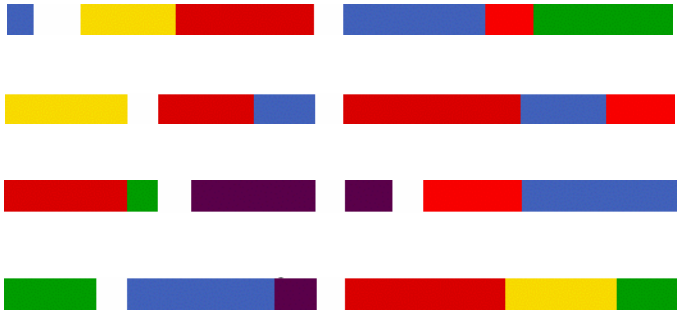
2002/08/23

A Study On Measurement System For Modeling of Migration Activities Of Shoppers



University of Tokyo
Center for Spatial Information Sciences
Shibasaki lab. D1

Kay Kitazawa

A Study On Measurement System For Modeling of Migration Activities Of Shoppers

Introduction of myself

Academic history etc.

Background of my research

Why modeling ?
Why measure movements ?

Measurement system

Detail of the system

Modeling of human behavior

My future works

Self Introduction

Kay Kitazawa

Born & brought up in TOKYO

Study background

2000/03 B.A. from the University of Tokyo
Department of Literature
"Social Psychology"

2002/03 Master of Environmental Sciences
from the University of Tokyo
Graduate School of Frontier Science

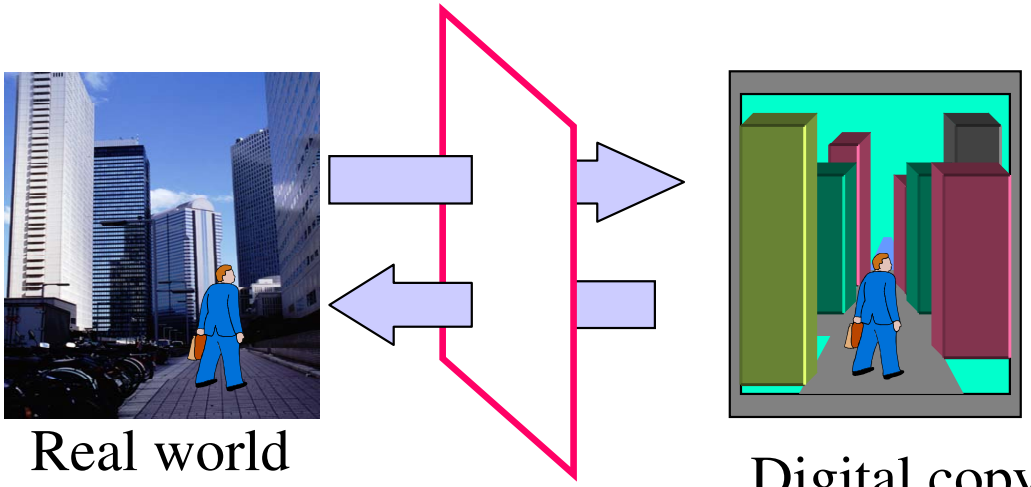
1st year of Ph.D course

Shibasaki lab.

Shibasaki lab.

Center for Spatial Information Sciences

3D digital city



Real world

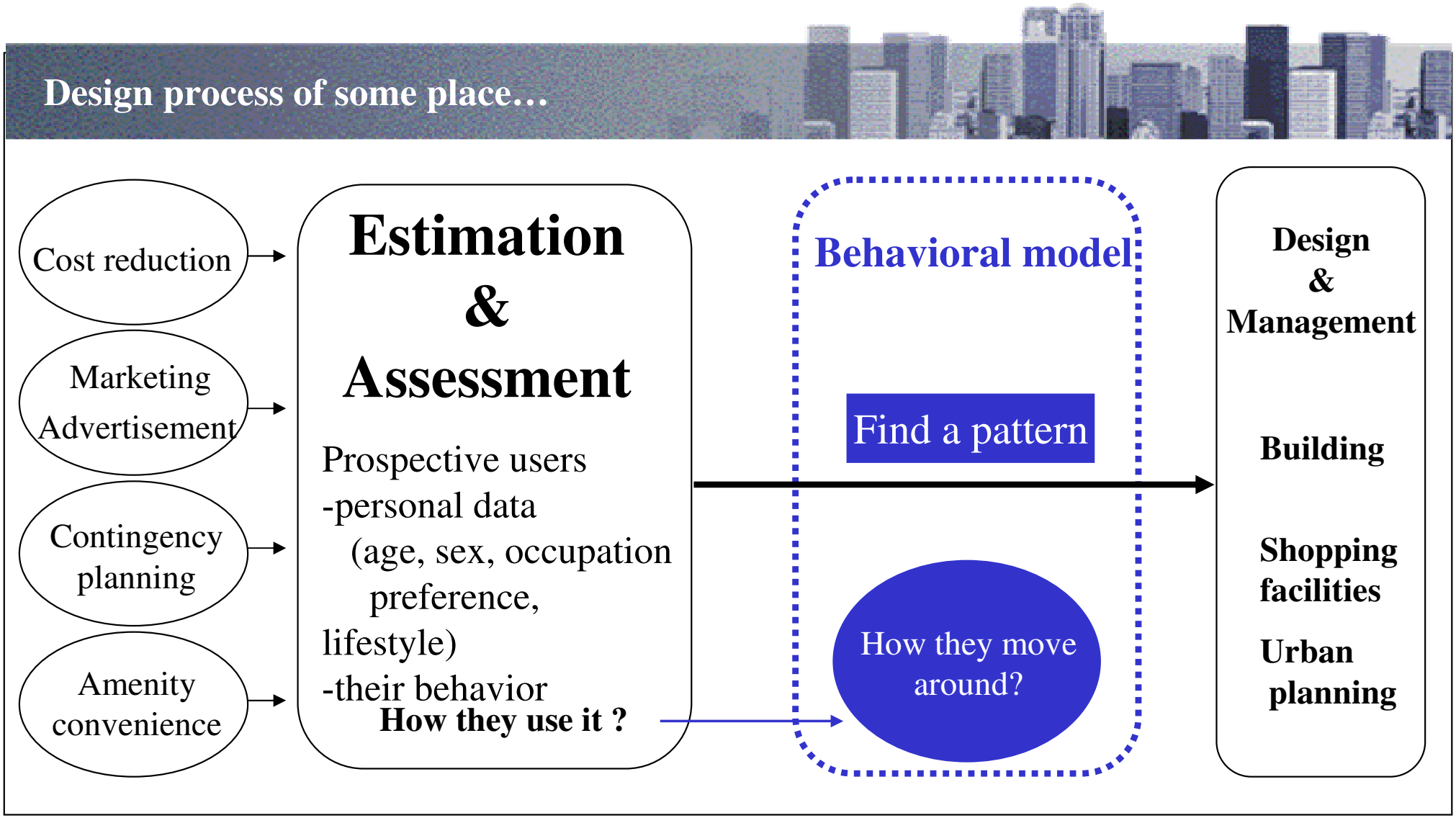
Digital copy

Remote sensing ---- 3D digital city map

Spatial Database ---- Standardization & Maintenance

Spatial analysis ---- Modeling of human activities

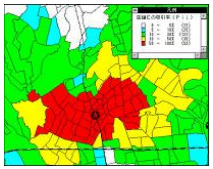
Why behavioral modeling ?



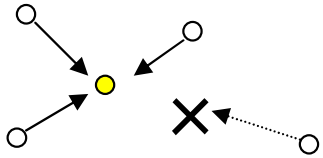
Current spatial model

Marketing **Traffic management**

Huff model
Disaggregate logit model



Location planning

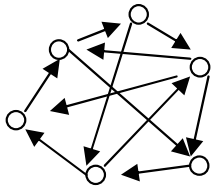


Probability of choice

Marcov chain model
Poisson regression model

Several destinations

Probability of transition



Single task **Choices are always rational** **Based on "Points"**

One objective?

No error? Perfect?

Between points?

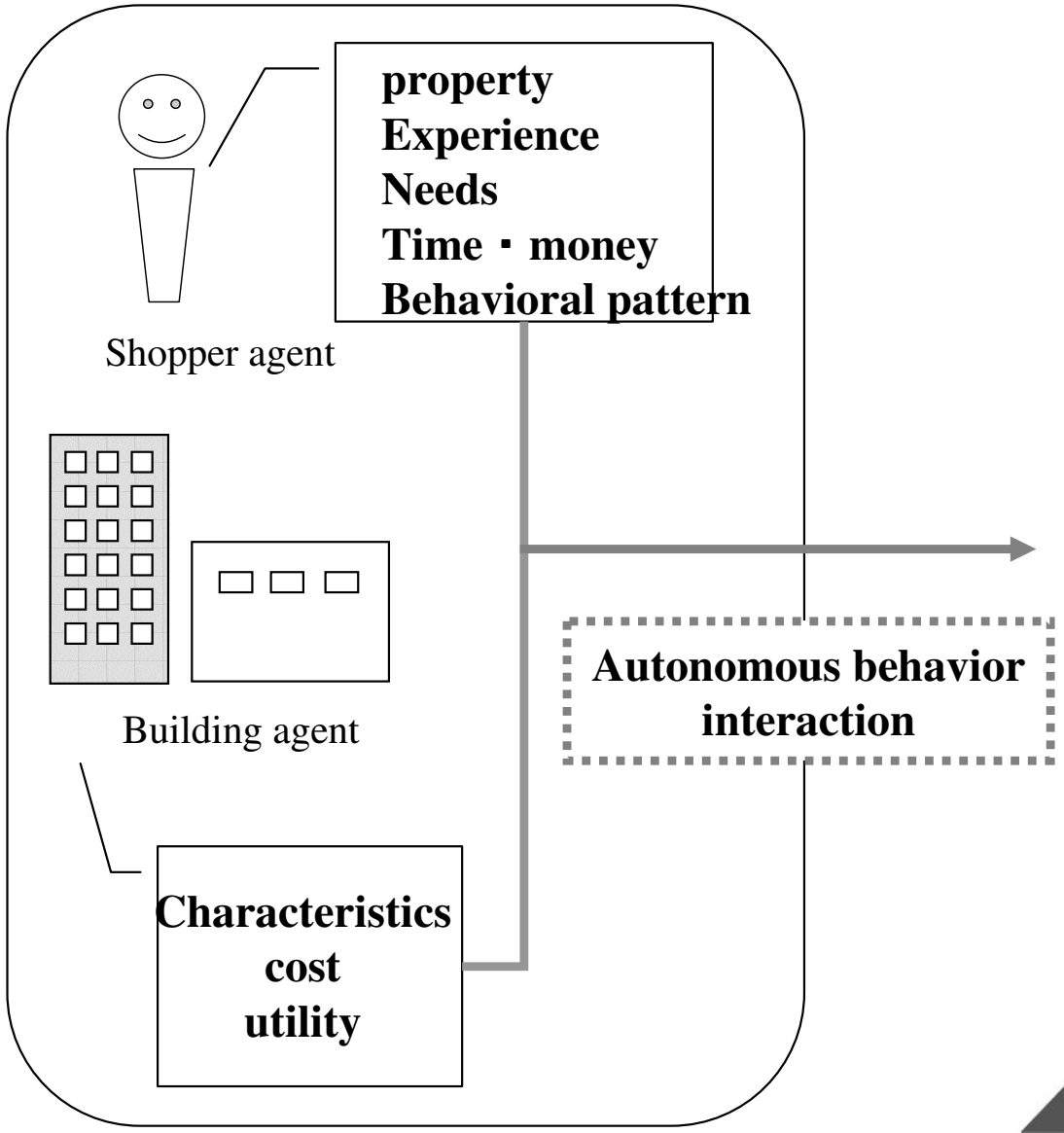
Combination and switch of several objectives

Limited-rationality based on lack of information

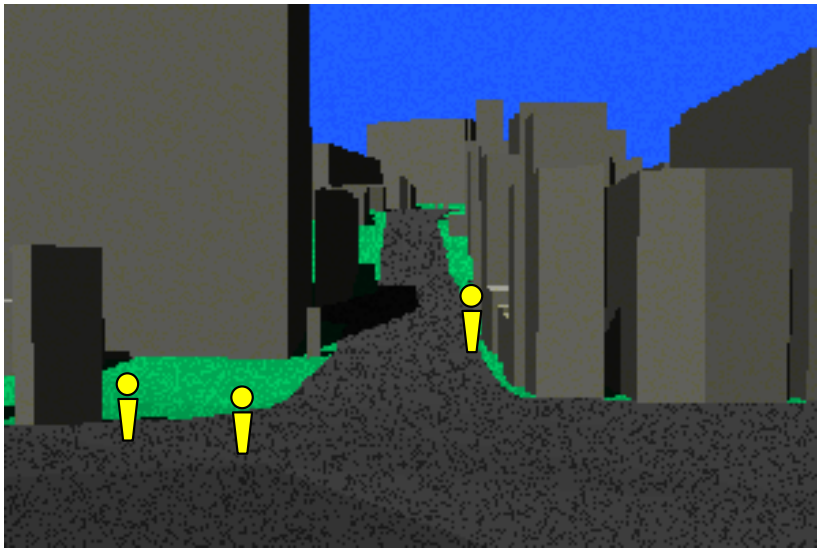
Focus on smaller scale

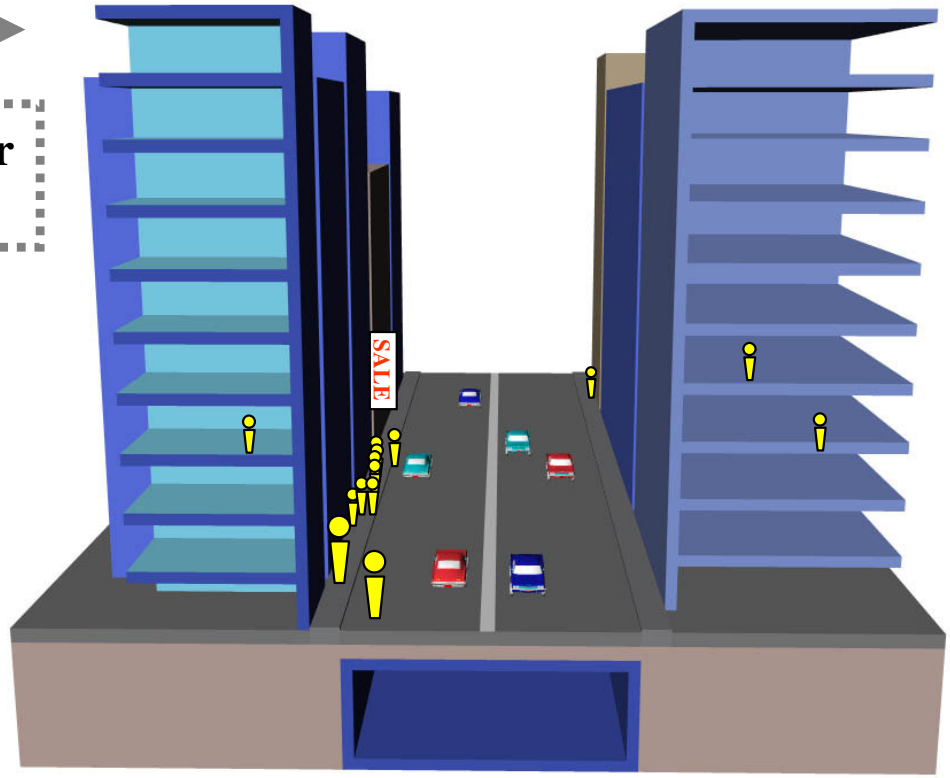
New behavioral model is needed

Multi-agent simulation



model

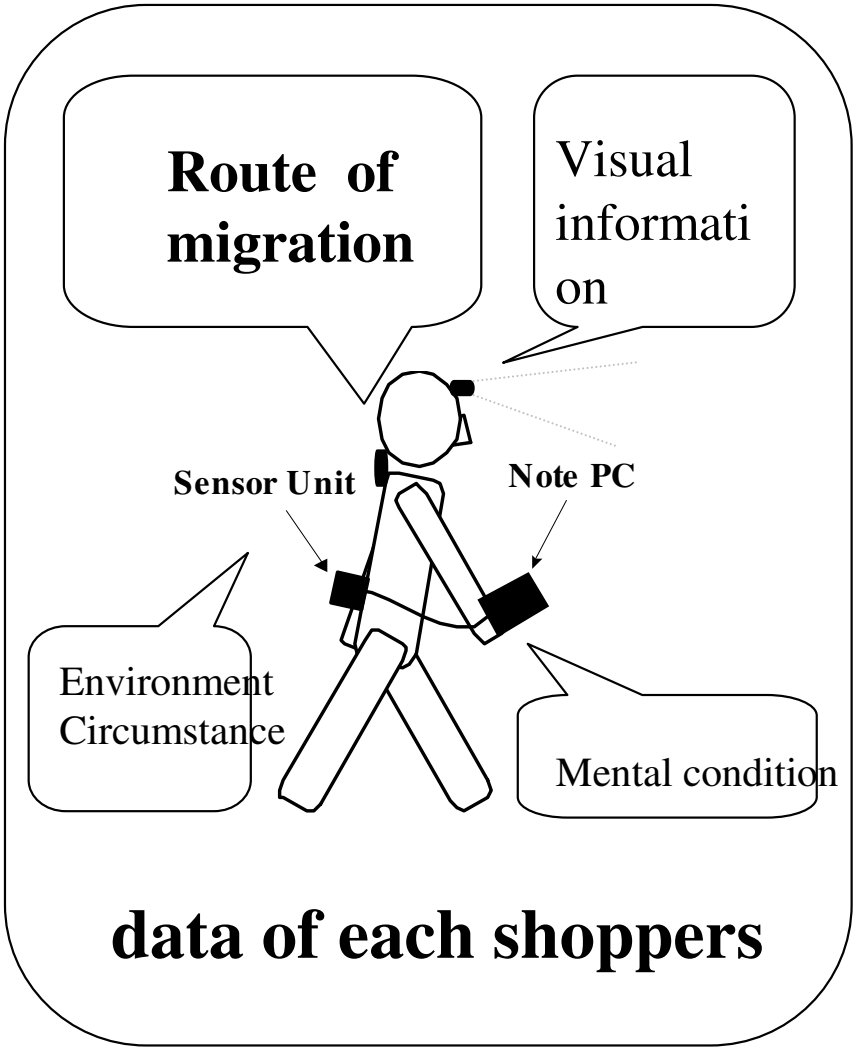




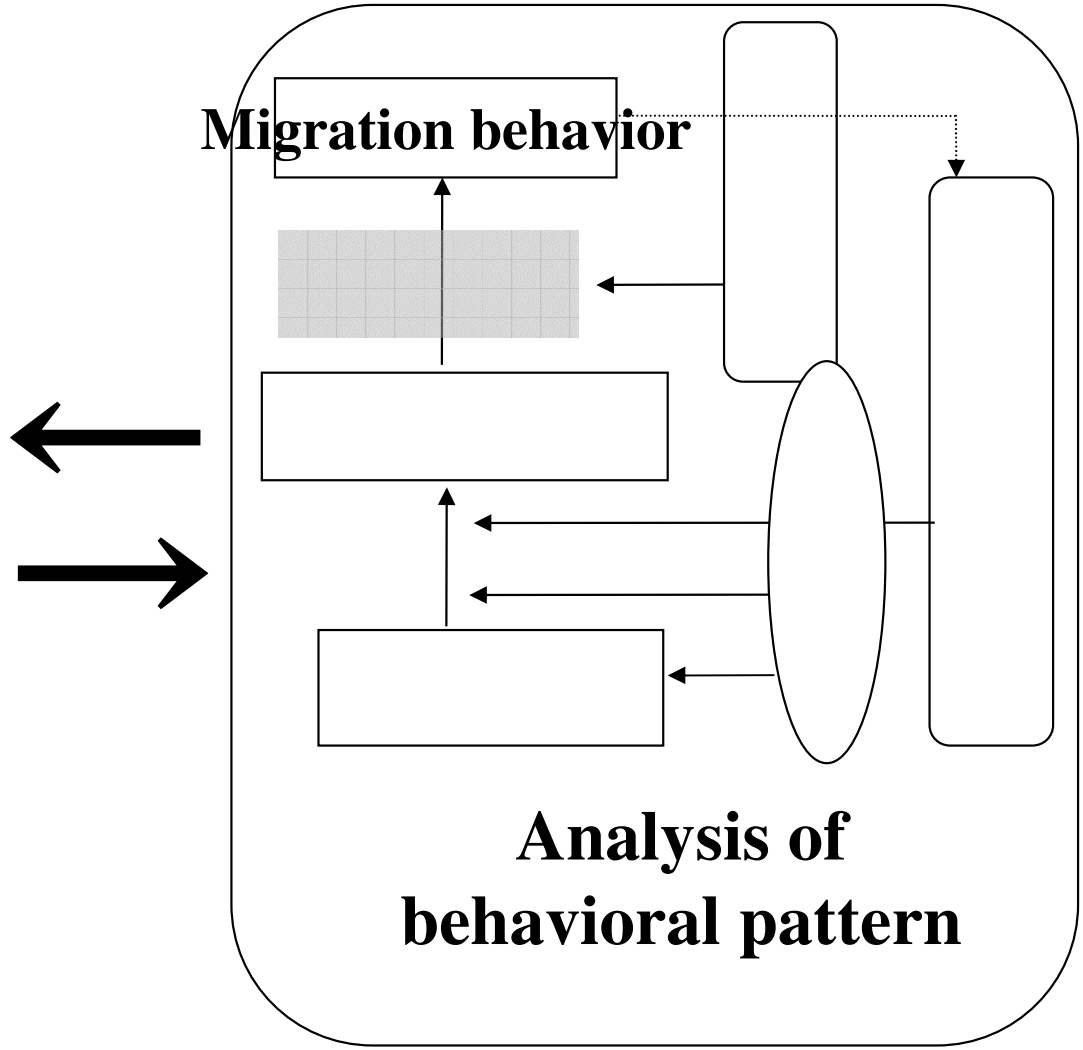
Measurement & Modeling

$$P_{ij} = (\alpha_j K_j M_j / D_{ij} T_{ij} \lambda) / \Sigma (\alpha_K j \cdots$$

Measurement system



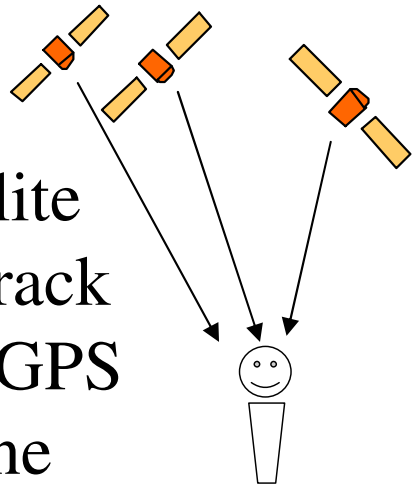
Modeling



Current positioning system

GPS-based technology

- GPS
- DGPS
- Pseudolite
- Snap Track
- Indoor GPS
- GPS One

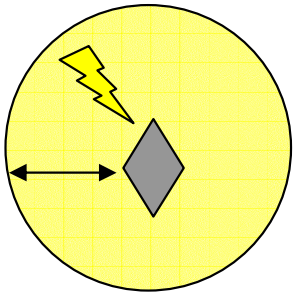


advantage	weak point
- global standard - high accuracy	- unavailable in some area - multi path problem

"base station" technology

- PHS
- Ultrasonic waves
- RFID Tag
- Beacon

(GI Stone)



advantage	weak point
- can be used everywhere	-Cost -No standard

Tracking technology

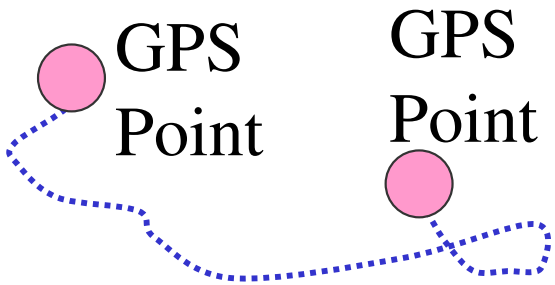
- Magnetic direction sensor
- Gyro sensor
- Video image processing

advantage	weak point
- can be used everywhere - detailed data	-Size -Low accuracy

→ Combination of several technologies

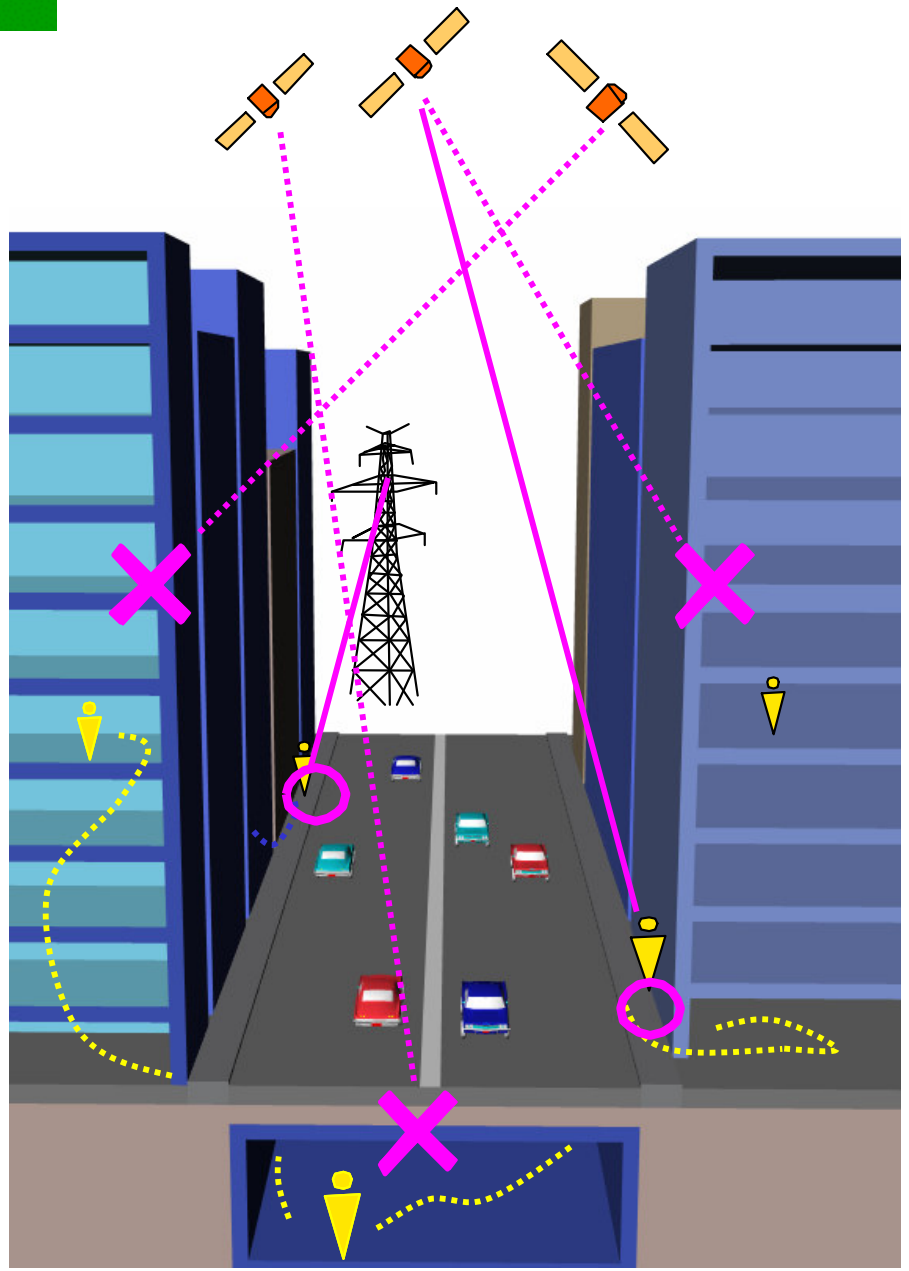
GPS is not always available

In the valley between high-rise buildings
Underground passage
Inside of buildings



We have to get trajectory between GPS points

<u>Complementary method of GPS is necessary</u>



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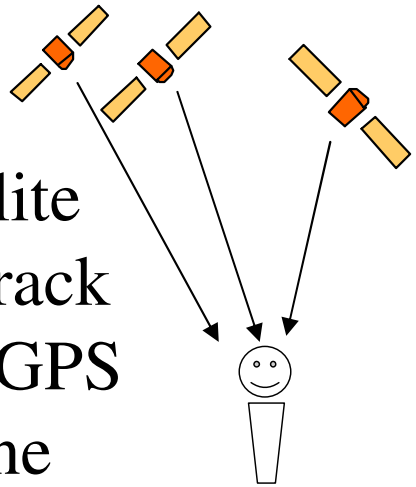

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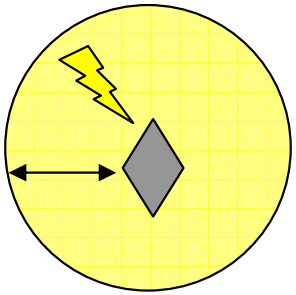

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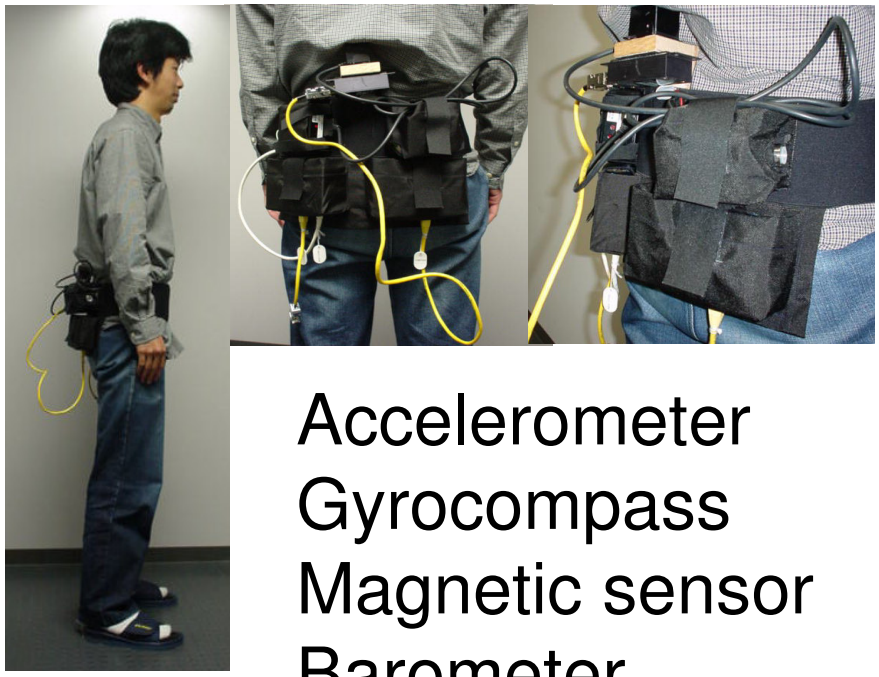
Tracking technology

- Magnetic direction sensor
- Gyro sensor
- Video image processing

advantage	weak point
can be used everywhere detailed data	-Size -Low accuracy

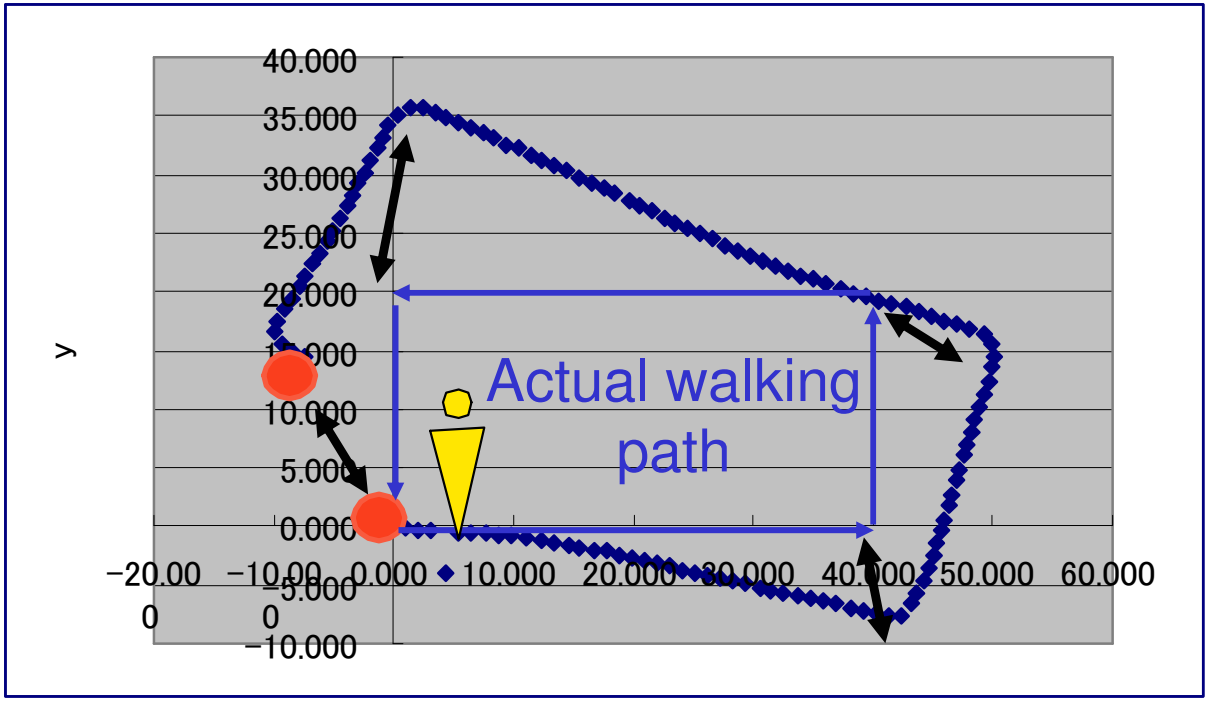
→ Combination of GPS & sensors

Personal Positioning System (PPS)



Accelerometer
Gyrocompass
Magnetic sensor
Barometer

Estimated track

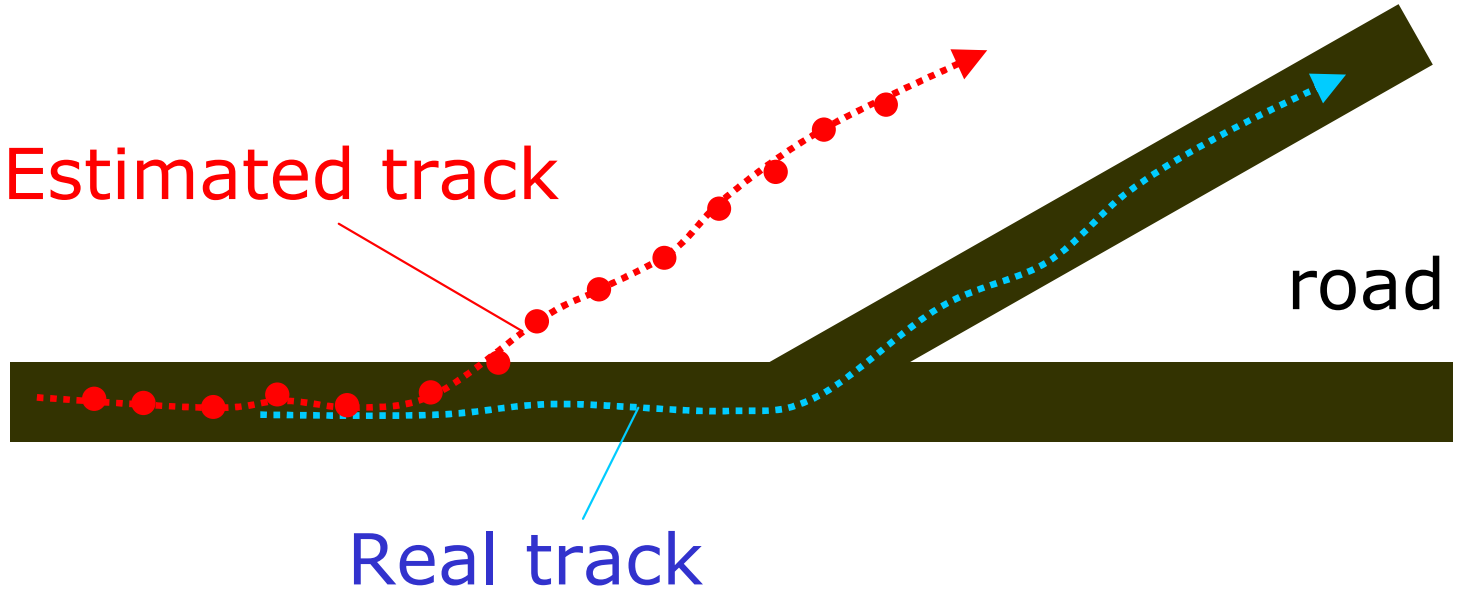


Accumulation of errors is inevitable

Map matching

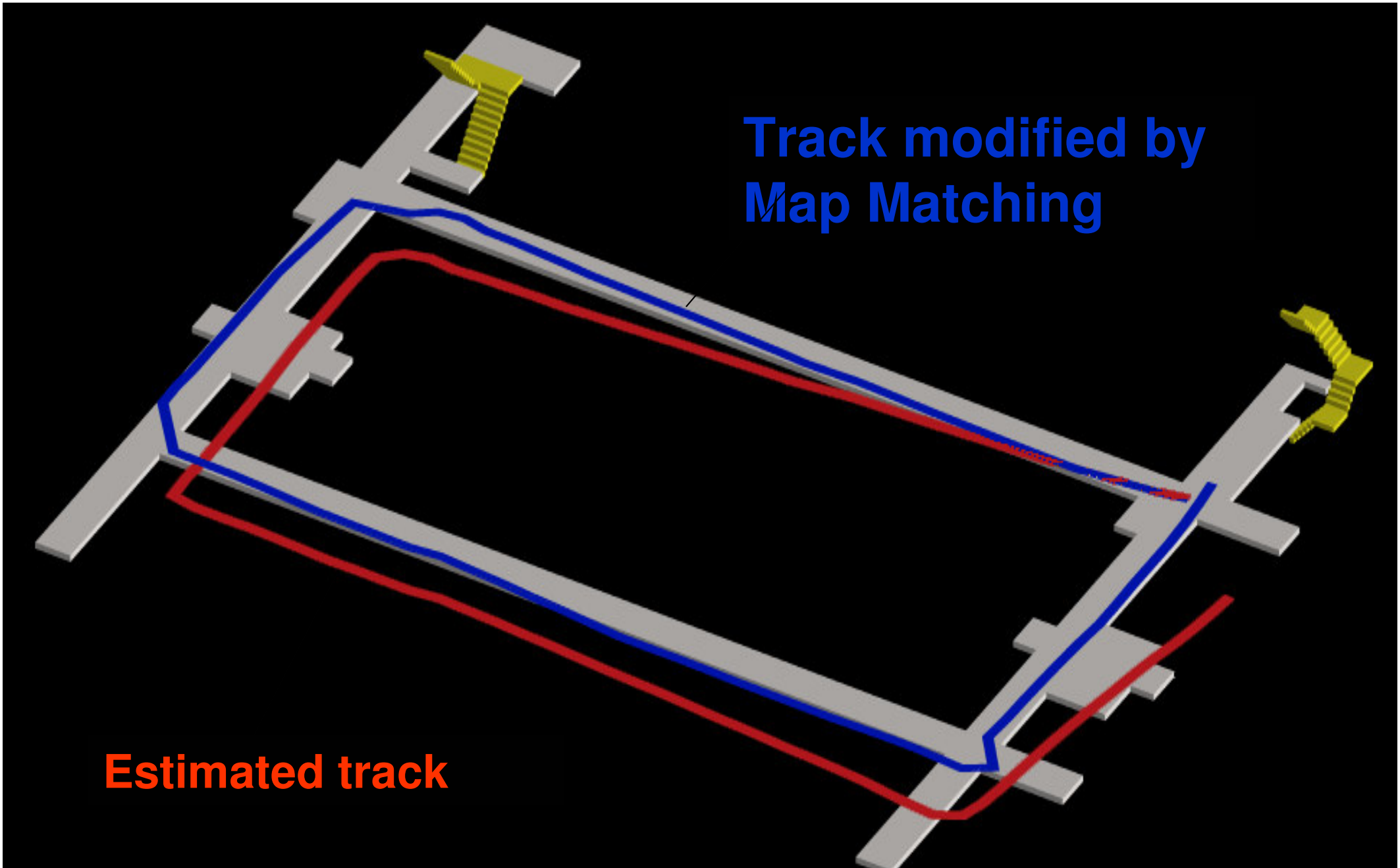
Map Matching

- **Adjust estimated track to plausible route**

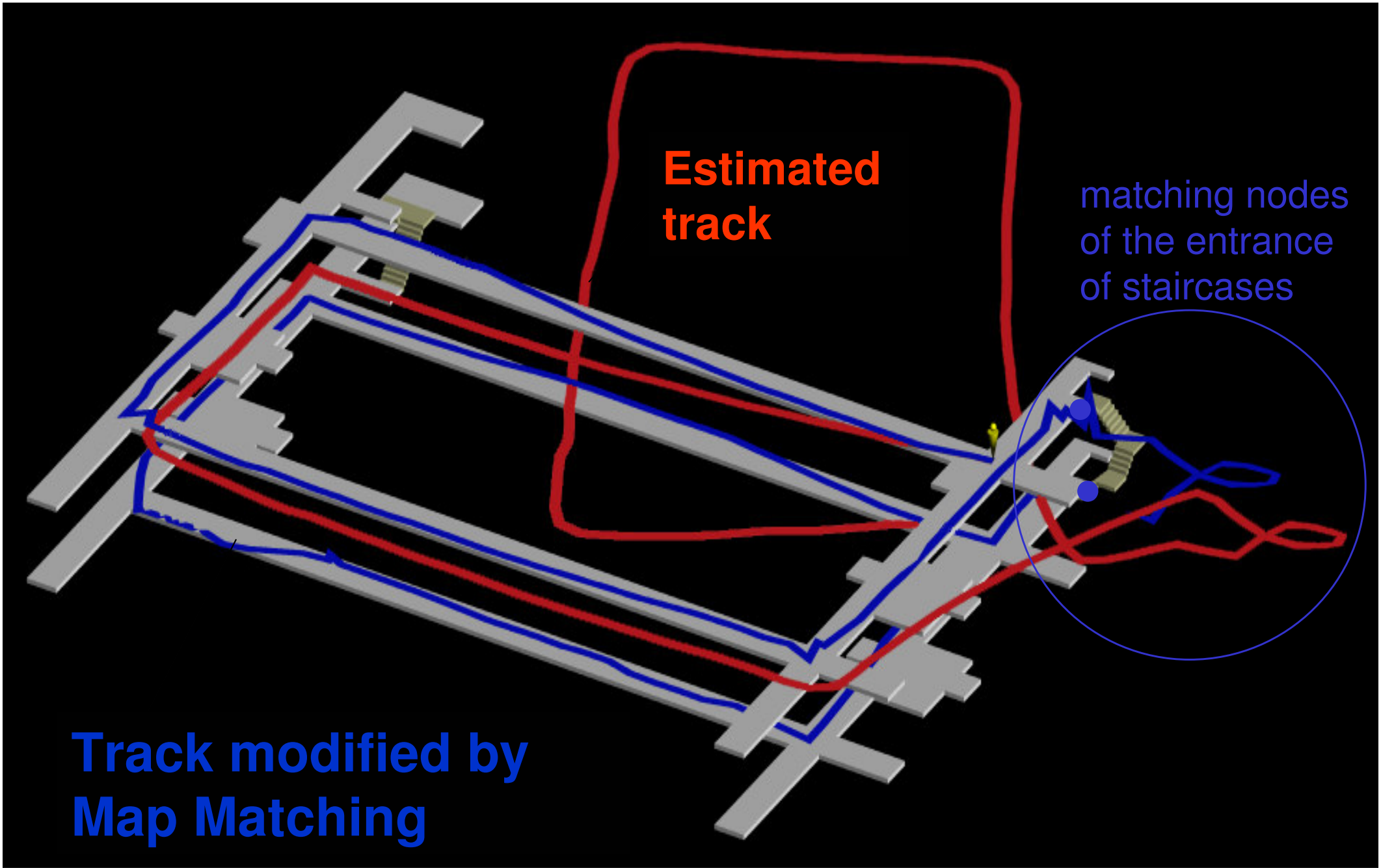


- **Modification by geographical data**
  - boundary (walls)
  - road network (edge / node)

Result : walk along corridor (2-D)



Result : 2 floors (3-D)



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GPS-based technology

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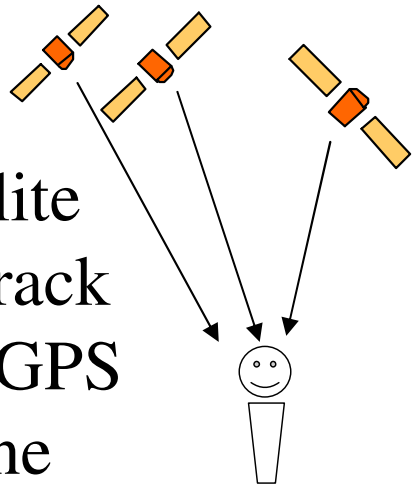

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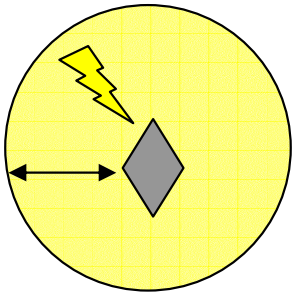

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Tracking technology

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advantage	weak point
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→ Combination of RFID-Tag & sensors

Measurement system

■Route of each shoppers

How shoppers move in shopping districts ?

ID:SBKCBSG
Coordinate
(-1368.9,3770.6,39.8)

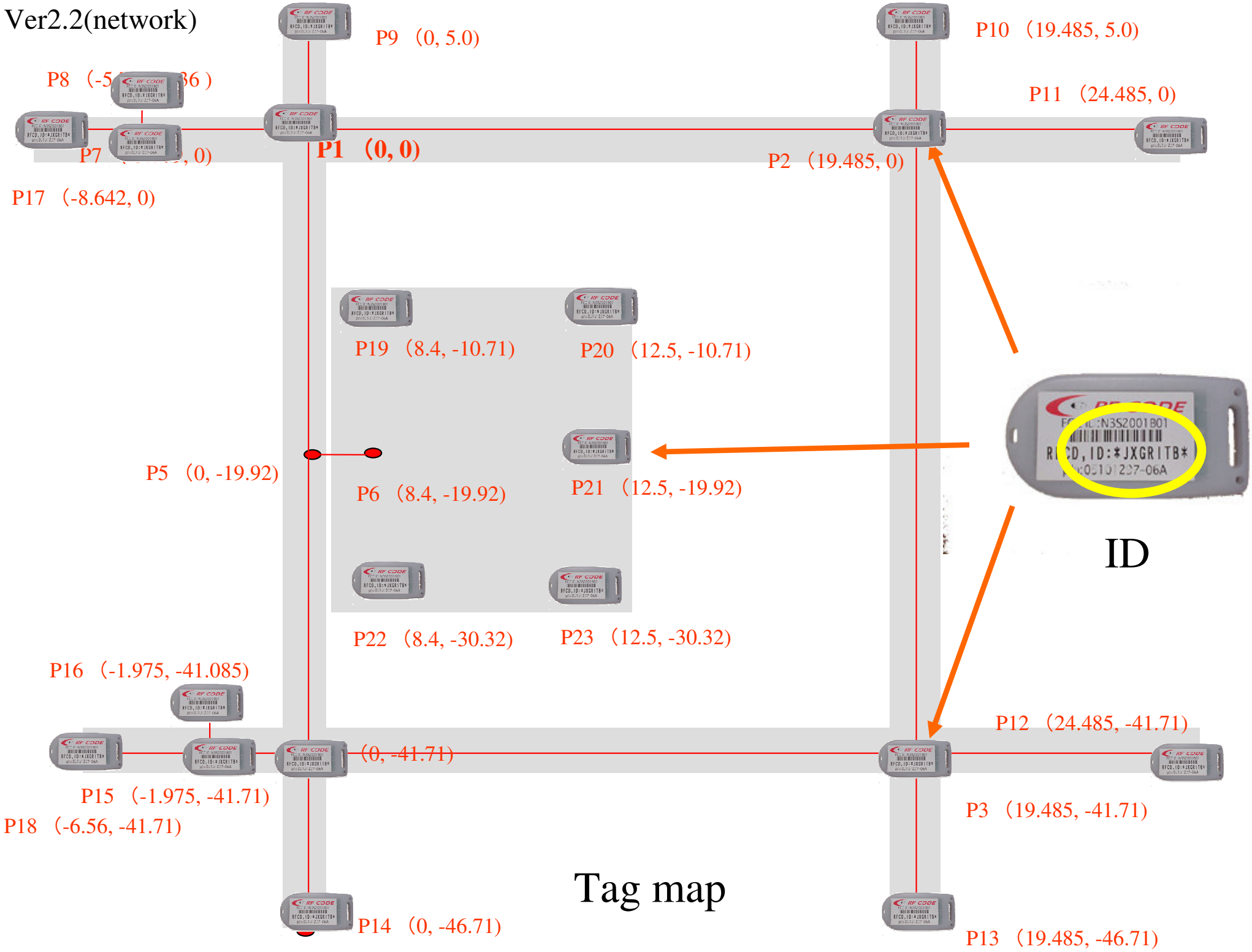
ID-location table

RFID tag

Map Matching

Personal Positioning system

RFID tag system


Ver2.2(network)
P9 (0, 5.0)
P10 (19.485, 5.0)
P8 (-5 36)
P11 (24.485, 0)
P7 , 0)
P1 (0, 0)
P2 (19.485, 0)
P17 (-8.642, 0)
P19 (8.4, -10.71)
P20 (12.5, -10.71)
P5 (0, -19.92)
P6 (8.4, -19.92)
P21 (12.5, -19.92)
ID
P22 (8.4, -30.32)
P23 (12.5, -30.32)
P16 (-1.975, -41.085)
P12 (24.485, -41.71)
(0, -41.71)
P15 (-1.975, -41.71)
P3 (19.485, -41.71)
P18 (-6.56, -41.71)
Tag map
P14 (0, -46.71)
P13 (19.485, -46.71)

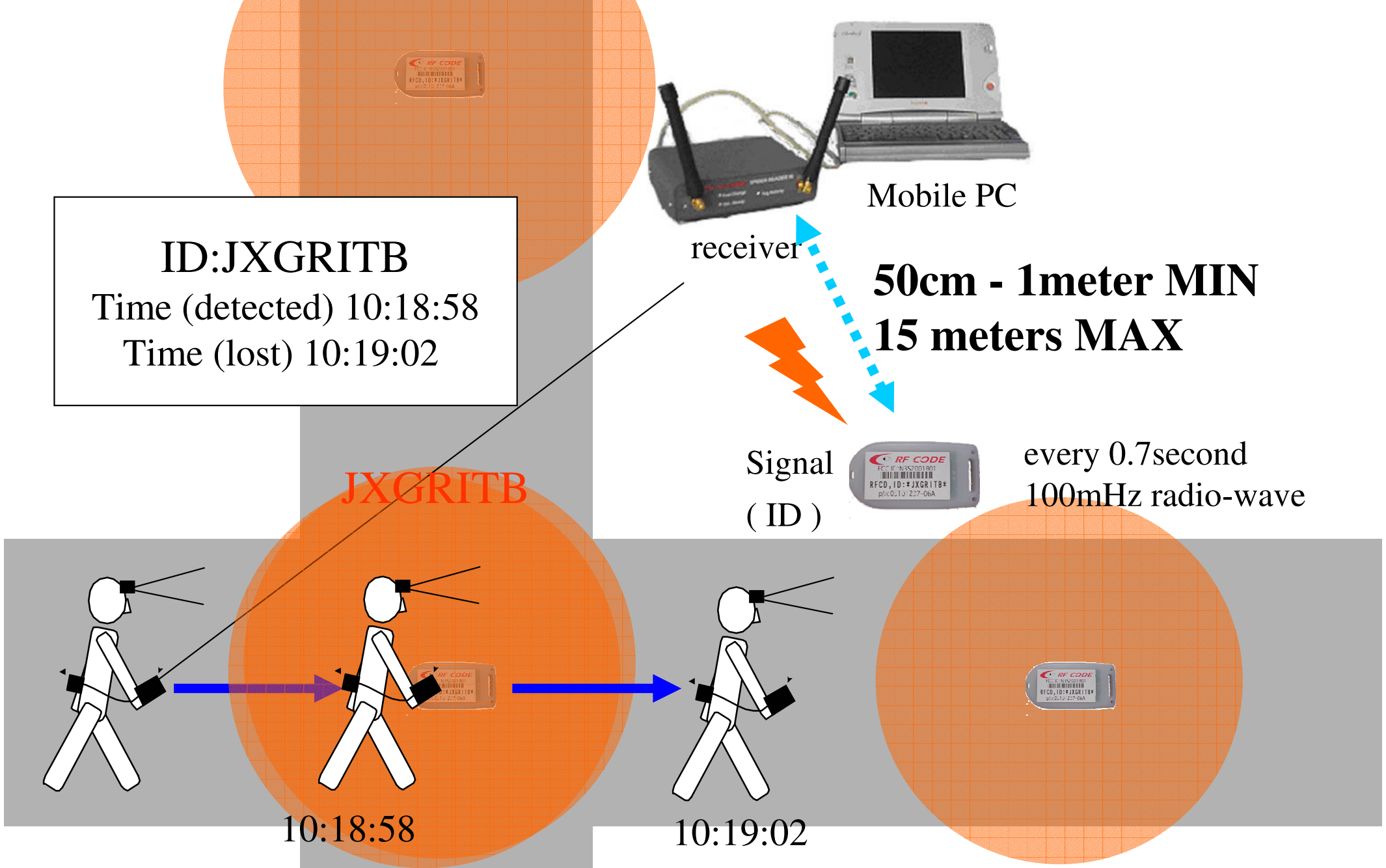
ID- location table

ID of Tag

Spatial coordinate （x,y,z）

p1	CHFXKPN	−13838.2	−37620.7	40.3	正門
p2	IWWXEVK	−13822.3	−37728.6	40.3	時計台
p3	KIKDPEA	−13794.8	−37730.5	40.3	角1
p4	CHYGMCW	−13778.2	−37886.8	40.3	角2
p5	CEKGSOV	−13766.0	−37882.8	40.3	Cエレベータホール（1F）
p6	MUUFFKZ	−13762.3	−37871.9	40.3	CDエレベータ（1F）
p7	KUISVXN	−13762.3	−37871.9	52.3	CDエレベータ（5F）
p8	BMOMZRU	−13759.6	−37874.2	52.3	CD−W
p9	HTKKJUF	−13741.1	−37871.9	52.3	CD−E
p10	ICQQMWJ	−13737.1	−37912.8	52.3	BC−E
▪	HULFUJQ	−13755.7	−37915.1	52.3	BC−W
▪	MIDPDVW	−13757.3	−37906.3	52.3	LAB−B
▪	BCYXALG	−13758.4	−37894.5	52.3	LAB−C
	MXDRBMC	−13733.2	−37953.7	52.3	B−E
	FMHZIWT	−13751.9	−37953.1	52.3	B−W
	DQCUJCI	−13753.9	−37955.8	52.3	Bエレベータ（5F）
	MNOFBOV	−13753.9	−37955.8	40.3	Bエレベータ（1F）
	GAEXGGN	−13759.0	−37946.4	40.3	Bエレベータホール（1F）
	ALCWERP	−13770.8	−37947.5	40.3	角3
	MACXHVY	−13768.5	−37969.6	40.3	角4
	MDJMYSE	−13770.6	−37991.2	40.3	角5
	AVNUSMO	−13835.6	−37996.2	40.3	角6
	HNQXYEV	−13845.3	−37910.6	40.3	角7
	ILRPAEM	−13853.5	−37840.0	40.3	角8
	IYMQWFP	−13914.2	−37847.2	40.3	角9
	BQPBFFU	−13918.8	−37789.4	40.3	角10
	IAFQJXZ	−13948.7	−37790.4	40.3	西門

Approximate location


ID:JXGRITB
Time (detected) 10:18:58
Time (lost) 10:19:02
Mobile PC
receiver
50cm - 1meter MIN
15 meters MAX
Signal
(ID)
every 0.7second
100mHz radio-wave
JXGRITB
10:18:58
10:19:02
Detection of tags

ID:JXGRITB
Time (detected) 10:18:58
Time (lost) 10:19:02

Newly recognized or lost from the sensor

Tag ID

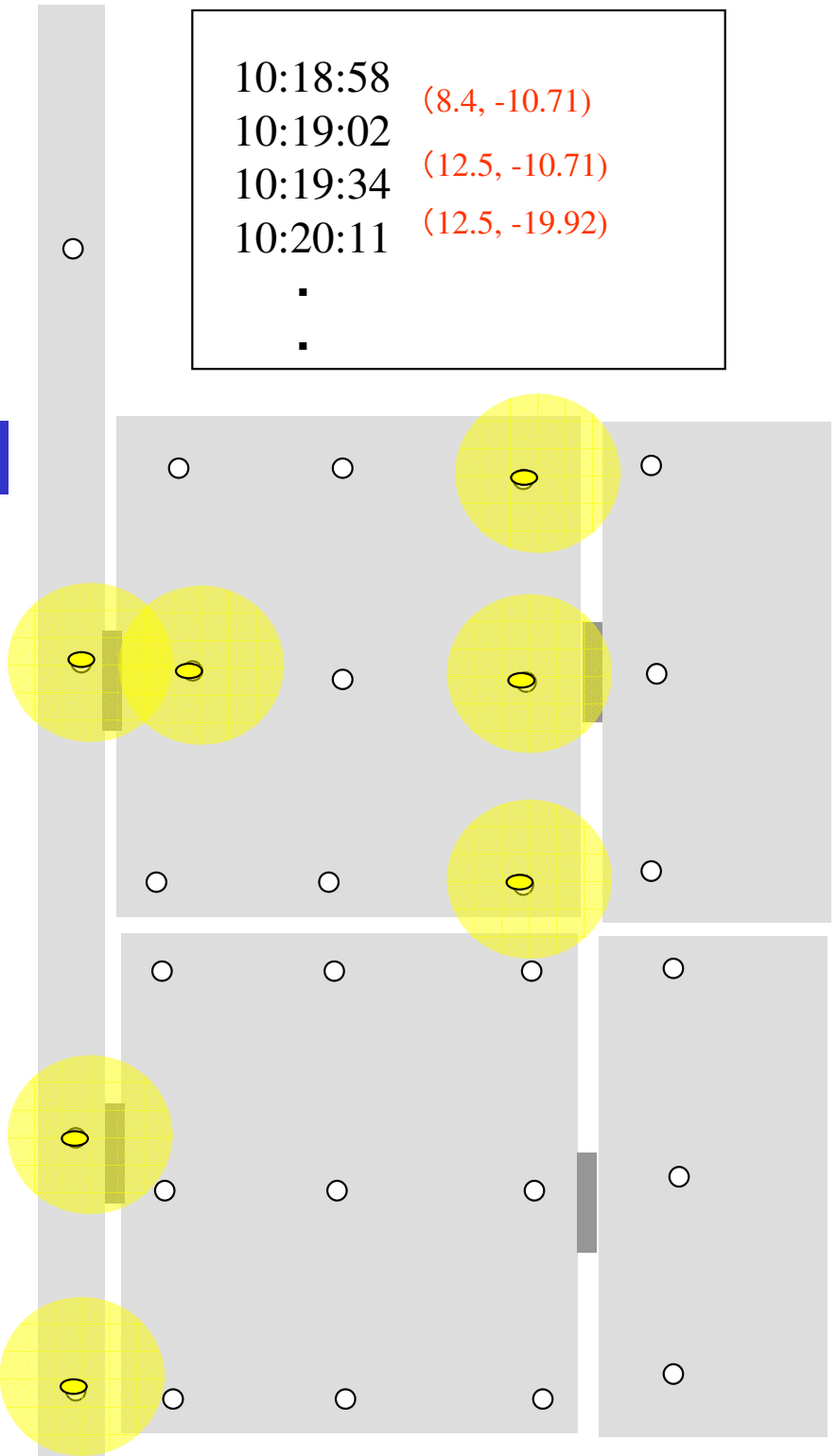
Time from Start point

0	V		0	60
49	N	CEKGSOV	1	1692
371	N	MUUFFKZ	2	12427
463	L	CEKGSOV	1	15492
1790	L	MUUFFKZ	0	59735
2192	N	BMOMZRU	1	73145
2220	N	KUISVXN	2	74056
2638	L	KUI		
2973	N	MID		
3275	L	BMC		
3331	N	BCY		
3407	N	BQF		
3438	N	IESH		
3753	N	MXD		
3759	L	IESH		
3778	L	BQF		
3804	L	MID		
3864	L	BCY		
4141	L	MXD		
4967	N	DQC		
5074	N	MAC		

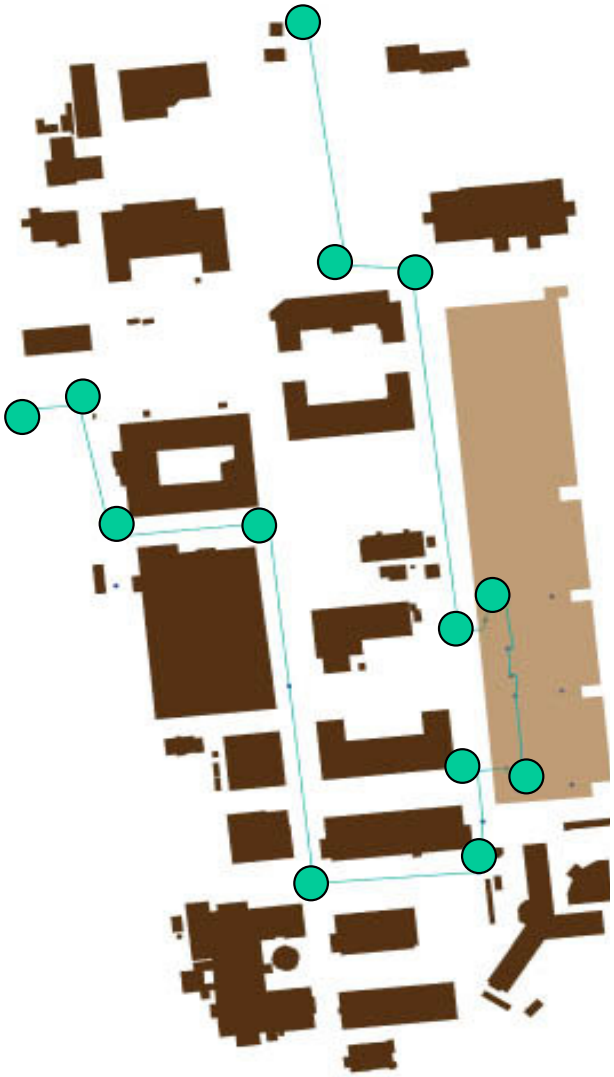
ID- location table

JXGRITB	X	Y

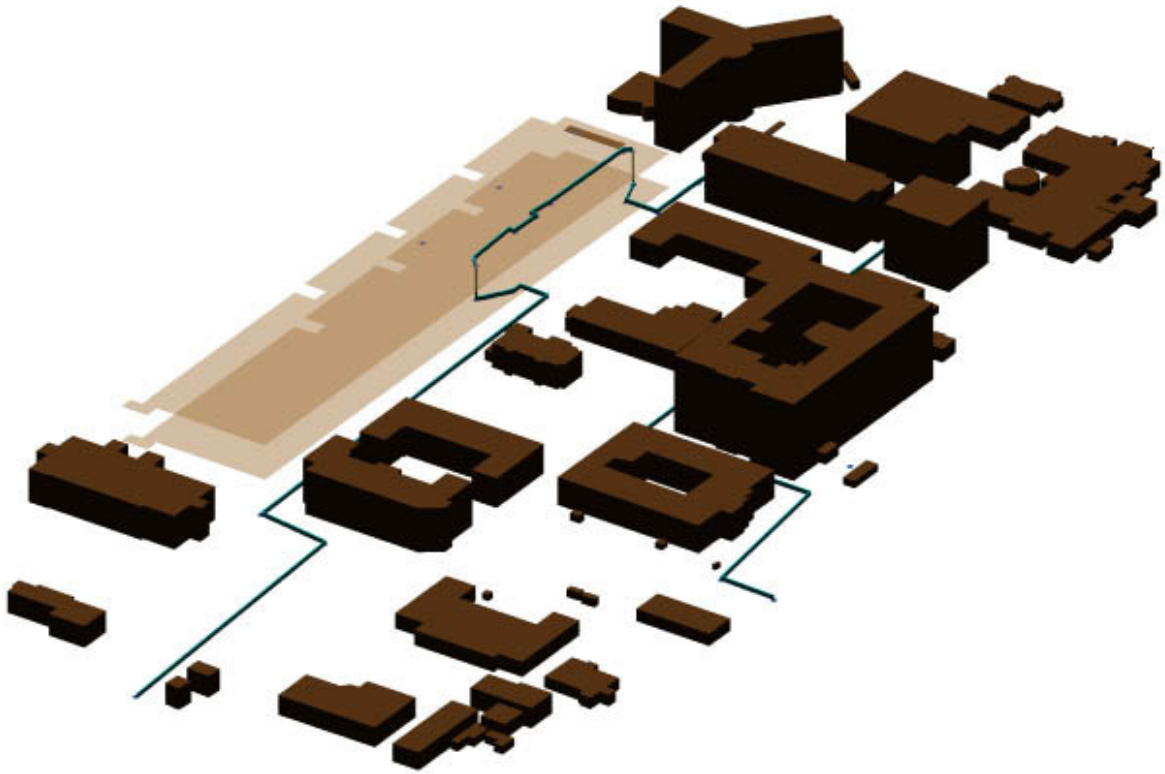
10:18:58 (8.4, -10.71)
10:19:02
10:19:34 (12.5, -10.71)
10:20:11 (12.5, -19.92)
.
.

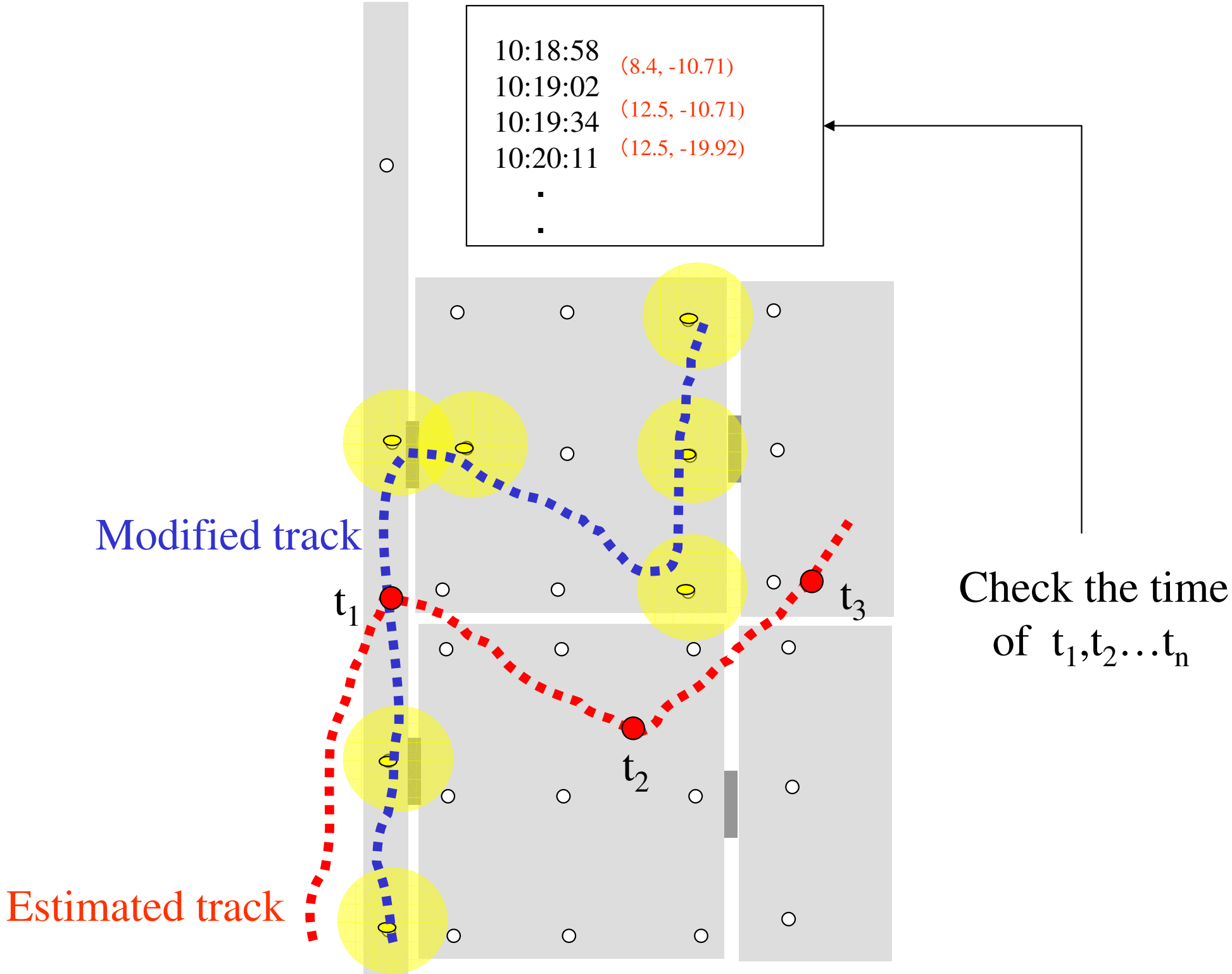


Experiment 1

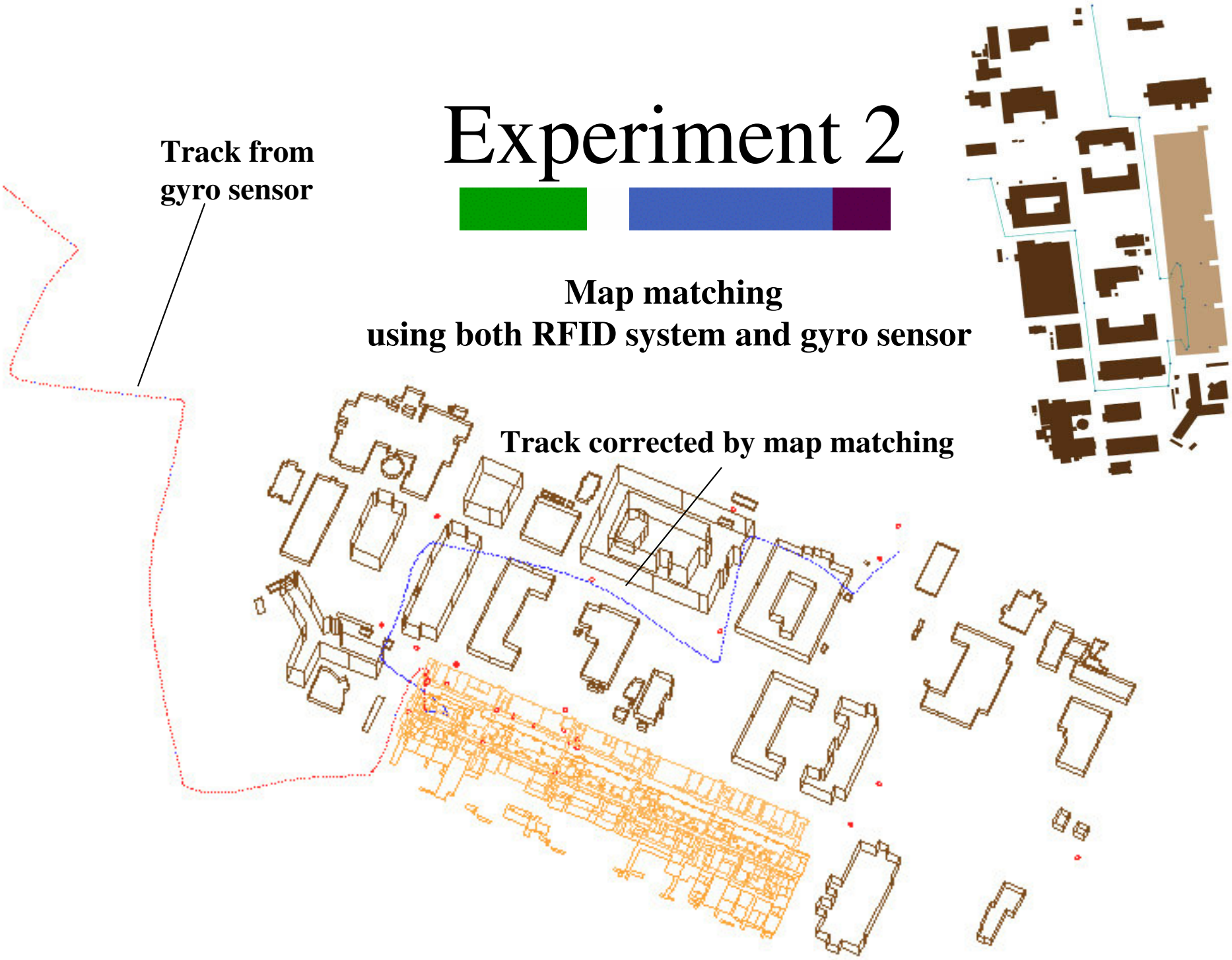


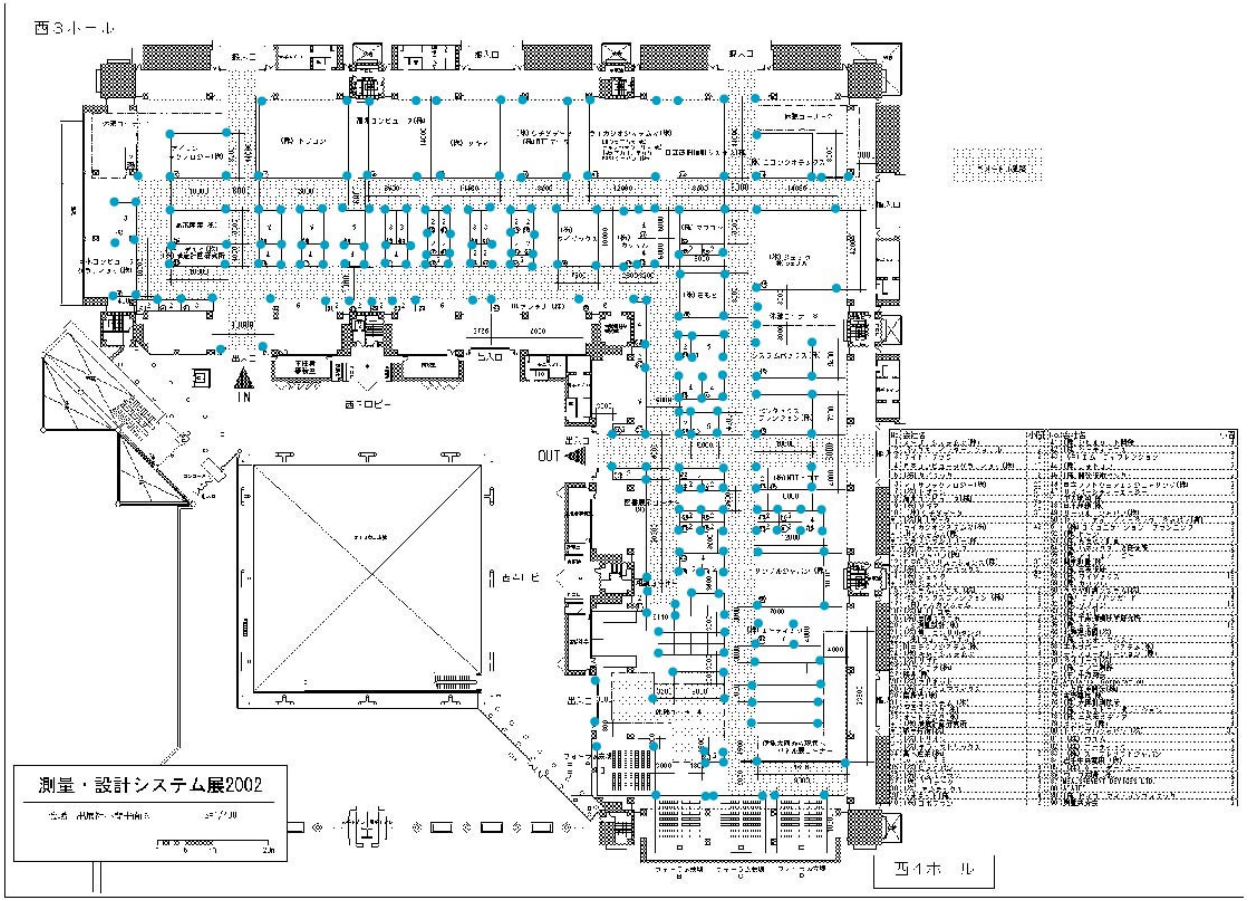
Tracking by RFID system




10:18:58 (8.4, -10.71)
10:19:02 (12.5, -10.71)
10:19:34 (12.5, -19.92)
10:20:11
Modified track
t1
t2
t3
Estimated track
Check the time of t1,t2…tn

Experiment 2





Experiment in Tokyo big sight

Measurement system

■Route of each shoppers

■Field of vision

How shoppers move in shopping districts ?
What makes them to move around ?

ID:SBKCBSG
Coordinate
(-1368.9,3770.6,39.8)

ID-location table

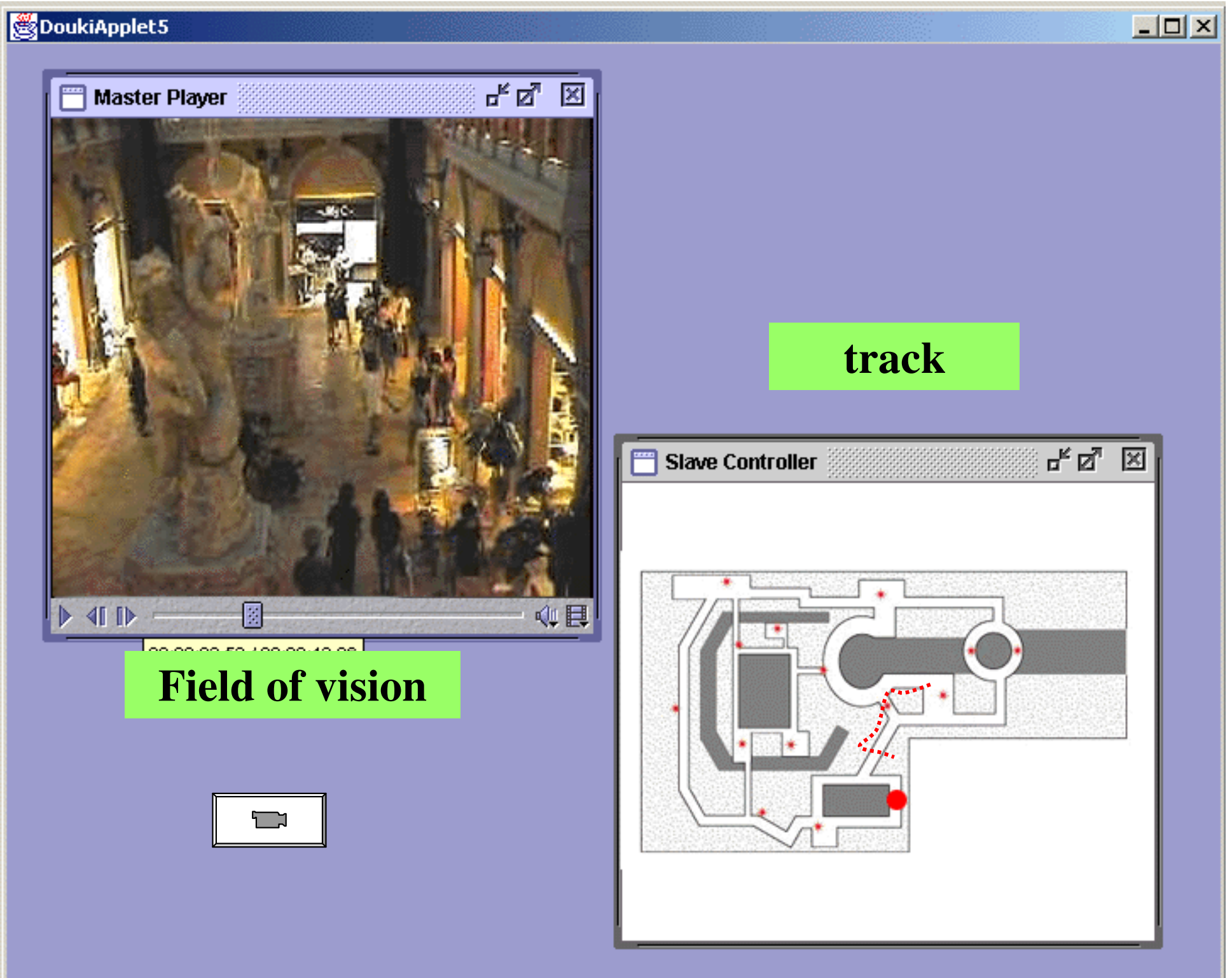
RFID tag

Map Matching

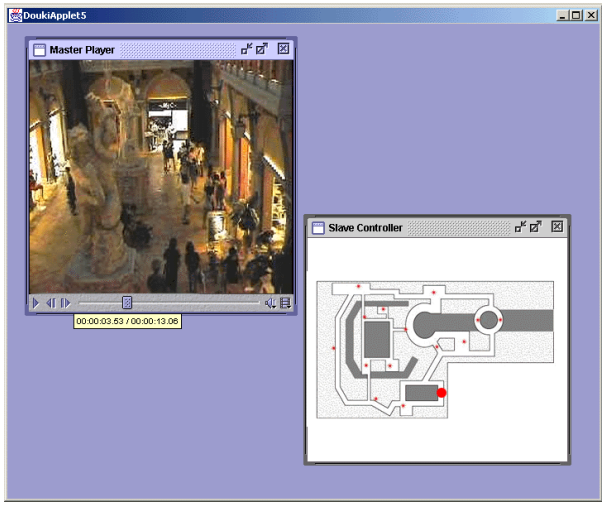
Gyro sensor

RFID tag system

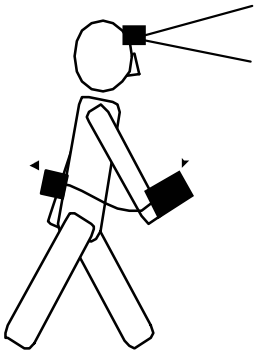
Eye camera


DoukiApplet5
Master Player
track
Slave Controller
Field of vision

my Future works



■improve the mesurement system



Classification of information source

-attention

- time

Accuracy of positional data

Quantification of experience and knowledge

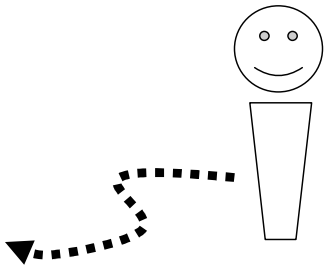
Experiments in large scale
(number of subjects, space)

feedback

Elaboration of the model

Empirical rule

- marquee
- image strategy
- marketing



Migration behavioral model