit a growth curve. A number of these studies have utilised Landweber’s data as a ‘truthful’ source for the dependent variable in their analysis. For example, Hollis (1996) used Landweber’s data tables from 1991 and 1995 to produce a crude binary indicator of network connectivity and chart how this improved over time according in relation to UN Human Development Indicator (HDI) groupings of nations. Drori and Jang’s (2003) analysis used Landweber’s data to construct an eight-level ‘Net Sophistication Score’ with change between 1991 and 1995 compared and then explained in a regression model. Landweber’s data are used essentially to show that things are getting better, and getting better quickly - which in a sense they are. However, as explained above, these data are a very limited metric, only accounting for the presence of connectivity and taking no account of the capacity of connection or their availability.

In addition to analytical studies, there also several methodological review papers that discuss how best to model Internet diffusion and particularly the need to develop more effective indicators (such as Daly 1999; Press 1997, 2000) and all these papers cite Landweber’s work. For example, Goodman *et al.* (1994, 31) note “Landweber maintains an *extensive* and *verified* ‘International Connectivity Table’ ... regularly updated and published in the Internet Society News” (emphasis added). Interestingly, sometimes the ‘immutability’ of Landweber’s work is questioned when it is cited as a ‘straw-man’ example of diffusion metrics of limited scope, thus opening the way for a call for more complex (‘truthful’) metrology (eg., Press 2000).

Landweber’s maps and data on ‘International Connectivity’ have also been utilised in national and international policy documents, particularly in relation to the ‘problem’ of the digital divide in Africa. An illustrative example is the UNESCO report titled *The right to communicate - At what price?* (1995) which features a Landweber map captioned as ‘Research network connectivity as of February 1995’ in a section discussing the problems of access for scholars in Africa. No interpretation was deemed necessary, again because of its self-evident claim to ‘truth’.

3.1 Problematising Landweber’s maps

Landweber’s series of ‘International Connectivity’ maps enjoyed an influential position as ‘immutable mobiles’, securing a particular imaginative geography of Internet globalisation in the 1990s through their simple and clear visual narrative. However, in many ways they are a deeply problematic representation of world-wide network diffusion. Landweber’s maps, of course, do not stand alone for criticism - the ‘truthfulness’ and authority of statistical mapping as workable representations of social phenomena have long been open to question in terms of the efficacy of cartographic design and, more recently, in terms of political critiques of the ways they shape perception in the service of particular interests and agendas (see for example, Crampton 2003 & 2004; Monmonier 1996). Both the technical weaknesses and the ideological concerns in statistical mapping usually remain unacknowledged by the map-makers, as such an admission, it is feared, would risk shattering cartography’s illusory objectivity. Many map readers approach statistical maps assuming them to be straightforward and essentially accurate geographical presentations of social reality. Yet, the degree of generalisation necessary for successful cartographic design means that social reality is inevitably simplified, often to a gross extent. This simplification is particularly pronounced in the widely-used choropleth approach and it is all too easy to draw naive and unsound conclusions as to the actual spatial distribution of the phenomena being represented from an orderly-looking world map. Therefore, in critiquing the representational effectiveness of Landweber's maps, I seek to highlight the practical and political degrees to which they grant partial views of Internet globalisation.

To begin, I discuss the key methodological problems, common to all choropleth mapping, and draw out the resulting political implications relevant to Landweber's work. These problems concern: (i) the choice of scale of presentation and the design of the zones for aggregation; (ii) the invisibility of small areas and the denial of temporality; (iii) the nature of the classification scheme applied to the zones, and (iv) the resulting issues of ecological fallacy and grouping bias. Building on this discussion, I examine the ideological nature of Landweber's mapping in terms of their role in the reproduction of imperialistic power relations.

(i) Zoning scheme design:

The size of the zones in choropleth maps has a direct impact on the level of generalisation of the social phenomena being mapped. Larger zones average over more people to give a much less detailed presentation of the population. The definition of the boundaries for areal zones can also have significant impacts on the nature of the representation (seen most clearly in terms of gerrymandering possibilities in drawing up electoral areas). Often map-makers producing choropleth maps - using secondary data from the census, for example - are constrained to use a predefined set of zones in which the data has been published. For many social phenomena this is problematic as the zone definitions are arbitrary, not having been drawn up to take account of the 'real' distribution of the social phenomena; as Crampton (2004, 47) puts it: "Where human life is lived continuously, the map (especially the choropleth) chops up and divides." The possible ways the 'chopping' can be done are manifold - as Openshaw (1984) and others have demonstrated under the rubric of modifiable area unit problems (MAUP) - it also ineluctably has political ramifications because they alter the visual properties of the map in favour of certain interests. In essence, zoning decisions can increase the perception of social difference or help to mask the extent of inequalities.

In the case of Landweber's work, the zoning scheme is the national level, as defined by the international standard ISO3166. Clearly, this is the most obvious scheme for global-scale statistical mapping. Indeed, world maps using countries as graphical containers for statistical data are so common that they are easily perceived as the 'natural' way of seeing the world, especially in atlases[12]. Yet, at the world scale, how efficient, let alone 'accurate', is it to aggregate 6.4 billion people into 192 pre-given country units - units that have been drawn-up arbitrarily in many cases? Many national borders are maliciously arbitrary in relation to the underlying social reality (the infamous colonial 'cartographic' partitioning of Africa being the archetypal case). The result is a set of mapping units with a huge range in terms of land surface and population size. Countries as units of analysis and mapping are a highly political metageography (Lewis and Wigen 1997). The definition of countries as stable, unitary objects, as we see them neatly drawn on world maps, masks tremendously contentious processes of territorial formation and ongoing maintenance - including some of the most bitter, bloody contemporary conflicts (e.g. the Balkans, Israel-Palestine, Kashmir). Notwithstanding this, country containers as units of analysis are undeniably *convenient* analogues because of their familiarity and their effectiveness for delineating the distribution of nation-state power as it currently operates (which remains pivotal for understanding many global socio-economic processes). Indeed, cartographic knowledges have played a significant role in the *creation* of the nation-states they supposedly represent (see Anderson 1991; Biggs 1999).

The question then, is how workable are countries as units of analysis for describing Internet globalisation? In many respects it seems illogical to create maps that demarcate the Internet into the arbitrary territorial jigsaw pieces of nation-states. After all, the network technologies of the Internet are forging connections and virtual groups that, according to some commentators, subvert the primacy of nation states and their boundaries. Border lines are essentially meaningless in the era of the 'death of distance', so the argument goes[13]. The use of countries in mapping the Internet is not only idiosyncratic; it has the visual effect of granting undue territorial authority over the 'space of flows'. Choropleth mapping 'chops' up what should be viewed as a continuous network flows linking people together into rhizomatic structures. "The

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[12] Although, this dominance is being partially usurped by the growing use of 'earth from space' satellite views which often do not show country boundaries.

[13] This rhetoric proclaiming the decline of national power can be traced back at least to the telegraph era and the utopian hopes spurred by wiring continents with undersea cables (see Standage 1998).

tracing of political borders in these maps of putatively virtual domains", Harpold (1999, no pagination, original emphasis) argues, "naturalizes specific relations between nation-state and network identities -- and, as a result, *obscures the global political forms of the Internet with a mosaic of individual national forms.*" Landweber's maps, like much of statistical cartography works to constrain the inherent disorderliness of the social worlds and reinforcing uniformity of the status quo.

Despite disputing the 'end of geography' thesis, I would nonetheless agree with Harpold that there is a *need* to loosen the metageographical shackles of the nation-state as a unit of analysis in the Internet and try to show some of the local, contingent forces that affect the patterning of digital interactions through relations of different lengths. Concurring with Harpold (1999, no pagination), I would argue that progressive analysis of the Internet "must look beyond the limited (and limiting) visual vocabularies of national-political identity, and base its investigations on new schemes for representing the archipelagic landscapes of the emerging political and technological world orders" . As a starting point, I think the world map shorn of boundaries by Yook *et al.* (2002) begins to illustrate some of possibilities (see Figure 6.9 discussed below)

The counter-argument is that the notion of the fading away of nation-state power has been overplayed in much of the globalisation talk on deterritorialisation. The transcendence rhetoric surrounding telecommunications and computer networking, especially redolent in the heady days of the dot-com boom, has been exposed as essentially hollow (e.g., see Graham 2004). The nation-state has been, and will likely remain, crucially important in the determination of people's actual experience of the Internet (setting legal parameters, regulatory structures, subsidies, censorship, and so on) (see Everard 2000; Jordan 1999, for cogent analysis). Most of the Internet, in terms of transmission infrastructures as well as content and services, is produced by large companies, and as Morgan (2004, 14) tellingly notes: "Contrary to fashionable notions of 'techno-globalism' and 'borderless worlds' the national environment remains a highly significant operating milieu for firms, even for so-called multinational firms." Moreover, many global firms are beneficiaries (and thus supporters) of current 'statist' metageography of consumer modernity - for example, exploiting differential regulatory systems in production and segmenting markets in profitable ways. Consequently, it can be argued that, in many respects, the most *appropriate* way to analyse and visualise the global geography of the Internet is in the form of country containers, as Landweber did.

Ultimately, Landweber's choice of units of analysis was down to map-making expediency. In terms of the workability of Landweber's maps, country boundaries are undoubtedly convenient because they render abstract notions of 'internet' and 'international connectivity' into easily understandable visual forms (at least for those who are acquainted with those cartographic conventions). This factor above all was particularly important at the beginning of the 1990s when the prospect of global networking was strange and unfamiliar to most people.

(ii) Hiding small places and silencing temporal variability:

The use of a map projection based on geographic area to represent statistical data at the global scale inevitably creates a distortion that visually favours territorially large countries and renders small, but populous, nations effectively invisible. Much of the 'data-ink' on statistical maps is, therefore, wasted in showing land where few people live. This technical weakness has obvious political repercussions in trying to understand the social processes taking place. This problem is a taken-for-granted, irresolvable artefact of global scale mapping and usually ignored. However, it has been purposefully highlighted by a number of socially-conscious cartographers and geographers, leading some to advocate counter-mappings based on cartograms (e.g., Danny Dorling; see below for further discussion). On Landweber's world maps, a number of countries are simply not drawn at the given scale and pixel resolution of the image. Many islands are indiscernible, including much of the Caribbean. A number of city-states, including the Asian techno-hotspots Hong Kong and Singapore, have such small geographic footprints that they do a cartographic 'disappearing trick'. Yet, these places are not unimportant in understanding Internet globalisation - several Caribbean nations, for example, have become important nodes in e-commerce and online gambling because of their offshore status (see Wilson 2003). This is ironic, as many of these nations are consciously trying to exploit the Internet to project a global image and overcome the inherent limits due to their small territorial size (see Brunn and Cottle 1997). The result, then, is a capricious map of Internet globalisation that excludes countries from consideration on the sole criterion of their land surface.

Statistical maps like Landweber's also necessarily distort dynamic processes by arbitrarily freezing them at a *single* point in time. The processes of Internet globalisation are shown fixed in time - credited to the actual day of publication - with no way to convey the underlying temporal dynamics of the diffusion of connectivity, such as the sequencing or rate of change. The denial of temporality in conventional cartography is only partially solved by the use of a series of surveys and maps that build up over time. However, the periodicity of compilation and publishing of statistical maps rarely have any meaningful relation to the temporality of the social phenomena being represented (periodicity is commonly just a function of administrative convenience, e.g., the decennial cycle of censuses). Consequently, the handling of the temporality of events in thematic cartography remains a largely unresolved problem[14]. This failure has ideological implications, as the inability to represent dynamic phenomena over space *and* through time means much of the subtlety of social life is simply unmappable (Dorling 1998).

(iii) Implications of classification

The final - and most significant - 'technical' problem with statistical maps concerns the process of data classification. The selection of the number of classes, and their intervals, for grouping data on choropleth maps is crucially important to the 'look' of spatial patterns and, thus, the impression that readers receive on the phenomena being shown. Producing workable classifications is a real challenge, as a balance must be struck each time a choropleth map is made, since, "[r]educing the number of classes achieves simplification at the expense of loss of useful detail, especially local contrasts" (Evans 1977, 99). In the days of manual cartography, cartographers almost always used a small number of classes as a matter of convenience rather than any because of any deeper philosophical or perceptual concerns. In recent decades, there has been considerable investigation by cartographic scholars into the specification of 'optimal' classification schemes from both the statistical point of view (e.g., Jenks and Caspall 1971; Evans 1977) and from the perspectives of aesthetics and map usability (e.g. MacEachren 1982;

[14] Developments in map animation and multimedia, and more recently in geovisualisation environments, are opening up interactive avenues for mapping phenomena spatio-temporally (see Cartwright *et al.* 1999; MacEachren and Kraak 2001) but have not yet delivered any generally applicable solutions.

Slocum and Egbert 1993). Computer mapping and GIS has made it much easier to experiment with different classification schemes for a given data set, but have given little help to users in choosing a workable one; and Jenks and Caspall's perceptive comment from 1971 still hold true: "We are certain, however, that many maps result from an almost accidental setting of class limits" (page 221). The use of an inappropriate classification scheme can, at a stroke, render a choropleth map unworkable.

However, beyond technical concerns on workability, it is clear that the nature of the classification scheme in statistical mapping has political ramifications. The design of the classification, either deliberately or unintentionally, serves a purpose in highlighting the 'right' spatial pattern for the map-maker's agenda. Active manipulation of classifications, as Monmonier (1996) ably demonstrates, opens up a rich array of ways to 'lie with maps'. The very simple fourfold classification Landweber applied to the complexity of world-wide patterns of Internet connectivity is problematic.

The distinction between the four classes in the map is important, and corresponds roughly to the increasing sophistication of services possible, the persistence of the connection, the bandwidth of links, and also the likely cost. Only full internet connectivity allowed interactive services, including telnet and ftp, that require persistent synchronous links. In a sense, the middle two classes are intermediary levels of sophistication in terms of possible services. '`Bitnet`' and '`EMail only`' connectivity only supported asynchronous interaction and did not provide persistent connectivity. '`Bitnet`' was a formal, fulltime network and users had to pay for access (Kellerman 1986). In contrast, the '`EMail only`' type networks of Fidonet and UUCP[15] were informal networks relying on volunteers to operate nodes for 'store and forward' email transmission (see Bush 1993). The bottom class of '`No Connectivity`' seems quite straightforward, although this will also have included 'No data' countries - the maxim, 'absence of evidence is not evidence of absence', always needs to be borne in mind when reading statistical maps.

[15] For half of the maps - versions 6 to 11 - the '`EMail Only`' category was expanded to encompass OSI networks in addition to UUCP and Fidonet; see Salus 1995 for discussion of significance of the OSI challenge to TCP/IP in the early 1990s.

Additionally, the process of data classification in statistical mapping usually implies, either explicitly or implicitly, a ranking of areas. When people are being represented on maps, the ranking has social meanings, with the map-maker exercising disciplinary power to produce an ordering areas (and thus people) from 'good' to 'bad' or sorting out the 'successful' from the 'failures', according to their criteria. Depending on the interests served, statistical maps are often instrumental tools of discrimination, operating as elements in larger systems of modern governmentality (Harley 1988a; Crampton 2004); for example in much 'top-down' analysis of poverty, the choropleth map is used as a visual instrument for identifying areas suffering 'problems' - and implicitly the 'problem' people who need help - and enabling the spatial targeting of 'solutions'. The judicious manipulation of data classification means it is possible to produce the 'right' ranking to identify the desired type of areas (and people) to target. The issue of biopower created through social order and instrumental targeting is at heart of 'Ground Truth' critique of GIS and geodemographics (Curry 1998; Goss 1995; Pickles 1995).

In the case of Landweber's map, the ranking serves the purpose of expounding a normative ranking of technological prowess. It has an explicit political ordering of countries based on their 'worth' to the global network project, running from *Good* ('`Internet`') to *Getting there* ('`Bitnet but not Internet`') to *Unacceptable* ('`EMail only`') and bottom of the list, are the *Failures* ('`No Connectivity`). This last group of excluded nations are ripe for 'targeting' with (Western) networking know-how to 'solve' *their* problem of underdevelopment. Most of the rich world is already comfortably ('naturally') classed atop Landweber's ranking, and with each passing map, it is possible to see how well the other straggling nations are doing to 'improve themselves' and climb their way up the list. Such quantifying approaches have been often been cited as examples of developmentalism (e.g., Yapa's 1992 analysis of GNP maps).

The political impact of the ranking of areas is frequently enhanced on choropleth mapping through the particular choice of shadings for the zones. These usually run from dark to light colour, giving off connotative meanings that strengthen the discriminatory nature of the ordering of areas. Dark colours and heavy shadings reinforce notions that these are the ‘darkest’ areas, with shadowy people and endemic failure - what Cosgrove (2003, 134) memorably calls “cartographic gloom” - while light colours give off the impression of progress, success and the ‘light of reason’[16]. It is interesting, however, that Landweber’s choice of colours are in perfect reverse of the norm, with the ‘gloomiest’ colour, the dark purple, being applied to the top category (full Internet) and the lightest colour, the yellow countries, with no connectivity.

(iv) Ecological fallacy and grouping bias

In addition to the issue of ranking, there are two more fundamental problems associated with the imposition of a constricting classification scheme on data in choropleth mapping. While classification is useful (often vital) to make complex patterns of variability in data simpler, and thus more easily comprehended, it also induces the ‘sins’ of grouping bias and ecological fallacy. These are visual-cognitive effects on the map reader which work to diminish the apparent difference *between* areas and overstate the level of homogeneity *within* areas. These ‘sins’ are not tractable from a map efficiency point of view, but must be embraced to begin to comprehend the ideological implications of statistical mapping. Landweber’s maps are an apposite example of both ‘sins’.

Ecological fallacy as a general statistical problem occurs when a relationship observed at one scale of aggregation is assumed to hold true when looking at a more detailed scale, without proof or testing. More specifically, in the case of statistical maps of social phenomena, it is the ‘natural’ tendency to assume that the residents in an area *match* the average conditions of the area as indicated through the uniform shading on the map. This notion is commonly expounded in media reporting on social issues such as crime, health, and education. This is problematic when demeaning social stereotyping based on the area’s characteristics come to taint individual lives.

In the case of Landweber’s maps, each country is assigned to one class and wholly shaded accordingly. The result is an easily-conferred visual impression that every

[16] Charles Booth’s poverty map of London is a ‘classic’ in this regard. The streets at the bottom of his ranking, ‘Lowest class. Vicious, semi-criminal’, are shaded black, while the top category, the ‘Upper-Middle and Upper Classes. Wealthy’, are coloured a light golden yellow.

location within the area has equivalent levels of connectivity and all citizens enjoy comparable access, which is clearly not the case. Uniformity in the shading of spaces on the map is all too easily translated into uniformity of places on the ground[17]. Therefore, the ideology of ecological fallacy in these maps instinctually promotes an artificial sense of homogeneity, masking socially-significant variation and inequality of Internet connectivity within countries. This denial of differences clearly serves the interests of Internet diffusionists.

The reality of network access is far from uniform, as many empirical studies have demonstrated (e.g. Press 2000; Warf 2001). The effect of ecological fallacy in Landweber's map is most flagrant in the poorest places. In most LDCs, international network connectivity, especially in the early 1990s when these maps were drawn, was likely to be very restricted, available only at certain elite institutions in primary urban centres. As Holderness (1998, 40) pointedly comments: "[t]here may be a full Internet connection at the university in Ulan Bator, but ten kilometres away there are no telephones." Significant basic access inequality issues remain in many LDCs today, which Castells memorably characterised for Africa as "technological apartheid" (1998, 82).

Ecological fallacy also has insidious effects for rich nations, imposing unrealistic visual homogeneity. In well-'wired' nations, including the U.S. and Britain, there were significant variations in take-up at in different regions throughout the 1990s[18] (e.g., see NTIA 1995; Office of e-Envoy 2002), often the focus for 'digital divide' policy initiatives. Although these differences in basic Internet access have closed markedly since Landweber's last map was drawn in 1997, socio-spatial differentials in networking capability are being replicated, in a quite similar fashion to the early 1990s, with the deployment of newer (faster, and more flexible) technologies like fibre-to-the-home and wi-fi (Townsend 2003).

[17] I would argue this is exacerbated because areal units in choropleth maps are drawn for simplicity, using a so-called 'space-filling' approach - that is, no part of the territory can be left blank as unclassified. This contrasts with dasymetric approaches, described below.

Due to the nature of the choropleth mapping, with its inherent visual dominance by geographically extensive areas, ecological fallacy also contains an in-built rural-urban bias. As the average rate, determined predominantly by densely populated urban areas, must be 'painted' across the whole zone, this can mean a significant overestimate of networking potential of rural areas. This is certainly the case, I would argue, with Landweber's maps (extreme cases, in Figure 6.2, being Russia, Canada and Australia). Whilst network access has certainly diffused to many rural areas, the economic reality is that Internet *production*, despite the 'spaceless' rhetoric, is to a large extent an urban phenomenon, dominated by hubs in a few large cities. According to Zook's (2005) empirical analysis of January 2002 data, the top 100 cities across the world, with only six percent of the global population, contained fifty percent of the Internet domain names.

The second carto-political 'error' caused by classification in statistical mapping is grouping bias, which is the prejudicial contraction of the differences *between* units of enumeration. Because of the limited number of classes, coupled to the selection of their interval points, it is often the case that really quite dissimilar areas end up being assigned, and visually labelled, to the same group. In conventional choropleth maps there is no scope for ambiguity or fuzziness, each zone must be classified exactly and it can only exist in a single group. In the case of Landweber's maps, all the diverse countries of the world have to fit into just four groups.

The lack of discrimination in the top Internet class is especially problematic. Only a minority of countries shaded Internet purple actually had comparable nation-wide infrastructures to support genuinely comprehensive network access, especially so in Landweber's first map from 1991 (Figure 6.2). The amount of international connectivity could vary from a single (expensive, low bandwidth) satellite link in the capital city along a spectrum of capacity, up to countries with dense networks of high-capacity fibre-optic cables linking many parts of the country to the Internet. For example, on the 1991 map, the three nations that constitute North America are all shaded purple, indicating they are in the same group because they all have Internet connectivity, yet it

[18] There are, of course, also inequalities along other important social dimensions such as age, gender, class and race.

is clearly inappropriate to claim that Mexico's Internet capability was equivalent to that in the USA and Canada.

In the final map produced by Landweber in June, 1997, a large proportion of the nations are classified as having full Internet connectivity. "Almost the whole world, it seems from a casual inspection of this map, has turned Internet-coloured" Holderness (1998, 39) sardonically commented[19]. Yet, this implied Internet hegemony through graphic homogeneity is pure map fiction. Despite their belonging to the same category, Petrazzini and Kibati (1999) demonstrate that USA, Argentina and Kenya, for example, have fundamentally different Internet statuses, noting that end-user access costs (adjusted for purchasing power) were nine-times higher in Argentina than the U.S., and a staggering 413 times more expensive in Kenya. It is not just in the consumption of the Internet that inequalities are masked: arguably even wider and politically more significant variations are hidden in terms of Internet production (again, demonstrated by Zook's (2005) analysis of the geography of the Internet industry). The result, then, for an unwary reader of the Landweber maps, is that countries coloured the same are easily assumed to have equivalent levels of connectivity in reality.

In combination, then, ecological fallacy and grouping bias result in graphical imposition of homogeneity, crushing diversity and erasing difference between places. The deeper question, then, is who benefits from the cartographic concealment of true inequality in the distribution of networking across the world in the 1990s? Making the situation *look* much better than the underlying social reality worked to the advantage of the diffusionist viewpoint.

3.2 Internet, imperialism and cartography

> As much as guns and warships, maps have been the weapons of imperialism
>
> -- Brian Harley, *Maps, Knowledge and Power*, 1988.

I now want to make a case that Landweber's maps can usefully be conceived, not as a

[19] Interestingly, he went on to construct his own version of Landweber's map, which tried to remove some of the grossest distortion of ecological fallacy and grouping bias (discussed below).

flawed but essentially benign cyber-age census-taking exercise, but as an example of imperial mapping. This is premised on the notion that the Internet itself should be seen as an expression of a current mode of dominant imperialism, that of U.S.-led globalisation (characterised by an aggressive neoliberal economic ascendancy, technological superiority, cultural hegemony in media and consumer brands, and, of course, excessive - 'full spectrum' - military power).

Swift and reliable communications, as lines of control, have been essential to maintenance of empires throughout history. The development of a global telecommunication grid, starting from the Atlantic telegraph in the 1850s, enabled remote imperial capitals to much more effectively direct trade flows, oversee diplomatic negotiations and order military actions (Hugill 1999). It is clear that the Internet is an integral part of contemporary imperial machinations, working in the reconfiguration of global economic relations in a cyber-age *Pax Americana*. The spatial structure of the Internet globally is at once a product of the unequal capital flows of American imperialism and also contributes actively to their (re)production.

Ameri-centric Internet globalisation depends on maintaining *de facto* control over key governance structures, particularly for the management of networking protocols, in the hands of U.S.-dominated institutions and corporations (Bernstorff 2003; Mueller 2002). The management of routing tables, the domain name system and the allocation of IP addresses should not seen as merely engineering details because it is increasingly clear that the keys to network lie in the control of the Internet's unseen 'plumbing'[20]. The politics of the allocation of vital IP addresses greatly favours American corporations and institutions to the disadvantage of the rest of the world[21], while the centre of the global domain name system (the 'A-root' server) remains, controversially, under the control of VeriSign, a U.S. corporation in Dulles, Virginia. The geopolitical struggles over control of the domain registration have been particularly intense (see Mueller 2002), with

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[20] In addition, see Lessig's (1999) 'code as law' analysis on the political importance of computing architectures. More generally, Foucault's work on governmentality is probably the best known theory on the power produced by what are seemingly technical and banal procedures.

[21] Analysis by Huffaker (2003) shows that the USA, with only 4% of the world's population, enjoys the allocation of 62% of the Internet's addresses.

widespread antipathy to current governance power residing in ICANN, a U.S. not-for-profit corporation under Californian legal jurisdiction. The domain system, vital to the successful operation of the Internet worldwide, is perceived by many as being subject to U.S. intellectual property laws which favour American corporations in disputes. Furthermore, in the summer of 2005, the U.S. Government confirmed its intention to indefinitely hold oversight power on the domain name system rather than the proceed along the path of handing the role over to an international body, noting that "[g]iven the Internet's importance to the world's economy, it is essential that the underlying DNS of the Internet remain stable and secure"[22]. Clearly, future security is directly equated to continued American stewardship over a global network.

In addition, the domain name system provides one of the most singularly obvious, but overlooked, signifiers of Ameri-centric Internet imperialism, the fact that they do not use a country code. The **.**us domain is very little used and, uniquely, American *domestic* government, military and educational institutions are able to identify themselves *globally* by domain names of their own (**.**gov, **.**mil and **.**edu). The use of these 'generic' domains for American institutions, without the locational encumbrance of a country code, is important because "[t]he unmarked category is the identifying mark of the powerful" (Drury 2000, no pagination); as such it is one of many example of American exceptionalism in international relations. In colonial discourses, being unmarked is an element in the establishment of what is 'normal' and what is 'different' and this is the same for the online world, where "[d]omain name technology indoctrinates users to equate '.com' with 'American' and encourages the assumption that the origin of 'unmarked' Internet content is American." (Drury 2000, no pagination). Everywhere else in the world, beyond the imperial centre, businesses are categorised by a country label. They are literally put in their place. The alternative is to settle for a thoroughly Americanised com/net/org generic label.

The second factor that favours Ameri-centric Internet comes from the fact that the physical infrastructures for long-haul Internet data transmission have an uneven geographic structure (see Arnum and Conti 1998; Graham 1999; Warf 2001). The way

[22] U.S. Principles on the Internet's Domain Name and Addressing System, June 30 2005, <www.ntia.doc.gov/ntiahome/domainname/USDNSprinciples_06302005.htm>.

the world is physically wired together internationally, using undersea fibre-optic cables and satellite links, results in what Cukier (2000) memorably terms 'bandwidth colonialism' where the worst-provisioned places end up paying more for their Internet connectivity. For many LDCs to get 'on the Internet' actually means leasing a connection to the U.S. The end result, Cukier (2000, no pagination) argues, is that "Internet's data flow finds all circuits lead to the United States, akin to the way all roads led to Rome in an earlier era of Imperialism." Many countries are thus dependent on the U.S. hubs as the switching centre for exchange traffic with neighbouring nations (Cukier 1999). The poverty of local interconnection is most obvious in parts of Africa, for example a recent international report noted tellingly that "[e]ven the world's two closest capital cities (Kinshasa, DRC and Brazzaville, Congo) were only directly connected for the first time during 2002 when mobile operator MSI Cellular, which has operators in both cities, established a microwave link between the two across the river Congo." (NEPAD 2004).

These kinds of unequal core-periphery relationship in capacity, and the economics of flow, means the Internet is not an idealised distributed mesh but, on a global scale, much more like a U.S.-centred star. This technical dependency has implications financially as ISPs in LDCs are required to bear the full costs of 'up-stream' links to the 'centre of the star', yet at the same time customers in the core are granted reciprocal access to the periphery. The result has been characterised politically as poorer users in the global South effectively granting a 'free ride' to affluent people in the North. At one level, then, international network connectivity is "often perceived by many LDCs (the 'south') as intended to talk to people in the north" (Goodman *et al.* 1994, 30).

Furthermore, the Internet is written in English. This is the third critical factor in explaining American hegemony in international networking. Although not especially surprising in itself, as it fits into the larger ongoing patterns of Anglo-American cultural imperialism engendered by the dominance of English across many media forms and knowledge domains (e.g. scientific publishing). The bulk of the content online is English (although this is diminishing) but, more importantly, the tools for building that content and the architectures for transmitting it are written in English (Jordan 1999). The structure of email messages, domain names and html tags, for example, is premised on English because fundamentally they are built upon the ASCII format for encoding text, which supports only the Western (Roman) alphabet. Note, of course, that ASCII is an acronym for the *American* Standard Code for Information Interchange. The introduction of Unicode in 1998, which supports many more character sets, will help redress this - although it may be too late to dislodge English from the foundations of networking protocols.

Given the extent of American dominance over the Internet stemming from technical governance, the physical structure of cables and English language, the key question is, how are the benefits accruing from international connectivity distributed between core, semi-periphery and periphery countries in the world economy. Is the Internet bringing empowerment or greater dependence to countries when they turn purple on Landweber's map? Main (2001) argues that connectivity is not necessarily a good thing and will not, by itself, automatically lead to better lives for the people who live in LDCs. In fact, it might actually exacerbate problems by concentrating economic activity and power in certain places and certain groups (the local elites, NGOs, government ministries with outside trade links, corporate branch offices). She pointedly highlights the naivety of infrastructuralist strategies focused on 'wiring-up' poor nations by noting "there are more cars in Manhattan than in sub-Saharan Africa, but no-one is suggesting sending automobiles to Africa" (Main 2001, 94)[23]. Connectivity opens up new and emerging markets to greater overseas penetration. Mapping international network connectivity is representing the spatial patterning of greater economic dependence.

4. Alternative representations of Internet globalisation

In terms of thematic cartographic design, there are several main alternative methods for mapping aggregate statistics for areal enumeration units beside the choropleth approach, such as cartograms and dasymetric mapping[24]. More drastic alternative modes of cartographic representation for statistical data are possible (although dependent on how

[23] This alludes to the oft used comment that there are more telephone lines in New York than in Sub-Saharan Africa.

[24] Other methodological strategies include classless mapping techniques (Tobler 1973), dot mapping and, more recently, mapping uncertainty (MacEachren *et al.* 2005).

the data is collected/published), by abandoning area-based enumeration and using different symbology based either on the point location of objects (such as proportional symbol maps) or on some kind of continuous field, often generated by interpolation from sample points (such as density surfaces). Here, I provide a brief review of a number of interesting projects which, by representing the global Internet using different cartographic forms, serve to problematise the 'default' nature of Landweber's choropleth maps and undermine the notion of being able to produce a single, optimal map of a given phenomenon.

(i) Cartogram mapping techniques:

Cartograms are a hybrid of map and diagram, in which an exaggeration of distance or area is deliberately chosen to highlight the structure of the thematic data at the expense of geometric accuracy. The most common is the 'area-by-value' cartogram where the units of enumeration are drawn scaled according the statistical data and not their geographic extent.

Even though there is a long history of cartograms (see Tobler 2004 for review), they are not commonly used compared to the choropleth map. This is due largely to the fact that they are perceived as being harder to produce and most software packages do not provide cartogram drawing functions[25]. When cartograms are deployed, it tends to be for consciously political reasons and a case is often made that they offer a more socially progressive way of mapping people (for example, in the of the *State of the World Atlas* by Kidron and Segal 1995). Cartograms are said to be rhetorically powerful because they eliminate the "...fundamental distortion of much past thematic cartography in (literally) drawing our attention to the patterns in places where the fewest people live" (Dorling 1994, 85) and thus offer a 'fairer' scheme of visual representation, particularly at the world scale (e.g. small, densely populated states can be easily seen). The major disadvantage of cartograms is their unfamiliar 'look'. Cartogram algorithms, contiguous ones in particular, can produce very warped country outlines, eliminating familiar shapes and shifting well-known landmarks, such that many people, who have been

[25] Various custom scripts and programs have been developed to create cartograms, (e.g. Dykes' (1997) 'cdv' system), but the extra effort required is usually not justifiable, compared to the ease of producing a choropleth map.

imprinted from a lifetime's exposure to the 'normal' visual geometry of world maps, find them confusing and difficult to read. Unfamiliarity can, of course, be viewed as a benefit as it can spark interest and help to undermine stifling cartographic conventions, but it can also reduce the workability of the map because people focus their attention more on the mapping technique than on the actual data being represented, thereby breaking one of Tufte's (1983) maxims for good information design.

A number of different cartogram techniques have been applied to the problem of representing the extent of networking across the world. Distance cartograms based on linear distortion according to cost, time and speed of travel have been employed to show how communications connectivity is differentially re-scaling the relationships between places, such as Arrowsmith and Wilson's (1998) 'telecom tectonic' world maps. While in 1998 *Wired* magazine featured, on a double page spread, a non-contiguous area-by-value cartogram, entitled 'The Wired World Atlas' (Conners-Petersen 1998). Countries were symbolised as rectangular blocks, with the size scaled according to telephone lines per capita. The map was promoted on the magazine's cover with the banner: 'Globally wired - your foldout guide to every nation's tech wealth' and the result was a quite familiar-shaped but very rectilinear-looking world. Its most striking visual feature in many respects, was the shrunken-looking African continent being overwhelmed by huge, overbearing European country blocks.

Another interesting project exploiting the cartogram approach to understand Internet globalisation was the 'Political Population World Map' created in 2002 by Italian artist Antonio Scarponi (see <www.globalab.org/eng/>). It is an animated non-contiguous area-by-value cartogram (delivered online using Flash) that shows the countries scaled according to number of Internet users (Figure 6.5). To achieve the re-scaling, each pixel represents a thousand people in what Scarponi describes as a 'demographic' projection. Country outlines are 'politicised' with their national flag. The animation runs from 1993 through to a future projection in 2015 and ably illustrates how the shape and relative scaling of the world changes as differential growth in the Internet user population plays out. In the beginning, the U.S. completely dominates the field of view, with Latin America and Africa barely visible (except for Brazil and South Africa), yet towards the end of the sequence, America shrinks from prominence as the maps becomes visually dominated by the expansion of India, China and central African states (based on *projected* online population growth in those countries). Also, some territorially large nations, which tend to dominate conventional geographically projected world maps, dramatically shrivel away because of their relatively small online presence - most noticeable examples being Russia, Canada and Australia. Separate European nations merge overtime to become a single dominant monolithic blue EU unit in the world map. Thus Scarponi's cartogram approach is a very conscious visual restructuring of the world through a map that focuses on population and not territory and emanates a markedly different imaginary geography of Internet globalisation compared to the pair of Landweber maps displayed in Figure 6.2, with the power of nation-states, denoted by graphic size, in the 'information age' concomitant to volume of people networked, rather than land mass connected.

<Figure 6.5 about here. Internet world cartogram.>

(ii) Dasymetric mapping techniques:

This mode of cartographic representation seeks to ameliorate the gross areal averaging inherent in choropleth maps by explicitly recognising the internal spatial distribution of the phenomena being represented to create a new set of zones to display the data. The goal is therefore to map the statistics, as far as possible, to their 'natural' zones rather than to arbitrary, prescribed units of publication (mostly based on administrative ones). The primary application of the technique has been in mapping social phenomena, particularly population distributions. Proponents of dasymetric mapping methods argue it can give a more accurate (realistic) - and hence a more rhetorically persuasive - visual representation, as they "help us to escape from the spatially bounded conceptions of human life produced by the choropleth map" (Crampton 2004, 50). Robinson (1982) traces the lineage of the dasymetric approach back to the 1830s, with the Harness population map of Ireland cited as the first published example. The positive virtues of dasymetric mapping were extolled by J.K. Wright in 1936, when he remapped aggregate population counts in Cape Cod to take account uninhabited areas within a township; he also provided a practical algorithmic method for apportioning densities to variable sets of zones. Yet dasymetric mapping has been used only very sporadically since Wright's paper, despite its obvious benefits. This is because it requires considerable amounts of ancillary geospatial data[26] and additional cartographic processing to produce, compared to the ‘straight’ choropleth map approach[27]. Also, like cartograms, dasymetric maps can suffer from the ‘unfamiliarity’ problem, as new boundaries generated to display the data are more complex and less uniform than the administrative units people are used to seeing.

Despite this lack of general use, dasymetric ideas have been applied to the mapping of global Internet geography. Journalist and activist, Mike Holderness (1998), offended by the grossly unrealistic Landweber view of the extent of world-wide network diffusion, produced an approximate, hand-drawn dasymetric reconfiguration as a political counter-map (Figure 6.6). His adjusted map removes some of the most egregious distortion of Landweber’s maps by fading non-metropolitan regions outside of the OECD core to account for their much lower ‘connection density’ and also greying out the uninhabited deserts and arctic tundra. Holderness has effectively doubled the complexity of the classification, so as to make “a first approximation at a realistic map” (Holderness 1998, 40), by introducing this notion of dense and sparsely networked regions (in many ways mirroring the more complex division in Landweber’s original data tables). Although the representation of dense and sparse was purely cartographic guesswork on Holderness’ part, the result is a view of the world with a very much more constricted degree of Internet globalisation, and with network connectivity significantly more spatially concentrated, than implied by Landweber’s homogenising choropleth display. The rich, dark purple shading of full Internet connectivity is limited to the core regions of the developed world in Holderness’ presentation.

<Figure 6.6 about here. Holderness map.>

[26] In terms of social mapping, necessarily detailed, small-scale, data on population distributions have been traditionally unavailable - although recent developments in urban remote sensing and household level geodemographics are changing this, at least in the UK (see Longley and Harris 1999 for review). In many ways, David Martin’s (1996) extensive work on surface-based population representations from the census provides one of the best routes to generating data needed for dasymetric mapping.

[27] The availability of GIS, enabling accurate manipulation and aggregation of spatial data, has made it potentially easier to create dasymetric maps (e.g., Mennis’ 2003, work using ArcView). However, as far as I am aware, no major COTS GIS package yet provides a simple ‘point-and-click’ function to generate dasymetric maps. Indeed, the help system for the market leader, ESRI’s ArcGIS9, contains no reference to them.

As Holderness (1998, 40) says of his map, “it is not dissimilar to a map of per capita income - or, for that matter, one of where the white folks are”. The global south is clearly rendered much more effectively as the unequal periphery through the use of faded colours, while the distinctive ‘spotty’ appearance nicely highlights to the map reader the tight concentration of the best connectivity in very few principal cities. In many ways then, Holderness’ dasymetric mapping of the Internet highlights most effectively the extent of division in network access. As such, it resonates with some other recent attempts at techno-geopolitical mappings focused on the inequalities of the globalising world, for example, the ‘new world map’ produced by Harvard economist Jeffrey Sachs (2000), focused on explicitly linking unequal capacity for technological innovation to problems of development.

(iii) Point symbol mapping:

For a variety of reasons, traditionally due largely to constraints in manual cartography, both area-based mapping alternatives to the choropleth ‘default’ have remained relatively little used. A much more common alternative for mapping statistical data is that of point symbology, using either graduated or proportional scaling to show the magnitude of phenomena at particular locations[28]. For point symbol mapping to give a plausible representation of the phenomena, it clearly needs more finely spatially resolved data (e.g. at level of individual cities or regions rather than country totals)[29]. Data representation using point symbology can be advantageous in rhetorical terms in thematic mapping as it helps to negate the visual homogenising effects of choropleth mapping (where large areas have to be assigned to a single class). The use of proportional point symbology has a further distinct advantage in that no generalisation distortion through crude classification is required, although careful scaling can be needed to avoid problems of illegibility through over-plotting of symbols.

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[28] For convenience or due to lack of data, the location of the point symbol is often an imperfect fudge - for example, being placed at the centroid of the area or located at principal city of the area.

[29] This can be a major problem where the map-maker is wholly reliant on secondary statistical sources that are typically published in aggregated form for large areal units. This is certainly the case with much of the mapping of the Internet, where few or no sub-national statistics are available.

Point symbol mapping, in a number of guises, is very common for the summary display of quantitative statistical data and, unsurprisingly, it has been widely employed in the analysis of telecommunication geographies (e.g. Jean Gottman's (1961) maps of inter-urban telephone call patterns in the U.S, Figure 3.2) and, more recently, Internet infrastructures (e.g. Zook's (2000), maps of clusters of domain registrations). In relation to the representation of Internet globalisation at the world scale, I want to contrast Landweber's choropleth approach with the point symbol mapping undertaken by John Quarterman[30] (Figure 6.7). This map was produced as part of his research into the geographical extent of 'the Matrix' (i.e. the patchwork of different networks which were able interchange email messages) and the representation uses a four-fold categorisation along similar lines to Landweber, denoted by distinct symbol shape and colour. The scaling of the symbols is on an exponential scale and they are positioned (as closely as possible) at the actual sites where connectivity is located, rather than aggregated to region or country. The measurement methodology employed by Quarterman was different to Landweber, being based on individual site level data, usually automatically generated listings as part of basic network operation (see Quarterman *et al.* 1993). In some senses, the nature and scale of Quarterman's data collection favour the point symbol based representation.

Comparing the two maps in Figure 6.7, the visual distinctions between them could not be starker. Whereas Landweber's view of Latin America is awash with colour, suggesting the countries are literally full-up with network provision, Quarterman's map is almost completely devoid of colour except for a small smattering of symbols. Green circular symbols, representing sites with full Internet connectivity, are present at only seven places on the map - a markedly different impression to the swathes of purple in Landweber's map, which blanket two-thirds of the continent in Internet connectivity. The case of Brazil, in particular, illustrates the extent of the homogenising distortion of choropleth mapping, with the whole country shaded one-hundred-percent-Internet

[30] Quarterman is a long serving Internet analyst, having produced a number of 'censuses' of computer networks in the past (see Quarterman and Hoskins 1986; Quarterman 1990). Much of his analysis in the 1990s was commercially self-published by his research consultancy, Matrix Information and Directory Services. Besides, this map of Latin America, Quarterman has produced a wide range of statistical maps tracking the structure and global diffusion of the networks through the 1990s, including a series of world maps of the Internet (Dodge 1999b), which in some senses were the only 'competition' to Landweber's presentation.

purple by Landweber, while on the Quarterman map the vast Amazonian interior is rightly a disconnected void.

Overall then, from a reading of Quarterman's map one would conclude that most of Latin America is *disconnected* from any form of network. By providing this kind of effective visual contrast to Landweber 'default', Quarterman clearly highlights the extent to which the rhetorical messages given-off by a map can be dramatically changed by using a different visualisation technique. Indeed, Quarterman *et al.* (1993, page CDA-1) allude to this in their introduction: "These are not traditional shaded geographic outlines nor node and link connectivity maps, but rather, maps that show locations and numbers of networked hosts and services. This representation of the network gives a presentation of where the networks go, rather than how they get there, and shows what areas are reachable by each network type." At the same time, it exposes how distorted a picture area-based choropleth mapping can provide by itself, especially if approached naively with the expectation of cartographic 'truth'.

<Figure 6.7 about here. Quarterman point map.>

(iv) Continuous field mapping:

One the major failings of all the alternatives examined thus far, is that they provide little or no sense of the where people are connecting, or potentially able to connect, to the networks. Quarterman *et al.* (1993, page CDA-1) admit their point symbol mapping, "do[es] not show exactly where the users are, but we show where the hosts they use are." One possible solution to this problem is to visualise the global Internet in relation to underlying population distribution. This can best be achieved cartographically through the use of continuous field representation, most obviously a surface representing population density. Surfaces are readily produced today as most GIS support grid data models and provide suitable methods of generation (such as interpolation from sample points). This form of representation has been effectively used by mobile phone operators to present coverage maps of notional wireless reception, and in the analysis of Internet infrastructures at various scales - for example the work of

Shiode and Dodge (1999) in the UK or more recently Gorman's (2004) doctoral research on critical infrastructure vulnerabilities in the United States.

In terms of Internet globalisation, the best available exemplar is the mapping undertaken by team of physicists based at the University of Notre Dame, who are exploring the fundamental principles driving the topological structures of complex networks like the Internet, most particularly concerned with fractal and small-worlds functions (Yook *et al.* 2002, 13,383). Their map shows two contrasting world views - where the internet is concentrated, against where most people live (Figure 6.8). The maps are density surfaces, where the land is colour-coded so that higher densities are darker. The top map (a) shows the distribution of the Internet as a density surface interpolated from point locations of some 228,000 core routing computers. The darkest orange shading represents the highest density, up to a maximum of 104 routers per grid. Underneath is the population density mapped in the same fashion (although the data range, according to the key, is not the same). Interestingly, the authors of the map chose not to use country enumeration, so the surface runs unimpeded across the continents. The effect of this is to present a more unified view, rather than a world chopped into arbitrary and irregular chunks.

<Figure 6.8 about here. Notre Dame map.>

The most striking feature on Figure 6.8 for the understanding of Internet globalisation are the places of mismatch between the two views of the world. As Yook *et al.* (2002, 13,383) explain the overall pattern, "while in economically developed nations there are visibly strong correlations between population and router density, in the rest of the world Internet access is sparse, limited to urban areas characterized by population density peaks." The surface for population density covers most of the land surface; in contrast, the Internet surface, outside of core regions of North America and Europe, is very speckled in appearance. The visual impression from seeing the state of Internet globalisation rendered as a continuous surface, as opposed to Landweber's choropleth view, is that it is very far from complete. It would be an interesting exercise to combine these maps together (as in GIS grid overlay) to reveal in their union where in the world the 'information society' is to be found.

(v) Exploiting interactivity:

Another potentially interestingly way forward to a more progressive mapping of the Internet, is to utilise the interactive power of the Internet to let readers create their own maps. Crampton (2001) suggests that part of the progressive cartographic research agenda that can flow from map deconstruction work is to "emphasize the importance of multiple perspective and multiple maps". Online GIS is one possible route that can provide the means for users to create their own maps, with necessary functions to set projection, classification, and symbology, along with the ability to zoom and interactively make enquiries. This offers users the ability to explore the data and critically examine the results in ways that are not possible with a fixed, single map mode of conventional cartography. (Of course, the tools of GIS and especially the data provided, will set the limits of what it is possible for the user to do). There are also clear links in this approach to the work on public participation in GIS that aims to reconfigure the technology, and how it is used, in ways that empower communities rather than dominating them. (See chapter eight for discussion on counter-mapping the Internet.)

Despite being more effective in the technical sense of more workable at conveying patterns of variability between nations and difference within nations, it is important to remember that all these 'alternative' maps, just like Landweber's, are products of particular people who are embedded in particular socio-political milieu and espouse their own agendas. It is worth reiterating that it not possible politically to produce the 'perfect' map - they all remain selective and socially-produced representations. In many ways, their ideological message seems to parallel that of Landweber, in that they highlight more strenuously the divisions. The interest served is to discredit the Internet diffusion discourse by elaborating the continued division and some cases increasing inequality of Internet penetration.

5. Re-thinking Internet globalisation metrology

Is it possible to conceive of more progressive, although not necessarily more 'accurate', approaches to the spatial analysis of Internet globalisation? Doing so means more than 'tinkering' with alternative representational forms, described in the previous section, to think about different modes of measurement and, indeed, very different types of questions about the nature of the Internet.

In quantitative terms, the first, obvious, approach is the development of more socially meaningful measures of Internet *availability*, which look beyond a single mechanistic score of hardware penetration, so common in diffusion reports and world maps. Staying at the country level as the units of analysis, this can be achieved with more sophisticated measurement systems, better able to capture socio-economic heterogeneity by combining multiple factors into a composite indicator[31]. A notable example here is the work of the Mosaic Group[32] whose global Internet diffusion index uses a six fold scoring system encompassing the social prevalence of access, geographic dispersion of access, sectoral absorption, connectivity infrastructure, networking governance capacity and sophistication of use (Press *et al.* 1998). The logical next step-up from availability is the measurement of Internet *activity*; however, quantitative assessment of this dimension through traffic statistics has proved to be an intractable problem (Abramson 2000; see also discussion in chapter seven). Quite simply, there are no comprehensive traffic statistics for the global Internet since the end of NSFNET in 1995.

In addition to availability and activity, some have argued for an empirical assessment of Internet diffusion focused on *utility* in terms of peoples' capacity to exploit it. For example, Gurstein (2003), using ideas from community informatics, has called for the analysis of digital divides to look at 'effective use' of the Internet in local settings that focus on the ability to actively participate in the production as well as consumption of the networks. In relation to the Asian Tsunami and supposed 'failure' of communications in the region, Gurstein (2005) notes:

> "From what I can gather most if not all of the communities impacted [by the tsunami] had Internet 'access' in one form or another. What they (and here I would include those with the knowledge who couldn't use it as well as those without knowledge) lacked rather, was the social, organizational, informational, and

---

[31] Comparable to methods used to produce deprivation indicators, such as the Townsend index, widely used in government policy analysis.

[32] An independent group of American computer science and public policy academics. See <http://mosaic.unomaha.edu/gdi.html>.

applications infrastructure which could have turned Internet access into an ‘effectively usable’ early warning system.”

Conceptualising Internet measurement in terms of the capacity for individuals and communities to take effective action online is also interesting because it moves the focus towards a rights-based agenda for assessment. Some commentators argue that the most socially relevant way to measure Internet globalisation now is as the ‘freedom to access’. For example, Guédon (2002, no pagination), noting the ‘completion’ of the access project charted by Landweber’s international connectivity maps, argued in a statement on the future role of the Internet Society that: “I believe a new kind of map ought to be issued each year by ISOC, and it would graphically display how the *rights* of access of cyber-citizens are respected or flouted, as the case may be”, a consciously political mapping, meaning that “ISOC would raise a moral voice in the world, a voice that would say: not only do we guarantee the existence of our cyber-citizens, but we also defend their cyber-rights.” There have been a number of ‘moral mapping’ projects with this kind of human rights agenda (e.g., the works of Michael Kidron) in the last couple of decades.

In terms of Internet globalisation, *Wired* magazine produced a world map in 1997 entitled ‘Freedom to Connect’ (Conners 1997; see also Harpold 1999 for a critique of the map’s measurement of freedom) and more recently in-depth annual studies have been produced by the NGO, Reporter without Borders (2003). Both examples are at the national scale and focused on government attempts at surveillance, filtering and censorship. The results are informative in that they show the highly fragmented nature of Internet globalisation, even in many OCED countries. Far from the cosy view of a uniformly wired world of Landweber’s maps, people across the world are being watched online. Contrary to the upbeat diffusionist rhetoric, online freedoms are, arguably, in reverse - and not just from more intensive government wiretapping spurred by the ‘war on terror’. The right to explore cyberspace anonymously and communicate freely is systematically being attacked by media corporations in their attempts to channel consumers and combat file sharing, along with criminals who are polluting virtual commons with spam and malicious viruses.

Perhaps unsurprisingly, there is tendency in the quantitative analysis of global Internet to focus excessively on technical and economic metrics - seen as solid, knowable data and easily gathered, rather than ‘fuzzy’ human experience. (This has been highlighted by Cornford (1999) as a general problem in the statistical assessment of impacts of ICTs.) The basic epistemological problem in all the above approaches seeking generalisable mappings is that they tell one little about people’s real experience. Statistical maps in this regard have an implicit tendency to dehumanise the world because they work best as simple stories of territorial averages, per capita scores and the rollout of governmental schemes. To broaden the understanding of the *peopling* of the global Internet, one must try to assess the rich, individual experiences of networking practices best gained through ethnographic case studies.

The work of anthropologists Miller and Slater (2000), examining how the Internet is variously adopted and adapted into everyday life of people in Trinidad, provides an authoritative exemplar of the benefits of exploring the local contingency of networking practice. Accordingly, they claim, “[s]ocial thought has gained little by attempting to generalize about ‘cyberspace’, ‘the Internet’, and ‘virtuality’. It can gain hugely by producing material that will allow us to understand the very different universes of social and technical possibility that have developed around the Internet in, say, Trinidad versus Indonesia, or Britain versus India” (Miller and Slater 2000, 1).

In particular, most existing statistical approaches and mappings completely fail in their representation of the African experience of the Internet. The result, at present, leaves Africa largely as a blank, the ‘dark continent’ of old. The blankness on Western-centric ‘top-down’ statistical maps of the network society masks the fascinating richness and diversity of the Internet’s percolation through Africa (see Barlow 1998; Goldstein 2004; Hall 1998; Oguibe 1996, for diverse examinations of the situation ‘on the ground’). The need is for analysis not to demarcate the spaces of diffusion but to give voice to the places of adoption.

A ‘bottom-up’ approach to the spatial analysis of Internet globalisation can also be undertaken by individuals themselves through active network exploration using software tools like traceroute (see chapter eight). In this mode of analysis one can determine whether a place is online (*can I reach it?*) and how it is connected to oneself (*how did the data travel back to me?*). In this way, the network is used to measure itself. This simple sounding epistemological switch, when scaled up through automated scanning, actually opens up a dramatically different way of 'diagramming' of the Internet. (See discussion in chapter four on the network visualisations by Burch and Cheswick and CAIDA.)

6. Conclusion

Landweber's maps provide a conceptually simple - one might say simplistic - picture of the global geography of the Internet. Taken as a series through the first half of the 1990s they create a compelling cartographic story of the rapid diffusion of network connectivity measured at the national scale. The maps, through the use of the most 'obvious' form of cartographic design, make it is easy to assume that they provide a clear and straightforward geographic presentation of the data. This is certainly how they have been used.

Yet, one must also recognise "that these depictions of network activity are embedded in unacknowledged and pernicious *metageographies* -- sign systems that organize geographical knowledge into visual schemes that seem straightforward, ... but which depend on historically - and politically - inflected misrepresentation of underlying material conditions." Harpold (1999, no pagination). An uncritical reading of them without realising that they are metageography could easily provide a distorted view of the actual reality of Internet globalisation experienced across the world. As noted, whilst most of the world, according to Landweber's last map in 1997, was connected to the Internet, this connectivity was not equally distributed in scope or cost. The majority of Internet-connected host computers are concentrated in relatively few countries in the global 'North', which in turn are the best interconnected with high capacity submarine cables. The uneven distribution of the Internet has wide economic and social implications, with greater benefits accruing to the centre and proportionally fewer for countries on the periphery.

World maps of statistical data, such as Landweber's, can play an important role in reflecting this unequal diffusion of technology, but they can also re-project views of them that seek to reduce difference.

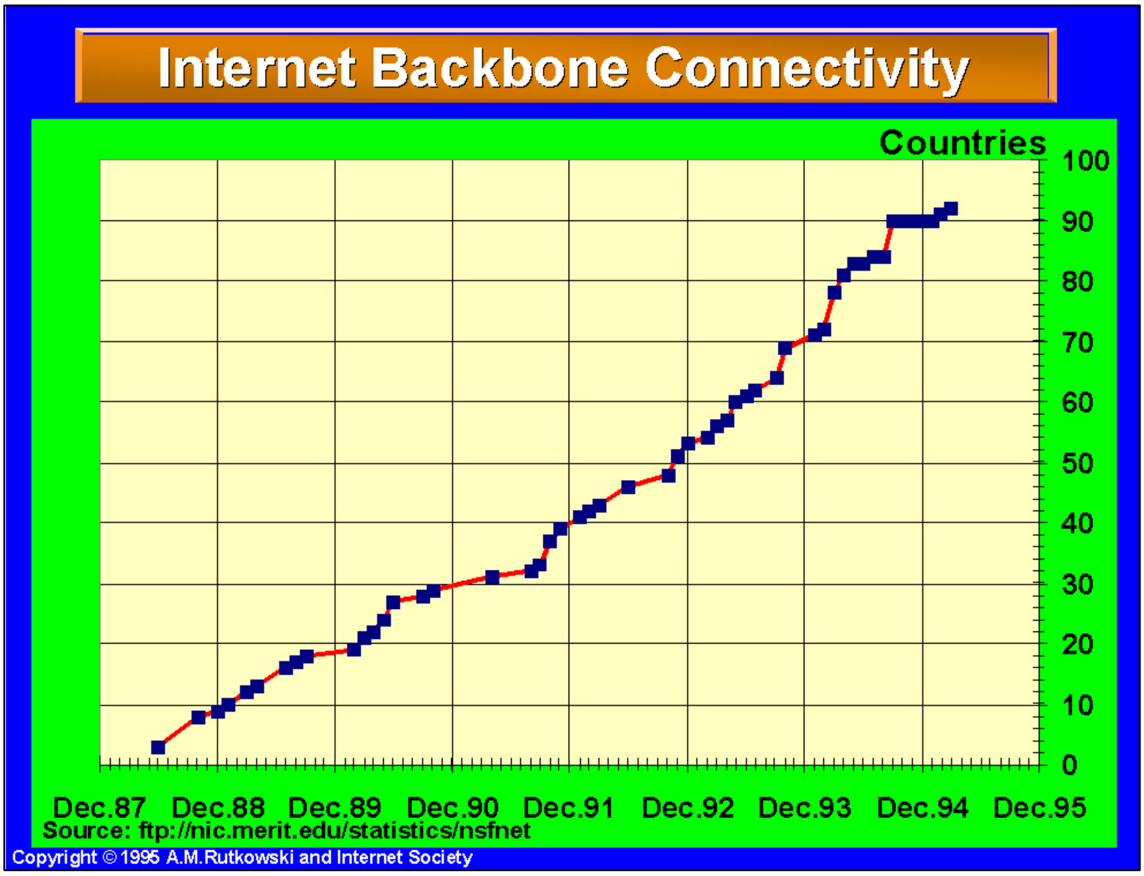
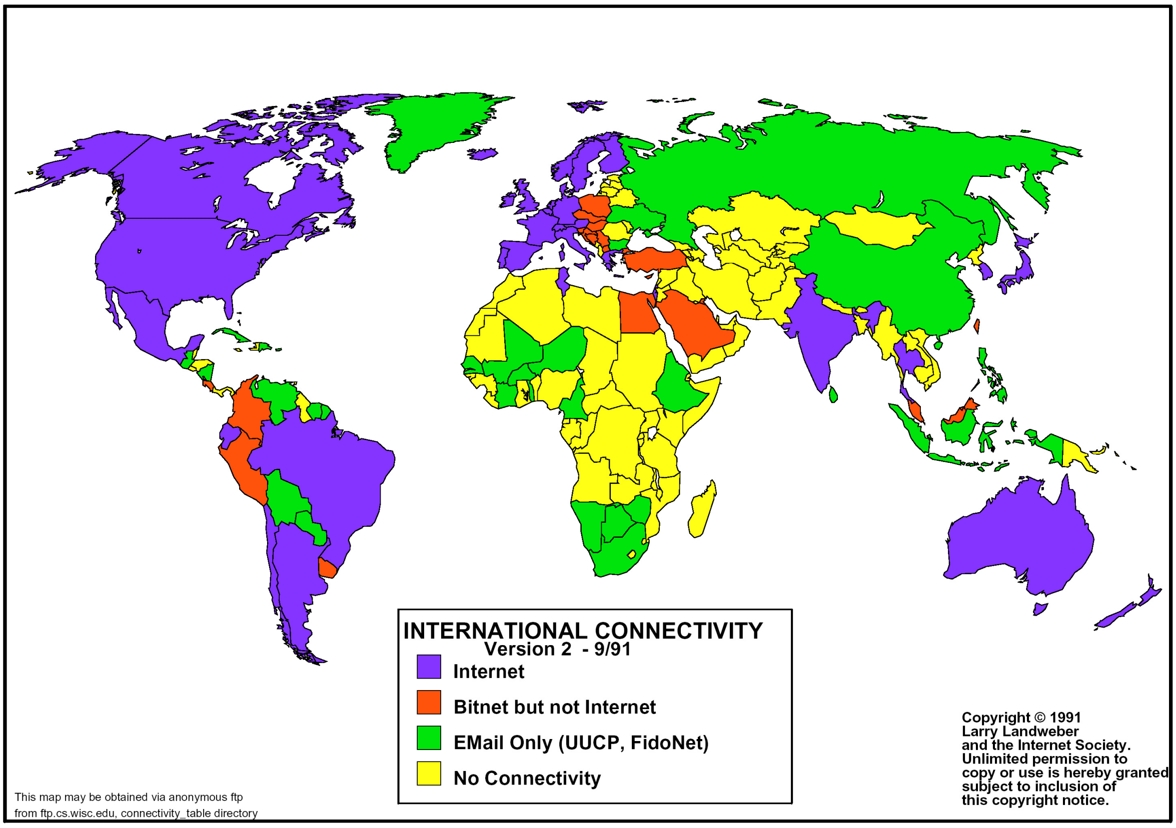


Figure 6.1: A typical Internet growth chart demonstrating the rapid pace expansion from the late 1980s through the first half of the 1990s as measured by the number of countries connected. The de facto meaning of 'Internet backbone connectivity' during this period was countries had to directly link to the United States to reach NSFNET (National Science Foundation network). The chart is from a Powerpoint presentation, entitled 'International developments and opportunities', given by Anthony Rutkowski, director of the Internet Society. (Source: Rutkowski 1995.)



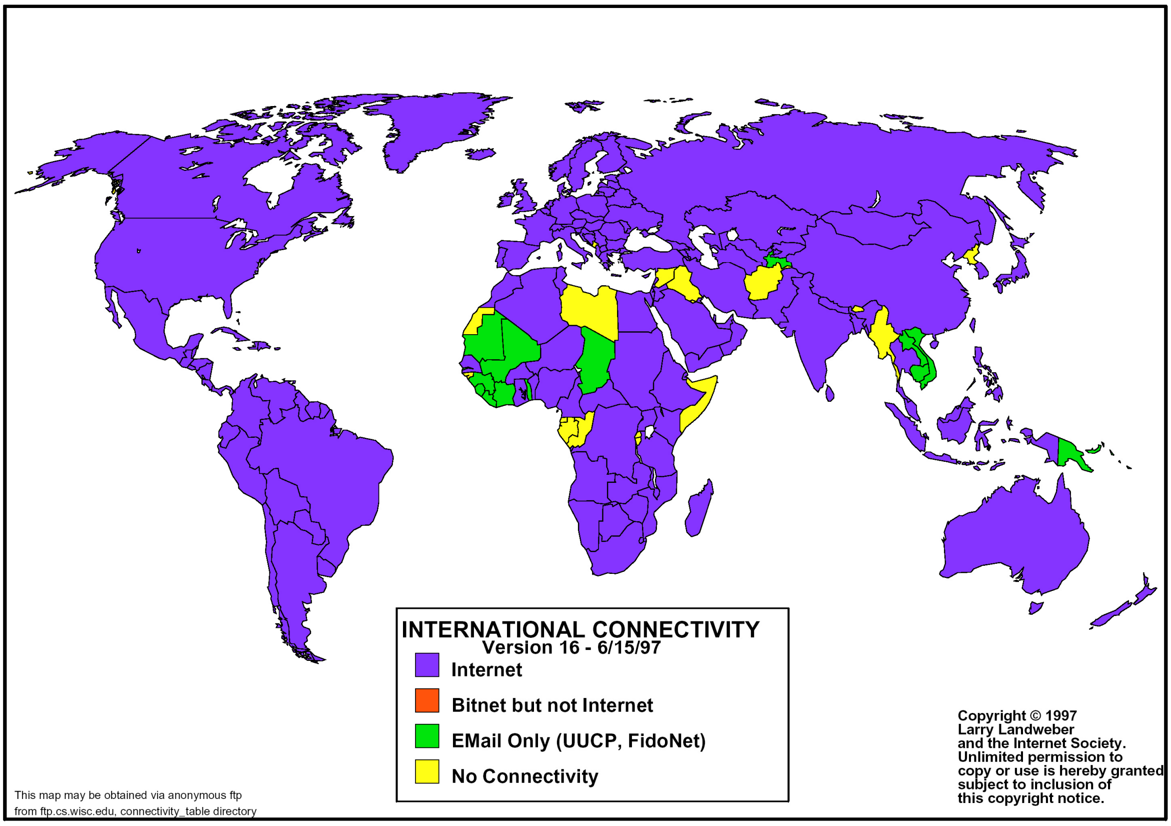


Figure 6.2: The first and last maps from Lawrence Landweber's series charting national-level 'International Connectivity' (source: ftp://ftp.cs.wisc.edu/connectivity_table).

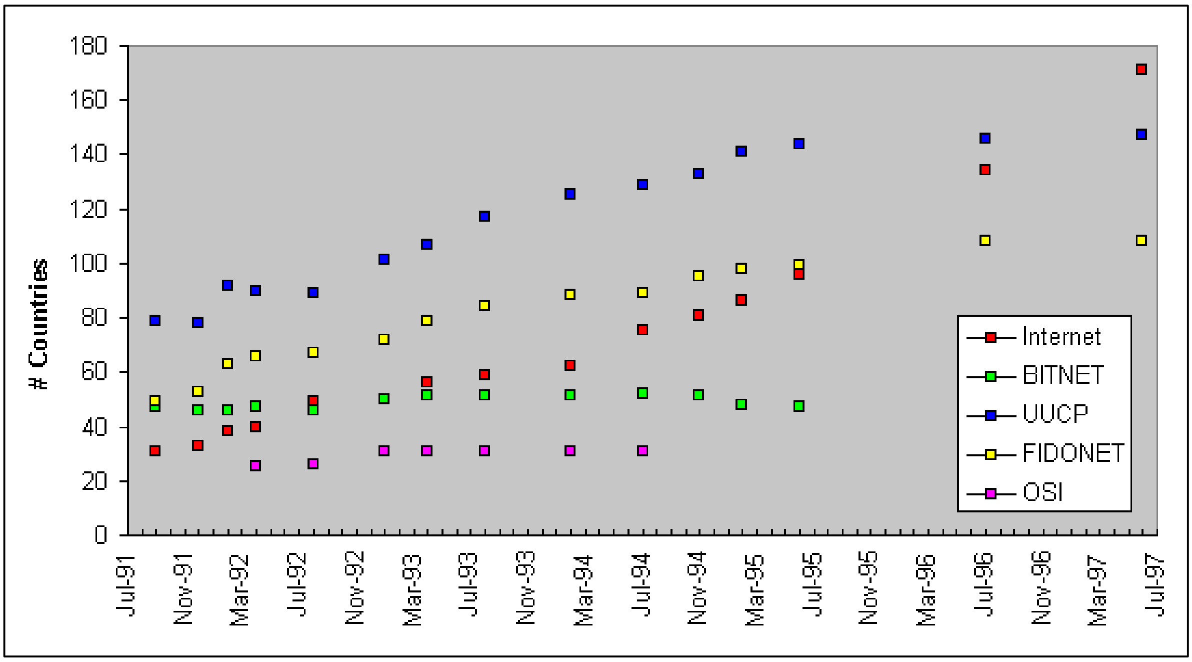


Figure 6.3: A longitudinal chart of “worldwide network growth” showing the range of network types Landweber mapped and the periodicity of his published surveys. (Source: Zakon 2004.)

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INTERNATIONAL CONNECTIVITY
Version 3 - December 2, 1991

Please send corrections, information and/or comments to:

Larry Landweber
Computer Sciences Dept.
University of Wisconsin - Madison
1210 W. Dayton St.
Madison, WI 53706
lhl@cs.wisc.edu
FAX 1-608-265-2635

Include details, e.g., on connections, sites, contacts, protocols,
etc.

Thanks to the many people from around the world who have provided
information.
-----------------------------------
In the following, BITNET is used generically to refer to BITNET plus
similar networks around the world (e.g., EARN, NETNORTH, GULFNET,
etc.).
---------------------------------
SUMMARY

NUMBER OF ENTITIES WITH INTERNATIONAL NETWORK CONNECTIVITY = 89

BITNET Col. 2  (Entities with international BITNET links.)
      b = minimal < 5 domestic sites =  18
      B = widespread >= 5 domestic sites = 28
      x = uncertain = 2
INTERNET Col. 3  (Entities with international IP links.)
      I = operational = 33
      i = soon available = 3
UUCP Col. 4  (Entities with international UUCP links.)
      u = minimal  < 5 domestic sites = 40
      U = widespread >= 5 domestic sites = 38
FIDONET Col. 5  (Entities with international FIDONET links.)
      f = minimal  < 5 domestic sites =  10
      F = widespread >= 5 domestic sites =  43
Col 6 = * = New connections expected in near future.

 ----  AF   Afghanistan (Republic of Afghanistan)
 ----  AL   Albania (Republic of Albania)
 ----  DZ   Algeria (People's Democratic Republic of Algeria)
 ...
 ...
 ----  BJ   Benin (Republic of Benin)
 ----  BM   Bermuda
 ----  BT   Bhutan (Kingdom of Bhutan)
 --u-  BO   Bolivia (Republic of Bolivia)
 ---f  BW   Botswana (Republic of Botswana)
 ----  BV   Bouvet Island
 BIUF  BR   Brazil (Federative Republic of Brazil)
 ----  BN   Brunei Darussalam
 --UF  BG   Bulgaria (Republic of Bulgaria)
 --u-  BF   Burkina Faso (formerly Upper Volta)
 ----  BI   Burundi (Republic of Burundi)
 --uf  BY   Byelorussian SSR (Byelorussian Soviet Socialist
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Figure 6.4: Part of the December 1992 ‘International Connectivity’ data table produced by Landweber (source: <ftp.cs.wisc.edu/connectivity_table>).

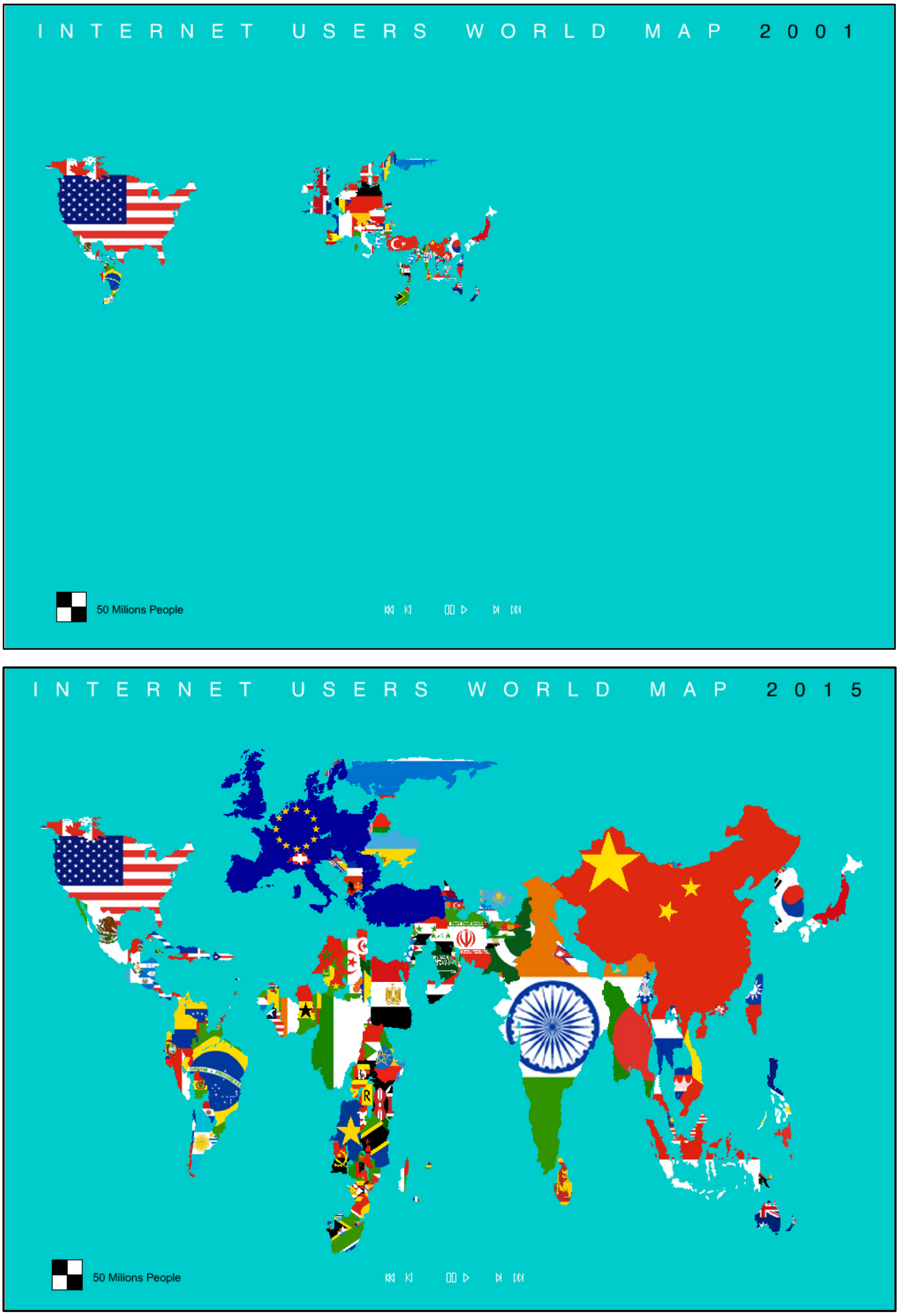

Figure 6.5: Screenshots of two frames from an animated cartogram visualising Internet globalisation created by artist Antonio Scarponi (source: GlobaLab 2002, www.globalab.org/eng/).

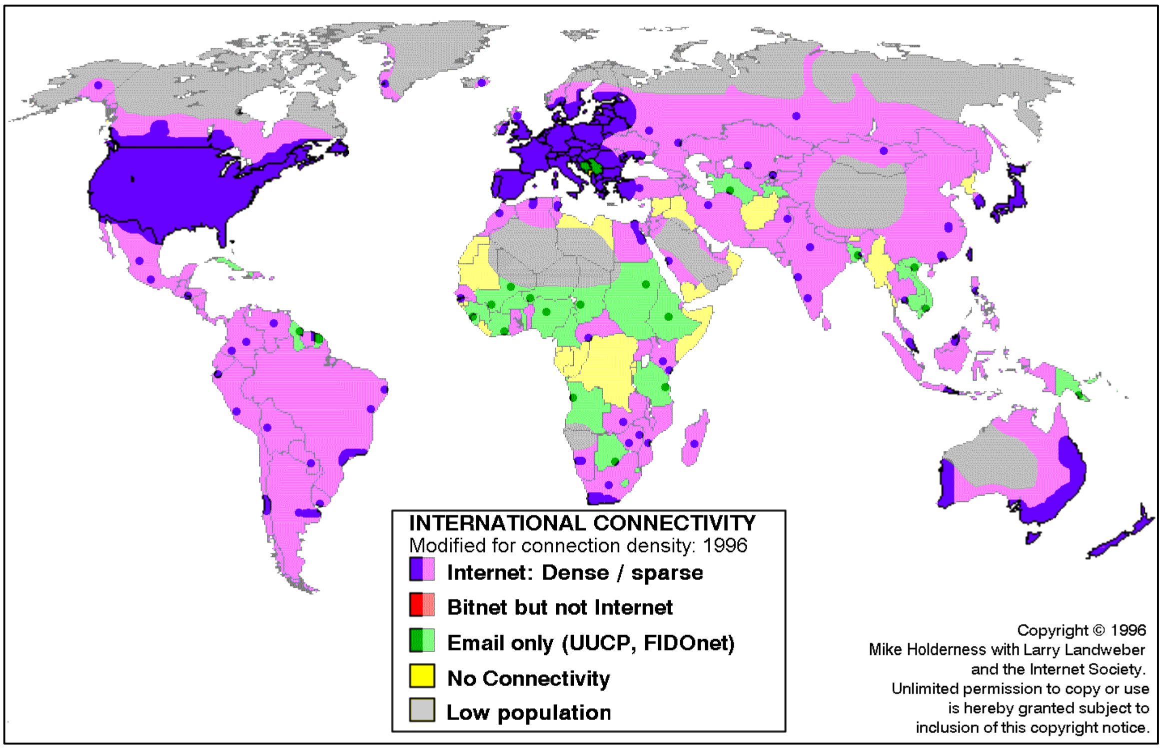

Figure 6.6: A hand-drawn dasymetric style map of 'International Connectivity' produced by Mike Holderness. It is a consciously political 'adjustment' of Landweber's original map that seeks to undermine the myth of rapid Internet diffusion. (Source: Holderness's website, <www.poptel.org.uk/nuj/mike/cyberdiv.htm>. Note, a slightly different black and white version of the map was printed in Holderness, 1998.)

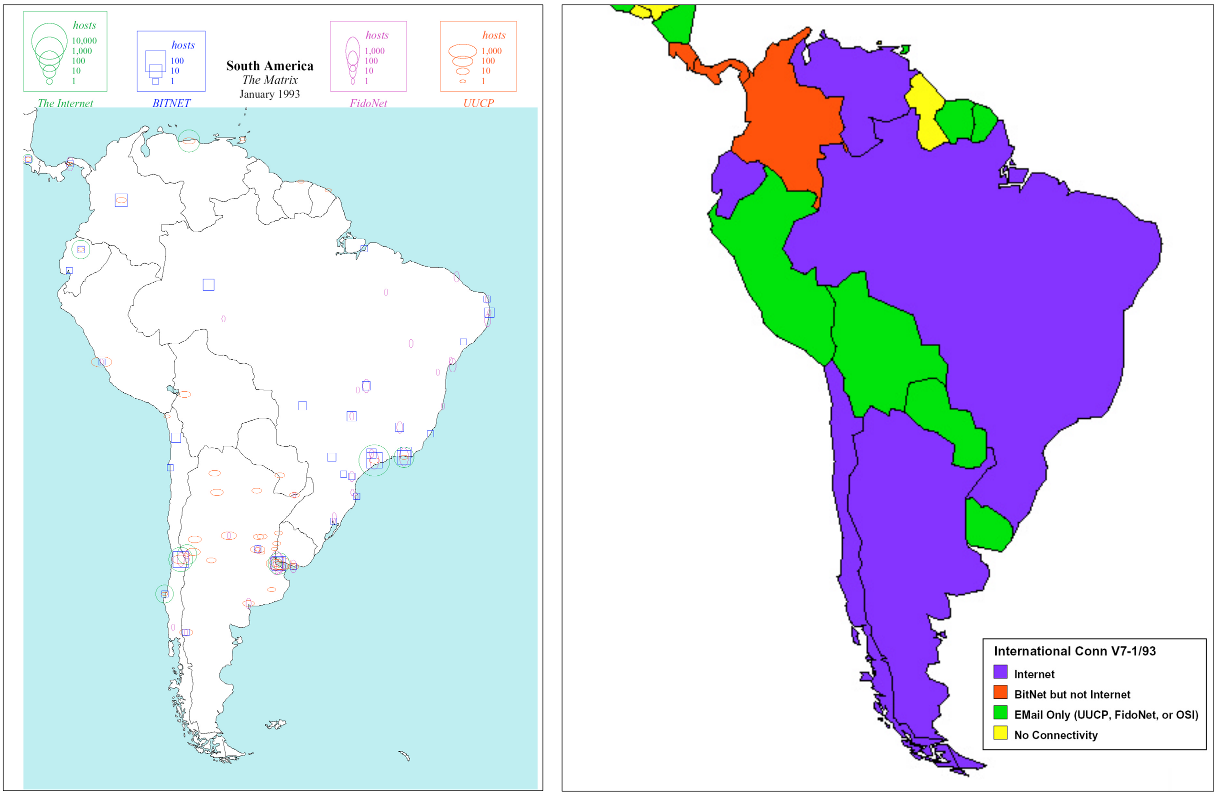

Figure 6.7: The ‘Matrix’ of computer networks in Latin America in 1993 shown using proportional symbol mapping, produced by John Quarterman (left). Displayed in juxtaposition is the Landweber representation of the same region, at the same date (right). (Source: Quarterman *et al.* 1993, page CDA 7; the portion of the Landweber map is edited from the version 7 map, available from <ftp.cs.wisc.edu/connectivity_table/>.)

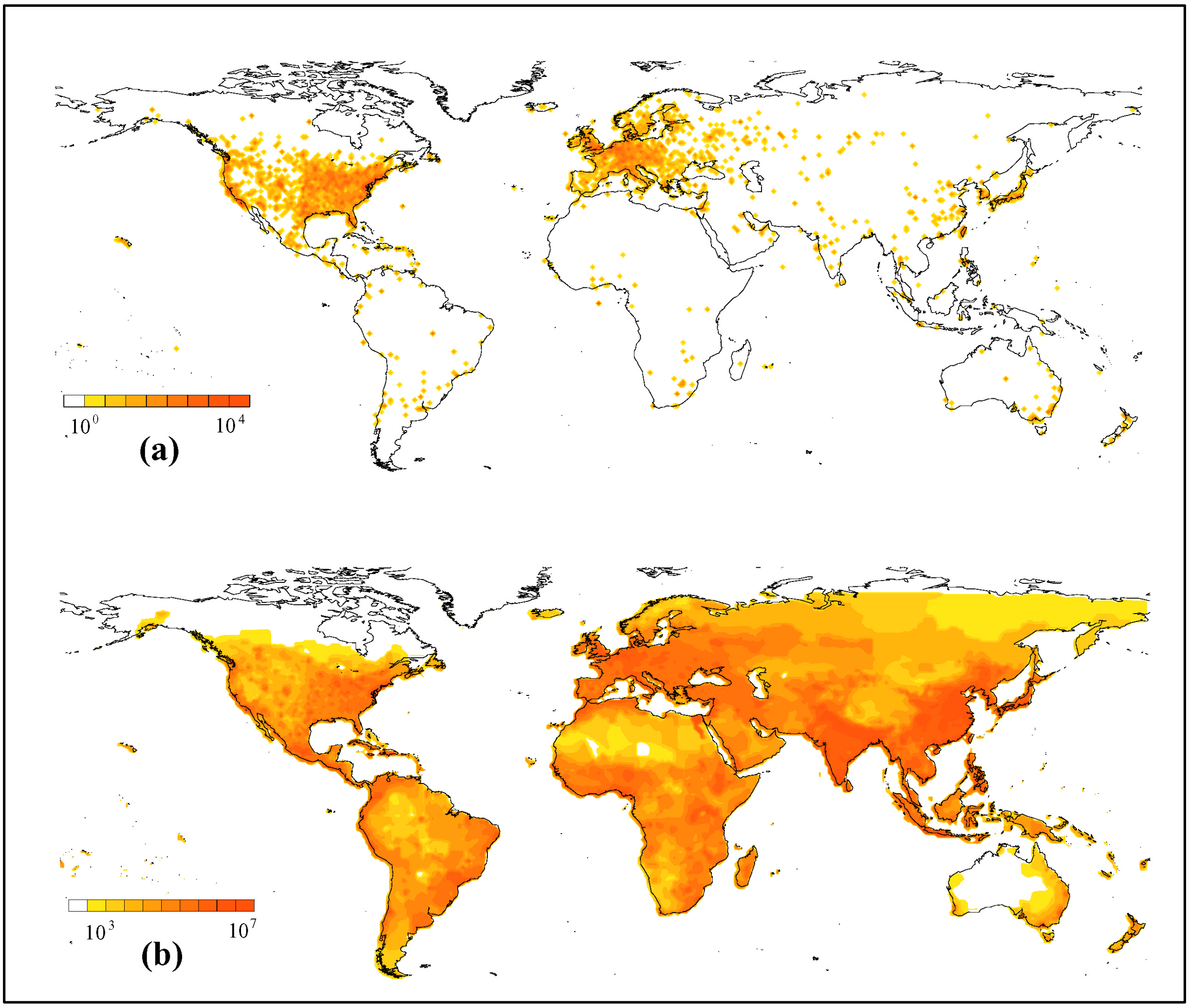

Figure 6.8: Continuous field representations of the global distribution of Internet routers in 2000 (a) and population (b). The cell size in the surfaces are 1 degree square and colour coded according to density. (Source: Yook *et al*. 2002, 13,383.)

Chapter 7

Spaces of Hype: Marketing Maps and the Myth of Internet Doubling Every 100 Days

Over the past five years, Internet usage has doubled every three months. We're seeing an industry that's exploding at exponential rates.

-- Kevin Boyne, chief operating officer of UUNET, WorldCom Inc.'s Internet networking subsidiary, quoted by Peter Behr in the *Washington Post*, 24 September 2000.

The advertiser generally uses the map both to enlighten and to persuade and only rarely to distort. The map is often the quickest, clearest, and most neatly organised method of conveying a geographical idea in advertising.

-- Douglas K. Fleming and Richard Roth, *Place in Advertising*, 1991.

Clinton, Miss., June 25, 2002 - WorldCom, Inc. (Nasdaq: WCOM, MCIT) today announced it intends to restate its financial statements for 2001 and the first quarter of 2002.

-- WorldCom press release.

1. Introduction

The focus of analysis in this chapter follows on temporally from Landweber's work charting world wide network diffusion in the early 1990s to look at marketing maps used in the promotion of Internet infrastructure during the growth bubble of the second half of the 1990s. A large number of maps of Internet infrastructures have been produced by commercial network operators for the purposes of marketing services and as an element in their corporate branding strategies. As such, they are the latest incarnation of a long lineage of marketing maps used to promote communications networks, including railways, highways and the airways. This genre of mapping is interesting theoretically as it drops the pretence of cartographic 'objectivity' by serving an overt commercial purpose, namely to attract prospective customers and investors in what are often highly competitive and lucrative business environments. The maps created seek to communicate persuasively to potential customers and investors the benefits of using the network operators' services above another company by highlighting key aspects of their infrastructure including its geographic extent, the range of important places connected and its capacity.

The marketing maps of WorldCom's UUNET subsidiary form the empirical locus for the analysis. The first map examined (Figure 7.6 below) dates from the start of 1997 and is temporally coincident with the conclusion of Landweber's statistical map series (chapter six, Figure 6.2). The juxtaposition in time of these two maps is symbolic of a switching point in the conceptualisation of the nature of the Internet, with dominant discourses shifting from the utopian outlook that viewed global networking as a space for progressive social and political empowerment, to a much more explicit capitalist perspective in which networks were a space of hype, a new commercial frontier offering untold financial rewards to those bold enough to invest, bold enough to believe in the 'New Economy' revolution. Many technology commentators, stock-market pundits and eager investors did *believe* that the Internet was growing at such a pace – it was widely asserted that traffic was doubling every 100 days - that huge amounts of new network infrastructure were needed. Sustaining the boom in network backbones required maps to show where the money was going, to make the building programs tangible, to make the dreams of great wealth seem true. The marketing maps were drawn, but as history now reveals, the 'doubling every 100 days' network growth turned out to be a myth and the predicted fortunes from selling bandwidth were millennial hubris.

2. Backbone boom and the doubling myth

> There is no way to give us an understanding of any society, including our own, except through the stock of stories which constitute its initial dramatic resources. Mythology, in its original sense, is at the heart of things.
>
> -- MacIntyre, 1985, quoted in De Cock *et al.* (2001, 209).

Just like a body, the individual elements of the Internet are held together by backbones. These are dedicated high capacity networks that aggregate traffic and provide transit between cities. Most of the backbones are built as overlay networks comprising switches at hub points (as opposed to separate, dedicated fibre optic cables in the ground). The backbones sit atop a hierarchy of Internet infrastructure and there are only really a handful of so-called 'tier 1' backbones that control most of long-distance transit of Internet traffic[1]. Smaller corporate networks, consumer ISPs and content hosting

[1] According to figures published by *TeleGeography* for 2002, ten providers had an 81% share of the capacity on the main routes in America (chart, page 30). The single largest provider was WorldCom at 29%, more than three times the next largest.

businesses generally need to connect to a tier 1 backbone so they are ‘on the Internet’ (i.e. their customers can reach all other points) and often they buy transit onto several backbones to maximise performance and improve network redundancy. The backbones themselves interconnect with each other at peering points to exchange traffic. Most people are typically unaware of the existence of this core element of the Internet and many of the companies that operate backbones remain relatively anonymous (except perhaps when many of them filed for bankruptcy in 2002) because of the end-to-end transparency of connectivity (one does not know which backbones one’s data traverses when browsing the web) and the fact they do not generally offer services to end-users (see chapter four for further discussion of infrastructure invisibility). However, a share of the money paid by customers to ISPs and hosting companies filters up the hierarchy to pay for the backbones.

(i)Beginnings, boom and bust

Companies operating dedicated Internet backbones emerged in the late 1980s in the United States, offering connectivity to businesses who were not able to use the academic networks, such as the NSFNET backbone. Many of these were small start-up companies, rather than established telecommunications carriers, and some grew out of regional consortia set up to connect local universities together (e.g., PSINET from NYSERNET in New York). One of the earliest commercial Internet network providers was UUNET, founded in 1987. Initially, UUNET was selling access to Usenet via a UUCP service and grew to become a dominant U.S. IP backbone operator by the mid 1990s, eventually being bought by WorldCom in 1996.

The provision of fibre-optic network infrastructure in general, and Internet backbones in particular, experienced enormous growth in the 1990s, with the second half of the decade seeing an especially frenzied pace of new building in the United States and also in Europe. In what can now be seen as a classic example of bubble economics, billions of dollars were speculatively invested in laying thousands of miles of new cables creating gigabytes of additional bandwidth. On many routes, available capacity doubled again and again in the space of a couple of years (Table 7.1). Indeed, several companies built wholly new national networks in the United States (e.g. Qwest, Level3 Communications) with the hope of capturing the lions share of Internet traffic and positioning themselves to dominate the so called ‘New Economy’[2]. Technical advances in fibre-optic systems were important enablers of this infrastructure growth (see Hecht 1999), but the major driving force, at least to start with, was the undoubted ‘bandwidth crunch’ in the mid 1990s. Traffic on the Internet grew extraordinarily quickly in the period 1995-96, when many millions of new users came online in a very short space of time (Odlyzko 2000), and there were worries of a shortage of available capacity on key routes. Predicting ongoing traffic growth of this scale held out the inviting promise of rich financial rewards for those quick enough to meet burgeoning demand. Subsequently, the rapid growth in backbone building, paralleling the ‘irrational exuberance’ in the e-commerce sector, became a self-sustaining rush as companies sought to position themselves favourably, and investors hastened to avoid missing the opportunity. Unsurprisingly, there were many new entrants into the backbone market with ambitious plans, but little experience of running network infrastructure, who nonetheless attracted sizeable investments.

<Table 7.1 about here. Bandwidth growth.>

Much of the new building was duplicative, covering the same routes and interconnecting much the same matrix of ‘important’ hub cities (Greenstein 2003). In a time of boom few seemed worried about problems of oversupply - this was time when ‘New Economy’ talk was rife and almost evangelical believe in never-ending exponential growth was prevalent. The key question about who exactly would use (and pay for) all this new capacity was never seriously asked. “[I]t was assumed that demand for the basic commodity, bandwidth, was unlimited, the recipe appeared to be ‘can’t miss!” (Brody and Dunstan 2003, 127). The hype-fuelled myopia from *within* the bubble, clouded judgement and the simple and convenient rationale of ‘if we build it, they will come’ was sufficient to lure many eager investors[3].

[2] Besides new networks in the United States, major investments were also made in intercontinental bandwidth through ambitious new submarine cables systems. Billions more were spent on constellations of low-earth orbit satellites to provide IP network services.

[3] The ‘luring’ was also aided by dubious practices and bad advice of some of the bankers, technology analysts and commentators (Brody and Dunstan 2003). With hindsight, the ‘independence’ of the advice given is seriously in doubt as some of the advisers stood to benefit directly, through consulting fees and stock holdings, from the companies they were recommending to clients.

The peak in Internet traffic growth in 1995-96 turned out to be a short-lived aberration. Customer demand thereafter, while still growing quickly at about 100% per year, was nowhere near rampant enough to absorb the available new bandwidth (Odlyzko 2003). It is estimated that less than four percent of the fibre optic cable that was laid during the boom was activated (Brody and Dunstan 2003, 146). The predictable outcome was a glut of bandwidth, resulting in falling prices and steep decline in revenues. By 2001 many new entrants into the backbone market were in financial trouble, unable to service their large debts. The high-profile crashes of many dot-com companies in 2001 announced that the 'New Economy' was not so different from the 'old' economy after all, repeating much the same patterns as earlier cycles of speculative technological boom and bust (e.g., railways in the 1840s and broadcast radio in the 1920s). Yet, the sheer scale of the telecoms crash in 2002 was unprecedented, encompassing many of the best-backed companies (for example, the Global Crossing bankruptcy cost shareholders $25.5 billion). The widespread bankruptcies of backbone providers also impacted on the large equipment manufacturers such as Lucent, Nortel, and Marconi. In all, the bandwidth bust has been estimated to have cost investors around one trillion dollars (Brody and Dunstan 2003). The indignation of over eager investors at the poor judgement of company executives would be inflamed further by subsequent revelations of serious corporate deception and wholesale fraud in the backbone sector.

(ii) Deficient data

A serious problem for those planning and investing in Internet infrastructure in the 1990s was the lack of network knowledge on which considered calculations could be made. "It's not like transportation engineers putting down hard numbers for expanding the interstate highway system." (Behr 2000, H01). The dearth of useful and credible Internet traffic statistics, in particular, encouraged an over reliance on what turned out to be poor data.

The Internet is poorly understood statistically and economically, especially compared to other utility and transportation systems, because of the lack of representative published metrics on network usage. There are a number of reasons for this, including the newness of the system, the pace of its growth, the distributed scale, and heterogeneous ownership structures. Further, network operators have few, if any, incentives to collect and publish traffic statistics - particularly as these may aid competitors. An alternative is instrumental measurement of the Internet by independent researchers but these attempts are usually fatally flawed by unrepresentative number and distribution of sample points (Murray and Claffy 2001). In terms of assessing backbones networks, as built, a number of statistical metrics such as route miles, fibre miles, number of hubs have been published (for example in reports from TeleGeography (2002) and OECD (2002)). Regional scientist Ed Malecki's (2004) recent analysis of investment in fibre optic network in the U.S. for example relied primarily on bandwidth aggregates between cities derived from *Boardwatch Directory* maps and provider marketing maps. Bandwidth is a useful but ultimately unsatisfactory variable (it is like developing road policy based on the width of tarmac between cities with absolutely no knowledge of the number of moving cars). Weaknesses in statistics are compounded by their lack of geographic discrimination and an unwillingness to account for inherent spatial uncertainty in data models (see Grubesic and Murray 2005).

A characteristic of most of the available published statistics is that they show the Internet is expanding quickly . It seemed that in the boom of the late 1990s the *best* of these statistics, and those that got the most attention, were the ones showing the most exciting, exponential degree of expansion. Yet, much of these growth statistics were of dubious quality based on unscientific methods and wholly unrepresentative samples. Some were well-meaning guestimates, some speculative and a few were complete fabrications - numbers literally plucked out of the air to feed to technology journalists and out to the market. Moreover, some 'analysts' had direct financial reasons to talk up the size and scale of the Internet. Statistical 'evidence' encouraged people to believe growth was everywhere and knew no bounds. Growth statistics fed the dot-com hype and the hype, in turn, fed back to those generating evermore extravagant numbers (Jordan 2001).

The lack of real 'numbers' on traffic growth opened the way for the biggest - and some claim the most fraudulent - piece of statistical evidence to circulate, that traffic Internet was doubling in size every 100 days or so. This corresponds to annual growth rates in excess of 1,000%. Importantly, the origin of this evidence is specific to traffic data at one time point and for one network, but it became a universal truth. As with other technology myths, such as nuclear-war survivability (discussed in chapter five), once the statement circulates it gains credibility through retelling, particularly when the retelling is in high profile outlets, including in U.S. government reports and by credible industry insiders (see Odlyzko 2003 for full details on this). For example, the doubling myth was boldly stated as *fact* in a widely circulated U.S. Department of Commerce report[4] and former chairman of the Federal Communications Commission Reed Hundt recited it in his book on telecommunications reform, *You Say You Want A Revolution* (2000). The power of myths is also that they tell people what they want to hear - many people wanted to believe that the Internet was growing so fast. And that the growth would continue to justify extravagant claims in business plans.

As with all myths the origins of the ‘100 days doubling’ are suitably vague but forensic bibliographic analysis by Andrew Odlyzko has traced it back to comments made by UUNET chief scientist Mike O’Dell in 1996. It was repeated in a February 1997 WorldCom press release. It was further reiterated by senior executives in the WorldCom, including CEO Bernie Ebbers. Even as late as September 2000 it was the mantra of the company, with Kevin Boyne chief operating officer of WorldCom’s Internet division UUNET quoted in a Washington Post article saying unequivocally, “Over the past five years, Internet usage has doubled every three months” (Behr 2000, H01). In promulgating the myth so widely it is clear that it was useful to WorldCom’s business strategies and as such they must share a slice of responsibility for hype of the bandwidth boom (Economist 2002).

The roots of the myth of traffic doubling every three or months lie in the unprecedented growth spurt for the Internet in 1995-96 when it might well have been true. At least for a time for UUNET’s network. Detailed analysis by Odlyzko (2003) of a range of traffic data from different networks shows that over the period as a whole growth doubling annually. However, the doubling every 100 days continued to be touted as truth for the rest of the decade and its simplicity and promise of potential revenues meant that it came to underlay the backbone boom (Dreazen 2002; Economist 2002). In this way, the myth was dangerously misleading. Further, “WorldCom’s phantom growth caused once-mighty telecommunications companies like AT&T to cut prices and slash costs in

[4] *The Emerging Digital Economy* report (April 1998) stated in the introduction: “Traffic on the Internet has been doubling every 100 days” (page 5). On page 11, the report stated: “UUNET, one of the largest Internet backbone providers, estimates that Internet traffic doubles every 100 days” (see <www.technology.gov/digeconomy/EmergingDig.pdf>).

the crippling race to keep up, from which they never fully recovered" (Belson 2005). The myth hurt the whole industry.

(iii) WorldCom's rise and the World-Con bust

WorldCom's corporate history is quite short, with conventional recounting usually opening in 1985 with the arrival of Bernie Ebbers, then a small-time entrepreneur in Mississippi, at a local long-distance reseller called LDDS. Through numerous take-overs and aggressive business manoeuvres, Ebbers quickly grew LDDS into a multibillion dollar operation providing full range of telecommunications services. In 1995 LDDS rebranded itself as WorldCom, a name befitting it globalist business objectives. At its height, WorldCom was second only to AT&T in the U.S. long-distance telephone market and the dominant global player in the Internet backbone business. Importantly, this achievement was facilitated by neoliberal structural and regulatory changes that reconfigured the American telecommunications landscape during this period. A key part of these changes was a lessening of government oversight of corporations across utilities sectors.

WorldCom was a major contributor to the Internet backbone bubble in the second half of the 1990s, engineering corporate expansion on a monumental scale with a string of billion dollar acquisitions and mergers (Table 7.2). Key in these was the 1996 take-over of MFS Communications (which included UUNET, then the biggest Internet backbone operator), swiftly followed by the acquisition of MCI for $42 billion, in what was then the largest corporate merger in history. (At the time of the merger, MCI was over three times the size of WorldCom). The stock value of WorldCom peaked in 1999 at $64.50 a share, representing a return of more than 7,000 times the initial investment (Figure 7.1). Ebbers was widely feted as a leader in the new breed of 'bandwidth barons' and in 1999 was named by *Forbes* magazine as the 174th richest American with net worth of $1.4 billion, based largely on value of his WorldCom stockholding (Jeter 2003). 1999 turned out to be nadir of the boom for WorldCom and the to some extent the wider telecommunications sector.

<Table 7.2 about here. Worldcom acquisitions.>

At the end of 1999 WorldCom company launched an even bigger proposal in the form of a merger with Sprint, in a deal worth a staggering $129 billion. This merger was blocked by threatened in-depth monopolies investigation by U.S. and EU regulators. The tremendous fifteen year growth spurt began to unwind in 2001 when revenues fell sharply and the stock price plunged (Figure 7.1). In the spring of 2002 the Security and Exchange Commission began investigating the corporation's books. Soon after WorldCom's boom was brought crashing to a halt with the public exposure of huge accounting irregularities of $3.8 billion[5], announced in a June 25 2002 press release. The stock price plunged to 20 cents and many thousands of employees were laid off overnight. On 21st July 2002 WorldCom was forced to file the largest bankruptcy in the world. Concern quickly focused on criminally fraudulent practices of the senior executives and the media quickly branded the company World-Con.

<Figure 7.1 about here. Worldcom stock graph.>

WorldCom's fraud, along with the collapse of ENRON (December 2001) and the associated failure of the global accountancy firm, Arthur Anderson, represented a huge blow to confidence in the financial probity of American business and prompted calls for new legislation on corporate governance. There were many other repercussions: "As people from all walks of life watched as WorldCom's betrayal devastated their investments and retirement nest eggs; they wanted to know what went wrong – when, why, and how?" (Jeter 2003, xxi). WorldCom's fall was also part of an industry-wide collapse in the market for network services in what has been called the "great telecoms swindle" (Brody and Dunstan 2003). In the ensuing fallout, some commentators have focused blame on WorldCom for deliberately exaggerating the extent of Internet growth (Dreazen 2002; Economist 2002); for example Sidak's (2003) detailed analysis of failures in regulatory oversight of the telecommunications market, uses the doubling myth as a key plank in his legal arguments on the potential liabilities of WorldCom. He argues that WorldCom's market power also brought a duty to report honestly: "In retrospect, it appears that WorldCom used this asymmetry of information to exaggerate the value of its stock by overstating the growth in Internet traffic volumes" (Sidak 2003, 230).

[5] The total fraud was eventually tallied to $11 billion (Belson 2005).

What relevance is the story of backbone boom, deficient data and growth myths in understanding the representation of the Internet in maps? The answer is that the marketing maps the backbone companies produced to promote their businesses had an important part to play in shaping the geographic imaginary of the Internet as a whole, and examining this cartography also illuminates the nature of the boom and deceit underlying it. However, before examining WorldCom's marketing maps, it is necessary to delve into some of the history of network marketing maps and think about how cartography is made to work in commercial promotion.

3. Maps and marketing

> Advertising is legalized lying. (Comment attributed to H.G. Wells.)

Given the ways that maps can be made to 'lie', it is perhaps not surprising that they are a commonly used visual trope in consumer advertising, corporate marketing and place promotion. As has been well noted, all maps are selective in what they show because they take a particular viewing position, they are essentially *selling* a viewpoint on space that serves certain interests. And like advertising, the best maps work when the viewers do not really feel they are being sold a selective view.

In scholarly discussion of the forms and purposes of Western cartography through history, it is frequently asserted that a distinct genre of propaganda mapping can be usefully discerned. These maps are categorised separately from 'normal' cartography on the basis that their goal is consciously political and their design 'look' is deliberately manipulated to present views of space to advance one message. Fundamentally, maps are propagandist in nature when they wilfully deceive people to change their behaviour. Yet, attempting to draw a sharp and workable distinction between propaganda maps and supposedly 'objective' cartography is obviously a problematic task. As Pickles (2004a, 39) points out, "notions of propaganda are ... centred on an unexamined boundary between 'truth' and 'falsity', an unstable boundary at best." In fact all maps have persuasive and deceptive qualities - scientific cartography strives to police certain norms on acceptable deception. Commercial marketing maps, as a form of propaganda in support of capitalist accumulation, carefully use the pretensions of objectivity in selling a respectable representation space.

The most obvious propaganda cartography is the statist mapping used by governments in asserting claims for the territorial naturalness of the nation, for the geographic right of territorial expansion or to exaggerate foreign threats (e.g., see Biggs 1999; Burnett 1985; Herb 1997). Many of the propaganda maps produced for mass consumption in times of war offer particularly egregious examples of cartographic artifice, often overlaid with crude racist symbolism, to generate fear of the enemy and engender greater labours from citizens (see Monmonier 1996, chapter seven; Tyner 1982). More subtle and insidious ethnocentric propaganda is said to pervade the world maps of many national atlases. The devices of cartographic centring and biased size distortions, fostered through projection design, are used to create an advantageous sense of national superiority that seems to be geographically ordained (Henrikson 1994). Overtly propagandist mappings are not the sole preserve of government, of course, and in recent decades non-state actors have created consciously political cartographies in counter-hegemonic discourses opposing, for example, nuclear weapons (Burnett 1985).

Nationalistic propaganda using cartographic imagery is also commercially deployed for the purposes of place promotion. Geographic maps are a commonly used as the central motif creating a sense of pride and distinctiveness of cities or regions in the marketing campaigns of tourist boards and economic development agencies (see Fleming and Roth 1991). The use of maps online, and other place-related iconography like flags, emblems and landmark photographs, has also come to the fore recently in the economic development strategies, particularly of small states, in what Brunn and Cottle (1997) term ‘cyberboosterism’.

Clearly, understanding the workability of propaganda maps depends to a great degree on the discourses in which they are used. When the discourse moves away from informing to *influencing* the reader, the map is evoked as an intentional means to change behaviour in one particular direction, resulting in what Tyner (1982) usefully terms persuasive cartography. It is evident that the growth in persuasive cartography in the twentieth century has seen a shift in emphasis from politically-motivated propaganda mapping to profit-driven promotional cartography. The shift is evident in the use of maps in consumer adverts that seek to channel customers to the benefit of private capital rather than national interests. “Whereas maps were once used to expand nation building they now build commercial empires that, in a very real sense, are eclipsing the nation-state in importance” (Francaviglia 2005, 11). Cartography’s growing service to private capital required new modes of map production. There was a decline in the primacy of state mapping agencies and a growth of commercial mapmakers, for example Rand McNally in the USA (Schulten 2001).

The workability of maps in service of commercial promotion has been surprisingly little examined in the cartographic literature, with only sporadic coverage since the Second World War (e.g., Harrison 1953; McDermott 1969; Monmonier 1996, chapter five). Yet the growth in commercial use of maps has been significant, particularly as new means of cartographic production enabled a much wider range of more attractive graphic representations (e.g. Richard Edes Harrison’s celebrated hemispheric map views), some of which were the direct result of new technologies created in the Second World War and subsequent cold war arms race (Cloud 2002).

At one level, advertising works semiotically through iconic images that show what the product or service looks like and indexical images that show how it can be used - car advertisements being a good exemplar, with close-up views of the form of the vehicle and then seductive shots of it being driven. Obviously, maps can serve indexically as a good way to show a complex, space-extensive product such as a transportation network to potential customers, the archetypal case being the airline route map (discussed below).

However, much modern advertising rhetoric is about creating a brand identity rather than demonstrating specific products and how they are used. Marketing is about generating a desirable image - the brand - that consumers will aspire to be part of. People *desire* goods and services from the brand in the hope that positive cache associated with brand is transferred onto them. Consequently, rhetorical messages in branding tend to be more subtle than ‘straight’ product advertising. (Think about lifestyle imagery used in establishing the brand values of different cars - young and sporty, luxury and business, families and reliability, and so on). Even though there is resistance and great cynicism from many consumers to these lifestyle marketing efforts, powerful brands, particularly those with global appeal, are recognised as hugely valuable assets. For some businesses, the building of the brand is arguably their primary activity as the products by themselves are largely indistinguishable (e.g., in the drinks industry). Many multinational companies spend hundreds of millions developing a brand identity and marketing it through numerous media channels. The most successful have become global icons recognisable in virtually all places. Indeed, these branding strategies themselves have come to be seen as a defining element in globalisation and deeply threatening in terms of cultural homogenisation (Klein 2000).

The production of brand imagery in a marketing campaign relies much more heavily on symbolic representations, rather than iconic or indexical semiotic forms. Commonly, the product or service is not shown at all - it does not really need to be. Instead, the goal is to conjure up the right mood using symbolic visual forms that resonate with readers through base human instinct, ingrained cultural conventions and positive associations (e.g., celebrity endorsement or sports sponsorship). Maps, when used adeptly, can have powerful symbolic qualities, able to exude a multiplicity of rhetorical moods required for effective brand marketing. At one level, a familiar map can symbolise a sense of pride in territoriality, taping into national identities and reassuring feelings of hearth and home, but they can also be used in conveying messages of adventure, exploration and the exoticism of distant lands. Antiquarian-looking maps can be used to suggest longevity, authenticity and traditional wisdom; while sweeping satellite views overlaid with glowing grids radiate feelings of thoroughly modernist techno-power (see also chapter four).

For example, in the corporate brand advertising of ‘hi-tech’ firms, maps are a common visual trope used purposefully to tap into the cartographic fetish of expansionism and the pseudo-militarist aura of command and control over the terrain (see Goldman *et al.* 2003). Corporate marketing designs mesh with business desires to “...wrap the world in complexes of arrows, networks and cages to represent their own ‘global’ presence.” (De Cock *et al.* 2001, 217). World maps, map-like satellite views and the Earth globe itself are now so thoroughly ingrained visually in globalist business discourses that their use can easily tip into cliché. The image of the globe in particular is a hugely powerful symbol that has multiple layers of meanings and has been exploited by a wide range of interests (Cosgrove 1994; also see chapter four).

Besides globes and geographic mapping, a panoply of other cartographic imagery is used for its symbolic power. These can include expansive landscape views of the countryside on the threshold between map and picture, or dramatic cityscapes, typically imaged as night-time vistas of lights. Cartograms and map-like pictorial graphics are also very common in marketing, often employing elements of fantasy or whimsical humour to produce a positive rhetorical effect (see Holmes 1991; McDermott 1969 for examples). Spatial rhetoric can even be conveyed simply from territorial outlines, as they are proven to be "a highly recognizable shape that cannot be confused with anything else" (Francaviglia 2005, 5).

(i) Marketing maps for transportation promotion

The use of marketing maps in the establishment of the brand identity of commercial transportation networks has a long lineage and one of direct relevance to understanding the selling of Internet backbones in the late 1990s. As Fleming and Roth (1991, 288-289) note, "[r]elative locations, distances, types of itineraries, transit times, and costs of transit are factors of significance in the advertising of railroad, ocean, and airline services." All these factors can usefully and persuasively be visualised in cartographic form[6]. Showing the geographic structure of routes offered is an especially powerful selling point and one that can best be conveyed rhetorically through network maps. This is well demonstrated in nineteenth century railroad cartography, for example.

The growth in railroads in the United States from the 1850s, especially during the speculative building boom following generous land grants from the government, led to fierce competition between companies on routes between major metropolitan centres. High quality network maps were one element in competitive marketing strategies (see Modelski 1984 for reproductions and useful interpretation). Initially derived from construction surveys and engineering plans, the output became ever more presentational in design and persuasive in purpose, such that "manipulating scale, area, and paths of railroads became common practice in advertising maps of the 1870s and early 1880s and in railroad timetable maps" (Modelski 1984, 4). Besides long-distance railways, the

[6] For typical examples, see the collection of transportation and communication maps from the nineteenth century provided by the maps division of the Library of Congress, <http://lcweb2.loc.gov/ammem/gmdhtml/trnshome.html>.

growth of mass transit subways, trams and buses at the end of the nineteenth and beginning of the twentieth century in most large cites required a new mapping idiom to inform passengers, and also to promote new ridership. Indeed, the development of complex metropolitan networks and the need to forge a public identity for an integrated system gave rise to one of the celebrated maps of the twentieth century, the London Tube 'diagram' (Garland 1994).

Harry Beck's supremely successful Tube map not only made a chaotic mess of lines and links under London into a legible system, it also created a powerful visual-cognitive template of the spatial layout of London in the minds of many visitors and residents. The cartographic form, drawing on ideas from electrical wiring diagrams, pioneered a new genre of schematic subway maps, which sacrificed locational accuracy for topological clarity and has been widely copied across the world (see Ovenden 2003). The Tube map established itself as marketing symbol par excellence for the Underground, as well as enjoying tremendous symbolic power world-wide for branding London and a distinctive sense of Englishness.

In promoting the network in the way it did, the Tube map also played an important part in promoting the actual form of London's urban growth (Hadlaw 2003). Extending the simplification and generalisation of cartographic practice to the extreme, Beck completely denied the twists and turns of topography for straight route lines; stations became uniformly spaced, and - most (in)famously - differential distance scales were applied to expand the crowded centre and greatly shrink the periphery. The result was to *sell* a selective spatial layout of London, a layout that is cartographically *marketing* a much more compact, orderly and accessible city than it really is. The distant suburbs, in particular, only look to be a few stops from the centre of town in Beck's vision of London, when in fact they are a rather long ride away.

The role of route maps in selling the desirability of automobile travel in America from the 1930s onwards provides another noteworthy example of persuasive network cartography. Detailed analysis by Ristow (1964) and Akerman (1993, 2002) has ably decoded the marketing rhetorics in the production of these widely used route maps, directed and subsidised by oil companies and motoring clubs. The free 'gas map,'[7] Akerman (2002, 187) observes, "promoted specific brands by associating them with positive social aspects of automobile travel and good customer service". Most state governments also produced official highway maps as a potent form of tourist promotion, with historic and scenic places of interest prominently marked. The manipulative techniques in service to marketing included "representing highways in thick, clean lines emphasizing connected populated places and cross-routes" (Akerman 1993, 16) along with clear route identification through numbering schemes. Importantly, the promotional elements did not in themselves diminish the need for clear, reliable route information to facilitate navigation - although "railroads ... were generally omitted" (Akerman 1993, 16), which conveniently worked to 'silence' the competition to the automobile. Similar techniques continue to be used to help drivers and sell road travel in the latest, advertising-supported, interactive route planning services available on the web (e.g., AA service in Britain, see Figure 8.6). Today, the extent to which car culture dominates in most developed countries means that the persuasive road rhetoric underlying mapping is so well masked that it is rendered unquestionable (see Wood 1992, chapter four).

In addition to rail and road, the most obvious application of the marketing maps is the promotional cartography of the airlines[8]. Virtually all glossy inflight magazines contain a high-impact route map that informs and above all persuades passengers of the space-transcending power of the airline. The map's "rationale seems to be to create an impression of the airlines entangling, even appropriating, the world in their own webs of commercial influence" (Thurlow and Jaworski 2003, 586-588). The route maps have been around since the start of commercial aviation as an obvious - and from a marketing perspective, absolutely intrinsic - way to make intangible schedules of flight times and lists of destinations into a coherent, believable and *real* network capable of carrying people quickly, reliably and safely. An interesting feature of airline route mapping over the years has been its willingness to experiment design-wise, particularly with unconventional projections as a means to get the 'right' promotional look for the map. Cartographic manipulation is put to the service of corporate centricism, necessary to

[7] The Petrol Maps website curated by Ian Byrne provides a comprehensive catalogue of examples for Britain, <www.ianbyrne.free-online.co.uk>.

[8] The Airchive curated by Chris Sloan presents an impressive array of route maps, <www.airchive.org>.

position the airline's hub of operations at the central point of the map view, and to create a convincing appearance of the desirability of its routes by making them look to be the shortest or most direct (Fleming 1984). In the last decade, the printed route maps in inflight magazines have also been significantly augmented by the airshow moving map provided as one of the entertainment television channels on many long-haul flights. This map dynamically updates the position of the plane to inform passengers of the progress of the flight, but it is also subtly promotes a particular sense of the air travel experience through a privileging, God's-eye, view of the world for passengers.

(ii) Promoting telecommunications with maps

Transportation marketing maps in their profit-driven agenda and cartographic strategies have much in common with examples produced by telecommunications companies to promote the extent of their networks to prospective customers/investors. Going back to the telegraph era in the mid nineteenth century, a number of competing companies used maps in their advertising to demonstrate the extensiveness of their network infrastructure by plotting the geographic pathways of cables and emphasising the cities connected[9]. The beginnings of intercontinental telegraph services from the 1860s resulted in a range of promotional cartography, both to attract investors and to celebrate the success of new cable connections[10]. A typical example is the map from the Anglo-American Telegraph Company (Figure 7.2). In many cases, these ambitious and expensive engineering schemes were initially intimately bound to the needs of imperial communications.. Servicing the communications needs of the British Empire was undertaken by the Cable & Wireless company; initially linking the territory on the 'red routes', it became one of the largest operators of networks across the world (Barty-King 1979). The company commissioned designer MacDonald Gill to produce the 'Great Circle Map' (Figure 7.3), a particularly refined example of telecommunications marketing genre, with its promotional cartouches showing scenes of building the network infrastructure and how it operated. The map also provides a seminal example of

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[9] Examples for North America can be found online in the David Rumsey map collection <www.davidrumsey.com> and the Library of Congress's collection <http://lcweb2.loc.gov/ammem/gmdhtml/trnshome.html>.

[10] See for examples maps and memorabilia associated with these engineering feats available on Bill Burns' 'History of the Atlantic Cable & Submarine Telegraphy' website, <http://atlantic-cable.com>.

projecting the company (and in an imperial sense, the nation) at the centre of the map, with cable route lines radiating outwards from Britain to join up distant lands.

<Figure 7.2 about here. Telegraph map.>

<Figure 7.3 about here. C&W Great Circle map.>

The task of promotional network mapping for telecommunications companies is harder than for transportation, but at the same time more important for marketing. As discussed in chapter four, the invisibility and intangibility of the infrastructures for message transmission mean there is little for people to see and feel. The telegraph, the telephone and the Internet lack the monumental, iconic architectures of vast rail bridges, wide highways carving through the landscape and majestic airport terminals that can be exploited for advertising imagery. (The prominence of the Post Office Tower in central London, as an exception to the rule, only reinforces the point of invisibility). Furthermore, the most conspicuous visible element in telecommunications networks, the telephone handset, has none of the dramatic visuality of fast cars, thundering trains and soaring jetliners.

Besides the invisibility of infrastructure, telecommunications networks are also intangible from the consumer experience perspective. In transportation, the friction of distance can be readily turned into fictions of experience by the marketers. Passengers and drivers have innate, physical knowledge of transportation networks through the journey. Positive elements of this physicality - the smoothness of the ride of the new car, the relaxing comfort of new seats on planes and so on - is commonly exploited as promotional narrative props that connect customers to brands[11]. Telecommunications, in their inherent virtuality, are completely lacking such experiential customer knowledge. The *lack* of human kinaesthetic involvement defines *tele*-communications. Telephones and the Internet provide customers with mere interfaces to the network, through physical devices like the phone handset and computer screens, not experience of the network itself. No knowledge of the network structure and materiality is gained from

[11] Of course, the all too common mismatch between customer experience and the projected images of marketers is the basis for much contemporary cynicism about corporations.

browsing the Web, for example - it gives off little physical sensation, except perhaps the sense of delay when waiting to connect or frustration when it fails.

Marketing telecommunications, therefore, tend to construct their own symbolic imagery in the form of route maps, in part to compensate for the lack of other iconography that can be more easily exploited (see the discussion in chapter four of major types of spatial metaphors used to represent Internet infrastructure). Route maps of telecommunication networks, while of no practical value for navigation, construct a sense of tangibility, a kind of second-hand experience of the network to compensate for the lack of physicality. This was particularly so when the technologies were new and customers and investors needed evidence of what they looked like and how they worked. This has been repeated with the development of the wide-area computer network from 1970s onwards when maps became a useful tool for making a novel, unusual and unproven technology seem real.

(iii) Internet backbone network marketing map

In some respects promotional Internet network maps as a genre can be traced back to those produced to document ARPANET in the 1970s, which were examined in chapter five. In terms of their semiotic format there is little to choose between the maps BBN produced to virtually witness the logical structure of links and hubs of ARPANET and the WorldCom marketing backbone maps detailed below. (Although, the later WorldCom maps clearly benefit from greater design finesse to make them more aesthetically pleasing). However, there is a real distinction to be drawn between them in terms of the core agenda they were created to serve. The ostensive purpose of the ARPANET maps was network documentation rather than corporate promotion.

To compete for new customers and investors, Internet backbones companies use a range of marketing techniques. Marketing as an umbrella term can cover everything a company does to promote and differentiate itself. It is more than just advertising, and includes the overall ‘look and feel’ of the company’s public image, its pricing strategies, special offers and discounts, the response of sales representatives and customer service staff, the PR output to the media. Consistently, network maps are deployed as a small but significant part of this marketing mix of activities.

In some regards, it seems that having a backbone map available seen as necessary in itself, irrespective of what the map shows. For marketing bravado, it is the ability to produce such maps that symbolises the company as a 'serious' player in the Internet infrastructure industry. A useful parallel can be drawn here to the airline industry, where Thurlow and Jaworski (2003) note in their study of promotional inflight magazines: "it is not so much what is *in* the magazines which is important, as the fact that the airlines have a magazine clearly identified by its ascription to a range of generic 'inflight magazine' features. .... it appears that the inflight magazine is a textual practice which marks an international airline as an 'international airline' - evidenced most obviously by its ubiquity." (page 586, original emphasis).

4. Semiotic strategies in network marketing maps

> Advertising says to people, 'Here's what we've got. Here's what it will do for you. Here's how to get it.'
>
> -- Leo Burnett, advertising guru.

The study of past transportation and telecommunication marketing maps reveals a number of consistent semiotic strategies used for cartographic persuasion of network infrastructures. These strategies - of selectivity, simplification and amplification - are really no different from the practices of 'objective' cartographies and their desire to produce representations that are as clear and unambiguous as possible. Importantly, I would concur with Fleming and Roth (quoted in the opening of this chapter) that there is no evidence of outright cartographic lies in marketing maps - there is no need. The job of selling the network can be well achieved more subtly through emphasis and suppression of map features.

Eight semiotic strategies can be identified in the representations of network infrastructure: range, reach, directness, centrality, plenty, capacity, silencing competition and exclusivity. Usually, some combination of these strategies are used and are implemented using a variety of design approaches exploiting the full range of graphic variables for map features, along with textual elements (titles, labels, legends, etc.), projection and the overall layout.

- *Range*: ‘our routes are the longest’

Fundamentally, the semiotic goal of the map is to demonstrate, in compelling visual ways, the *extensiveness* of the network coverage offered by the company. Extensive range is best confirmed cartographically by *long* route lines shown criss-crossing the whole map extent (or as much of the extent as is plausible without fraud). Line length is paramount as it draws the reader along the route, suggesting a network with a powerful capacity to traverse distances, to transcend space. If the company is positioning itself as the premier national network, the map must try to show all of the country to be well covered with long route lines. Likewise, if the company is pursuing a globalist strategy, the map should demonstrate a fully world-wide range of routes, stretching across continents and effortlessly spanning oceans.

- *Reach*: ‘our routes connect to all the right places’

Closely allied to impressions of extensive route coverage, is the need to demonstrate the reach of the network on the map. The reach of a network is assessed by how well it connects to *important* places. Importance, here, is determined by the target market for the network.

- *Directness*: ‘our routes run straight and true’

The network should not only connect to all the important places, it should also look like it provides *uninterrupted*, point-to-point, links between these places so prospective customers do not have worry about interchanges.

- *Centrality*: ‘our routes are at the heart of the action’

The combination of a wide ranging network, directly reaching all the right places, should exude the impression of a network offering all the advantages of centrality to customers, a network naturally positioned at the heart of things.

- *Plenty*: ‘we have many routes’

“[N]umerousness indicates success, and success indicates a superior product” (Monmonier 1996, 68). Effective promotional network cartography, should not only show how much of the terrain is spanned or which places are connected, it must also powerfully demonstrate the sheer *abundance* of routes offered by the company. In prosaic terms, the company which is best able to show many routes, projects an image of strength through plenty, a sense of security through numerousness.

- *Capacity*: ‘our routes can cope with demand’

Well proportioned lines imply lots of capacity and a strong, healthy network easily capable of meeting all demands without the risk of clogging or congestion. Conversely, overly ‘skinny’-looking links can appear insufficient to carry bulky loads and imply an under-strength network. Solidity of lines, through their graphic weight on the map, can also be useful semiotically as it implies the network is well built, it is secure and, above all, it can be trusted.

- *Silence Competitors*: ‘show only our routes’

The silencing of competitors is the key characteristic differentiating informational cartography (serving the interests of consumers by mapping all available options) and promotional cartography (serving the interests of one company). Unsurprisingly, commercial network operators resist comparative mapping, particularly when their infrastructure, in terms of range, reach, plenty and capacity, does not stand up well against competitors.

- *Exclusivity*: ‘privilege our routes above all else’

The role of a marketing map is to focus squarely on demonstrating the impressiveness of the network and it should not be cluttered with any extraneous contextual details that could distract readers. A degree of selectivity is, of course, inherent in cartography; however, in persuasive mapping, selectivity goes further to exclusivity - producing privileged views of world to service the needs of network marketing and the interests of capital.

5. Decoding WorldCom’s backbone maps

> The network maps are a critical sales tool for us - throughout the world.
>
> -- Henry Ritson, global marketing manager, UUNET - An MCI WorldCom Company, 2000.

The semiotic characteristics of marketing maps used to sell network infrastructures will now be considered in detail in relation to one specific Internet backbone company, WorldCom. The focus of the analysis is on the global scale marketing maps published from 1997 to 2001. WorldCom's maps of this time cover a historically noteworthy period and represent an economically significant sample of the backbone industry.

A sample of seven different maps are analysed here (see Figures 7.6 - 7.11). In addition to the cartographic materials gathered periodically from WorldCom's public corporate websites, an email interview was conducted in April 2000 with Henry Ritson, then global marketing manager at UUNET, who had responsibility for the production of the maps for some of this period (published as Dodge 2000c).

(i) WorldCom's network marketing rhetoric

Before examining a sample of the marketing maps produced by WorldCom, it is instructive to first consider the wider promotional context in which they were embedded. This is best achieved by looking at the structure and content of the corporate website describing the network and how this frames the maps themselves[12]. The March 2005 MCI corporate website presentation is used as a representative exemplar.

The textual marketing narratives, unsurprisingly, describe the network in an emphatic fashion, stressing its capacity and extensive geographic reach (Figure 7.4). The tone of language used - dynamic verbs, fact-laden, 'punchy' phrasing - is textbook marketing speak. However, one can also see that this is carefully crafted language, for example with the conscious insertion of caveats and subtle qualifiers where necessary to avoid making factually false statements. The text is also peppered with engineering jargon, a direct call to scientific authority, signifying this as a technical sales pitch rather than a consumer one.

<Figure 7.4 about here. Network marketing text.>

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[12] Additional elements of network marketing not considered here include active PR to create positive 'buzz' in the media; sales staff interactions with customers and prospective customers; print advertising in telecommunication and international business magazines (see De Cock *et al.* 2001 for examples); corporate awareness television advertising (see Goldman *et al.* 2003 for analysis); corporate sponsorship; promotional brochures, mailshots and exhibitions.

The narrative's primary aim is articulating that MCI's network is the best available, tapping into obvious rhetoric on size, scope, speed and so on (Figure 7.4). Archetypal claims include: "[t]he company's expansive IP footprint, coupled with its direct interconnections, exceeds all other competitor networks...", "MCI offers the fastest speeds available over IP today." Other common marketing practices deployed by MCI in this narrative, include the claims that company was 'first' and is thus at the forefront of Internet development; that the company owns and controls the whole experience; that the company can meet all customer's needs - the complete solution. Additionally, several statements directly outline the benefits to prospective customers, stressing not only 'biggest is best' but also security, reliability, and safety; for example, the closing assertion of the text highlights the fact that the network is monitored by skilled technicians to ensure "optimal efficiency 24 hours a day, 365 day a year." This kind of statement chimes particularly well in the current risk-averse climate of the so-called 'fear economy'.

Beside what the marketers choose to emphasise in the text, branding messages also work through what is left out. The most striking omission in this marketing statement is any mention of pricing. By not referring to low costs, MCI is positioning itself as a premium service that does not have to attempt to compete on cheapness. Also, omitted are customer testimonials.

Another core rhetorical strand underpinning the text is the stress on the global credentials of the company (thereby revealing clearly MCI's globalist business strategy). The word 'global' is used seven times and 'world' five times; emphasis is also given to the company's presence across the world with network facilities "in more than 140 countries and over 2,800 cities" (Figure 7.4). MCI is clearly attempting to project an image of itself as being 'in the world' and positioned to dominate global telecommunications. The 'worldliness' of the rhetoric also implicitly offers the cachet of globalism to prospective customers and investors of MCI. The global rhetoric as a promotional device is very common in corporate brand marketing, particularly in IT, telecommunications and airline sectors (De Cock *et al.* 2001; Goldman *et al.* 2003; Thurlow and Jaworski 2003). Indeed, being seen to be 'global' is often used as a key selling point to domestic buyers and investors. Clearly, if a company does not lay claim to be a global player in the age of globalisation one might question their corporate virility.

The network maps themselves are embedded on the ‘Global Presence’ web page (reproduced Figure 7.5 screenshot). The page directly spells out MCI’s network sale pitch (what marketers call the ‘unique selling proposition’) to customers and, especially, investors, starting with the forceful opening tag line: “For reach, reliability, speed, and security, our global network is unparalleled.” In just one line, the author tries to encompass pretty much all of the key product advantages. A hierarchy of maps from global to regional to national is then presented to the reader. The maps are directly cited in a process of ‘virtual witnessing’ (see chapter four) and “[f]or the experienced technical customer, they act as ‘hard facts’ to back up our marketing claims” (Ritson interview 2000). Essentially the invitation to the reader says: ‘go on, look at the maps and *see* for yourself just how great our network really is’. This is the classic appeal to unimpeachable cartographic authority to justify the ‘unique selling proposition’ for the network. The evidential authority of the map is, itself, backed up by indexical ‘facts’ listed in the seven bullet points (Figure 7.5), that detail the ‘strengths’ in terms of some ‘honest’ engineering numbers. Overall, then the marketing materials are designed to convey a sense ‘hard-headed’ engineering seriousness by drawing on the semiotic tropes of machinic, cartographic and statistic authorities.

<Figure 7.5 about here. Global Presence web page.>

(ii) WorldCom’s marketing maps

The map artefacts are produced ‘by hand’ in Adobe Illustrator using spreadsheets of data of network connections provided by the engineering department; “this takes several days per map” (Ritson interview 2000). A quarterly update cycle is used as “an appropriate cost/benefit balance between keeping the maps up-to-date and the resource implications of getting maps drawn to print quality” (Ritson interview 2000).

A critical point to note is that the maps show inter-city routes and installed capacity only. They do not show how much of the capacity is active, or how much data traffic is actually flowing across the network routes. The routes between hubs are represented as logical links and not geographic cable pathways. Given the speed of change in 'Internet time', the temporal accuracy with static maps is always problematic, as Mike O'Dell then Chief Scientist at UUNET notes: "the engineering data change constantly, so there is a challenge to 'smooth' some of detail so the [maps] stay relatively accurate while at the same time don't violate external statements of 'over <mumble> locations' where people literally count dots on drawings to check-up on such statements" (pers. communications, March 2000). A balance must also be struck between accuracy and artistic licence. The maps are published on the corporate website and identified by text and logos as officially sanctioned public statements of the corporation. Therefore they have to tread a fine line between portraying the infrastructure in the most favourable way and wilful deception. Outright lying on the map could too easily be exposed and open the corporation to adverse publicity, potential accusation of deliberately fraudulent statements and criminal deception of investors/customers.

The first available map is the "UUNET Global Network", dated first quarter 1997 (Figure 7.6). Although clearly identified through the UUNET logo, the network was a subsidiary of the WorldCom corporation by this point (Table 7.2). In graphic design terms this is the simplest marketing map of the WorldCom set, being a restrained black and white line art composition. It has a distinct engineering feeling about it and has many stylistic commonalties with the ARPANET maps discussed earlier (see chapter five).

The title clearly proclaims this to be a *global* network, but in terms of range of infrastructure mapped this is clearly a problematic claim to sustain. While the U.S. territory is well covered, everywhere else looks distinctly sparsely covered. There is a rather tenuous feel to the connections to Europe: just two thin lines terminating in London. Asia-Pacific looks better in some regards, with several long network strands carving straight across the ocean, but there is no actual mesh of networking within the region. The map is unhelpful because it shows too well that vast swathes of the world are far outside the range of WorldCom's networking. To increase the perception of network range, the cartographer has shrunk the extents of the map - cropping off the top and bottom of the world and removing a large slice through the middle of the Eurasian continent (including the whole of India).

<Figure 7.6 about here. 1997 map>

However, the reach of the network looks rather more positive than the range, with many of the major hubs (Tokyo, Los Angeles, Chicago, New York and London) of globalisation interconnected by UUNET / WorldCom. The map focuses effectively on identifying the cities connected, rather than the countries. Other well known 'important' places for business are also connected and consciously identified - Singapore, Hong Kong, Paris, Frankfurt and Zurich.

WorldCom's global network is projected consciously to create image of corporate centrality. The hub of operations in the Northeast of America is visually privileged by its positioning in the middle of the map view. The map is a textbook example of ethnocentricism with North orientated at the top, America centred and whole. Centrality for the U.S. and for WorldCom is doubly reinforced because there are no links out to the periphery of globalisation (South America and Africa are wholly bypassed) and all links lead back to the North American heartland[13].

In terms of the last two semiotic strategies for promotional cartography, plenty and capacity, the 1997 map is mixed. The North American heartland appears at first glance to have plenty of network routes criss-crossing. However, on closer inspection it is apparent that many U.S. states do not have a hub and the lines cross over them without connecting. Outside North America, the network fares worse - just four hubs in Asia-Pacific and only eight to cover Europe. The impression is not one of an abundant network throughout the world from this map, but one of a largely unconnected globe. The capacity of the network again looks relatively healthy for North America, with some well proportioned black lines representing DS-3 routes (45 Mbps) and fairly large circular hubs, but the international routes run at a much lower capacity (1 Mbps) and are mapped by rather spindly looking lines and dot-sized hub symbols that suggest a rather thin, frail network overall.

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[13] Except for a somewhat curious link between Monaco and Singapore, that does the uncomfortable cartographic trick of disappearing at one edge and then reappearing on the opposite side of the world.

<Figure 7.7 about here. 1998 and 1999 maps>

The next map in the sequence moves forward about a year, showing UUNET's "Global Backbone Network' in May 1998 (Figure 7.7 top). This map is clearly the product of the same design approach as the 1997, however, the colourised version is arguably actually less workable than the black and white version it updates. The legend is somewhat simplified and the technical language is toned-down compared to 1997.

Little has changed in terms of range of the network in that year. If anything, there actually seem to be fewer long links, particularly in Asia-Pacific (the dropping of links Tokyo-San Francisco and Tokyo-Sydney being obvious). There are several more links across the North Atlantic but they are tightly clustered together. The lack of network range in the northern latitudes now also seems problematic, with the empty extents of Greenland and the Canadian Northern Territories drawn large (and exaggerated by the map projection). The corporate centrality of WorldCom in this Mercator view of the world remains potent and if anything is somewhat enhanced by the imposition of the three-class colour-coding of nations. The golden-coloured corporate heartland of North America and parts of Northern Europe comes to the fore on the map, followed by a select few beige nations deemed privileged enough to have a UUNET hub. The rest of the world literally shrinks into the background of the map by the application of the light 'natural' green wash. This signifies unidentified, unimportant, unprofitable territory outside the sphere of WorldCom's corporate concerns. As a network marketing map, the presentation remains quite ineffectual in terms of plenty and especially capacity.

The next map shows a dramatic shift in design, presenting "UUNET's Global Internet Backbone" draped over a stylised 'marshmallow' world, from the summer of 1999 (Figure 7.7 bottom). The map has lost all its clunky engineering legacies, a function of 'proper' marketing people taking over the design of the network maps, under the direction of Henry Ritson, at UUNET's office in Cambridge, UK (interview 2000). The design styling would develop over the next three years, but remain quite consistent in terms of colours, key symbology and fonts (see Figures 7.8 and 7.9).

In terms of demonstrating network range, the 1999 map is quite an improvement over the previous two examples. The somewhat unusual choice of projection means that many long orange-coloured route lines sweep from the West coast of America across the entire width of the map to reach the Asia-Pacific cities. These routes are represented by smooth curves which draw the eye along their full length from American origin points to distant destination in the Orient. The lines are also spread apart, aiding range identification and increasing the perception of plenty of routes. However, one must question the validity of this presentation of routes. Obviously, all route lines are generalised to some degree on marketing maps but they should probably be shown actually going in the right direction around the world! Additionally, showing routes in this way also unintentionally punctures further the globalist claims of the corporation, as the lines can be seen to pass *over* all of South America, Africa and India.

Unlike the two previous examples, the 1999 map shows the whole extent of the world (the dissected India is restored). The projection is a ‘one-ocean’ viewpoint focused on the Atlantic, with the Pacific Ocean effectively disappearing at the margins of the map. This, in combination with the unification of the Eurasian landmass, creates clear problems for the persuasive presentation of a supposedly global network. The whole left-hand side of the map, stretching east from Stockholm to the Bering Straits, becomes an eye-catching vast white void, entirely unpenetrated by WorldCom.

These problems with map extents and the display of route range also impact on the sense of centrality in the overall presentation. The graphic centre of the map is now occupied by Western Europe. In a design sense, the overall map looks unbalanced - the dense left side appears to outweigh the empty void on the right. This ‘off-centred’ presentation in relation of corporate power was quickly corrected (see Figure 7.8).

The reach of the network is still well-defined with the maps focusing on cities that are connected. Unlike the previous map, two different sizes of hubs are distinguished by the size of the symbol and label font. Indeed, the strength of the clusters of hub symbols tends to dominate the map, rather than the route lines between them. The primacy of cities is further enhanced by the greater degree of exclusivity on this map compared to the previous ones. The background is represented by expansive empty continents. This is a conscious de-politicised rendering of the globe, a neoliberal *terra nullius* for globalising capital.

The density of city hubs and interlinks in the two core regions of North America and Western Europe scores well in terms of the semiotics of plenty. The super-abundance in these parts of the map also makes the rest of the world look more starkly empty. Pragmatically coping with such a large contrast is difficult; “You try and show a map of the world’s Internet and you can’t ever find a scale or legend which will cope with the differences in line density between Northeast of the USA and more ‘Internet remote’ areas” (Ritson interview 2000). The capacity of the network is better demonstrated in this map, with the use of thicker lines and inclusion of colour coding of routes by bandwidth. One can speculate as to whether the ambiguity in the representation of capacity has positive semiotic impacts. Of course, the use of data classification to group diverse features together into a small number of categories is a stock in trade of statistical cartography (as noted in chapter six with regard to choropleth maps). While classification is useful for simplification it also works to mask variability in the data. This masking could have useful benefits in marketing by maximising the impression of capacity because, without knowledge of the underlying data distribution, the map reader cannot tell how many of those bright orange-coloured lines are 45Mbps bandwidth and how many are really at 1.5Mbps - this is a not an insignificant difference, after all.

Moving forward, again by another year, we come to the marketing map of “UUNET’s Global Internet network” for June 2000 (Figure 7.8). The corporate fortunes of WorldCom were beginning to slide by this point, as the growth charge through the second half of the 1990s began to slow (see Figure 7.1). In overall design style, there is clearly a lot of common heritage with the previous map. However, some of the more radical elements in the 1999 design have been toned down. Most obviously, the centring of the map is changed to give North America back its rightful (in terms of corporate power) privileged position. Also, the unusual rendering of the continental outlines in the 1999 map has been dropped in favour of more conventional geographic shapes.

<Figure 7.8 about here. June 2000 map>

In the same fashion as the 1997 and 1998 maps, the unified world is split and the ‘Indian cut’ is again made to shrink the extents of the Eurasian continent. There are a whole lot of long route lines, rendered in bright colours, across the pale blue North Atlantic and Pacific oceans. Most run arrow-straight and have been consciously spread apart to improve their legibility and also their semiotic potency. The parallel track-like routes to Europe in particular seem to cover the whole sea. The extra long route line from Seattle across the Pacific and down through the whole of China to reach Singapore is also demonstrative of extreme range. Linked to the overall impression of network range, UUNET's infrastructure now also appears to offer many more *direct* routes than in previous maps, especially connecting into European cities. All the improvements in the presentation of the range of the network in the June 2000 map are, however, more than offset by the complete failure to demonstrate the reach of UUNET's network.

The slightly larger scale of mapping employed and the growing density of network route lines and hubs means that the cartographer chose not to identify the cities. The simple removal of labels to improve legibility is actually highly problematic for persuasive communication, as readers cannot tell which 'right places' the network reaches. If one knows something of the geography of world cities, it is possible to make plausible guesses, but prospective customers and investors can not tell for certain which cities are connected. To the untrained eye, the scattering of red squares of the UUNET hub on the map now appear to be a random collection of points. Additionally, I would argue that without citing cities by name (and by deleting countries as well) the visual-cognitive link between infrastructure and place is broken on this map; the result seems like a disengaged network floating *above* the world, the network is rendered so exclusively that it does not actually come into contact with the world. This impacts directly and significantly on the power of map to conjure up the required sense of tangibility in reader's minds. The logical network looks too virtual to be really tangible.

In terms of demonstrating plenty and capacity, this map also gets mixed results. The underlying network has expanded greatly over the 1999 extents and there is an appearance of a denser meshing of links in the American heartland and also in Europe. Indeed, the overwhelming plenty of mapped infrastructure, at this scale, completely smothers the Northeast USA and the Bay area; as such it is counterproductive to cartographic workability. The growth of the route links in Japan, across Australia and branching down to Puerto Rico in the Caribbean are also useful additions for evoking a plentiful, successful network. There is now so many links on most routes that the cartographer has chosen not to try to show them, instead the presence of multiple links is represented by placing small numbers ('x2', 'x3') embedded in the middle of the line.

Whilst an acceptable pragmatic technical solution to convey information factually, it does nothing in terms of semiotic strategies for marketing maps to evoke in readers the power of network infrastructure being built by UUNET. The number of routes is many times greater than the year before, but it does not look like it from the map.

The display of route capacity is partially improved by using six different coloured-coded line types instead of the three classes in the 1999 map. The choice of colours seems rather random, however, and does not suggest a building intensity through hue. Line weight is sensibly employed to suggest increasing capacity and the overly thick style of the 1999 is avoided. Looking at the key, it should also be noted how much the peak network capacity has increased. In one year, the highest bandwidth links (shown by dark green route lines) have grown fourfold from 2.45Gbps to 10.0Gbps. These routes in the Northeast USA (in a ring linking NYC-DC-Chicago) are hard to spot being heavily overplotted with other lines.

The last map from this era of WorldCom's dominance of Internet infrastructure comes from January 2001 (Figure 7.9 top). The company was experiencing problems at this point with falling revenues, large debts and a steeply declining stock price (Figure 7.1). The projection and extents of the underlying base map remain unchanged, along with the problematic lack of city label needed to identify the network hubs. The demonstration of network range has been improved on transpacific routes with the links being stretched into long swooping curves that seem to be pulling Asia towards the American heartland. The network has also expanded, finally, into the 'Global South' with a notable series of route lines dangling down from North America to Brazil. This is somewhat undone by the removal of lines across the Atlantic, with the tremendous track-lines of the 2000 map replaced by two rather understated thick gold-coloured lines into London. The demonstration of abundance has intensified, with even more overplotting of link lines to create an impossible tangle in the core networked regions. The capacity encoding remains unchanged, apart from the somewhat strange addition of one new category at the bottom. This new low bandwidth level of just 64 Kbps looks embarrassingly small compared to the rest and has been seemingly added to accommodate a single new route in Latin America, likely to be between Sao Paulo and Buenos Aires (although one cannot be sure of this reach, due to the lack of city labels).

<Figure 7.9 about here. January 2001 and March 2005 maps>

For completeness sake, the discussion of WorldCom's global marketing maps is brought up to date by examining the current version presented on the MCI[14] corporate website, as of March 2005. The map is a very different design origin to the Ritson produced ones (Figure 7.9 bottom). It is delivered as an interactive Flash application and serves partially as an index map to access more detailed regional scale maps. The overall projection used is a 'standard' geographic world map centred interestingly on Europe, rather than the United States. Harking back to the map from 1997, country boundaries are added back in. Indeed, of all the cartographic attempts to justify the claims of offer a *global* network, this map presents some of the most plausible evidence, with the links into several countries in South America, to India and into Africa (admittedly only to two cities in South Africa).

The map has a very much simplified symbology compared to earlier examples and there is no legend, logo, date, contact information or other corporate identification. In terms of identifying network reach, no effort is made at all, as no hub locations are indicated. Only two classes of network links are distinguished (green ones and orange-coloured ones), but it is not clear what their capacity is. Only in terms of demonstrating network range does the 2005 map score reasonably well; the links running down through the South Atlantic to South Africa are especially effective. The impression of range, however, is diminished because the Atlantic-centred projection necessarily splits the Pacific, so breaking the routes here in half.

6. The map and the myth

In conclusion, I want to consider the relationship was between cartographic imagination displayed in the WorldCom marketing maps and the hype of Internet doubling in size every 100 days. Cartography has long served the exclusive and exclusionary interests of private capital. The emergence of the marketing map genre over the last century has been one of the most conspicuous developments in cartography, although little analysed in comparison to scholarly preoccupations with nation-state mapping.

[14] This WorldCom's post-bankruptcy corporate entity.

Maps are needed to differentiate one network from another. As Henry Ritson, UUNET global marketing manager put it:

> “What we have to illustrate is that, since the Internet is ‘many networks connected’ you get better, faster, more reliable service if the network you connect into first is able to take you most of the way to your destination ‘on an uncongested motorway’ rather than hitch-hiking across a variety of crowded lanes. Our network maps basically show the area of the Internet that we have the ability to manage directly - and if we are managing it we can maintain high quality of service ...” (interview, 2000).

The maps were also as much about impressing investors as luring customers from competing networks. By analysing WorldCom’s maps it was demonstrated that marketing maps are workable in showing the strengths of a network to investors and differentiating it from competitors through eight distinct semiotic strategies: range, reach, directness, centrality, plenty, capacity, silencing and exclusivity. However, it was also apparent that they had mixed success in tapping into these eight strategies. As such, the case study shows the real difficulties in effectively mapping Internet infrastructure even when the interest being served is dedicated exclusively to commercial persuasion without the pretence of objectivity. The most significant failing in the maps overall was the all too obvious mismatch between the bold claims of WorldCom to offer a global network service and the mapped reality of its infrastructure that barely covered a third of the world.

Despite the semiotic failings in the maps, they were produced frequently by WorldCom, were prominently displayed on the corporate website and were obviously an integral part of the company’s marketing message. The maps’ primary goal was to justify bold marketing claims by providing attractive and authoritative visual proof of the extent of UUNET’s network. The maps drew on the reserves of cartographic *gravitas* - people tend to believe what they see on the map as real, particularly when it is shown using familiar metaphors of geographic world maps. Three distinct truth claims arise from the use of cartography in service of backbone marketing:

(1) ‘Biggest is best’: The map can prove, better than other rhetoric devices, that the network is as large as is claimed. One can see it really does connected continents, link

all those important cities, span oceans. The expansive scale of the network as demonstrated beyond doubt on the map implies a successful company.

(2) The network is made *tangible* through the map. The rendering of invisible, unknowable, virtual network links into real lines inscribed onto a familiar landscape connects customers instinctually to the infrastructure (as discussed in chapter four). As Ritson commented: “The Internet is such an intangible concept for people that it is easy for them to assume that whichever Internet provider they choose, they will still connect to the ‘same Internet’.... The network maps show what the infrastructure really is” (interview 2000). Of course, the map can show this with particular emphasis to make it look rather more than it is.

(3) The third and most important truth claim is that of *trust*. The network, when mapped *must* look permanent, safe and trustworthy. The backbone marketing map says: ‘we are here to stay. Look at all the infrastructure we’ve built. You can trust us with your precious data.’

As is now apparent, faith in WorldCom generated by cartographic trust was misplaced. Events happening *off* the map fatally damaged these truth claims. Despite having the biggest Internet backbone, WorldCom went bankrupt in July 2002. More widely, the crash of the telecoms sector in 2002 exposed the hollowness of the hype that underlay all those marketing maps. The maps were born out of the myth of internet traffic doubling every 100 days and they were also an element in promulgating this mythical narrative. They were visual, irrefutable, cartographic prove of the growth happening and the need for more and more bandwidth. Ritson himself repeated this mantra:

> “the network has been growing at 1000% per year for several years now. The map can go significantly out of date in a week. It is a terrifying moving target. I’m not even sure if anyone has ever had to map anything that grows this fast before.” (interview 2000).

But of course, the maps were not really saying that. They were showing the building of speculative bandwidth. They showed more and more infrastructure, but investors could not see (and some probably did not want to see) that all those thick gigabit route lines were only half full, a quarter full, had only a trickle of packets or were actually empty. It was easy to believe that maps were showing growth in demand - after all, why would a commercial company be building links between cities if they did not have the traffic to fill it? Airlines do not fly with empty planes, why would backbones networks be running empty pipes - and then spending billions building yet more pipes?

Basically, Worldcom were claiming to install much more infrastructure than they actually needed, to hide losses and artificially boost revenues. They gave the impression of carrying much more traffic than they actually were. “UUNet routinely counted fiber-optic capacity as traffic, rendering the statistic essentially worthless as a barometer of the Internet’s growth.” (Dreazen 2002, no pagination). The backbone maps were a component in this deception.

However, accusing the maps of misleading is disingenuous at one level. The maps were doing what they were supposed to be doing. They *were* marketing maps, not independent, information maps, and made no pretence at showing traffic. Indeed, within their own parameters and agenda of marketing they were accurate and honest. It was just that there was no other source of information - so people believed the claims of doubling growth every 3 or 4 months and took the maps that were available (and pushed out by companies) as credible, solid, cartographically honest evidence. (Indeed, marketing maps from ISPs were exploited in this regard in a good number of academic studies on Internet topology and growth (e.g., Malecki 2002, 2004; Townsend 2001) and for policy analysis (e.g., OECD 2002).

What of the backbone business now the dust from the 2002 crash has settled? Well it is still there - the Internet as a whole did not miss a beat and still continues to grow at a healthy rate. WorldCom, however, is vanishing as rapidly as it grew. The tainted name itself was erased when the corporation emerged from bankruptcy in April 2004 as MCI. In February 2005, it was announced that MCI was to be acquired by Verizon, a major U.S. telephone company, for a mere $5.3 billion. Meanwhile, Bernie Ebbers, the former chief executive of Worldcom was found guilty in federal court in March 15 2005 of orchestrating the fraud and is likely to receive a substantial jail sentence.

In the end, the marketing maps showed the bones of the Internet and people assumed the whole body was healthy. How then can knowledge of network health be determined? One way is to empower individual users through alternative mappings of the network performance in real-time, building specific cartographic knowledge from the ‘bottom-up’. This is the focus of the next chapter.

Table 7.1: Growth in potential bandwidth of the U.S. domestic inter-city routes, 1999-2002. (Source: TeleGeography 2002, 9.)

Rank	Route	1999 (Gbps)	2002 (Gbps)	Multiple Increase
1	New York - Washington DC	7.5	137.4	18
2	Los Angeles - San Francisco	5.1	129.9	25
3	Sacramento - San Francisco	NA	124.9	NA
4	Atlanta - Washington DC	4.2	111.1	27
5	Chicago - New York	4.0	110.3	28
6	Dallas Fort Worth - Los Angeles	3.8	72.9	19
7	Philadelphia - Washington DC	0.7	68.9	94
8	San Francisco - Seattle	3.9	68.3	17
9	Dallas/Fort Worth - Houston	5.3	67.9	13
10	Portland - Seattle	0.7	64.9	88

(Gbps = gigabits per second)

Table 7.2: Principal WorldCom acquisitions, 1995-2001. (Sources: Jeter 2003; Sidak 2003, 241; corporate press releases.)

Date	Target	Price (billions)	Business
Mar. 1995	WilTel Networks	$2.5	Facilities-based CLEC
Aug. 1996	MFS, UUNET	$12.5	IP network provider
Jan. 1997	Brooks Fiber	$2.4	Facilities-based CLEC
Jan. 1998	CompuServe	$1.3	ISP
Jan. 1998	ANS Communications	$0.5	ISP
Aug. 1998	Embratel	$2.3	Brazilian long-distance provider
Sept. 1998	MCI	$40.0	Long-distance provider
[Oct. 1999	Sprint*	$129.0	Long-distance provider]
Oct. 1999	SkyTel	$1.7	Paging service
July 2001	Digex	$5.8	Hosting services

* This merger was effectively blocked by government regulators in the U.S. and EU.

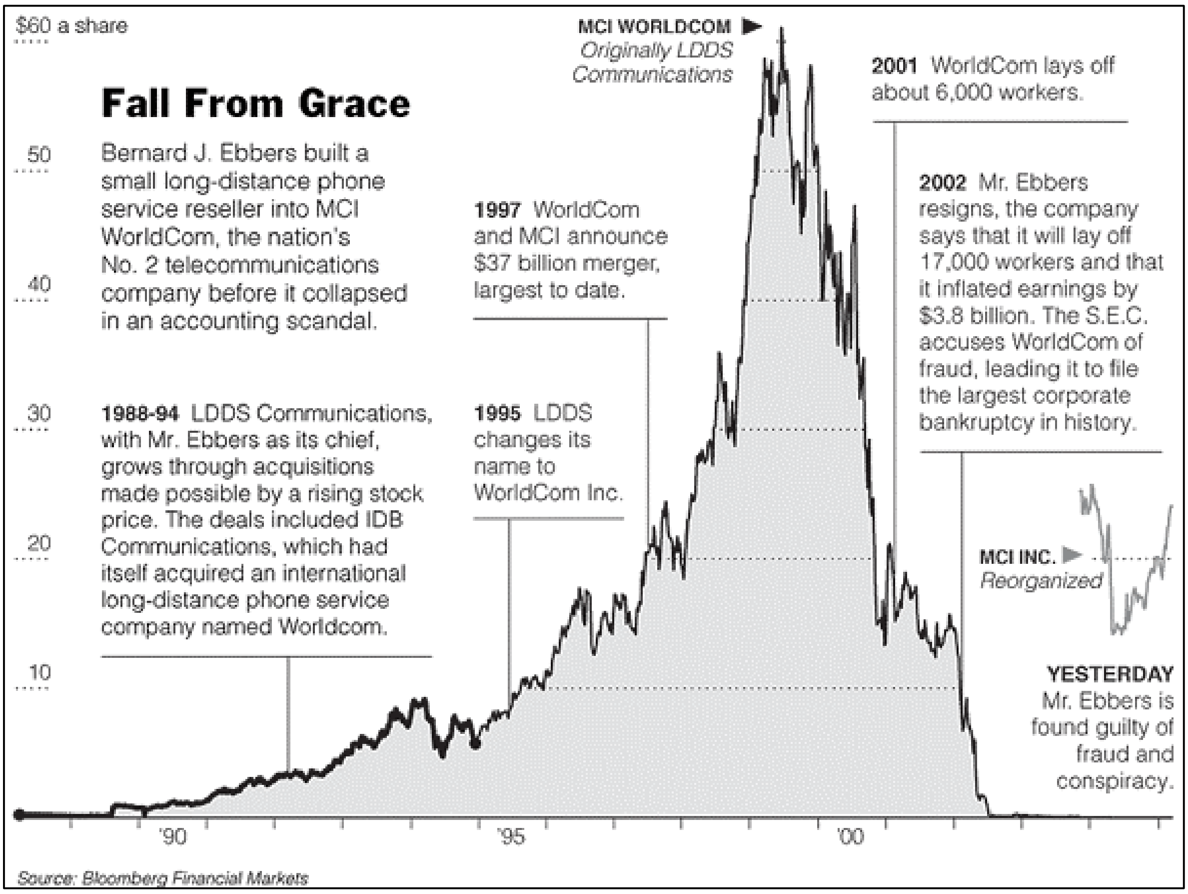


Figure 7.1: The fluctuating share price of WorldCom in relation to its corporate history. (Source: graphic accompanying Belson 2005.)

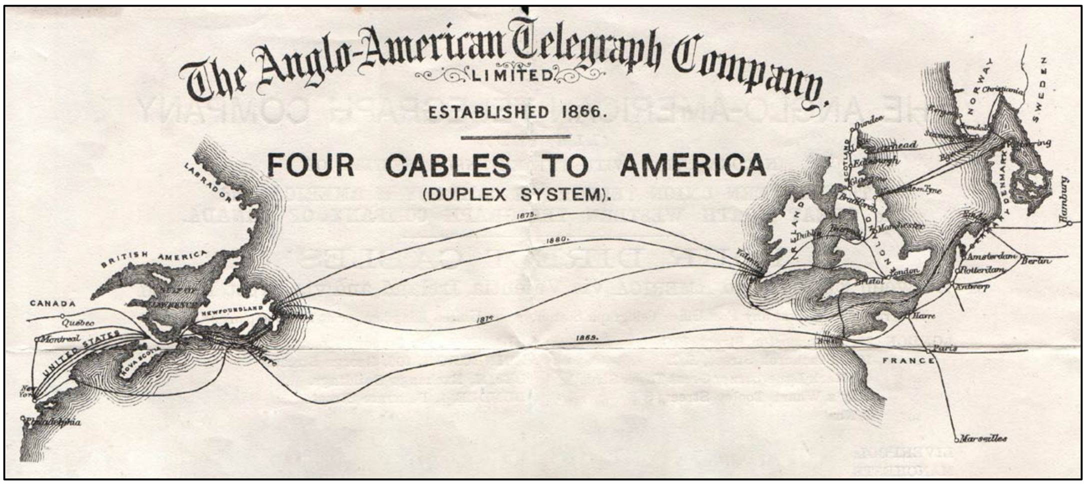


Figure 7.2: Marketing map from the telegraph era (source: Bill Burns, <www.atlantic-cable.com/Maps/index.htm>.)

Figure 7.3: An attractive azimuthal projection map of the world produced to market the globe spanning Cable & Wireless telecommunications network in 1945. (Source: Courtesy of Cable & Wireless Archives, Porthcurno, Cornwall.)

Our Network

MCI's extensive global network is a key advantage for business customers of all sizes.

MCI® owns, operates, monitors and maintains one of the largest communications networks in the world. Our network facilities are throughout North America, Latin America, Europe, Africa, and the Asia-Pacific region, in more than 140 countries and over 2,800 cities.

Our 98,000-mile fiber optic network is designed to support the largest array of data communications and voice products in the world.

MCI owns the world's farthest reaching global network (based on company-owned POPs), and spans more than 4,500 Points of Presence (POPs) throughout the world, with 2.2 million global dial modems and high-capacity connections to more than 102,000 active buildings. The global IP network can circle the globe more than four times. Additionally, MCI remains the most connected Internet backbone provider with the greatest number of Autonomous System network connections. The company's expansive IP footprint, coupled with its direct interconnections, exceeds all other competitor networks and enables its business customers and ISPs to reach more destinations directly through MCI's global IP backbone than any other carrier.

MCI offers the fastest speeds available over IP today. We were the first to route and switch OC-192 IP network traffic. MCI also has the most scalable IP network available, offering speeds from dial to OC-48.

MCI's IP data solutions are directly built into a wholly-owned global network, for direct, safe, secure access.

Skilled technicians in Network Operations Centers around the world monitor the network for optimal efficiency 24 hours a day, 365 days a year.

Figure 7.4: Promotional description of MCI’s network infrastructure. The style and content is emblematic of the form of marketing rhetoric promulgated by WorldCom throughout the 1990s bandwidth boom. (Source: MCI website, March 2005.)

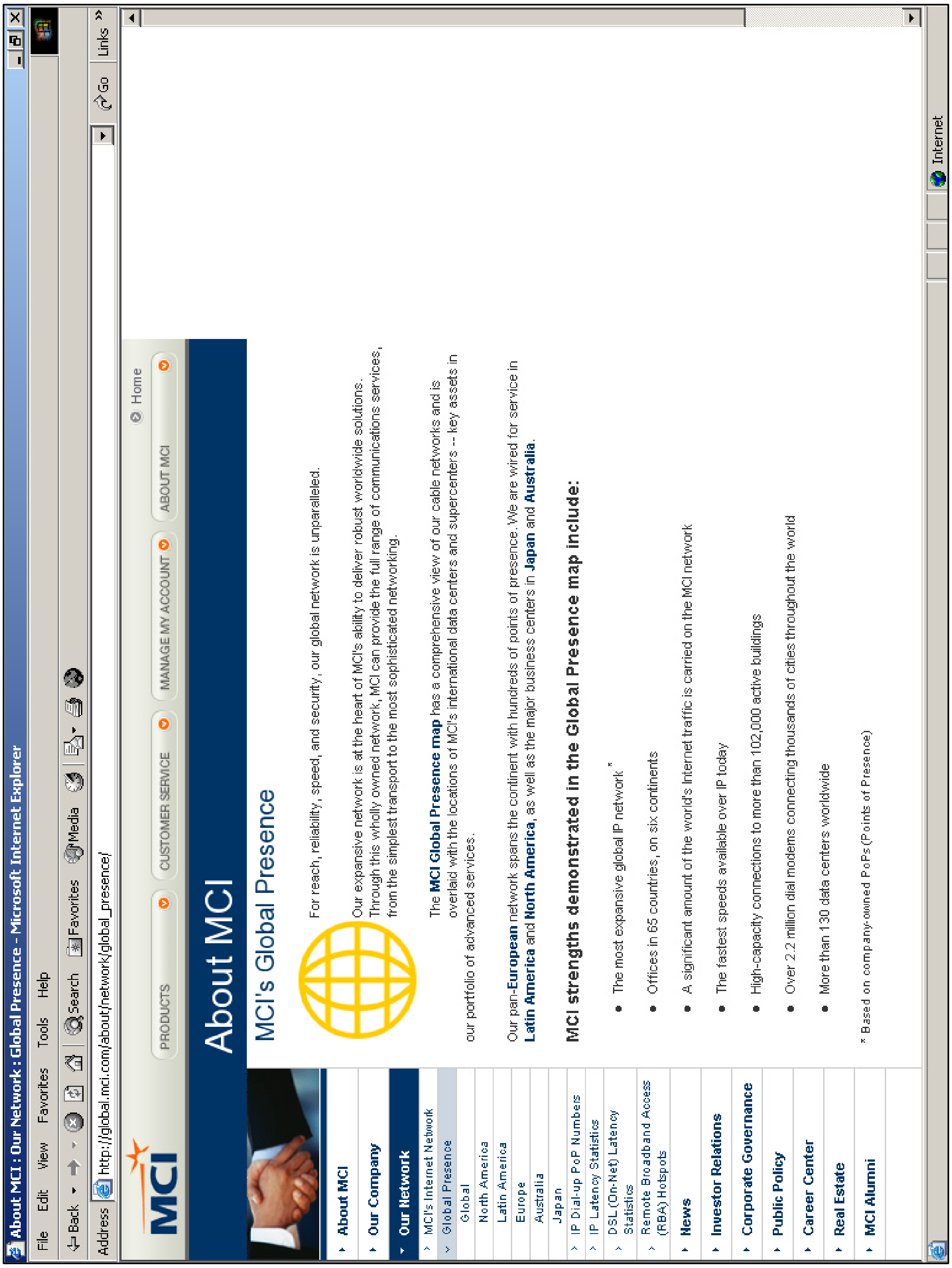


Figure 7.5: The promotional context in which network marketing maps are embedded on the MCI corporate website. (Source: MCI website, March 2005.)

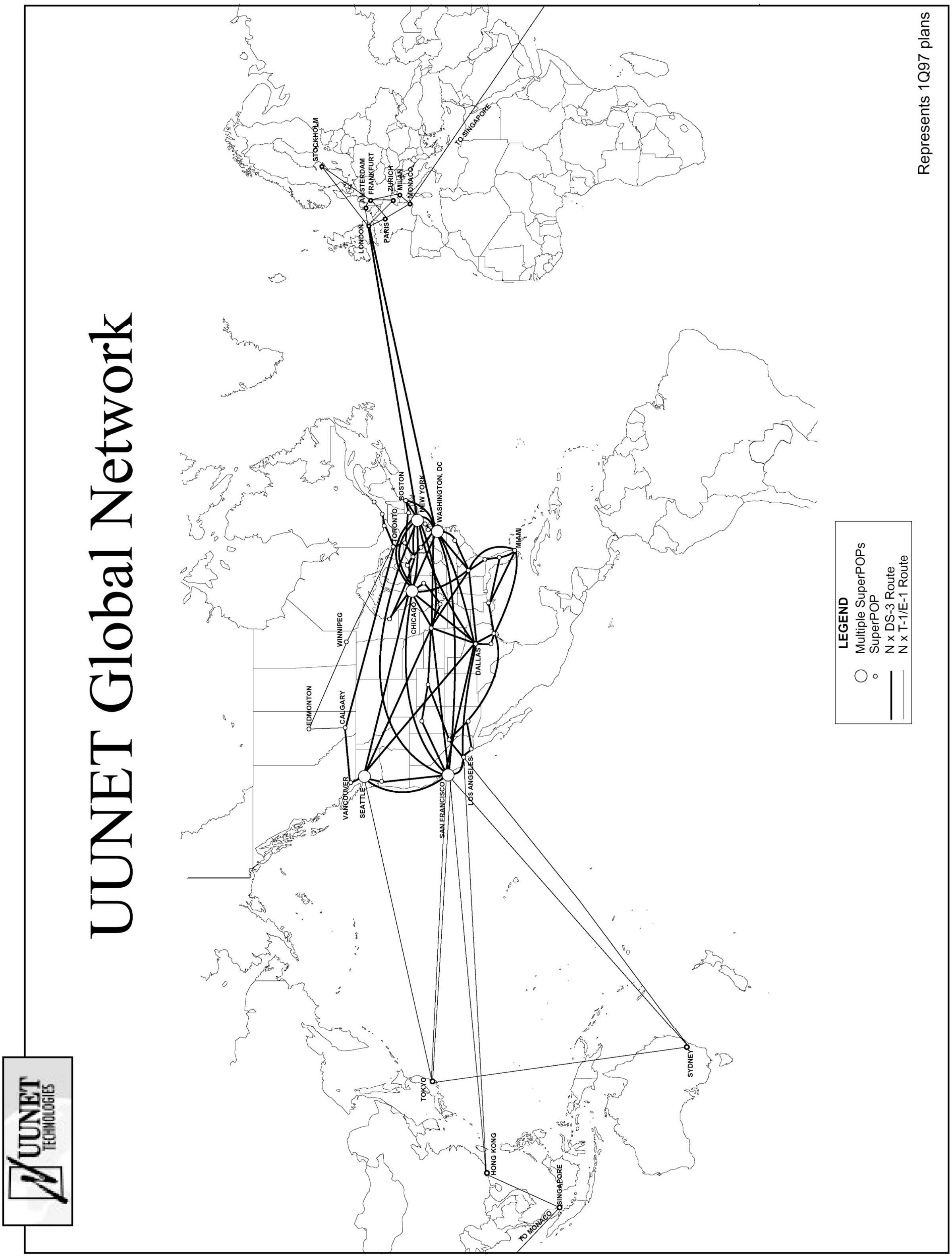


Figure 7.6: WorldCom’s global scale marketing maps showing the newly acquired UUNET backbone from spring 1997. (Source: Originally published on corporate website. No longer available.)

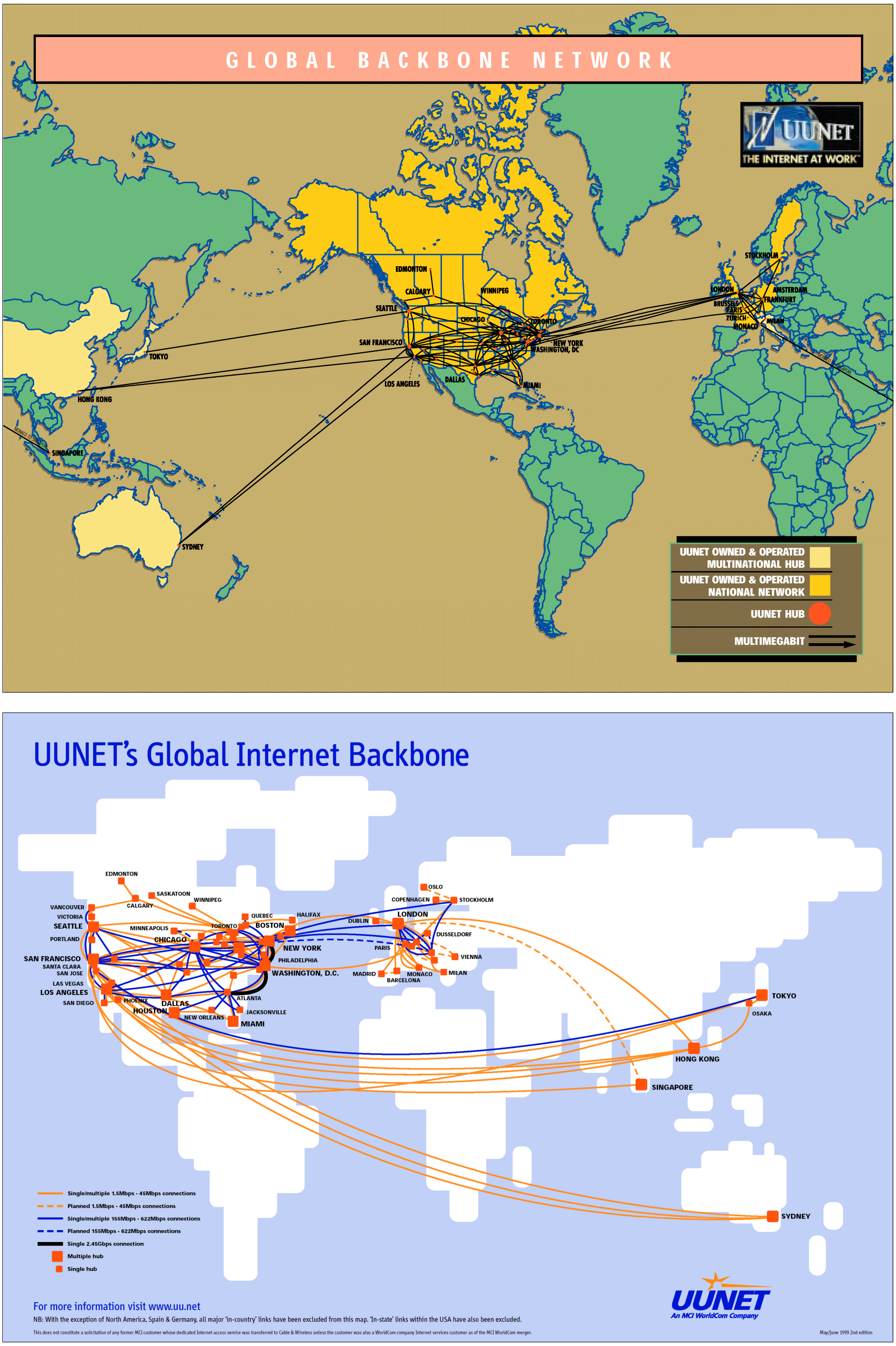


Figure 7.7: Global scale backbone marketing maps produced by WorldCom's UUNET backbone, from May 1998 (top) and June 1999 (bottom). (Source: Originally published on corporate websites. No longer available.)

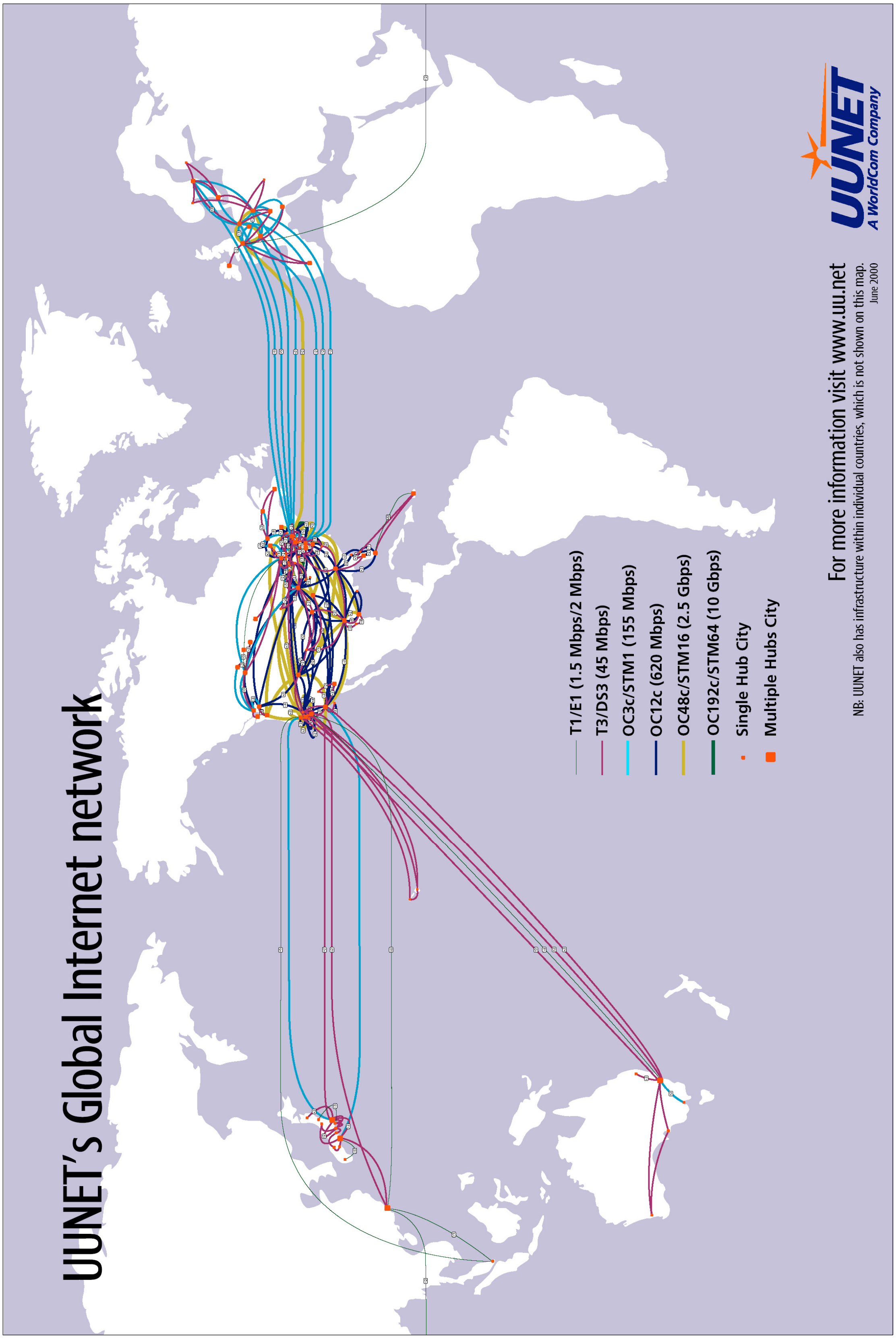
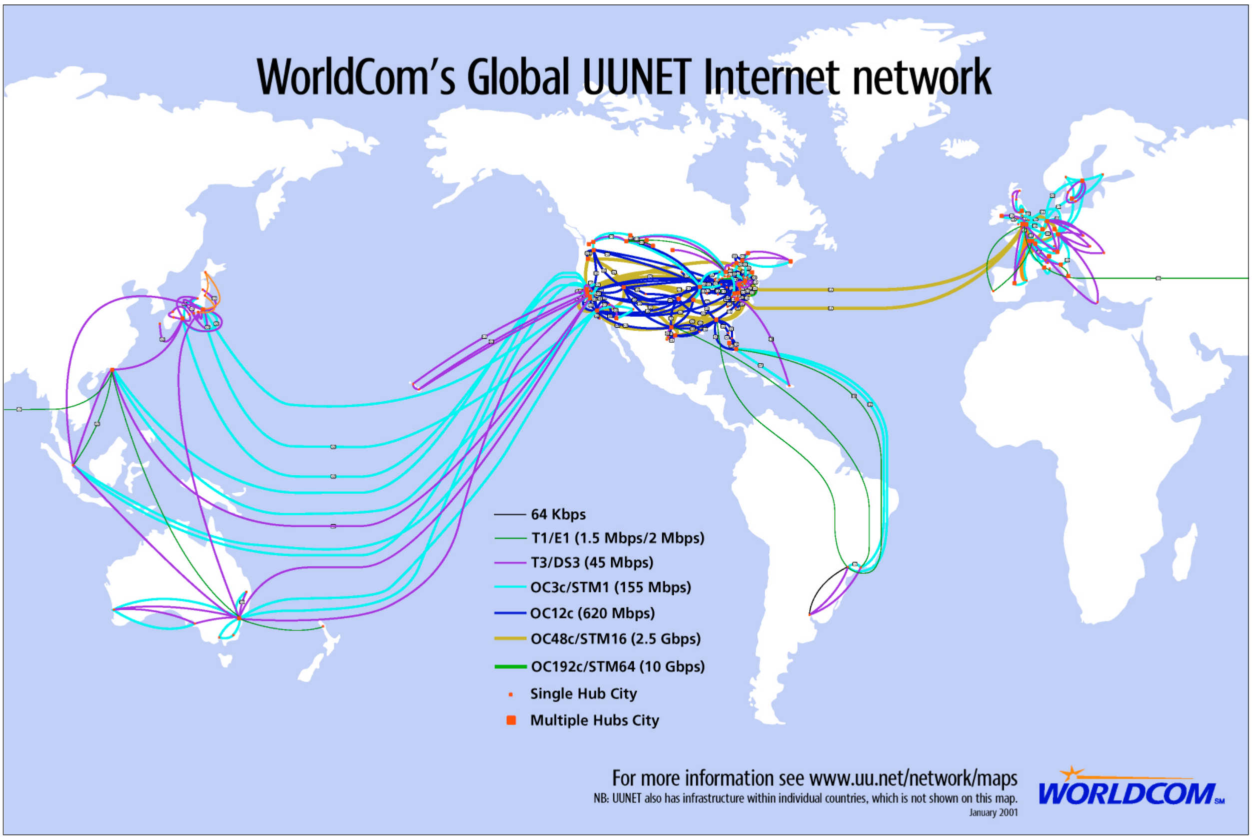


Figure 7.8: Global scale backbone marketing map of WorldCom's UUNET network, June 2000. (Source: Originally published on corporate website. No longer available.)



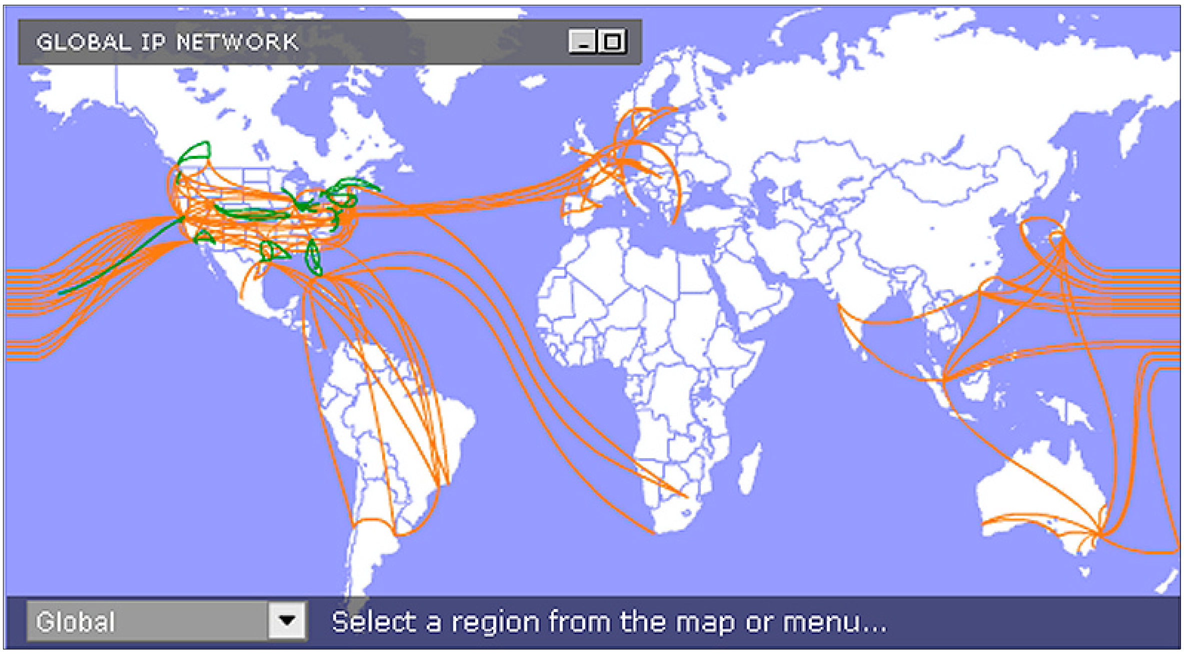


Figure 7.9: Global scale backbone marketing maps of WorldCom's UUNET network in January 2001 (top) and the MCI network in March 2005 (bottom). (Source: Originally published on corporate websites. 2001 map is no longer available.)

Chapter 8

Spaces of Flow: Performing Traceroutes and the Possibilities of Network Counter-Mapping

The problem is that many, many people never see the Internet as such; they only see the way HTML is translated on their screen ... they believe surfing the Web is equivalent to exploring the whole of the Internet. And of course, many service providers ... are quite eager to reinforce this impression as it transforms potential Internet citizens into nice, passive Web consumers.

-- Jean-Claude Guédon, posting to *Internet Society member mailing list*, 2002.

We have been adequately cautioned about mapping as a means of projecting power-knowledge, but what about mapping as a productive and liberating instrument, a world-enriching agent.

-- James Corner, *The Agency of Mapping*, 1999.

I have a vision of the Songlines stretching across the continents and ages; that wherever men have trodden they have left a trail of songs...

-- Bruce Chatwin, *The Songlines*, 1987.

1. Introduction

What is the route to a counter-mapping of the Internet? How can one generate a different perspective of the Internet showing not the skeletal framework of 'hard' infrastructures, but capturing the 'soft' sinews and dynamism of data flows. Not a surface representation drawn externally to the network, but an interior view of the network generated by its own workings. Such a mapping, capable of revealing this *essence* of the Internet, needs subtleties in data collection, it needs to be aware of different temporalities and, most importantly, it needs to take a non-authoritarian viewpoint of mapmaking to overcome the ideological limits of 'top-down' cartography. It will be quite different to the territorially fixated, uni-positional cartography, including network diagram produced by engineers to document their work (discussed in chapter five); the neo-imperialistic statistical mapping of Internet globalisation (chapter six); and the persuasive marketing maps of backbones (chapter seven).

Novel counter-mappings of the Internet should, therefore, be built ‘bottom-up’ by many hands, as part of practices of everyday network use. The suggested route to network counter-mapping examined here is dynamic visualisation of the space of flows which can be performed by ‘ordinary’ users, using traceroute software tools. While novel in this regard, traceroutes can also be situated within existing cartographic representation of routes to support wayfinding and in section three they are related to strip maps for road navigation and Aboriginal songlines.

2. Characterising network counter-mapping

The potential of counter-mapping, a genuinely anti-hegemonic cartography able to challenge predominant power relations by highlighting social inequalities, has intrigued many scholars who are interested in critical cartography. For example, Crampton (2003) has a chapter on “positivities of power, possibilities of pleasure”, Pickles (2004) ends his book with a discussion of “counter-mappings: cartographic reason in the age of intelligent machines and smart bombs”, and Wood (1992) concludes with a chapter titled “the interests the map serves can be yours”. Here I identify four themes that seem foundational to the possibility of producing counter-mapping for the Internet: fracturing of authorship; temporal sensitivity to the variable durations of events; the collapse of the map and territory dichotomy; and a concern for mapping performances over map products.

(i) Authorship: Questions around who has the authority to write and whether they remain anonymous to readers has been central to post-modern critique of many texts, including cartographic ones. Hegemonic cartography is authored, predominantly, by a single voice that strives to maintain its anonymity and distance from readers. The ‘disappearance’ of the author is helpful to privilege the maps claims to scientific objectivity, as well as limiting cartographers exposure to criticism and restricting access to underlying ‘technical’ processes of map creation (Wood 1992). The majority of maps of the Internet, and all those I analysed in previous chapters, enjoy a singular, fixed and distanced authorship; they are maps made from a privileged external position, to be publicly distributed and consumed. “The result is that although we have great access to maps”, Aberley (1993, 1, original emphasis) argues, but at the

same time we are also disenfranchised cartographically because, ".. we have also lost the ability to *conceptualize*, *make* and *use* images of place."

In approaching network counter-mapping, the modernist unity and authority of map authorship must necessarily be fractured. Individuals need to (re)assume the ability and responsibility to write their own cartographic texts, to make images of places for themselves. This change in authorship is, of course, fundamentally a readjustment in power relations as people move from map-users (the consumers of 'professionally' made maps) to become mapmakers. When authorship is everyone's right and everyone knows who makes maps, there is no more privileging through disembodied anonymity. The result then, for counter-mapping is not a singular, master viewpoint over the Internet, but many viewing points within the constituent networks of the Internet. Not a global gaze, but many local glances. Fractured authorship for counter-mapping implies, fundamentally, the making of *personal* representations of particular places, that are made in the moment to meet particular individual needs, not an impersonal cartography scrutiny of space published for general use.

Distributing the rights to map authorship to many not only opens up multiple viewpoints from within the network, it is also an element in taking control in decision-making. In this fashion, individual and especially local group participation in collaborative mapping efforts has been promoted as means of empowering people, communities and social formations (e.g., Kitchin 2002). The recent emphasis on the potential of GIS and digital mapping in public participation in local planning and environmental protection is apposite[1] (e.g., see Craig *et al.* 2002). In terms of empowerment, the act of participation in the mapmaking process, by bringing people together in new conversations and in shared activities, is itself often more important (and has longer lasting impacts) than any cartographic artefacts produced. As Aberley (1993, 131) asserts: "[t]o build our maps, we will once again range over our territories, learning the flow of energy that offer limit and opportunity."

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[1] Although the real emancipatory potential in terms of 'jumping scale' to influence regional/national decision-making in a lot of local public participation GIS efforts is questionable (Aitken 2002). Additionally, participatory mapping used in local activism does not necessarily entail progressive politics as many campaigns can be socially conservative (e.g., NIMBYish attitudes to protect privileged lifestyles from new development).

Given these characteristics, it is unsurprising that the fracturing of authorship is perceived inherently as a threat to powerful, hegemonic cartographic interests. When people are able to choose what to show on *their* maps, and how to show it, and what is done with the results, inchoate fears are commonly expressed by 'professionals' over the lack of accuracy in these 'amateur maps', their failure to follow appropriate mapping standards, their poor design and other unspecified dangers in terms of misleading people by their *mis*representation of reality. In fact, such 'amateur' maps simply reflect a different reality.

(ii) Temporal sensitivity: Hegemonic cartography by inclination shows a static world in which dynamic, unpredictable and mobile processes (the spontaneity and serendipity of events that make places feel alive) are frozen at specific and externally specified points in time. Beyond narrow technical concerns for legible representations, this freezing has important ideological implications because the resulting maps inherently privilege the status-quo and entrench power-relations that are most easily 'frozen'[2]. For example, the survey time points in Landweber's statistical mapping of Internet globalisation (discussed in chapter six) work to 'lockdown' the complex, multivocal processes of diffusion into neat and ordered forms that favour hegemonic narratives about the 'naturalness' technological expansion. Such fixity of things and locking-down of events into regular time slots is really a cartographic fiction, and it gives an artificial sense of permanence to the world that is really working as series of dynamic, overlapping and contested processes (such as the social-spatial spread of Internet access and use).

Static maps are inherently and particularly selective in what they can show and not show. The surveyors gaze has always favoured things that appear fixed in the landscape (or with relatively long durations to human sensibilities). As Bunge (1971) notes: "[m]aps attempt to integrate over time, that is, maps assume an average span of time. This means that nothing that moves is mapped, and therefore property is inherently preferred over humans." Things that move or change quickly

[2] Of course, the elements of the landscape that are deemed permanent and mappable is itself culturally contingent and varies over time. Map in the nineteenth century often indicated watering places for horses, for example, reflecting the dominant mode of transport of the time.

and unpredictably tend not to get mapped[3]; this is clearly problematic for constructing worthwhile and workable representations of the Internet as the actual work networks are doing can never be mapped. As discussed in chapter seven, the backbone maps of WorldCom showed nicely the network structure of fibre-optic cables but nothing about what was (or was not) being carried through the cables.

Furthermore, most cartography conventionally shows the material results of social and economic processes and not processes themselves (e.g., they map cities in terms of building footprints and not activities occurring within those buildings). In terms of a Marxist political economy analysis, the spatial fixes of capital are mapped in exacting detail (roads, factories, houses, property boundaries, etc.), but the underlying destructive processes of capital circulation remain hidden from cartographic gaze (which is, arguably, useful to the perpetuation of inequalities in this social system). Again, thinking back to the marketing maps discussed in the previous chapter, there is little or no work representing the processes of capital circulation that lead to spatial fixity in terms of the particular configuration of backbone links and city hubs that network corporations built in the 1990s boom.

Counter-mappings will by necessity be more human-centred and process-orientated if they are able to be more sensitive to different temporalities of phenomena and events (including the kinetic irregularities of the space of flows through the Internet). They will also resist the hegemony of conventional cartography by exposing the chronological-fixity of the majority of 'professional' maps. One way to achieve this much needed sensitivity is to make maps of the moment, that is visualisations dynamically generated at the time of their viewing, much like Doppler radar scans of rain clouds provides a map of the (nearly) now every time they are produced. The result is a process of mapmaking that can be easily and quickly repeated every time a map is requested, but never results in an exactly reproducible map because it draws upon temporally unique sample of data[4].

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[3] Governmental concern with evermore detailed mapping of the weather is an interesting exception to the rule. Efforts to map (and in some senses, thereby, control) future weather patterns is clearly useful to many hegemonic interests, not least the military.

[4] The fact that the repetition of the mapping process will not result in same map representation also undermines the 'scientific' requirement of reproducibly of results, which is important to truth claims of modernist Western cartography.

(iii) Collapsing map and territory: When one can make maps of the moment, in certain important ways, this installs a radical reconceptualisation of space always *becoming*, rather than space having its own separate, and permanent existence. This ontogenetic view of space is useful to network counter-mapping because it undermines the strict ontological separation of map and from the territory. As is well noted, this dichotomy is important in underpinning the spatial essentialism of Western cartography and aids the key truth claim of 'scientific' authority to be merely a 'mirror of nature'. A major theme in critical cartography has been expose the fallacy of this claim and demonstrate the inherent co-production of the territory and its representation (see chapter two).

Accepting space as ontogenesis goes further because it means there is no territory in a meaningful sense until it is mapped. The way that space and representations of it conflate into a single ongoing performance is evident in many of the most interesting cyberspace mapping projects, particularly of information spatialization (e.g., spatial interfaces for navigable hypertexts and self-organising neural network maps; see Dodge and Kitchin 2000a; Fabrikant 2000; Skupin and Fabrikant 2004). Here the map, as an interface for user-directed visual of navigation beckons the territory into being as it goes. The space literally does not exist in an experiential sense until it is simultaneously navigated and mapped. The collapse of map-and-territory into singular spaces of becoming "may help us understand why there are now millions of people in cyberspace but few maps showing how to get there", Staple (1995, 71) argues, because "[i]n a very real sense the session is the map".

(iv) Performing mapping: Flowing directly from this ontogenetic notion in which the map and territory are conceived as a single, unfolding process, the fourth characteristic of network counter-mapping is the necessity to privilege this process in any analysis of spatiality. This is a significant shift in epistemology from critiquing map representations per se (which is at the heart of the Harley's deconstruction of the power-knowledge in cartographic texts for example), to fully understanding the ongoing practices of their creation, that is explaining how the mapping is *performed*.

An interest in how maps *become* what they are, rather than describing what they are, is mirrored in scholarly writing on performativity across the social sciences in the last decade or so, perhaps most notably in Butler's (1990) work retheorising the social reproduction of gender and sexual identities. A number of human geographers have engaged with performativity theories in tackling different aspects of cultural and social spatiality (e.g., Rose 1999; see Nash 2000 for useful review), with Nigel Thrift's non-representational theory being the most prominent contribution. In simple terms this is conceived as a theoretical approach which moves "away from the analysis of texts, images and discourses, and towards understanding the micro-geographies of habitual practices, departing from deconstructing representations to explore the nonrepresentational" (Nash 2000, 656). The example, used by Thrift, of dance as a focus for study of performative body-practices is useful here in conceptualising new ways of mapping practices for the Internet because its playfulness "eludes rather than simply confronts or subverts power through its capacity to hint at different experiential frames" (Nash 2000, 656).

Acknowledging the unthinking creativity and playfulness running through mapping performances has been largely ignored in scholarly analysis of Western cartography (especially in the history of cartography) that focuses almost exclusively on the map artefact in its final representational form[5]. The contexts in which the mapping proceeds and the embodied performance of mapmakers are obviously much harder to account for using conventional research methods. Although this is beginning to change as some scholars seek to challenge the predominance of cartographic texts by focusing on understanding practice, largely through ethnographies of map use in different contexts (see Perkins 2004 for review).

How does a focus on performance help generate novel network counter-mappings? Most obviously in terms of resistance to imposed conventions. Nash's (2000, 655) comments regarding gender as a 'doing' are applicable here, to thinking afresh of the map as a 'doing': "performativity rather than fixity of identity at least allows the possibility of challenging and parodying these naturalized codes." In terms of

[5] Of course, there are a good many 'practical' (non-academic) books on cartography published which cover some aspects of map performativity in terms of embodied use; for example the 'how-to-do' manuals and guides detailing skills of map-reading and land navigation.

developing performative counter-mappings through a focus on practices that resist conventions, the ideas of de Certeau (1984) offer another useful starting point. The ways he argues for the productive capacity of banal daily activities (such as the actions of cooking and walking through city streets) to continually open up micro-subversive tactics that challenge the cultural logic of hegemonic structures. This subversion includes official cartography whereby the embodied performance of walkers work in realigning, deflecting or ignoring registration grids, authorised streets names, postal codes and all the other 'proper' lines of ownership. As Siegmund (2001, 38) notes "Spaces are never given. They remain forever in transition because they are the tentative results of the process itself." One can take control of the process by performing spaces differently, even in subtle unobserved ways.

A number scholars have also shown interest in the performativity of mapping to break apart the Cartesian conventions underpinning Western 'scientific' cartography. For example, in understanding medieval mapping as an interactive media for the performance of imaginative journeys (Connolly 1999) or the mapping cultures of preliterate aboriginal societies built upon performed knowledges rather than texts (such as the Canadian Inuit peoples, e.g., Lopez 1986; Rundstrom 1991, and Australian Aborigines groups, e.g., Sutton 1998a; Turnbull 1993). Rundstrom's (1991) early call for extending critical cartography to take account of non-textual mapping cultures through a concern for process is significant, particularly for reading indigenous mapmaking as form of resistance to colonial cartographic power. Process cartography, according to Rundstrom (1991, 6) "situates the map artifact within the mapmaking process, *and* it places the entire mapmaking process within the context of intracultural and intercultural dialogues occurring over a much long span of time."

Performativity is also imaginative not instrumentalist. So the shift from mapping as static text to an active performance opens the way for creative remixing (and re-mapping) of existing cartographic forms in Western capitalist contexts, as well as the freedom to imagine wholly new modes[6]. Crampton's (2001) in analysing maps as social constructions, also argues for productive capacity of geographic visualisation in which creative interactivity empowers users. Pinder (1996) considers the role

[6] I think this is apparent in the innovative work being done in information visualisation by researchers and new media artists.

Situationist ideas for alternative psychogeographical mappings that open up avenues for subversive, playful and inventive city mapping. Corner (1999) focuses on creativity through individual agency in relation to maps and design plans used in city planning, and argues for mapping "as an open and inclusive process of disclosure and enablement" (p. 250) with "its cunning exposure and engendering of new sets of possibility" (p. 251).

Performativity also acknowledges the importance of individual self-expression. Mapping as a *personal* performance, in combination with the fracturing of authorship, means that the restrictive conventions of map aesthetics and the rules of 'good' design are necessarily relaxed. Mapping can be 'rough and ready', with unconventional aesthetics and still be an effective performance (e.g., see Crouch and Matless's 1996 analysis of the Parish map project). A focus on performativity could usefully mark the end the fetish for accuracy and 'scientific' optimisation that has obsessed much of cartographic research and scholarship in previous decades (see chapter two). Cartographic self-expression opens up creativity and stops people being stifled by thinking that a map must have the spatial precision and topographic sophistication of Ordnance Survey Landranger sheet to be counted as a 'proper' map. In post-modern terms, there is no universal map, no privileging of one map as more correct than another; there is no one true map, but many diverse mapping performances. Importantly, for network counter-mapping then: a map is not map by what it looks like, a map is a map by how it performs space.

Many of these performative aspect, particularly in terms of resistance to conventions and creative self-expression, are evident in the emergence of the 'open-source' cartography in the last few years (see Russell 2005). This re-conceptualisation of mapmaking by 'doing-it-yourself' is to large degree it happening outside of academia and the GI industry, being driven by enthusiastic and loosely co-ordinated collectives of activists and artists (so-called 'citizen cartographers', Dodson 2005). Open-source cartography exploits the creative power of so-called 'locative media' (GPS and wireless communications), the collaborative capacity of the Web and free/open-source software, and 'bottom-up' spatial annotations and tags to produce a rich geospatial Web free from copyright. Open-source mappers, through their embodied performance on the ground tracing routes with GPSs, are advocating a new kind of cartographic epistemology. Mapping becomes very much way of thinking critically through the practices of mapmaking and not the end products.

‘Open-source’ mapping also has a distinct ideological base and on counter-culture ethos (itself a mixing of libertarian freedom of access to information, the socially progressive benefits of non-profit production and opposition to corporate capitalism)[7]. It also has a marked streak of irreverence illustrated, for example, in name of one of its key mailing list: ‘geowanking’[8]. Most of those involved in this movement have no formal cartography training or professional GIS credentials, just an interest in the geography in its common-sense meaning, a liking for maps, a deep affinity with technology and, above all, passion for ‘hacking’[9] their own elegant solutions (indeed, one of the first books to formalise the field is called *Mapping Hacks*, Erle *et al.* 2005). Such ‘carto-hacking’ work practices are evident, for example, in the OpenStreetMap initiative[10] in London led by Steve Coast (a physicists by training), which is directly challenging the monopoly of the governmental control of cartography at small scales by creating a process (the easy, low-cost tools and data sharing platform) for people to map their own city as they go about everyday activities. The map is not revered and reified as a special knowledge product, (a ‘Master Map’) built by an elite and then used by a select few, but something that can be creatively made by many hands and enjoyed by anyone and everyone, without copyright restrictions. In the particular context of British geospatial data infrastructure, this ethos is mixed with a distinctly anti-establishment streak focused on the longstanding critique of Ordnance Survey’s monopolistic pricing/licensing model that have effectively excluded many individuals, non-profit groups, and local communities from the mapping game (Dodson 2005). Citizen cartographers aiming “to build a set of people’s maps: charted and owned by those who create them, which are as free to share as the open road” (Dodson 2005, no pagination), represent a direct challenge to the closed-world of the

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[7] It is ironic that this work is so heavily reliant on the GPS system, designed, funded and maintained by the U.S. military.

[8] See <http://lists.burri.to/mailman/listinfo/geowanking>.

[9] Hacking used here in its original sense of a creative act of exploration of technology rather than malicious/criminal intent of recent popular usage (Levy 1984).

[10] See <www.openstreetmap.org>.

cartographic officialdom, with its right as unaccountable mapmakers of the State and Capital to provide an exclusive topographic text that grids so many aspects of daily live.

3. Representing routes - strip maps and songlines

The different cognitive mapping strategies typically employed for route following mean that different modes of information structuring and representation are more or less effective. MacEachren (1986), following Downs and Stea (1977), makes a useful distinction, in cognitive terms, between *process* and *state* descriptions of space. Process descriptions concern "a set of instructions for moving from one location to another" (MacEachren 1986, 14) and can be most effectively displayed in particular cartographic forms, such as strip maps[11]. State descriptions give a wider range survey of the landscape in which features are shown in relative position with each other on the basis of some locational framework (e.g., a national grid). General reference mapping in atlases and on topographic sheets from national surveys are very effective cartographic representations of state descriptions. However, topographic maps, in trying to serve a range of purposes, are less efficient for route following because they present a cacophony of diverse information, much of which is irrelevant to immediate navigational tasks in wayfinding (e.g., explicit identification of the correct turning point).

The production of state descriptions usually requires considerable effort in data gathering and in the reconstruction of the data into legible cartographic representations. Process descriptions, on the other hand, are much more easily and widely authored. For example, the description given to guide a friend to a new home or office in the form of a sequential list of actions and landmarks ('turn right at the war memorial') or sketched quickly as a wiry line diagram on a post-it note. While prosaic at one level, this individual creation of process knowledge is actually a powerful demonstration of the ability of people to unselfconsciously *perform* mapmaking that has sufficient accuracy and clarity to solve the problem of the moment. Rather than rely on the state descriptions given in the products of

[11] These are specialised maps that eliminate other extraneous information save for a sequence of features and/or actions that unambiguously describe the path between two points.

‘professionally’ published cartography, this performance of route mapping empowers individuals to describe their place in the world to others.

The everyday cognitive mapping problems inherent in route following and use of process descriptions to solve them are common throughout history and across all cultures. However, the forms of map representation created in response are diverse, and include: verbal/pictorial narratives of paths, written itineraries, line diagrams, portolan charts and strip maps. Some of the oldest surviving examples relate to ritualistic journeys made after death, such as the Egyptian ‘guides to the beyond’ maps drawn on coffins dating back to around 2000 BC (MacEachren 1986). The focus of the following discussion is, firstly, on strip maps for road navigation and, secondly, on narrative, non-representational cartography of Aboriginal songlines. These two genre are relevant, conceptually, to situating Internet tracerouting within wider cartography knowledges.

(i) Strip maps

One of the best known strip maps is the Roman *Peutinger Table* (Figure 8.1). It displays, in a highly schematic, fashion, multiple linear road routes across the Roman empire. Major compromises are made in terms of scale consistency and orientation of roads to be able to represent process descriptions as effectively as possible. Any attempt to plot cities accurately in geographic position relative to each other is sacrificed in favour of sequentially ordering of places along the route line.

<Figure 8.1 about here. Peutinger Table.>

The representational approach of the *Peutinger Table* illustrates many of the essential characteristics of strip maps as set out in MacEachren (1986) five-level schema of ‘stripness’:

Level 1: linear form omitting geographic detail beyond a narrow route corridor,

Level 2: orientation with a direction other than north at the top, not orientated along a cardinal direction,

Level 3: lack of concern with geographic orientation; no indication of cardinal directions given, Level 4: relaxation of planimetric accuracy to allow variations in scale and orientation between different parts of the map so as to maintain the linear format of the route,

Level 5: strict linear representation of route way with complete disregard to consistent scale or direction.

(Following MacEachren 1986, 8.)

It is apparent that as the ‘stripness’ level increases in MacEachren’s schema, so does the degree of distortion from accepted topographic norms. Strip maps become increasingly abstract models of reality, such that at fifth level in the schema they could more easily be classified as non-geographic diagrams rather than maps. Diagrammatic strip maps such the London Tube ‘map’ or the *Peutinger Table* are excellent for wayfinding, but only as long as the traveller sticks exactly to the specified routes. As soon as the traveller deviates from these routes, the extent of distortion mean the map is of no use for pinpointing other locations, their relative positions or correct direction between them.

Many surviving medieval maps, that predate the invention of topographic survey cartography of the state, can be usefully classified as strip map according to MacEachren’s schema. The celebrated Gough Map (dating from the 1360s), for example, comprises strip-like representations of major roads and rivers. As such the Gough Map is a route following tool to the early Middle Ages Britain, rather than a scaled topographic map of the landscape (Harvey 1980). Other noteworthy surviving strip maps from the middle ages were for long distance pilgrimages, such Erhard Etzlaud’s *Rom Weg* (Rome way) and the celebrated maps of St Alban’s monk Matthew Paris, that prefigure his itinerary *Chronica majora*, created to lead the faithful to Jerusalem[12].

The opening of ‘age of the stage coach’ in the later part of the seventeenth century and the development of extensive systems of turnpike roads required new process

[12] Although, Connolly (1999, 598) argues that Paris’ maps were actually used for imagined pilgrimages by monks not able to physically travel to Jerusalem: “The Benedictine brother who perused these pages understood this map primarily through its performative possibilities, as a dynamic setting ... that led through Europe to the Crusader city of Acre and eventually to a complex representation of Jerusalem” .

descriptions. Road itineraries and strip maps were printed in quantity for travellers, for example John Ogilby's *Britannia - a Geographical and Historical Description of the Principal Roads thereof* (Figure 8.2). This contained a hundred pages of strip maps showing some 7,500 miles of major road routes mapped at a scale of 1 inch to the mile - it was "Britain's first road atlas" (Harvey 1980, 180). The route to be followed is drawn in near straight lines up the page and a compass is given on each strip to indicate changes in orientation in the roads. As such Ogilby's attractive and functional strip maps can be classified into level two of MacEachren's schema.

<Figure 8.2 about here. Ogilby's strip map.>

An alternative presentation of process descriptions for road travel that does not fit into MacEachren's schema is the textual list. An example of this approach is *Paterson's Roads*, a comprehensive guide book published in 1822 by Edward Mogg. It is sequential itinerary (Figure 8.3), with the central column listing the names of town and village in order they would be encountered by the traveller, along with significant actions/landmarks such as crossing a river (bridge symbol), entry to turnpikes (gate symbol) and left and right hand side turnings (pointing fingers). Different styles of fonts distinguish the relative size/importance of settlements and the outer columns describe points of interest along the route. This simply produced, yet highly functional, representation of process descriptions has much in common with that used by Internet traceroutes discussed below.

<Figure 8.3 about here. Paterson's Roads strip list.>

Such 'strip list' itineraries have become a common way to represent navigational instructions for car drivers. In the last decade or so such route following tool has become individual available through software products like AutoRoute. Also, many motoring websites and mapping portals now provide sophisticated interactive route planner facilities which allow drivers to produce individually tailored journey plans on-demand (Figure 8.3). Again, the form and function of such route following mapping tools for drivers is paralleled directly by Internet traceroutes tools used to map network data flows.

<Figure 8.4 about here. The AA strip list.>

(ii) Aboriginal 'dreaming-tracks'

> Aboriginal Creation myths tell of the legendary totemic beings who had wandered over the continent in the Dreamtime, singing out the name of everything that crossed their path - birds, animals, plants, rocks, waterholes - and so singing the world into existence. (Chatwin 1987, 2)

Besides strip maps and itinerary lists, there are other very different, non-representational, formulations of process knowledge for route navigation which have real utility in thinking about alternative ways of mapping the Internet. The contemporary example of route representation for car drivers shown above, is focused on transiting people efficiency across space by *disconnecting* them the local situation as far as possible, thereby eluding the social meanings and the multiple histories embedded in the landscape being traversed. Yet, when thinking about the possibilities of counter-cartography, perhaps there should be a positive attempt to create alternative route mappings that work by *reconnecting* people with the landscape they are travelling through by describing places encountered in terms of their social meanings and communal memories. Clearly this is a major challenge, but the complex spatial-spiritual mappings of Australian Aboriginal groups open-up interesting epistemological possibilities for just such a 'reconnection'[13]. In particular, songlines[14], the narrative poems that were chanted ceremonially by many Aboriginal groups to describe the routes of their totemic ancestral beings criss-crossing central Australia, provide a vibrant non-western, performative model for creating and communicating process descriptions of the environment and, more speculatively, for

[13] Aboriginal maps encompasses a diverse range of forms, including landscape iconography and mapping performances (see Sutton 1998a,b). The best known examples, following their success on the international art market, are the acrylic dot paintings from Central Australia which often represent, in plan view, elements of landscape topography using stylised graphical forms to link physical features to totemic meanings. To read them correctly requires a very different cultural context to a Western Cartesian one (Turnbull 1993).

[14] Popularised and romanticised by Bruce Chatwin's (1987) best selling fictional treatise on nomadism. Chatwin's conceptualisation of songlines was based largely on the work of anthropologist T.G.H. Strehlow who dedicated decades of his life to studying Western desert Aboriginal groups, including their sacred songs. Strehlow published his findings in a monumental and controversial book, titled *Songs of Central Australia,* in 1971.

reconceptualising the mapping the Internet at the level of network connectivity and data flows (also see Staple 1995 in this regard).

Songlines were not representations of the territory according to the conventions of Western cartographic texts, but a form of oral performance that continually (re)created a culturally meaningful ontology of connected places based on the 'footprints' of the spirit ancestors[15]. The songs were an integral part of the 'Law', the matrix social-cultural practices and conventions, believed to derive from Dreamtime (the eternal past-present when the world was brought into being), that governed Aboriginal life. As such "[t]hese 'primitive' songs were never regarded as the idle personal vapourings of poets" (Strehlow 1971, 678), instead they held an indispensable role in the ongoing spiritual life of communities, and were continually brought alive through embodied practices of music-making and dancing, and folded into religious ceremonies at particular sacred sites. On aesthetic grounds, songlines were also far from 'primitive'. They were complex, linguistically elaborate, multi-layered with symbolic meanings and their performance, covering many cycles of narrative verse, could last days (Berndt and Berndt 1964, 307-320). Elkin (1964, 304), for example, cites the *Djanggawul* dreaming that contained 188 song cycles, which when translated and transcribed into text ran to over ninety pages. As such they are equal to any of Western hymns and epic chanted verse and provide one of the most impressive examples of cultural knowledge creation in pre-literate societies (Strehlow 1971). While it is patently impossible to adequately convey songlines in written form, see Figure 8.5 for an illustrative fragment.

<Figure 8.5 about here. Strehlow's segment of Honey Ant verse.>

Descriptions of the pathways through the land ritually intoned in songlines were elemental to belief structures of some Aboriginal groups because their nomadic lives were deeply tied to their environment with a degree of intimacy that is hard for most

[15] I consciously describe songlines in the past tense as it unclear the degree to which they survive within contemporary Aboriginal life. I am also alert to the dangers, as a white, Western academic in an elite university, of drawing superficially on indigenous concepts as an example superficial neo-colonialist cultural appropriation of the 'exotic'. Indeed, similar accusations were levelled at Chatwin at the time publications of *The Songlines.*

‘modern’ Western peoples conceive. As such they provide a powerful example where the map and the territory are one; events in the songlines, as Burrows (1999, 187) notes, are “frozen as the visible and enduring features of the landscape. In this way the landscape is appropriated for the mindscape.” Songlines can be conceived as cognitive strip maps that had power to beckon space into being for Aborigines: “Creation occurs by means of song ... as though the landscape is a musical score” (Judge 1998, 184).

The notion of beckoning ones ‘home’ spaces into existence by performance (writing, painting, songs and so on) has been discussed by a number of geographers, most notably in Yi-Fu Tuan’s work on place-making through language. Crucially, this is not merely the description of land, as Tuan (1991, 688) argues that “[n]aming is power - the creative power to call something into being, to render the invisible visible, to impart a certain character to things”. In terms of cartographic practices, a number of critical scholars have pointed to the power of toponyms in literally creating the landscape, particularly in the context of colonial mapmakers denial of indigenous place names (e.g., see Harley 1988a; Rundstrom 1991). The political significance of the (re)naming of Ayers Rock as Uluru being an apposite Australian case. Such processes of ‘creating through naming’ are foundational in many religious stories in different cultures. In Christian mythologies, for example, it is recounted mostly powerfully in the Book of Genesis:

> And God said, “Let the water under the sky be gathered to one place, and let dry ground appear.” And it was so. God called the dry ground “land”, and the gathered waters he called “seas”. And God saw that it was good.

Songlines where not only spiritually powerful in creating home space, they had everyday practical significance for people navigating from place-to-place. They were an accumulation of detailed environment knowledge, recorded in poetic forms, and recallable through song performance. Songlines as maps in the mind were performative mnemonic devices. Every part of a route had to recorded, so unspectacular parts of the landscape, at least to outsiders eyes, were significant elements in the song. The geographical and temporal sequence of locations of water, food sources and shelter encountered is preserved in the unfolding order of the songline narrative (Figure 8.6) which itself became essential in understanding the *meanings* of the travels of the totemic beings during Dreamtime. “The ‘roads’ or routes must be followed and everything of significance sung, because the past is perpetually and causally related to the present” (Elkin 1964, 303). According to Chatwin (1987, 13) songlines functioned as “both map and direction finder. Providing you knew the song, you could always find your way across country”. As such they were a vital element in survival systems for Aboriginal groups because of the unpredictability of water and food supplies in much of Central Australia. So accurate, recallable knowledge of sustaining routes was not a religious indulgence, it was very much a matter of live and death. The utility of Aboriginal tracks, envisioned through songlines, was recognised, although probably little acknowledged, by some white explorers who ventured into the vast ‘unmapped’ Australian outback at the end of nineteenth century. Mulvaney (2001, no pagination) for example quotes Walter Roth who noted in 1897: “for future pioneers .... a knowledge of the aboriginal lines of travel or trade-routes might prove of great value, since only along them would there be a chance of finding water.”

<Figure 8.6 about here. Path map of verses of Inma Langka.>

Songlines are a particular kind of memorialised mapping performance which grew from a human metaphysical sense of spatiality premised on route rather an area-based containers. “Aboriginals were wanderers ...[they do] not imagine territory as a block of land hemmed in by frontiers: but rather as an interlocking network of ‘line’ or ‘ways through’” (Chatwin 1987, 56). This conception was determined environmentally to a large degree, as the scarcity of readily accessible water meant it was not possible to deviate from sustaining routes. Indeed, the land between songlines that was too far from water for safe walking was a “kind of no-man’s-land .. [with] no permanent economic value and ... little, if any mythological significance” (Elkin 1964, 177). In comparison white pastoralists with a alien European spatiality of fixed, fenced-in farming and desire to capitalise all available territory wrought tremendous damage on the Australian ecosystem within a few decades of their arrival. The Aboriginal networked conception of spaces as ‘ways through’ resonates with the Internet, particular regarding the forms of information spaces that are delineated by hyperlink pathways rather than well bounded areal territory (Judge 1998; Staple 1995).

Several other aspects of songlines are of relevance to thinking about network counter-mapping of the Internet using traceroutes. Firstly, songlines speak to a mode of mapping that is embedded in the continuous flow of historical detail and is highly socially situated, a 'writerly' performance where there is no meaningful separation between author and reader. As such they, arguably, represents a powerful countervailing to the Western cartographic trajectory towards technological domination of the landscape and instrumentalist production of externalised, disembodied route mapping. Secondly, songlines were built from particular knowledges enacted by people in places, rather than as generalisable geospatial data held separated in material texts. Following from this, unlike most Western mapping, songlines make no truth claims for completeness of coverage: "one of the most important aspects of Aboriginal knowledge systems is that they do not universalise. Moreover, the fact that knowledge is localised and specific is one of the keys to its value" (Rose 1996, 32). As such the notion of general purpose map cartography, reusable across different contexts, would have been a wholly foreign concept, instead Sutton (1998b, 399) notes, Aboriginal maps are "unique performances, like most ceremonial enactments .... While elements of both maps and ceremonies may remain constants, their selection and combination in each case is always likely to be event specific." There maybe repetition of the performance, but this can never reproduce the same map. Thirdly, Aboriginal mapping is also inherently limited in scale because "[c]reating a 'map' is an act of asserting one's associations with land. Since one can speak only for one's own area, such maps must normally be expected to be geographically egocentric" (Sutton 1998b, 399).

Despite, the inherent local nature of songline performance, they were reported to have stretched for hundreds of miles, with some reaching right across the continent. This was possible because of there co-authorship across communal groups. "As a rule no local [group] owns a complete myth." (Berndt and Berndt 1964, 201) and the sharing of process description, with each part linking to the next to complete a route, meant that "all those whose countries, irrespective of tribe, are situated along the path ... have a secret bond of friendship and a mutual claim to hospitality and protection"

(Elkin 1964, 177-79). In the songs of *Wadi Gudjara (Two Men)*, for example, the supernatural beings wandered across most of Great Victoria and the Western Desert, "passing through dozens of local group territories and covering possibly twenty-five to thirty dialect or language units" (Berndt and Berndt 1964, 201). Empirical studies of the migration of oral culture as well as the physical movement of material artefacts (such as hatchet stones, shells and ochre) demonstrate that many songlines operated as routes of trade, sometimes over very long distances (Mulvaney 2001). Despite outside perceptions of Aborigines as 'primitive' and scattered hunter-gatherer peoples, the result of songlines was that "[t]he whole of the Australian mainland was part of one vast system of trade and knowledge, and information networks are apparently thousands of years old" (Rose 1996, 43-44). The concept of songline networking is evocatively captured in David Mowaljarlai's *Bandaiyan* map (Figure 8.7).

<Figure 8.7 about here. Bandaiyan map.>

As a form of process knowledge for guiding movement through landscapes rich in memory and meaning songlines offers up a holistic and naturalistic mode of mapping that provides an effective antidote to the individualistic and mechanistic metaphors and Cartesian maps that underpin so many of the metaphors and representations of the Internet (see chapter four). Therefore, in terms of questioning cartographic conventions and highlighting the different potentialities for network counter-mapping, most especially in terms of performance, songlines are a useful cognitive mode for the thinking about Internet traceroutes. If songlines created route knowledge that successfully constructed Australia for Aboriginal communities for thousands of years, can traceroutes work as virtual songlines to construct the Internet for its emerging virtual communities?

4. Traceroutes

Freely available software tools called traceroute can empower people to perform network mapping for themselves and, thereby, begin to reveal the unseen structures of their Internet. The resulting traceroute maps are valuable process descriptions and a means to actively explore both the internal topology of Internet connections and gain some sense of the external geographic location of infrastructure nodes. To some degree these software tools can be conceived as a mode of network counter-mapping in that they provide new perspectives on the Internet not typically seen. They are also political in sense that look ‘beneath’ the surface veneer of Web interfaces which “tend to keep users naïve about the apparatus that organizes and facilitates online navigation and how its processes occur in time and extend across space” (Parks 2004, 39).

While it is possible to learn a lot about the Internet from critical scholarly writings, by deconstructing popular discourses and through the analysis of secondary statistical data (e.g., see Dodge and Kitchin 2000a), for real understanding, there is no substitute for ‘going out into the field’. One way to do useful network fieldwork ‘inside’ the Internet is to use traceroute to examine its infrastructure operations first-hand, seeing how it is inter-connected and the particular routes data takes to specified destinations (Dodge 2000d; Dodge and Kitchin 2006). An engagement with the infrastructure through network fieldwork can help to foster a more critical engagement with the media and can contribute, in a small way, to changing users of the Internet from passive consumers to more informed and active citizens of their network. Empowering users in this way raises technical literacy and diminishes the ‘knowledge gaps’ between experts and amateurs (Parks 2004, 40) and is one of the most effective ways to respond to Guédon’s (2002) lament on enforced technical passivity quoted at the opening of this chapter.

Importantly, to use traceroutes as a network fieldwork tool it is not necessary to be an ‘authorised’ network engineer or ‘professional’ computer scientist. Anyone can begin to probe the workings of the Internet without permission because the Internet is built and operated in a fundamentally different way to other large communication networks, like the telephone system. These other networks are closed systems built on proprietary infrastructures, and purposefully try to keep ‘consumers’ away from their inner workings. The Internet, on the other hand, was purposefully designed as an open network that in some senses encourages active exploration and experimentation. Because the Internet is a ‘network of networks’ and not a single entity under the control of a one institution, it can only operate via public agreements to share data freely between its myriad constitute parts using open protocols (the core one being TCP/IP). Thus anyone can use the Internet as long as long as they follow the protocols, and consequently users are able to take an active role in producing the network themselves (quite different from the telephone). Many of the most effectual

Internet services came about via ‘bottom-up’ innovation from researchers, students and enthusiastic users exploiting this open architecture to try out new things[16].

Network counter-mapping using traceroute does not require a large investment in expensive, specialised equipment because the Internet can be used to measure and map itself. Traceroute as utility software is universally available on PCs as component of the operating system. It was created in 1988 by Van Jacobson at Lawrence Berkeley National Laboratory in the U.S., for practical engineering purposes of ‘debugging’ network problems (see Carl 1999; Rickard 1996). In spite of the thoroughly technocratic origins of traceroute, it can also be re-conceptualised in politically challenging ways, providing tactical spatial knowledge of the media that can not be gained in any other way; for example, Cukier (1999 and 2000) used traceroute data in support of his arguments on bandwidth colonialism (see chapter six). Indeed, Pickles (2004a, 194) advances exactly this notion re-deploying and re-writing what seem ostensibly hegemonic mapping instruments as one route to new forms of progressive cartographic praxis, arguing there exists the “possibility of opening the contradictory moments within existing practices to new opportunities and alternative projects”.

Traceroutes can provide direct visual evidence of the Internet’s hidden political economy, showing the logics of data routing following the cheapest paths rather than the geographical shortest. (Much international Internet traffic is still routed through the U.S. as the cheapest means of transit between regions.) This can sometime result in anomalous circuitous routes being chosen. Traceroute output can also show which telecommunications carriers dominate the transfer of traffic between certain countries and on key inter-continental routes. These companies are likely to be influential in the structuring of global communications and tracerouting provides an alternative way to quantify the extent of their power (see the work of Sam Paltridge, OECD 2002).

Lastly, the output from traceroute provides a useful way to assess the number of international borders crossed and determine which different territories (i.e., separate

[16] The invention of network email, still the single most important Internet service, in 1971 by Ray Tomlinson, is one of the best examples of this (see Abbate 1999).

legal jurisdictions) the data transits. The more ‘points of contact’ in the flow from origin to target, the more potential there is for Internet traffic to be intercepted and subjected to local regimes of monitoring, filtering, censorship and data retention (e.g., see Reporters without Borders 2003). Does data flows transit through a third-party nation that has hostile intentions. Particularly in regions of conflict, being able to identifying territories that are transited might be vitally important in terms of assessing the risks in communication. For example, does an email to someone in Palestine transit through Israel?

(i) Traceroute as a mapping methodology

Traceroute ‘mapping’ is trivial to perform by simply typing the command and a target Internet host[17]. While the results are sparse black and white text rather than a elegant graphical map[18] (Figure 8.8), they are nonetheless a really useful starting point for network counter-mapping the Internet. In representational terms traceroute’s sequential output is a ‘strip list’ closely comparable semiotically to Paterson’s Roads from 1822 (Figure 8.3) and a virtual equivalent to the AA driver’s route (Figure 8.4).

Traceroute produces a process description of the path that data packets take between two points on the Internet, showing all of the intermediate nodes traversed, along with an indication of the speed of travel for each segment of the journey. Process descriptions from traceroute, with some careful decoding, can reveal much of about the complex geography of routing data across the Internet showing how many nodes are involved (often more than twenty), the seamless crossing of oceans and national borders, and the convoluted transfers through separate networks, often owned and operated by competing companies.

<Figure 8.8 about here. Tracert screenshot>

The process description gathered concerns logical routing (at layer three of TCP/IP five layer network model) and thus presents only a ‘high-level’ summary of the

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[17] On Window PCs this is done in the command prompt as: ‘tracert hostname’.

[18] Although, this data can be visualised in more sophisticated fashion, including with geographic mapping of the output. For details, see <www.cybergeography.org/atlas/routes.html>.

network in terms of topological connections. Below traceroute's view of the Internet there is a much more detailed level of telecommunication infrastructures which handle packet transport (so called layer two) and then there are physical cables in the ground (layer one). These lower-levels of detail are not measurable using present fieldwork techniques.

To illustrate what can be learnt from tracerouting the Internet, it useful to decode one in detail. The example taken here is a trace from a PC in London to the `www.jasonnolan.net` website[19]. While simple to perform, decoding the output of a traceroute does require some effort. At first glance it does look rather cryptic. The traceroute example (Figure 8.8) gives a complete linear route listing showing how data packets travelled through the Internet starting in London and ending at Houston in the U.S. the apparent location of the Web server which publishes `www.jasonnolan.net` website[20]. Each line identifies the name of network node traversed along with three time measurements in milliseconds - such as `211ms 180ms 170ms`. Each node traversed is identified by its domain name and numeric IP address. These node name are rather strange, long domain names (e.g., `dllstx1wcx3-pos6-0.wcg.net`) and they are routing computers at the core of the Internet; their domain names are not normally seen by users. With a little bit of more decoding many of these router domain names yield useful information, such as the type of hardware, the bandwidth of the link, the name of ISP that owns a node and most importantly a node's approximate location (usually at the city level)[21]. Fortunately, for traceroute decoding, many of the large ISPs apply a consistent naming conventions throughout their network infrastructures (as can be seen from the domain names of nodes owned by `wcg.net`, Figure 8.8).

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[19] The choice of destination host is immaterial to understanding the traceroute process. For convenience this particular example was taken from Dodge and Kitchin (2006).

[20] This likely location was determined as reliably as possible by looking up the registered owner of the IP address (64.246.60.38) and through traceroutes (see Dodge and Kitchin 2006).

[21] The geographic location of the node is often represented in these types of domain names as an abbreviated city name. For example, `dllstx` at the start of segments 12 and 13 could sensibly be guessed to mean Dallas, Texas. Some ISPs use the familiar three letter airport identification codes (e.g., LHR for London Heathrow) as their city naming convention.

In terms of interpretation of structure of the space of flows in the journey to www.jasonnolan.net presented in the traceroute 'map', the first thing to note is that data travelling from London to the destination passed through sixteen intermediate network routers, to reach the target (node 17). At least three different networks were traversed, British Telecom (BT), Williams Communication Group (WCG), and Everyones Internet.

Reading the route line by line, it begins with the first node showing how a user's PC is connected to the Internet. From the domain name we can see that it belongs to bt.net. From local knowledge, it is known that ealing in the domain name is also an area in West London, so we can take this is an indicator of its likely geographic location.

The next 'hop' in the journey to node 2 is rather mysterious with no domain name to decode. We have to assume it is a node within BT's network in London. Node 3's domain name indicates it is a another BT node in Ealing, London. Node 4 again says ealing and BT. The node also states ukcore which we might reasonably take to mean this node is within BT's core network for the United Kingdom. Node 5 is also in BT's ukcore network. Notice, the increase in latency as measured by the RTT at this point in the journey. At 'hop' 6 in the journey the data leaves BT's network and is handed off to another ISP called wcg.net (Williams Communication Group, now part of Wiltel corporation). The cryptic abbreviation at the start of the domain name (lndnuk1icx1) can reasonably be decoded as London, UK. The convention on this ISP's network is to start the router domain names with a 4 letter abbreviation of the city, followed by a 2 letter code for country / U.S. state. Note, the big jump in RTT and the appearance of * for two of the times (this means timed-out, no response) at this point, probably due to traffic 'congestion'.

The next segment in the journey sees the data packets cross the Atlantic to New York, most likely on an undersea fibre-optic cable. The start of the router domain name for node 7 is nycmny which can be decoded as New York City, Manhattan, New York. The RTT increases greatly at this point, again with two * timeoutes. From New York the data travels on wcg.net network to hrndva at nodes 8 and 9, which is Herndon, Virginia (one of Washington D.C.'s satellite towns which has a great deal of Internet infrastructure related companies). The next two steps in the journey on wcg.net's network are in `drvlga` which is somewhere in the state of Georgia. However, it is not immediately obvious which town `drvl` refers to, likely it is a suburb of Atlanta, the main Internet hub point for the state. Approaching the end-point, as the data moves on into the state of Texas, going through Dallas (`dllstx`) in nodes 12 and 13 and then to final destination, the city of Houston, Texas (`hstntx`) at node 14. At node 15, the wcg.net network exchanges the data to a new company, everyonesinternet (Everyones Internet, Inc). Nodes 16 is most likely on EveryonesInternet network but the router does not have a domain name, so it is hard to know for sure. Node 17, somewhat confusingly called `jessica.cpanelserver.co.uk`, is the domain name of the Web server that hosts `http://www.jasonnolan.net` website. (It is unclear why this server in Houston has a *co.uk* domain name.)

This might seem like a complicated Internet journey, but it is fairly typical of the space of flows. Billions and billions of similar journeys are invoked by many millions of Internet users every minute. These happen automatically and usually hidden from users by the interfaces of access software. It is important to realise that Internet routing is dynamic, it can change second by second. The process description produced by traceroute is a live scan and always represents a 'one-off snapshot' of space of flows at the point in time it was charted. Running the same trace at a future time is quite likely to give a different route[22]. Unlike real world routing, data routing through the Internet is not reciprocal. Tracing in the reverse direction from Houston to London could well give a very different traceroute. Furthermore, running thousands of traceroutes (automated with custom software) to lots of different points across the Internet has been used to gather data to chart the topology of the core of Internet as a whole. These have been impressively visualised as massive graphs, providing some of

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[22] To gauge the dynamism and non-reciprocal nature of the space of flows it is useful to run traces from different places on the Internet using Web-based traceroutes (e.g., see list at <http://traceroute.org>). In this way it is possible to 'triangulate' the Internet and to get a sense of the relationship between speed of flow (latency) and geography (physical distance). In the space of flows, just like in the material transportation, this relationship is not always linear because of barriers, lack of connectivity, congestion and poor capacity. Understanding this variability can give insights into underlying structural processes driving the growth of the Internet (e.g., see Murnion and Healey 1998; Murnion 2000).

the most evocative images of cyberspace to date (see Figure 4.9 for an example; Burch and Cheswick 1999; Branigan *et al.* 2001 for details).

5. Are traceroutes meaningful as network counter-mapping?

> You cannot travel on the path before you have become the Path itself.
> --Gautama Buddha

In representational terms traceroutes are limited. Their obtuse output (the end 'representation' of the process description of the space of flows) requires significant effort in interpretation, it lacks spatiality in its presentation beyond sequential ordering of records, and it displays no graphical embellishments to please or beguile the user[23]. In short, traceroutes do not *look* like maps. And yet traceroute do *work* like maps and they are related to long lineage of route mapping tools, able to effectively communicate process knowledge. Taking these normative characteristics as given, I want instead to focus this concluding discussion on the degree to which traceroutes are able to fulfil the criteria for effective network counter-mapping. How far are traceroutes, both as practical software tools and more generally as a concept for mapmaking, able to offer real potential for alternative, anti-hegemonic maps of the Internet? Furthermore, to what degree is it useful to conceptualise traceroutes as a form of performative knowledge like Aboriginal songlines?

The first criteria of network counter-mapping is fractured authorship. This has political implications because many mapmakers, working freely at the local scale, open up new spaces for democratic power in decision-making. Traceroute scores well on this criterion. Conceptually many authors can create their own maps of the Internet using traceroutes without regard to central authority. In practical terms, the rights of authorship is not held exclusively because of the open architecture of the Internet and the wide accessibility to traceroute software.

[23] Indeed, it pointedly appears to be anti-aesthetic, although this was not the case when it was written in 1988 when command-line interfaces still dominated software and the Internet itself was a text-based media.

Yet, there are powerful countervailing forces making it harder and riskier for authors to make their own maps using traceroutes. Individual networks on the Internet are increasingly being designed and operated in a much more closed fashion, which deny rights of authorship to users. An increasing amount of the Internet is also being hidden behind firewalls and thus invisible to traceroute's survey method. For example, UCL have recently begun blocking traceroutes on the campus network as a security precaution against malicious scanning and virus propagation amongst vulnerable PCs. Other areas of the Internet are also using security issues as a way to try to develop more proprietary and profitable business operations in which active users (for example sharing material on peer-to-peer networks and using voice-over-IP) are not welcome.

Next, the scale of mapmaking using traceroute is inherently local and situated rather than global and disembodied, which matches well the needs of democratised authorship. Performing a traceroute reveals the network *umwelt*[24] of the individual mapmaker. This acknowledged egocentric view of the spaces of flow is refreshing in comparison to the claims from other more panoptic and 'objective' attempts to produce universal maps of the Internet. However, it is also problematic from a larger perspective of opening up decision-making, as it is not at all clear how multiple *umwelten* might be linked or combined to 'jump scale' and effect wider power relations[25]. Additionally, there is no guarantee that being able to author traceroute maps leads to more progressive politics. Traceroute software tools are ripe for hegemonic mapping as much as for counter-mapping. Indeed, much of the discourse driving traceroute development in last few years stems from their potential in law enforcement investigations because they can help to overcome the 'cloak' of online anonymity. For example, this is readily apparent when looking at the marketing materials and customer testimonials presented on the website of the leading commercial traceroute application, VisualRoute (www.visualware.com) and in a marketing 'puff-piece' (Goldman 2005) promoting the virtual crime-fighting potential

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[24] This concept was developed by Jakob von Uexküll (1957) to account for the different perceptions of space by animals as particular self-worlds based on the varying capacity of sensing organs and cognitive capacity between species. So a common environment of, for example, a tree would be experienced as different *umwelten* by a beetle and a squirrel.

[25] There is some scope in collaborative Internet scanning projects (see Spring *et al.* 2004), but this is beyond the means of the majority users.

of VisualRoute, with its unique capacity to pinpoint the location offenders by tracing their online activities.

Besides the conflicting democratic potential of traceroute, there is also thorny issue of whether people really want the right of authorship, even when it is available to them. Are most people, most of the time (relatively) happy with being passive consumers and having maps authored for them? Do Internet users want greater technical literacy at the level of understanding data routing? Or are they accepting of their ignorance of the operation of the infrastructures servicing everyday living (electricity, water, communications). As long as flipping the switch, turning the tap and clicking the mouse brings forth the expected commodities then all is fine? It is not at all clear that typical Internet users would be bothered to use traceroute. In such circumstances of ambivalence how genuine is the scope of network counter-mapping the Internet?

The second counter-mapping criteria is the need to ‘rewrite’ cartography to create novel mapping that can show changes. Traceroute truly excels on this criteria, offering temporal sensitivity to capture the essence of the data flows that is absent in the vast majority of other maps of the Internet. Every traceroute, drawn of the moment, is a unique timespace map of its own making. It is sensitive to kinetic dimensions of the spaces of flows, felt in millisecond of CPU clocks and software code rather than biologically-sensed durations of minutes, hours and days of the human chronology. Traceroute as inherently time-sensitive counter-mappings which privileges fields of activity above fixed spaces of ownership.

This is not only of practical relevance for making maps of the Internet, it also has wider political implications for cartographic praxis. Traceroute focuses our attention on possibilities to map dimensions of ‘real time’ processes via dynamic scanning of timespaces is its the most significant contribution to counter-mapping. This contribution is aligned with Virilio’s (1997) philosophies of speed in which he asserts that a focus on understanding real-time will be as significant as the discovery of real space perspective by Italian artists in the Renaissance for our perception of the world. As real-time increasingly supersedes real-space in structuring many human activities then traceroute is, at least tentatively, one of first mapping methods to make this visually accessible to people.

In terms of the third criteria, counter-mapping must seek creative ways to collapse the unproductive map-territory dichotomy of Western spatial essentialism, such that space changes, fundamentally, from *being* to *becoming*. Traceroute achieves this, following on from its focus on temporalities, because it conceptualises the space of flows not as a thing itself (that can be deterministically mapped with conventional cartographic techniques), but as a space beckoned into existence by continuously unfolding dynamic fields of activity. Traceroute works here because it is actively scans rather than passively monitors. The action of scanning can be seen, in a dialectical sense, as making a flow through space so as to map the flow. Traceroute is, therefore, actually an ontogenetic mapping method; much like the notion of songlines where Aboriginal trails are continuously brought into through the singing of the routes.

In using traceroute tools as network counter-mappings, the act of performing the tracing (a hybrid human-software process) beckons the space of the flows into being. The pathway to be the traced ('the territory') and the tracing of it ('the map') are a single space, made in the moment inside the network from the movement of packets of data. The network infrastructures, in terms of wires, routers, electrical power and software are pre-existent, but the space of flow mapped literally does not exist until the moment of the traceroute performance. This instance of the space of flows ceases to exist upon completion of the trace. The next traceroute command a user performs - which exists at a new point in real-time of course - may well repeat the route (making use of the same wires, routers, code, etc.) but it can never traverse the same territory, it *must* become its own path afresh, it *has* to 'sing' its own space of flow into existence. This novel kind of ontogenetic mapping of the Internet is bringing forth what Virilio (1997, 24) calls the trajective, the momentary spaces in-between the subjective and objective, a "being of movement from here to there, from one to the other."

The last criteria of network counter-mapping concerns the privileging of performance above the product and this is the crucial point in assessing traceroute's efficacy. Is tracing the space of flows really performance or merely an automatically generated representation? People run traceroutes to map out their own data route through the space of flows, but they never travel themselves, they never embody the flow, so how far does this really a constitute an embodied performance? Are they singing their Internet into existence or merely watching a bit of software operating? Is the text written onto the screen a songline through cyberspace or just a mechanical output from a clever algorithm?

Initially, the degree of performativity in tracerouting seems limited. While it is an embodied practice to *initiate* (a person must sit at a computer and interact via keyboard and screen to enter a command), however, once the enter key is pressed, the tracing process becomes solely a software practice that is essentially ‘black-boxed’ from the users until the text is written back out to the screen. Consciously, in the previous section, the actual algorithm that traceroute software uses to calculates the route of the data was not explained. (At one level, this is not necessary to know to make traceroute tools work, although, most technical guides (e.g., Rickard 1996; Carl 1999) revel in explaining the full detail; it is actually an ingenious ‘hack’.) Thus tracing has little of the energy, the unthinking playfulness, the spontaneity of being, commonly associated with performativity.

Once the traceroute software has completed and written out the result to the screen the human is called upon to read the route. The question here is whether decoding the trace text is performative in equivalent ways to reading poetry, telling a story or singing a songline? The kind of close reading of the traceroute text as presented here is perhaps more like a deconstruction of a text and again lacks much of the unconscious energy and unspoken creativity that is commonly associated with performative actions.

The deeper problematic aspects of advancing traceroute as performative is the degree to which it really shifts analytical attention from representation to practice. The mapping practice is really about decoding the traceroute representation (as seen in the previous section). So tracing network songlines is a practice that can only be humanly embodied as a text (literally lines of text representing the data route hop-by-hop). So performing traceroutes might actually be said to takes us backward to strictures of texts.

In terms of performativity theory, there is also an issue about trying to draw a conceptual linkage between traceroutes and songlines in terms of the dangers of romanticising ‘primitive’ knowledges as more animate and unthinking. The result, one might argue, is actually obfuscating the material reality of the Internet’s operation by this call to more an ‘authentic’ indigenous knowledge (which is based on an essentialist Western readings of nature and the nomad). Is the attempt to link traceroutes to songlines merely part of a “classically Romantic tradition of desiring to return to an unmediated, authentic relationship to the world, to be like ‘primitive’ others who are unburdened by thought .... to reject the modern in favour of the ‘primitive’” (Nash 2000, 657).

However, having run many traceroutes myself, I would counter that it *can* be conceived as a performance, but of a new form. It is coded performativity, which hybridises the actions of human initiative and intuition with software celerity and diligence to conjure a unique understanding of the real-time of the Internet. The resulting folding together of practices, relates directly to what Thrift identifies as “a sensitivity to the prediscursive *and* discursive, to the part-practical *and* part-representational” (quoted in Nash 2000, 661, original emphasis). It combines the abilities of (warm) human practice, with the algorithmic capacities of (cold) code. The software sings in combination with the user to beckon trajective spaces into being. One cannot see or touch the software ‘singer’, yet when compiled and executed it becomes animate in its own kind of way. More and more of the living spaces are becoming animate through such coded performances (see Dodge and Kitchin 2005; Thrift and French 2002.)

Lastly, whilst acknowledging that traceroutes are imperfect in several respects, they do nonetheless offer a viable and meaningful route to for network counter-mapping because they have genuine potential to effect a shift in mentality from publishing a universalist Map of Internet, to manifold local performances of internet mappings. Furthermore, like songlines, traceroutes challenge the Cartesian conventions of geographic mapping dominated by topographic representations, engaging attention on the new and pressing “spatialities of connectivity, networked linkage, marginality and liminality, and the transgression of linear boundaries and hermetic categories - spatial ‘flow’ - which mark experience in the late twentieth century world.” (Cosgrove 199b,

5) Yet, perhaps the greatest change that traceroute presage will not be in the performance of mapping per se, but the attitudes of the map performers: “By evolving maps which speak our alternative, we will more importantly be evolving ourselves. We will be transformed by the active reinhabitation of place” (Aberley 1993, 131).

Figure 8.1: Part of the *Peutinger Table (Tabula Peutingeriana),* a narrow strip map measuring 6.75 meters long and only 34 cm wide. The sequence of the cities, spas and staging posts on the map, and indications of distances between them, provided valuable process knowledge for route following in Roman times. (Source: <www.culture.gouv.fr/culture/archeosm/archeosom/istre-m2.htm>.)

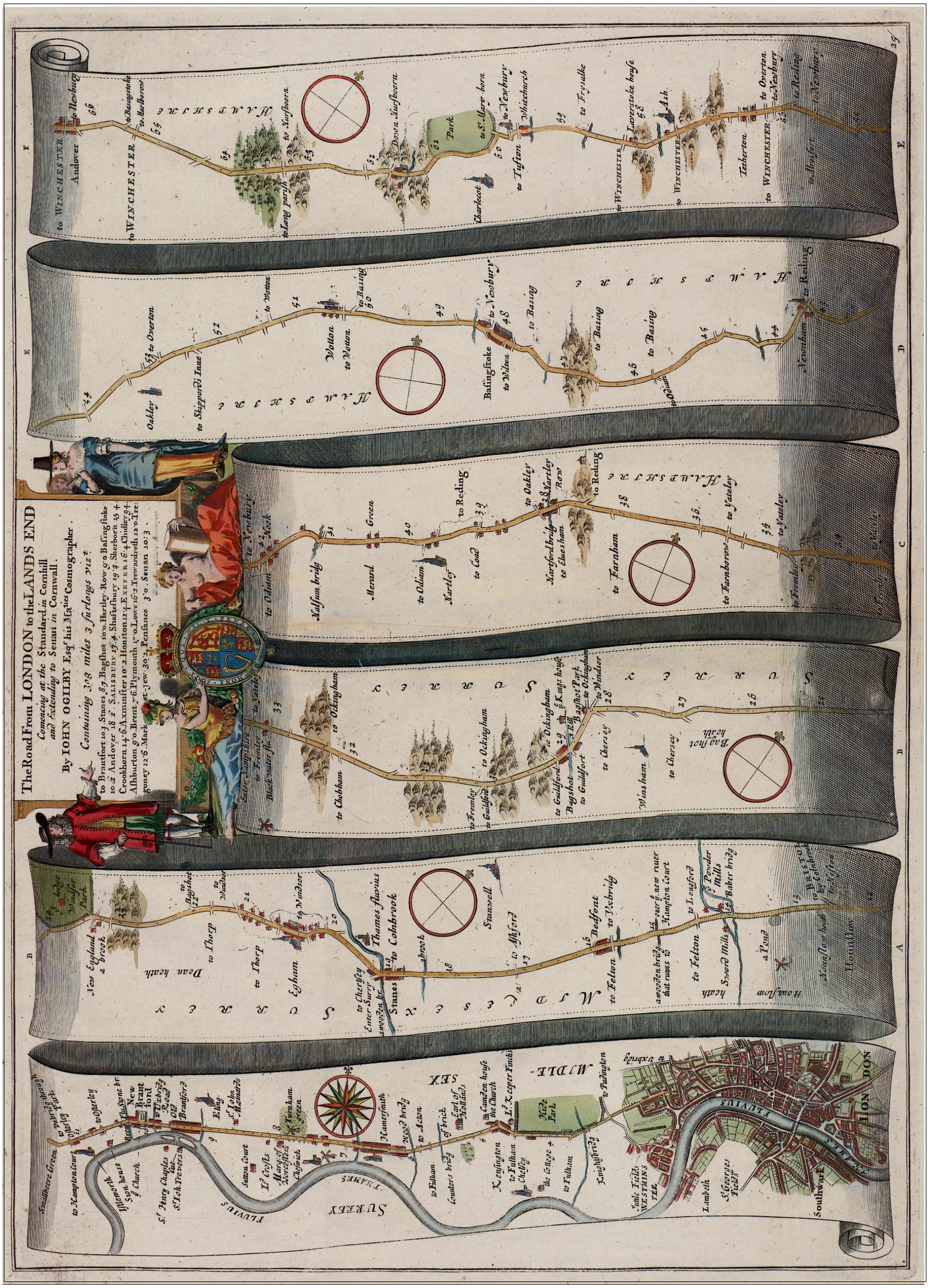
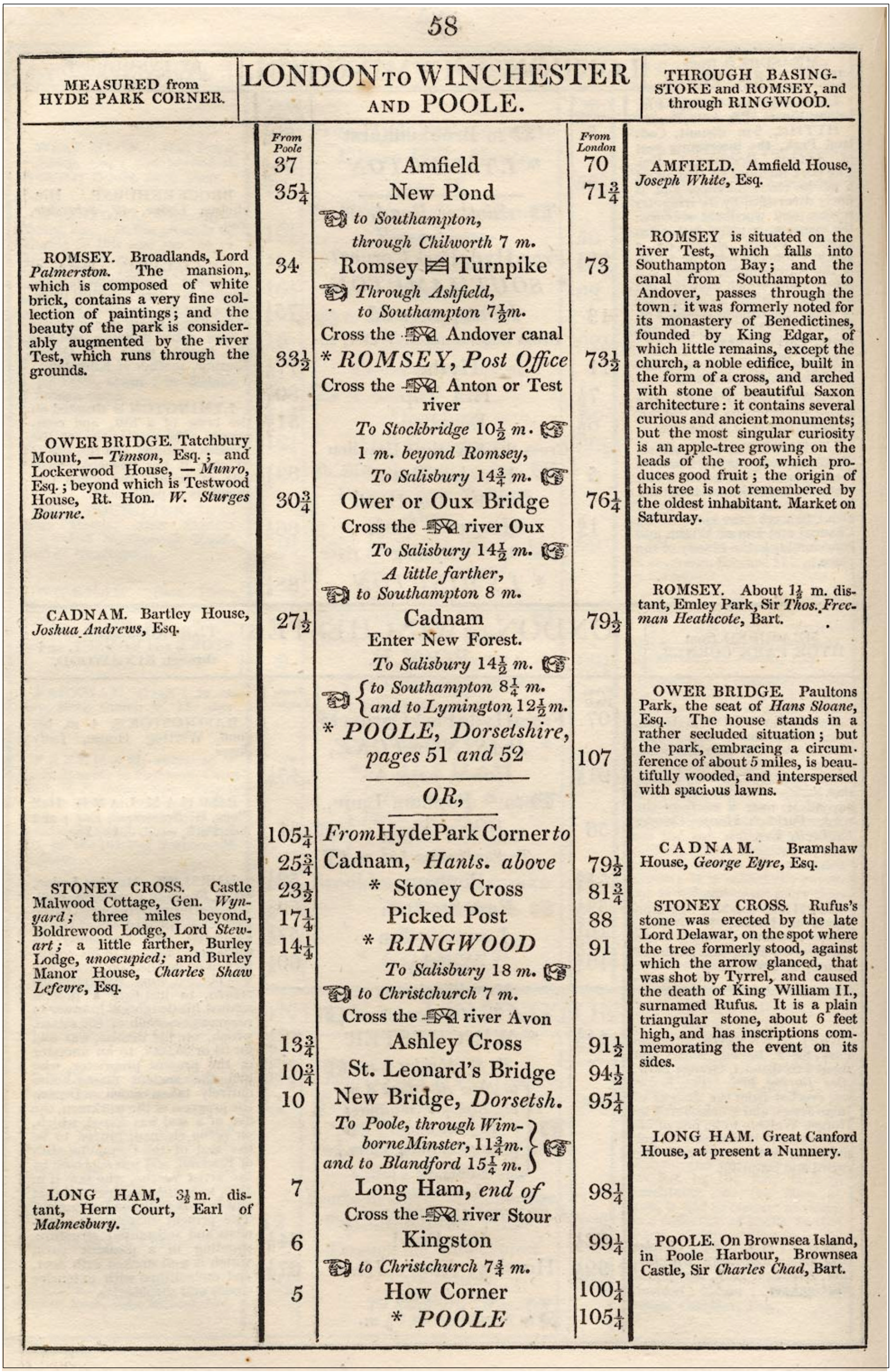


Figure 8.2: An example of an seventeenth century English strip map for road navigation. Distance is marked out per mile by numerical labels and dots in the road. Limited topographic detail directly encountered on the route is given via pictorial hill symbols. (Source: Martin and Jean Norgate, *Old Hampshire Mapped* website, <www.geog.port.ac.uk/webmap/hantsmap/>.)



58

MEASURED from HYDE PARK CORNER.

LONDON TO WINCHESTER AND POOLE.

THROUGH BASINGSTOKE and ROMSEY, and through RINGWOOD.

From Poole		From London
37	Amfield	70
35¼	New Pond	71¾
	☞ *to Southampton, through Chilworth 7 m.*	
34	Romsey Turnpike	73
	☞ *Through Ashfield, to Southampton 7½m.*	
	Cross the Andover canal	
33½	* *ROMSEY, Post Office*	73½
	Cross the Anton or Test river	
	To Stockbridge 10½ m. ☞	
	1 m. beyond Romsey, To Salisbury 14¾ m. ☞	
30¾	Ower or Oux Bridge	76¼
	Cross the river Oux	
	To Salisbury 14½ m. ☞	
	A little farther, ☞ *to Southampton 8 m.*	
27½	Cadnam	79½
	Enter New Forest.	
	To Salisbury 14½ m. ☞	
	☞ { *to Southampton 8¼ m. and to Lymington 12½ m.*	
	* *POOLE, Dorsetshire, pages 51 and 52*	107
	OR,	
105¼	*From* Hyde Park Corner *to*	
25¾	Cadnam, *Hants. above*	79½
23½	* Stoney Cross	81¾
17¼	Picked Post	88
14¼	* *RINGWOOD*	91
	To Salisbury 18 m. ☞	
	☞ *to Christchurch 7 m.*	
	Cross the river Avon	
13¾	Ashley Cross	91½
10¾	St. Leonard's Bridge	94½
10	New Bridge, *Dorsetsh.*	95¼
	To Poole, through Wimborne Minster, 11¾m. and to Blandford 15¼ m. ☞	
7	Long Ham, *end of*	98¼
	Cross the river Stour	
6	Kingston	99¼
	☞ *to Christchurch 7¾ m.*	
5	How Corner	100¼
	* *POOLE*	105¼

ROMSEY. Broadlands, Lord *Palmerston.* The mansion, which is composed of white brick, contains a very fine collection of paintings; and the beauty of the park is considerably augmented by the river Test, which runs through the grounds.

OWER BRIDGE. Tatchbury Mount, — *Timson,* Esq.; and Lockerwood House, — *Munro,* Esq.; beyond which is Testwood House, Rt. Hon. *W. Sturges Bourne.*

CADNAM. Bartley House, *Joshua Andrews,* Esq.

STONEY CROSS. Castle Malwood Cottage, Gen. *Wynyard;* three miles beyond, Boldrewood Lodge, Lord *Stewart;* a little farther, Burley Lodge, *unoccupied;* and Burley Manor House, *Charles Shaw Lefevre,* Esq.

LONG HAM, 3½ m. distant, Hern Court, Earl of *Malmesbury.*

AMFIELD. Amfield House, *Joseph White,* Esq.

ROMSEY is situated on the river Test, which falls into Southampton Bay; and the canal from Southampton to Andover, passes through the town. it was formerly noted for its monastery of Benedictines, founded by King Edgar, of which little remains, except the church, a noble edifice, built in the form of a cross, and arched with stone of beautiful Saxon architecture: it contains several curious and ancient monuments; but the most singular curiosity is an apple-tree growing on the leads of the roof, which produces good fruit; the origin of this tree is not remembered by the oldest inhabitant. Market on Saturday.

ROMSEY. About 1¼ m. distant, Emley Park, Sir *Thos. Freeman Heathcote,* Bart.

OWER BRIDGE. Paultons Park, the seat of *Hans Sloane,* Esq. The house stands in a rather secluded situation; but the park, embracing a circumference of about 5 miles, is beautifully wooded, and interspersed with spacious lawns.

CADNAM. Bramshaw House, *George Eyre,* Esq.

STONEY CROSS. Rufus's stone was erected by the late Lord Delawar, on the spot where the tree formerly stood, against which the arrow glanced, that was shot by Tyrrel, and caused the death of King William II., surnamed Rufus. It is a plain triangular stone, about 6 feet high, and has inscriptions commemorating the event on its sides.

LONG HAM. Great Canford House, at present a Nunnery.

POOLE. On Brownsea Island, in Poole Harbour, Brownsea Castle, Sir *Charles Chad,* Bart.

Figure 8.3: A page from a detailed route itinerary from London to Poole spatialised as a ‘strip list’ rather than a map. It is taken from a book of itineraries called *Paterson’s Roads*, published in 1822. In many respects the ‘strip list’ provides comparable amount of process knowledge as the Kitchin strip map shown in the previous figure. (Source: Martin and Jean Norgate, *Old Hampshire Mapped* website, <www.geog.port.ac.uk/webmap/hantsmap/>.)

AA Route Planner Great Britain

Your route results

From Queenborough,Kent
To Chislehurst,Kent | Reverse this route
Distance 40.7 miles | Show distances in kilometres
Time 0 hr 57 min

Plan a new route | View a map of your route

Travel (miles)	and then	to take	total (miles)
0.00	**Start out at** Queenborough,Kent	**B2007**	0.00
0.18	At roundabout take the 3rd exit onto Queenborough Road - A249 (signposted Maidstone)	A249	0.18
0.80	At roundabout take the 2nd exit onto Sheppey Way - A249 (signposted Maidstone)	A249	0.98
1.76	Kingsferry Bridge	A249	2.74
3.27	Bobbing Interchange	A249	6.01
0.65	Junction with A2	A249	6.66
2.10	Junction with M2	A249	8.76
0.09	At roundabout take the 3rd exit onto the A249 (signposted Maidstone)	A249	8.84
4.14	Kent County Showground	A249	12.99
0.01	Long descent of Detling Hill	A249	12.99
1.49	At roundabout take the 3rd exit, then join the M20 motorway (signposted M20 London, The West)	**M20**	14.48
8.93	Keep in right hand lanes then continue forward (signposted London)	**M20**	23.41
9.88	Continue forward on the M20 (signposted London, Lewisham)	**M20**	33.29
0.99	Continue forward onto the A20	A20	34.28
4.36	Branch left onto Frognal Corner, then at roundabout take the 1st exit onto Perry Street - A222 (signposted Bromley, Chislehurst)	A222	38.64
1.48	At traffic signals turn right onto the A208 (signposted Mottingham)	A208	40.12
0.58	**Arrive at** Chislehurst,Kent	A208	40.71
-	Section time 0:57, Total time 0:57	-	-

Figure 8.4: A contemporary example of driving itinerary generated 'on the-fly' in response to user specified start and end points. It is provided as a free service on the AA's website as a feature to attract customers. (Source: <www.theaa.com>, April 2005.)

The first set of couplets comes from the Northern Aranda Honey-Ant Song of Ljăba. It describes the honey-ants in their cells under the roots of the mulga trees. At the same time these honey-ants are visualized also as human-shaped totemic ancestors, wearing decorations of down on their bodies. The "blood-hardened soil" where the honey-ants are dwelling refers to the Ljăba ground-painting: this symbolizes the original home from which the honey-ant ancestors had first sprung.

1\. /: Mĭlbmắnālălắlănŏū́pắjănŏū́ :/ (Ilbmắna lắla *nŏ́panắma, Book XVI, p. 6, verse 6.
/: Mĭntĕrīntjĕlắlănŏū́pắjănŏū́ :/ *Intĕ́rintjalắla *nŏ́panắma.)
Thĕ ánt-wŏrkĕrs yóndĕr dwéll, évĕr dwéll:
Ĭn ríng-tiĕred hómes thĕy dwéll, évĕr dwéll.[39]

2\. /: Mătnĕ́ntĕrĕntĕ́rănŏū́pắjănŏū́ :/ (*Tnĕ́nterentĕ́ra *nŏ́panắma, Ibid., verse 7.
/: Mĭntĕrīntjĕlắlănŏū́pắjănŏū́ :/ *Intĕ́rintjalắla *nŏ́panắma.)
Ăbdómĕns ădórned thĕy dwéll, évĕr dwéll;
Ĭn ríng-tiĕred hómes thĕy dwéll, évĕr dwéll.

3\. /: Măkĕ́rĕnbĕnŋĕ́ilănŏū́pắjănŏū́ :/ (Kĕ́renbĕ́nŋala *nŏ́panắma, Ibid., verse 8.
/: Mĭlbmắnālĕlắlănŏū́pắjănŏū́ :/ Ilbmắna lắla *nŏ́panắma.)
Ĭn blóod-hărdĕned sóil thĕy dwéll, évĕr dwéll:
Thĕ ánt-wŏrkĕrs yóndĕr dwéll, évĕr dwéll.

39\. Although "*nŏ́panắma" strictly speaking means "dwell always", I have here translated it as "dwell, ever dwell", for in the sung Aranda version "Mĭlbmắnālălắlănŏū́" would have been felt to be a complete line (= ilbmắna lắla nắma); consequently the -pắjănŏū́, which sounds like a peal of chimes at the end of all these couplets, is felt to *repeat* the idea already contained in the syllable -nŏū́-. In my English version I have not marked any half-stressed syllables; but the third syllable at the beginning of each line could well have been marked in this way. The rhythmic measure and tonal pattern of the first twenty-one verses in this group have been given above, page 42.

Figure 8.5: A small part of an Aboriginal songline as recorded, codified/translated and interpreted by anthropologist T.G.H. Strehlow. (Source: Scanned from Strehlow 1971, 685).

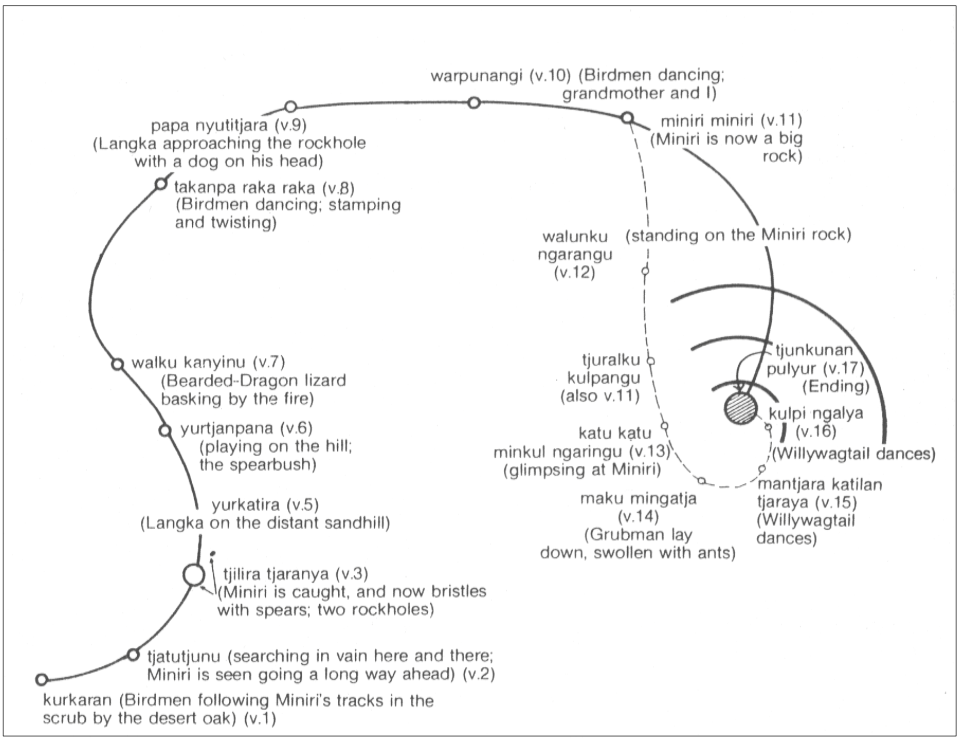


Figure 8.6: A contemporary attempt at a partial visualisation of a songline by sketching the path beckoned into being by the verses of Inma Lanka. It was drawn as an aid to teaching non-Aboriginal students by a tribal song leader. The key words given to each point along the route summarise the major theme of particular verses of the song. (Source: Scanned from Ellis 1995, 118.)

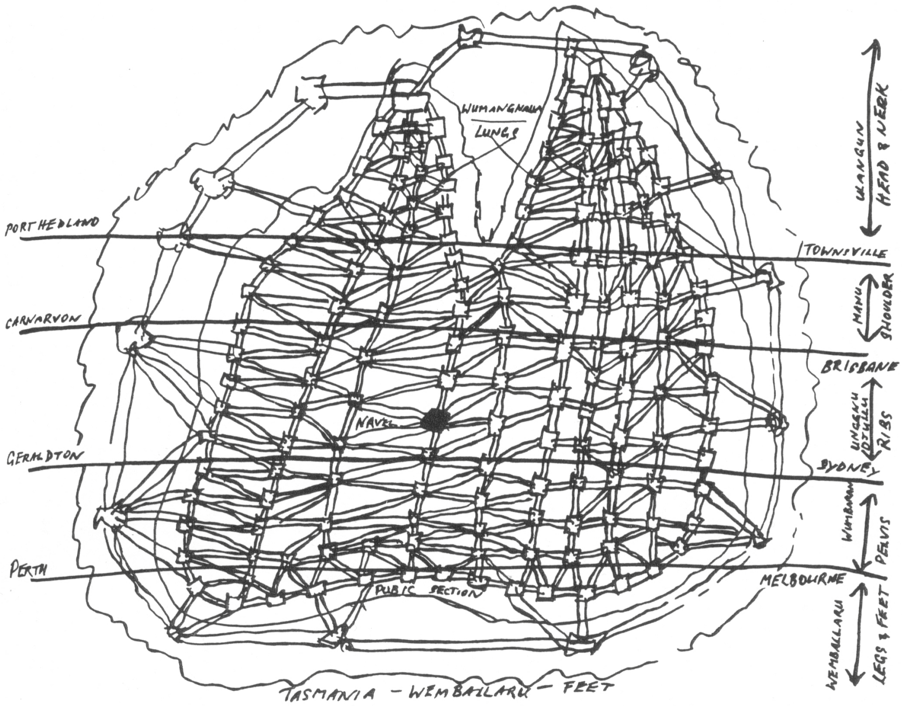


Figure 8.7: *Bandaiyan - Corpus Australis*, a contemporary cartographic envisioning of Australia as a human body built from lattice of songlines by artist David Mowaljarlai (source: scanned from Sutton 1998b, 415). In explanation of his map, Mowaljarlai noted: "The squares are areas where the communities are represented, and their symbols and the languages of the different tribes in this country from long-time ago. The lines are the way the history stories travelled along these trade routes. They are all interconnected. It's the pattern of the Sharing system." (Mowaljarlai and Malnic 1993, 190).

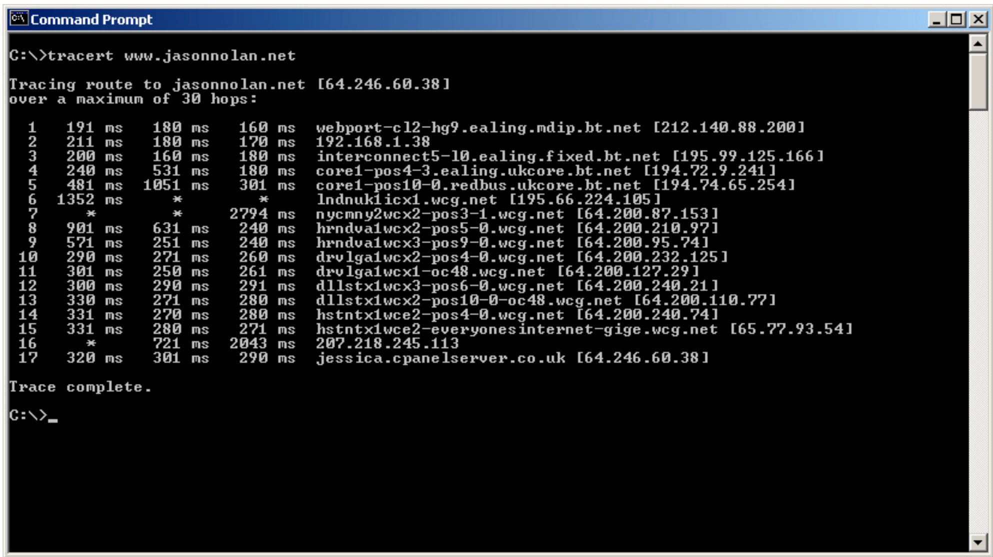


Figure 8.8: Performing a traceroute using Window's tracert utility to map in detail the path from the author's PC in London to `www.jasonnolan.net` web server. The process knowledge is presented as list of routing points from the origin down to the destination. This particular journey passed through sixteen intermediate waypoints to reach the destination (a server with the name `jessica.cpanelserver.co.uk`). The location of these waypoints is given in terms of their domain names and numeric IP addresses. Three time distance measures to them is also given.

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