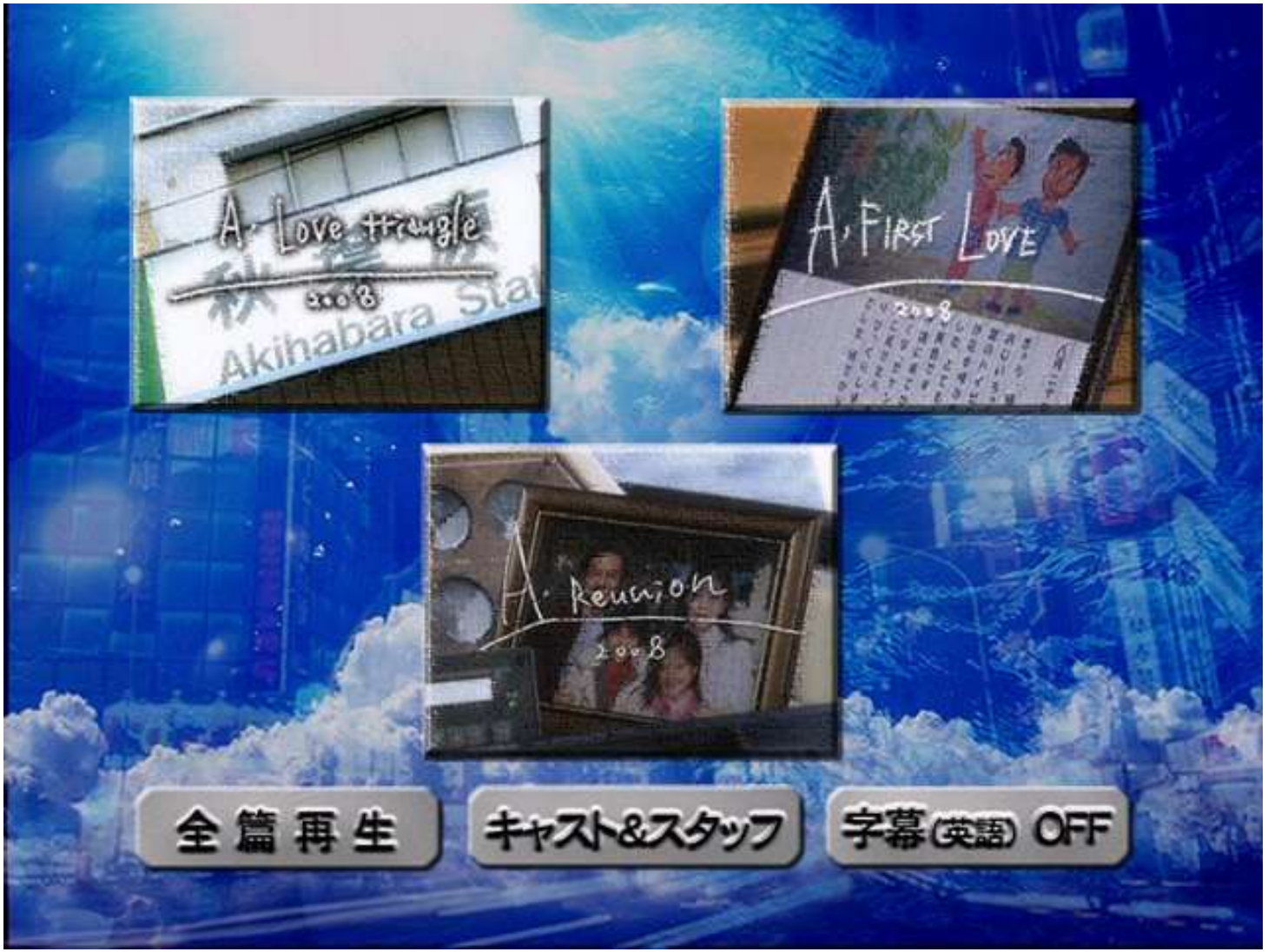
Challenges in Creating Ubiquitous Services with Mobile Sensing Systems

Hideyuki Tokuda
Keio University
hxt@sfc.keio.ac.jp
http://www.ht.sfc.keio.ac.jp/~hxt

2003: Small Stories in 2008



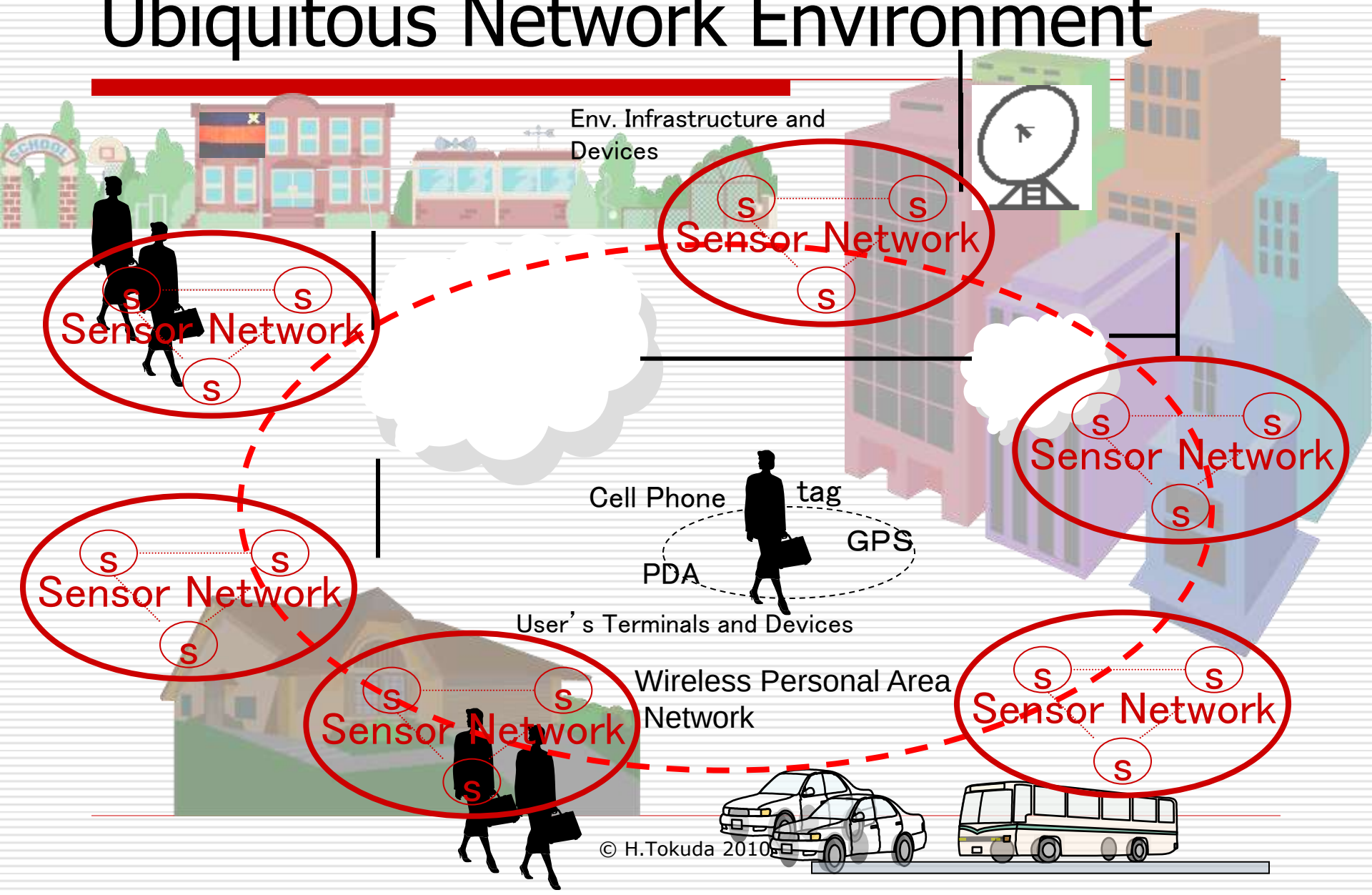
A Love Triangle (2003)

What is the Ubiquitous Network Project?

What is a Ubiquitous Network?

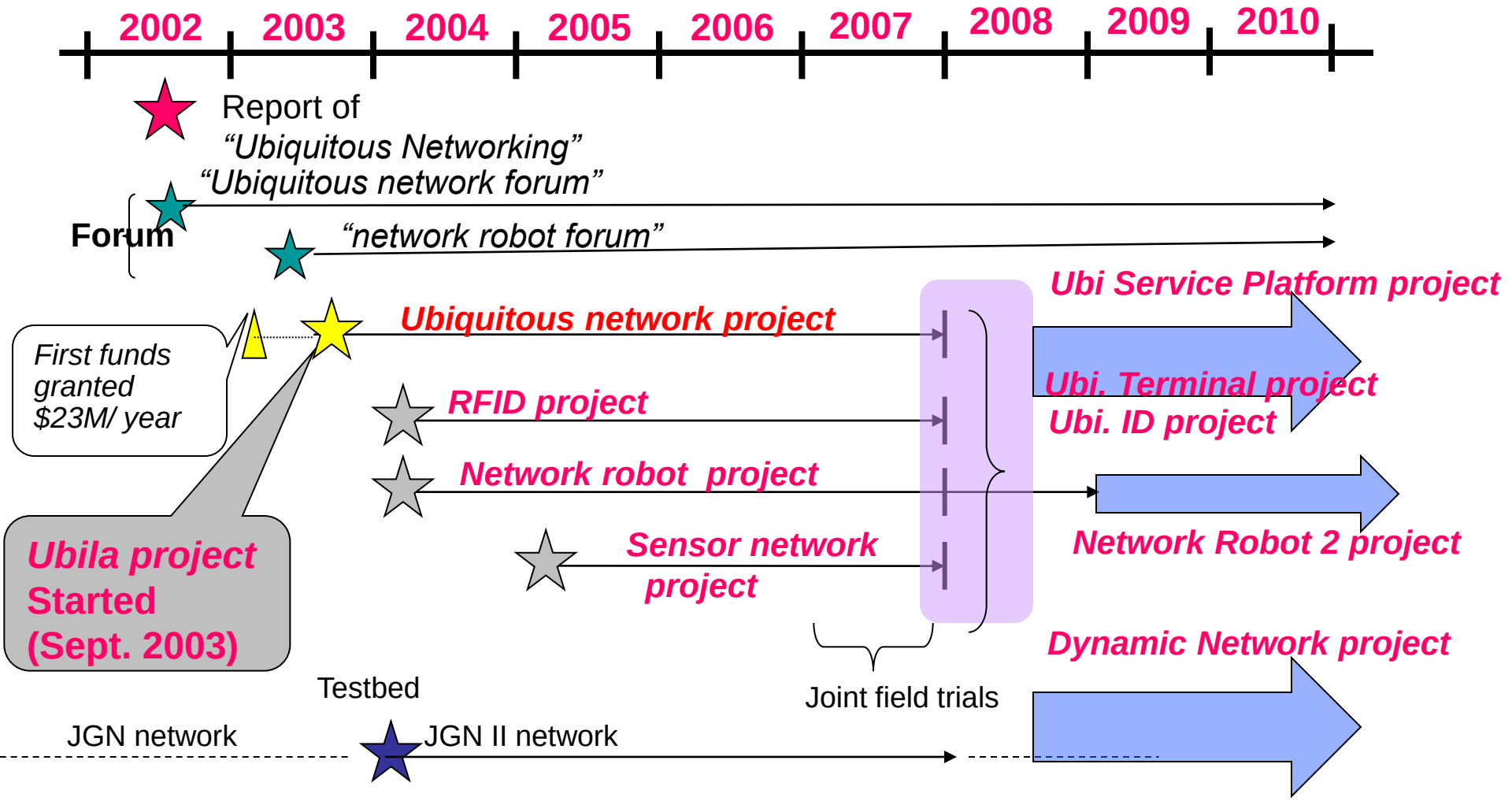
- A Ubiquitous Network is an information and communication network which enables people to access networks, terminals, services and contents at any time or place in a seamless, easy, safe and natural way.
- It realizes Freedom from
  - space and time
  - in selection of networks, terminals, services and contents
  - network risks
  - constraints in networking real objects
  - capacity restrictions

Ubiquitous Network Environment



© H.Tokuda 2010

Roadmap of Ubiquitous Network Projects in Japan



Outline

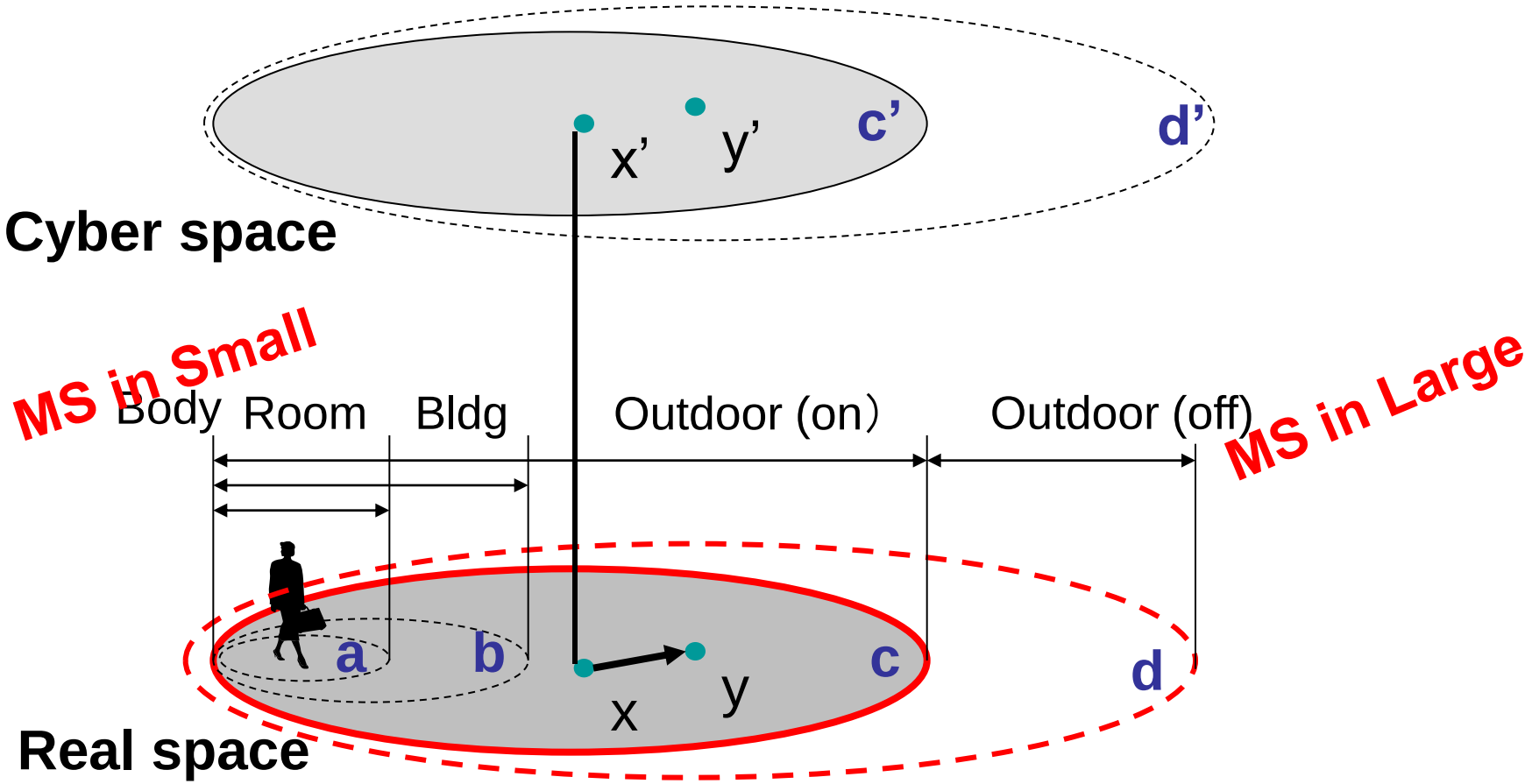
- A bit of History
  - Ubiquitous Network Project in Japan
- What are Ubiquitous Services?
  - Ubiquitous Services with Sensor enabled smart phones
- Creation of Ubiquitous Services
  - Case Studies with Sensors and Mobile Devices
- Challenges in Mobile Sensing Systems
  - Technology Shaping and Social Innovation
- Summary

What are Ubiquitous Services

Ubiquitous Services

- Service type: any3 vs. only3
  - At anytime, anywhere, for anyone
  - Only now, only here, only for me/us
- Ubiquitous Services
  - Context-aware Services
  - Context-aware Information Services
    - Presence Service for your friends (Real-Space SNS)
    - Push-type information service
  - Context-aware Health Care
  - Mobile e-Commerce with RFID tags
  - and more…

Classification of Ubiquitous Services



Smarter Ubiquitous Platforms are available!

Sensor enabled Smart Phones, Kindle & iPad, Eye camera･･･

Sensor enabled Smart Phones

- Internal Sensors
  - GPS
  - Camera
  - Accelerometers
  - Light Sensors
  - Microphone
  - Cellular radio signal strength
  - Bluetooth
  - WiFi
  - Smart Cards (Osaifu Keitai)
  - Active/Passive Tags
- External Sensors
  - Biosensors
  - Alcohol sensor
  - Pressure sensor
  - Mote Sensor
  - Zigbee sensor

Is Ubiquitous Service Everywhere?

What can we offer after sensing?

Health **C**are

Awareness

Education

Marketing

Democracy

Sustainability

Fun

and more...

Outline

- A bit of History
  - Ubiquitous Network Project in Japan
- What are Ubiquitous Services?
  - Ubiquitous Services with Sensor enabled smart phones
- Creation of Ubiquitous Services
  - Case Studies with Sensors and Mobile Devices
- Challenges in Mobile Sensing Systems
  - Technology Shaping and Social Innovation
- Summary

FASH system

Health care: uCare Applications

<smart object service, DIY deployment, ULC-WSN,
personal behavior modeling, monitoring & alert model>

System architecture and Fatigue detection

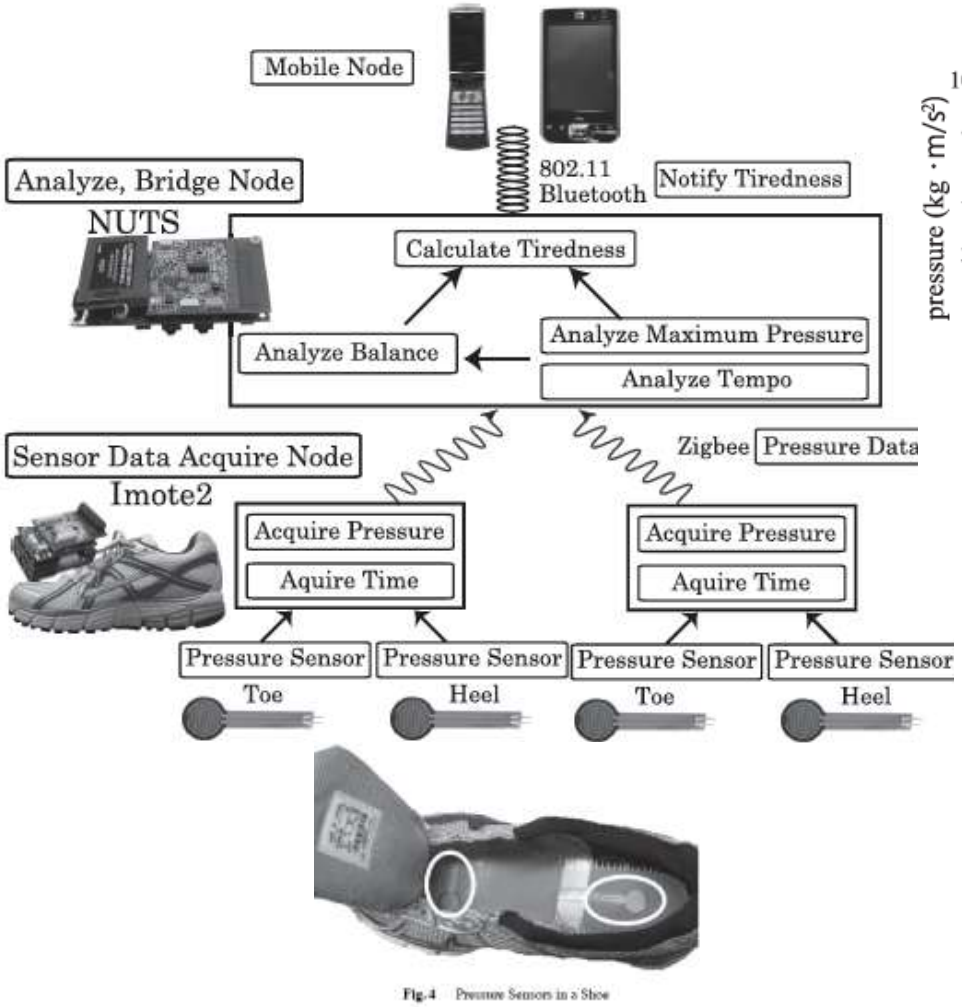
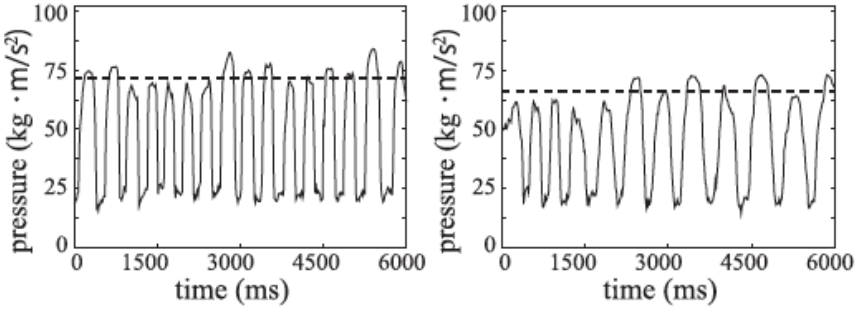


Fig. 4 Pressure Sensors in a Shoe



(a) before fatigued (b) after fatigued

Fig. 2 Pressure values vs. Time before and after fatigued

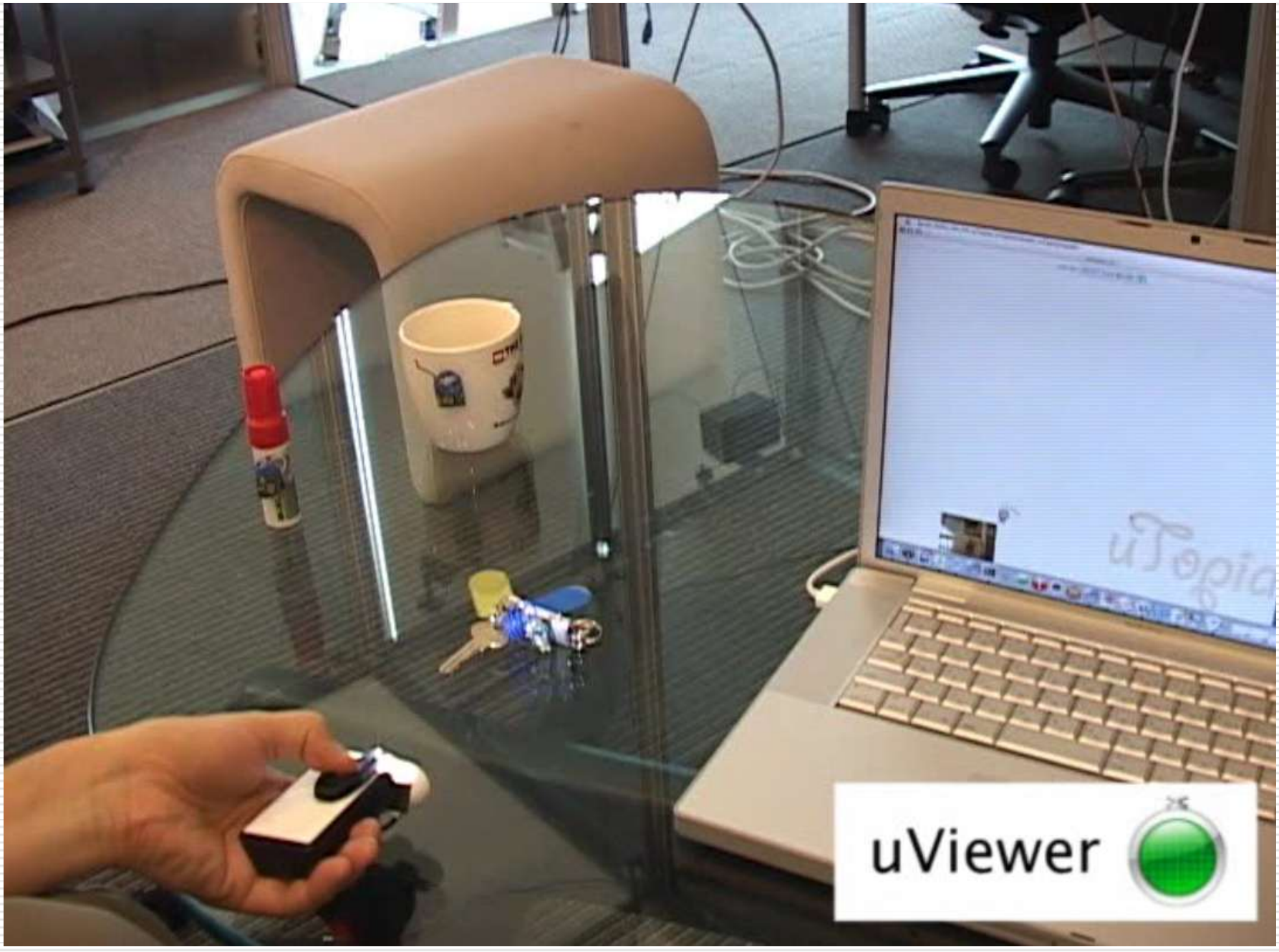
Table 1 Comparing Sensors for Detecting Tiredness

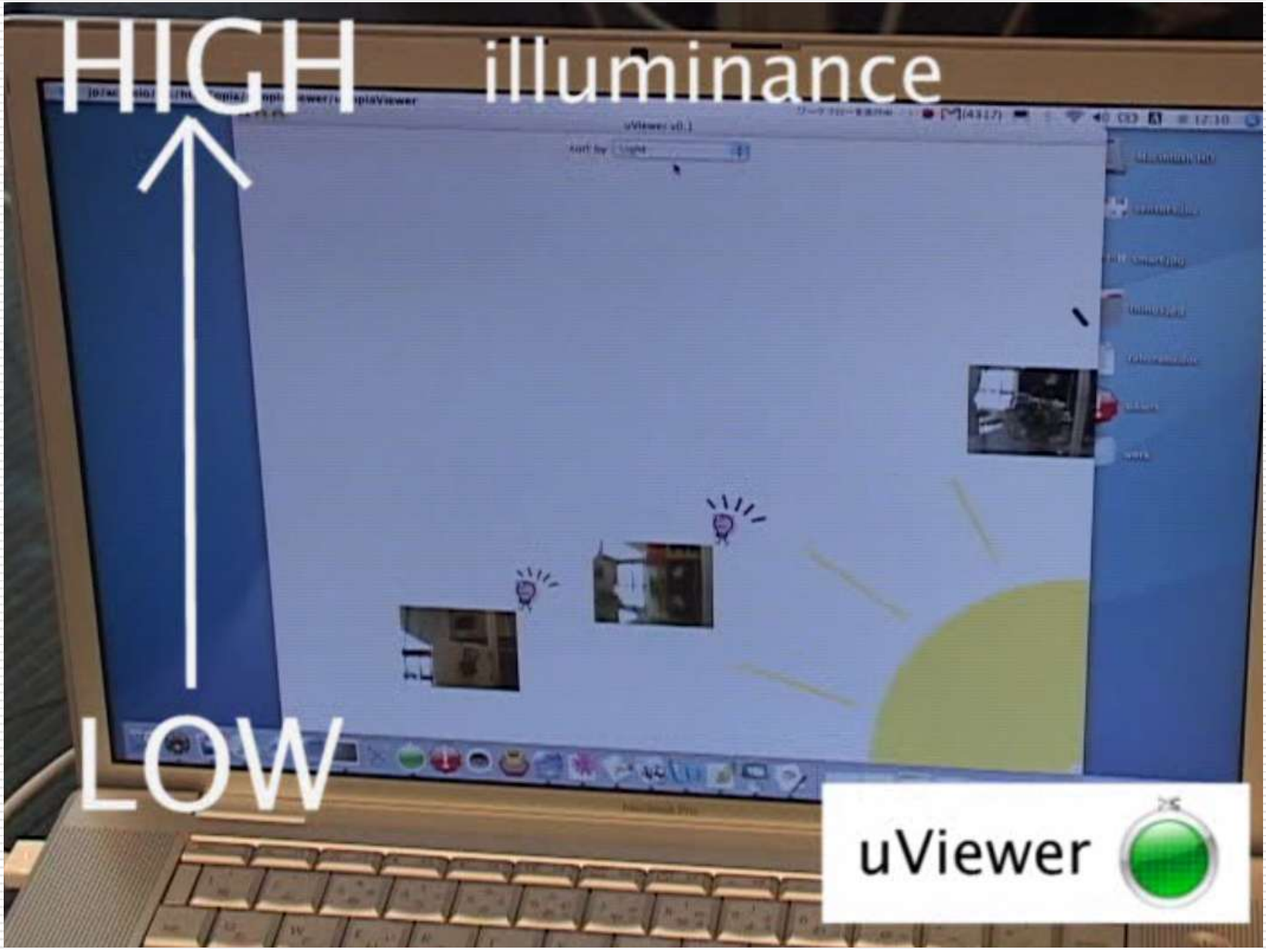
	height of legs	tempo	body balance	usability
accelerometer				
waist	poor	good	good	poor
feet	good	good	poor	good
waist & feet	good	good	good	poor
camera	good	good	good	poor
pressure sensor	good	good	good	good

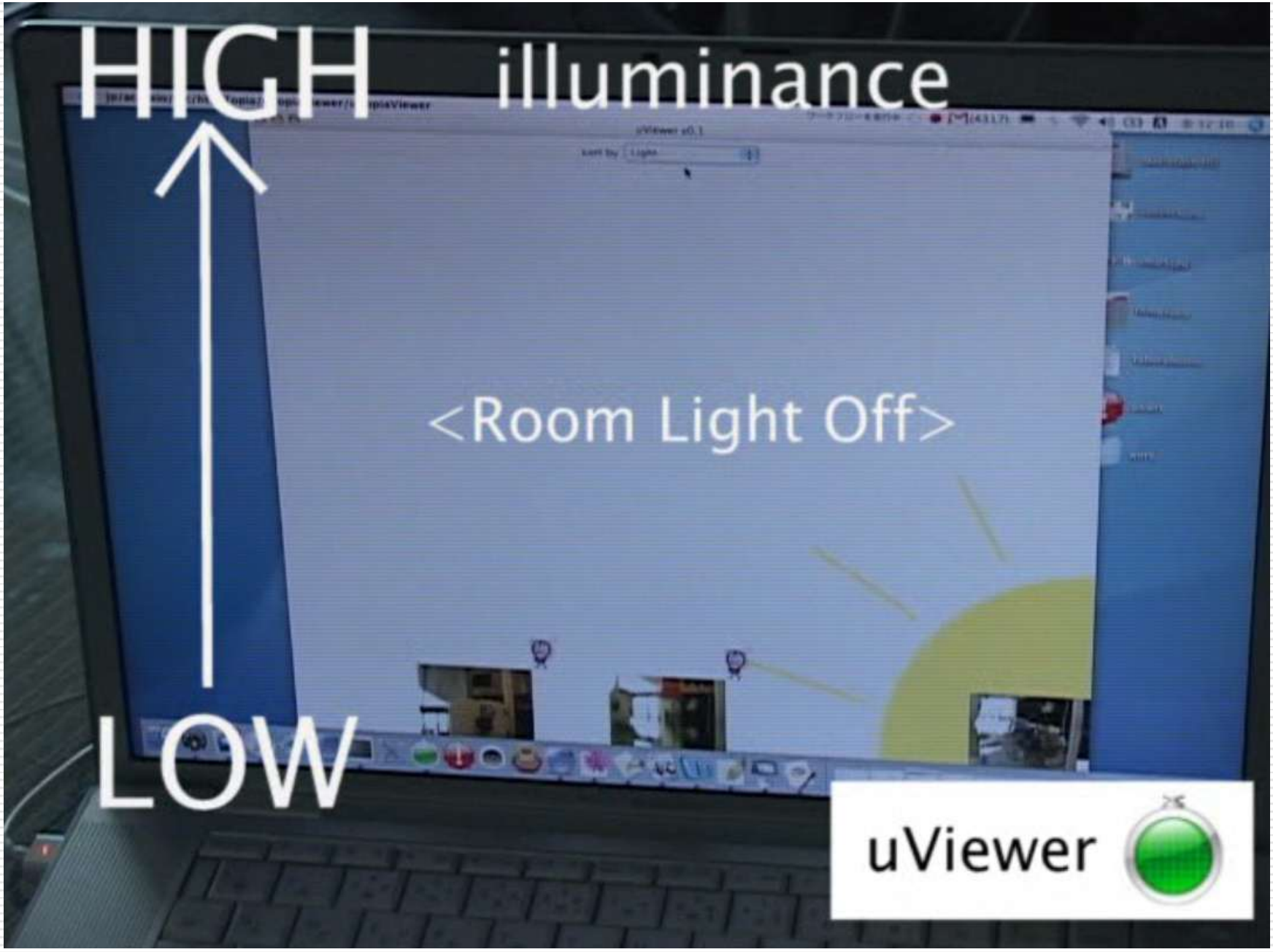
DIY Smart Object Services

Health care: uCare Applications

<smart object service, binding problem, DIY deployment, privacy, personal behavior modeling, monitoring & alert model>


uViewer

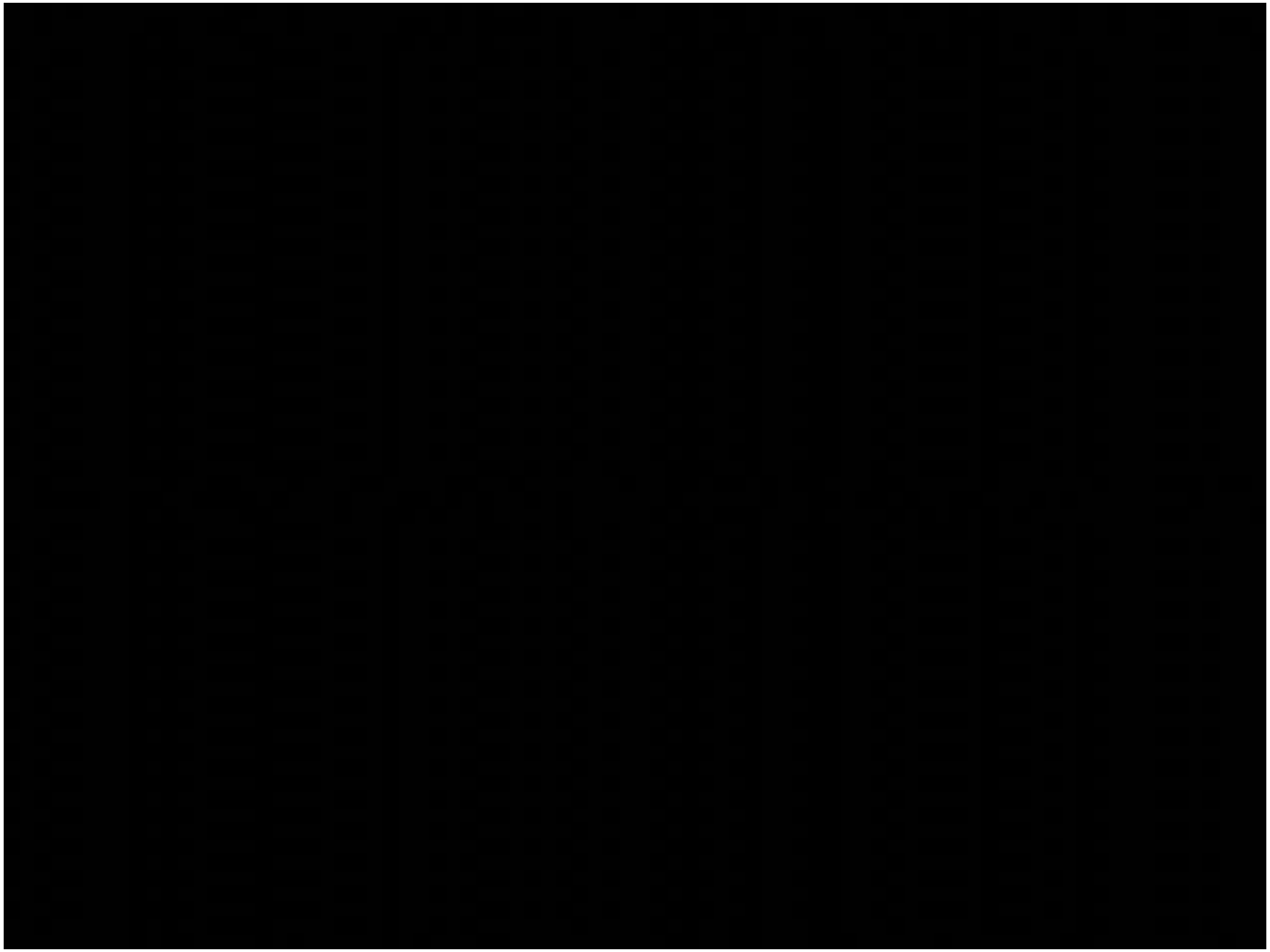

HIGH
illuminance
LOW
uViewer


HIGH
illuminance
<Room Light Off>
LOW
uViewer

uCare DIY Service

© H.Tokuda 2010

DIY Smart Object Service (UbiComp 2006 Video)



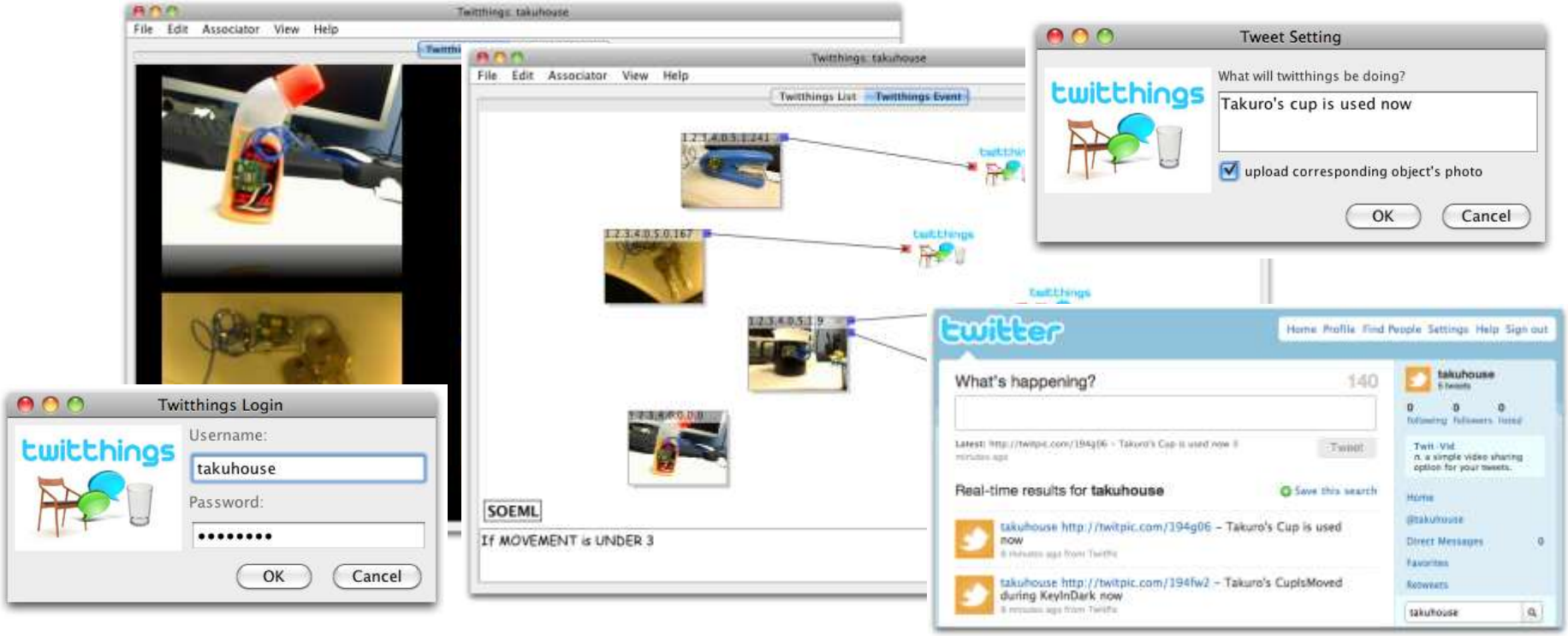
TwitThings

Awareness Applications

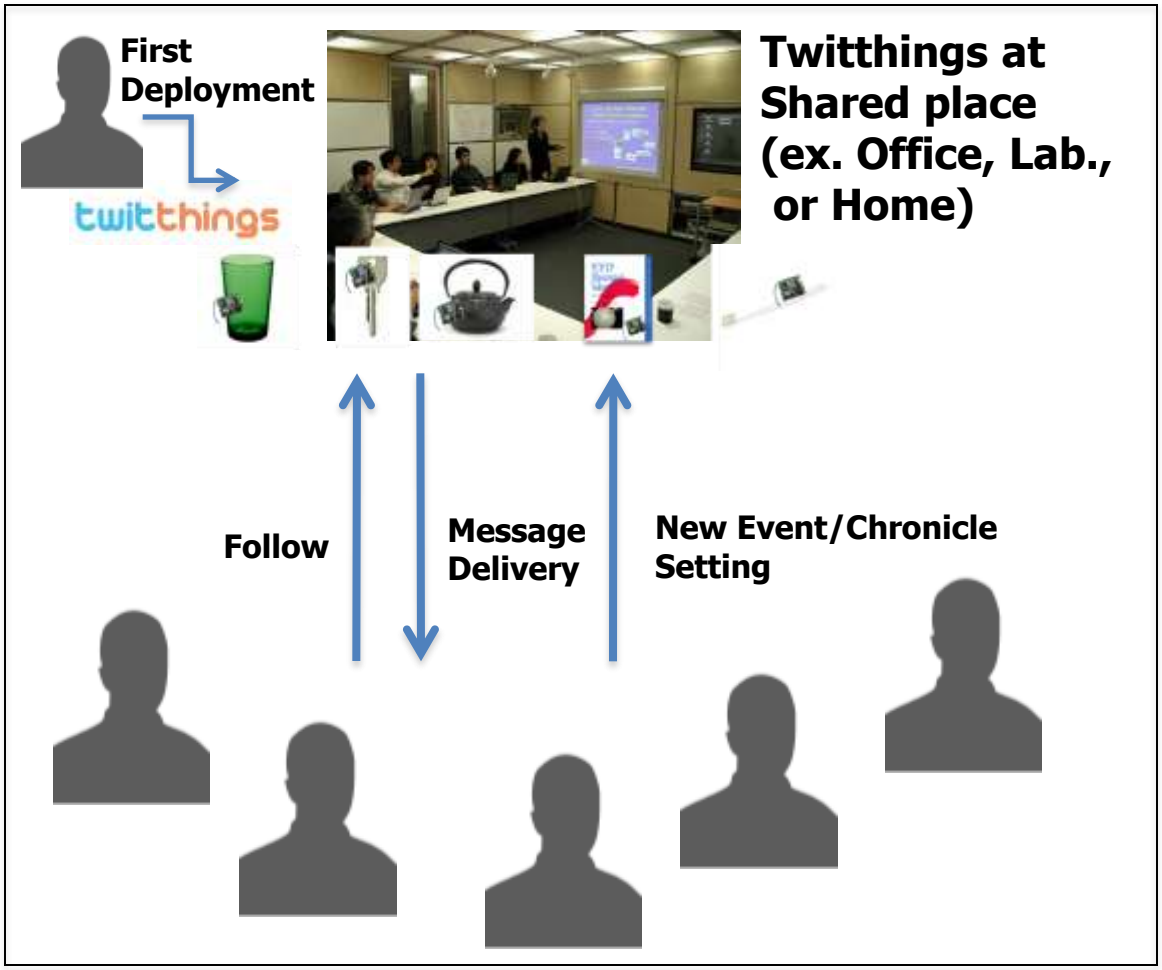
<smart object service, binding problem, DIY deployment, privacy, personal behavior modeling, monitoring & alert model>

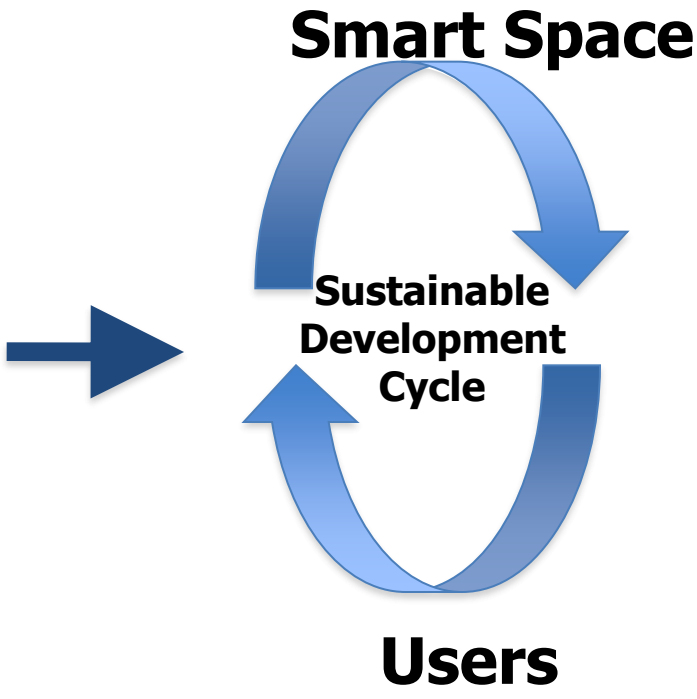
twitthings

- **Twitthings(Twitter™ + Things)**
  - A sustainable context-aware application for motivating IoT(Internet of Things) with ULC-WSN



Twitthings: Sharing, Discovering and Defining Things' Happening





SHGP-SFC system

Ubiquitous Language Learning Environment

<Context-aware Data Delivery Model, Persuasive Technology, personal Learning Monitoring and modeling>

Ubiquitous Lang. Learning Environment

Environment Germany: ”live learning” in scenes of contact during summer language classes in Germany
Environment Japan: bridging classroom learning and every day life, more learning opportunities, exchange with other students

Context Detection

Digital Media Selection Engine

A student approaches a bus stop

Extracting video “Asking for directions in public transport”

The system provides context-dependent learning materials

iPhone etc.

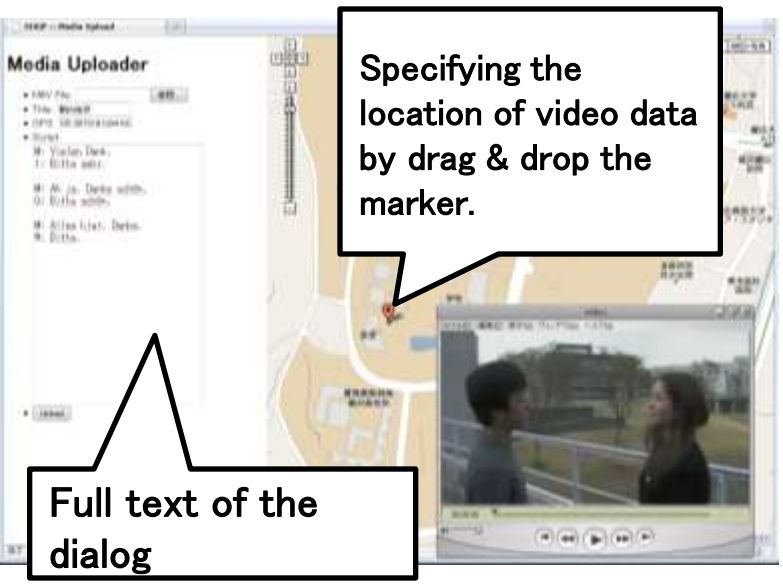
ide tokuda lab.

Ubiquitous Lang. Learning Environment

Learning:

independent of time and place, according to context

Teachers locate the educational materials on a specific point of Google Map with several metadata description for it.



①Location Sensing

Location Sensing by using GPS

②Selective Dissemination of Videos According to a Spatio-Temporal Context.

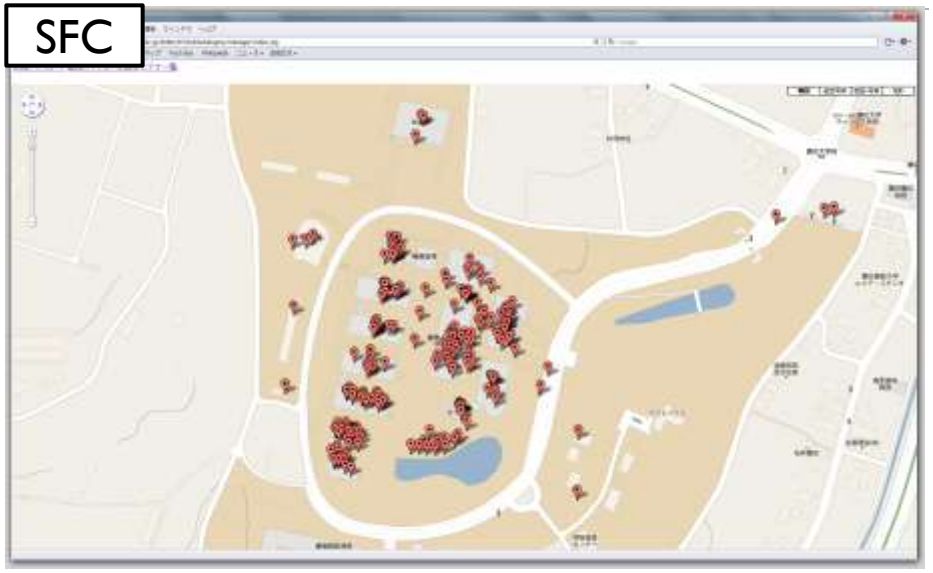
Selective Dissemination of Videos According to a spatio-temporal context.

Playing the received videos

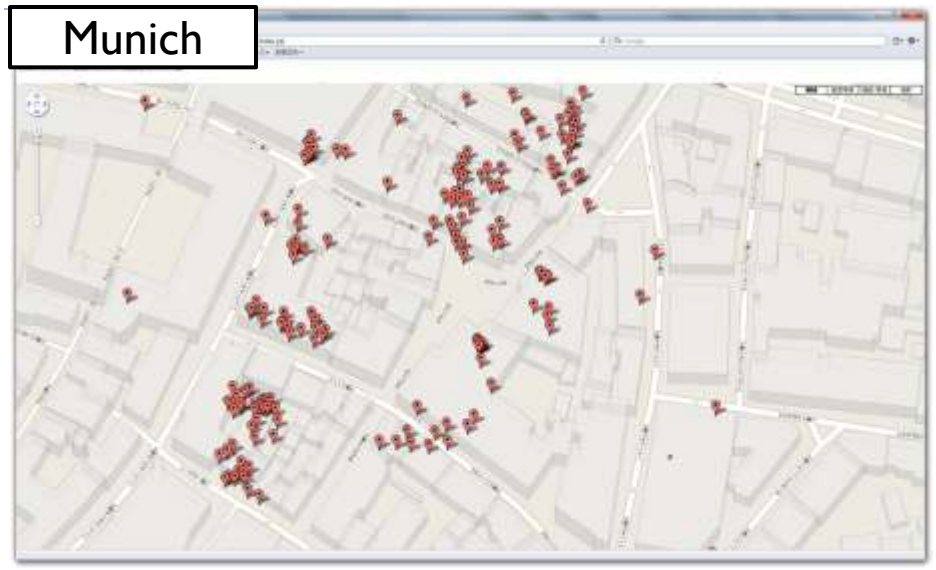
hide tokuda lab.

SHGP: Experience-Connected Ubiquitous Learning Environment
168 videos are located on the following 4 sites: Keio SFC Campus, Martin Luther University of Halle-Wittenberg, University of Bonn, Munich

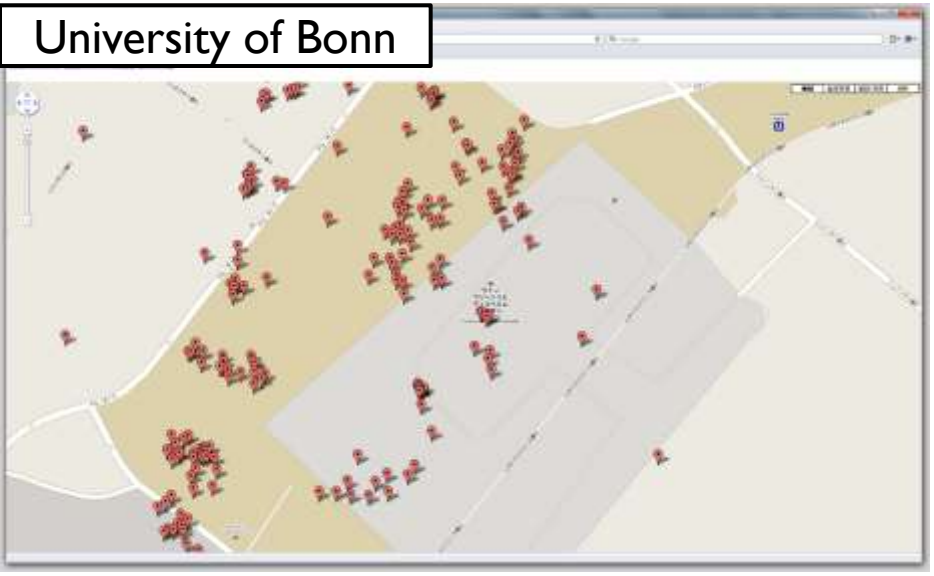
SFC



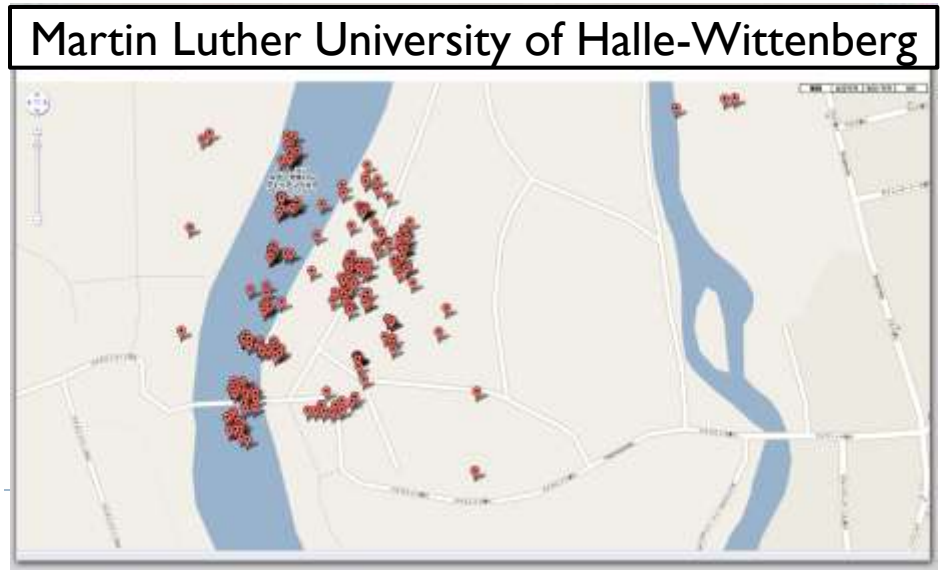
Munich



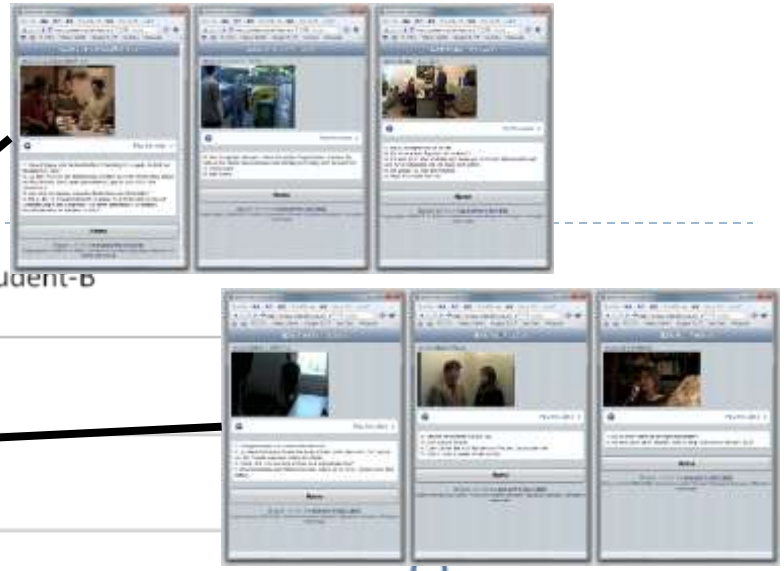
University of Bonn



Martin Luther University of Halle-Wittenberg



General tendencies (Access data registered)
Time Series Audience Measurement 2



Swing Reference Code

Service Finding

<Service finding, Location-based deployment, Crossmedia tool, monitoring & marketting, >

QR code

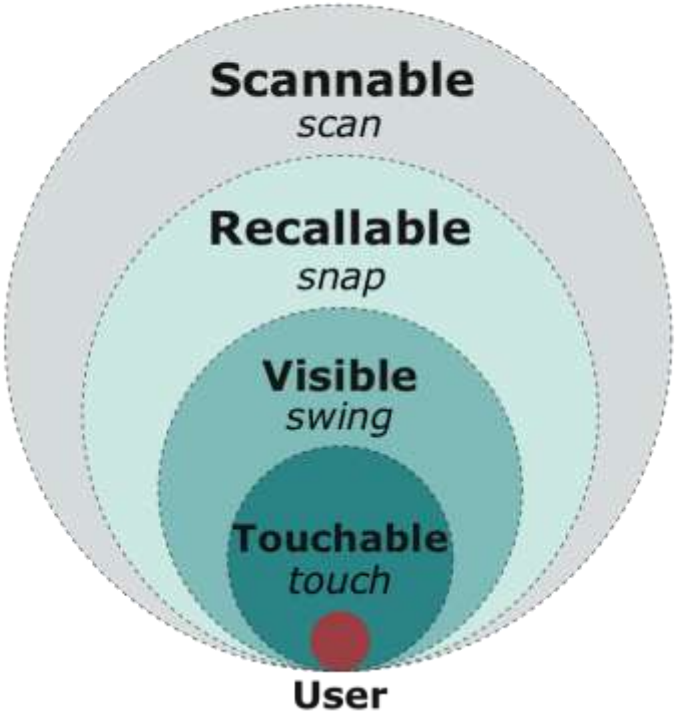
Cross-media Tool
Communication Tool
Traceability Tool

hide tokuda lab.

Service Finding and Interaction

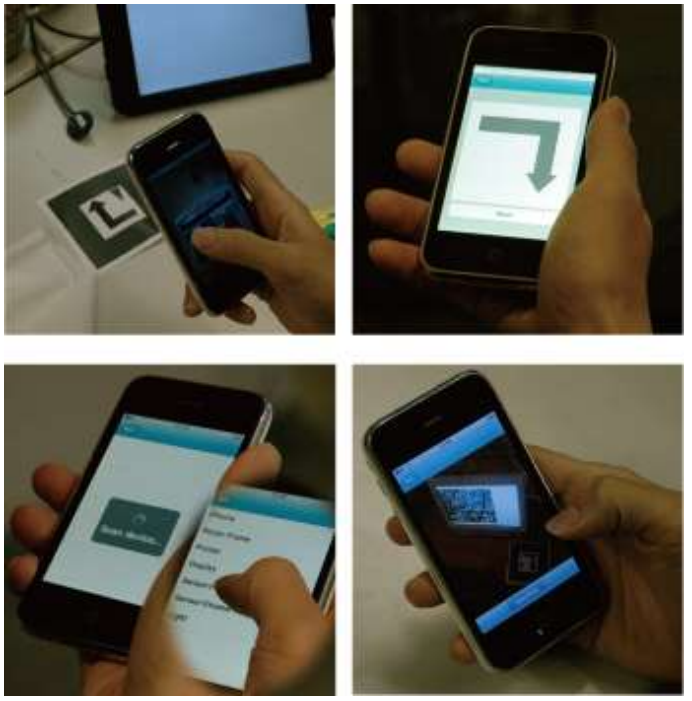
No Silver bullet

Physical and Cognitive Distance Based Selection



Touch (RFID)

Swing (accelerometer)



Scan(Network)

Snap (Still Image)

Swing, Snap and Stamp It!(UbiComp 2009 video)

Swing, Snap and Stamp It!: Device Interaction with Fun

Keio University, Japan

Katsuya Hashizume
Kazuhiro Imura
Kyohei Kawada
Naoya Namatame
Tomotaka Ito
Masaki Ito
Jin Nakazawa
Kazunori Takashio
Hideyuki Tokuda

Swing Reference Code (2009)

Follow-me Services

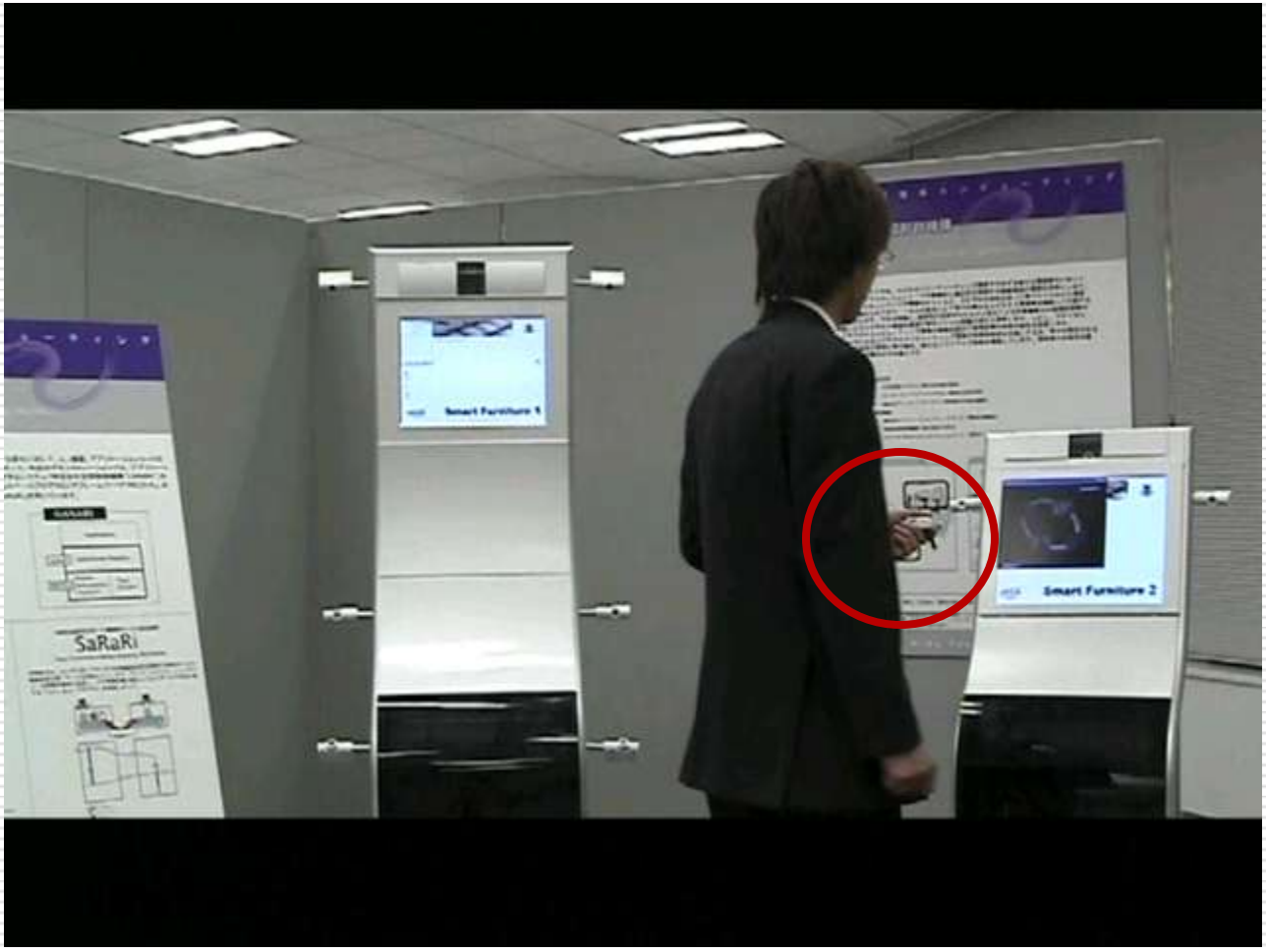
Dynamic Adaptation of Services

< real-time software migration, localization, authentication, dynamic adaptation >

Follow Me Type Service (1)

© H.Tokuda 2010

Follow Me Type Service (2)



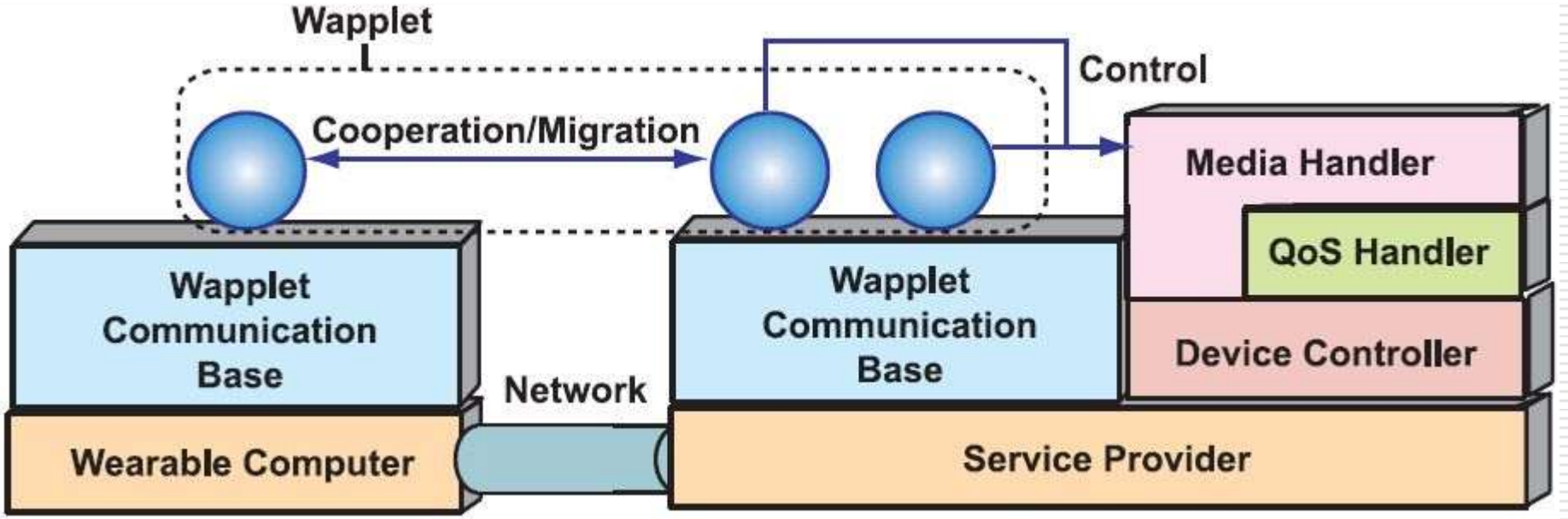
© H.Tokuda 2010

Service Roaming

© H.Tokuda 2010

Wapplet architecture

- Application = config module+ wapplet module
- Java Objects + Location Transparent Method Inv.



© H.Tokuda 2010

Live! Commerce Akiba

Capturing Customer's Preference in Real-Time

< context capturing, real-time marketing analysis, data mining>

Ubiquitous Week in Akihabara

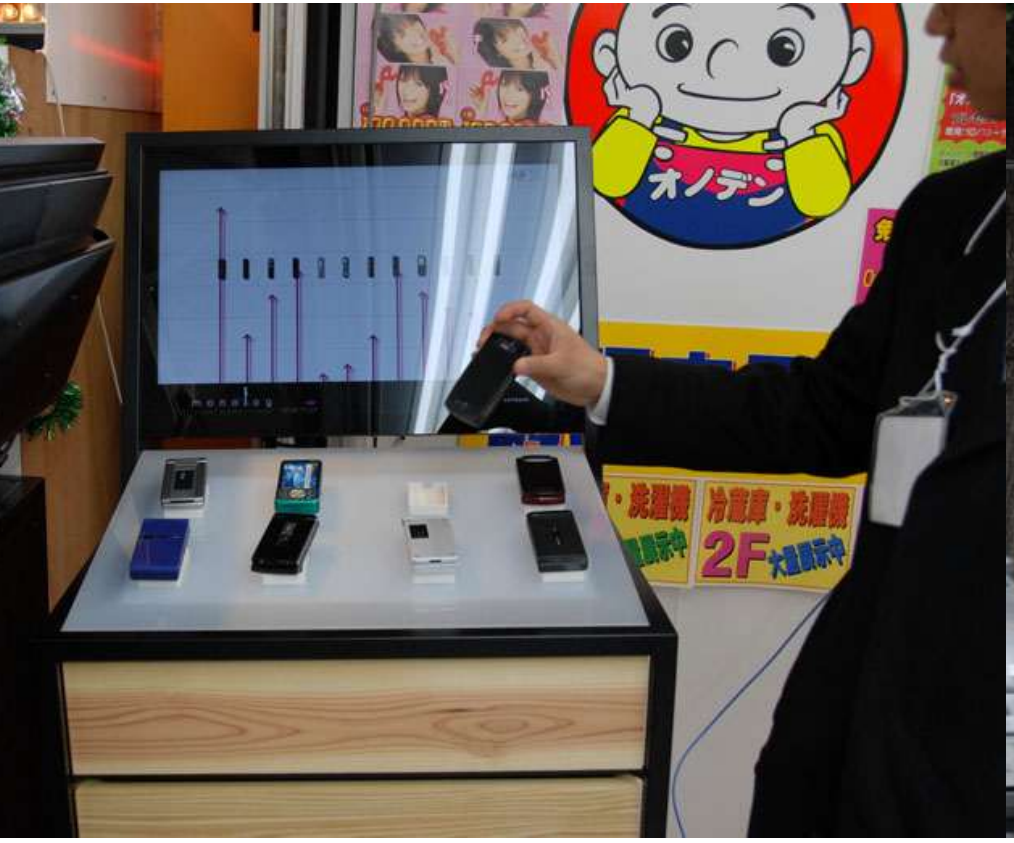
11/25/2007-12/30/2007

© H.Tokuda 2010

Live! Commerce Akiba (1)

© H.Tokuda 2010

Live! Commerce Akiba (2)



© H.Tokuda 2010

Live! Commerce Akiba (3)

© H.Tokuda 2010

Akihabara Demo (1)

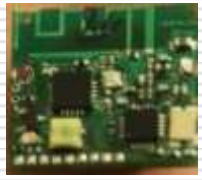
© H.Tokuda 2010

Akihabara Demo (2)

© H.Tokuda 2010

Experimental Results

- Onoden and Kaiyoudo at Akihabara
  - Date：11/29-30（UNS2007）
  - Real-Time Data Collection
  - Touched vs. Interested
- Total Events
  - 5401 Events
    - Touched：3510
    - Interested：1891
- Total Data
  - 3,950,000 records
    - Total 243MB
  - uPart’s sensing period: 1sec.



Airly Notes and Mebius Ring

Citizens Awareness

< Real-time Sensing & Posting, Visualization, SNS >

ユビキタス技術による環境モニタリングの実証実験

Airy Notes

ユビキタス技術で環境を感じよう！

電車を降りた瞬間むっとした熱気を感じてうんざりするような日でも、新宿御苑を訪れればひんやりとしたさわやかな空気の流れを感じることができる。これは、御苑の豊かな緑と水のはたらきによるものです。近年の調査では、御苑が周辺地域に冷ややかな空気を送り込み、都市気候の緩和に貢献する都市のクールアイランドであることも明らかになっています。

"Airy Notes" プロジェクトでは、新宿御苑 100 周年記念イベント「玉川上水の復活に向けて」の一環として、ユビキタス技術による都市環境モニタリングの実証実験をおこなっています。センサ機能を持つ超小型コンピュータによるユビキタス（いつでもどこでも）な環境情報の取得と可視化により、御苑の環境を視覚的に身体的に感じてもらうことをねらいとしたものです。

紙シェルター

耐水紙でつくられたセンサの庇より、表面に貼られた 2D コードを使い、携帯電話からその uPart の観測値にアクセスすることができます。

uPart (165 個)

温度、照度、振動センサを備え、観測データを定期的に無線通信で発信する、大きさ 2cm 四方程度の超小型コンピュータです。

計測・発信と受信の機材

ドイツ カールスルーエ大学で開発された超小型コンピュータと受信の機材を用いています。

xbridge (11 個所)

uPart から送信された観測データを受信し、データベースサーバに送ります。

観測地点とネットワーク構成

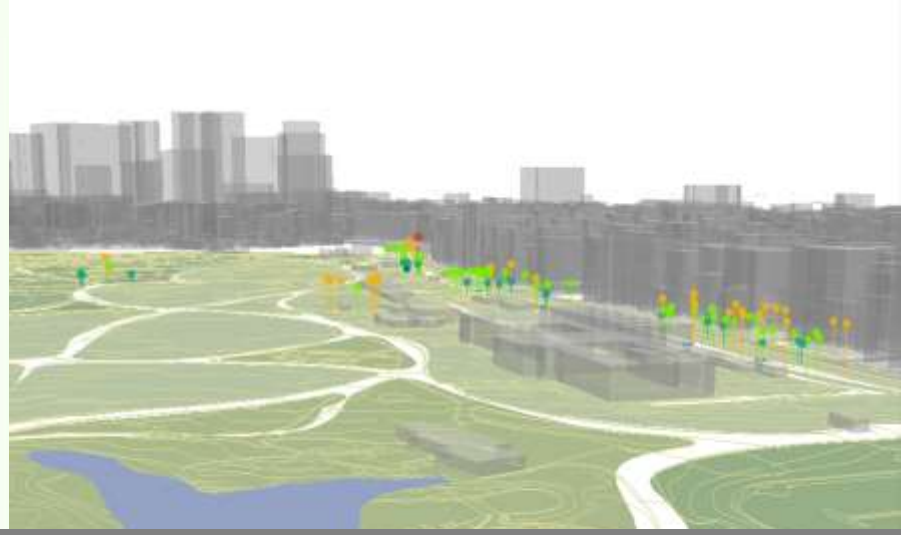
センサ（uParts）の観測値は、インターネットを通じて即時に収集され、いつでも最新の情報を見ることが出来るようになっています。

環境情報の可視化と共有

今、自分のいる場所の気候は前の晩とは？　昨日のこの時間は？　もし、ここに水が流れていたら？　もし、この緑がなくなってしまったら？　ちいさな子供の感じている環境は？……　設置した多数のセンサの観測情報が、インターネットを通じて即時にデータベースまで送り届けられる、"Airy Notes" は、さまざまな条件下の気象情報を可視化し、比較、共有するためのシステムとしての展開することを構想しています。

Airy Note 体験エリア（新宿御苑）

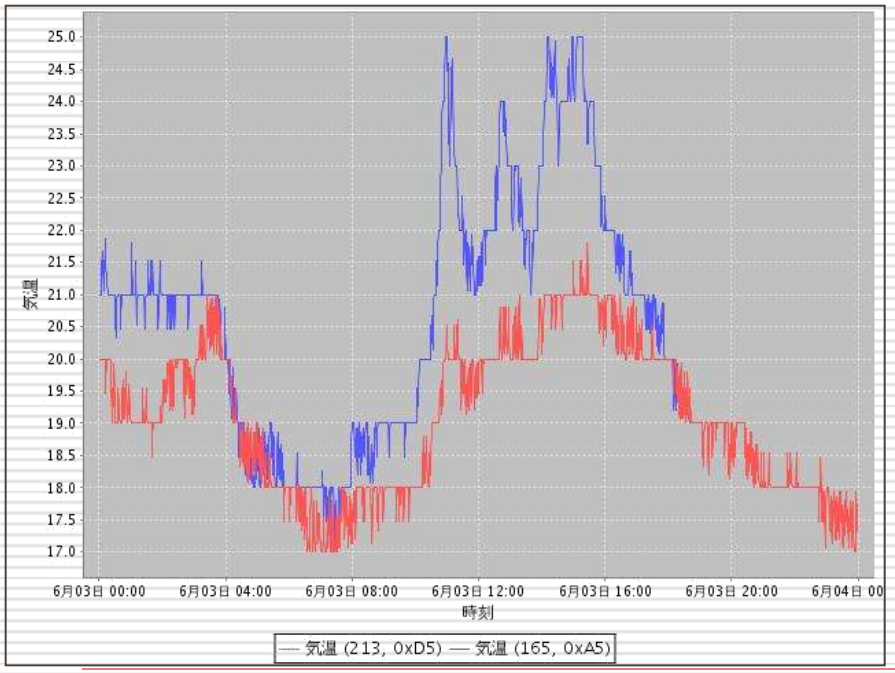
この実証実験を体験することができるのは、以下のエリアです。ぜひお越しください。

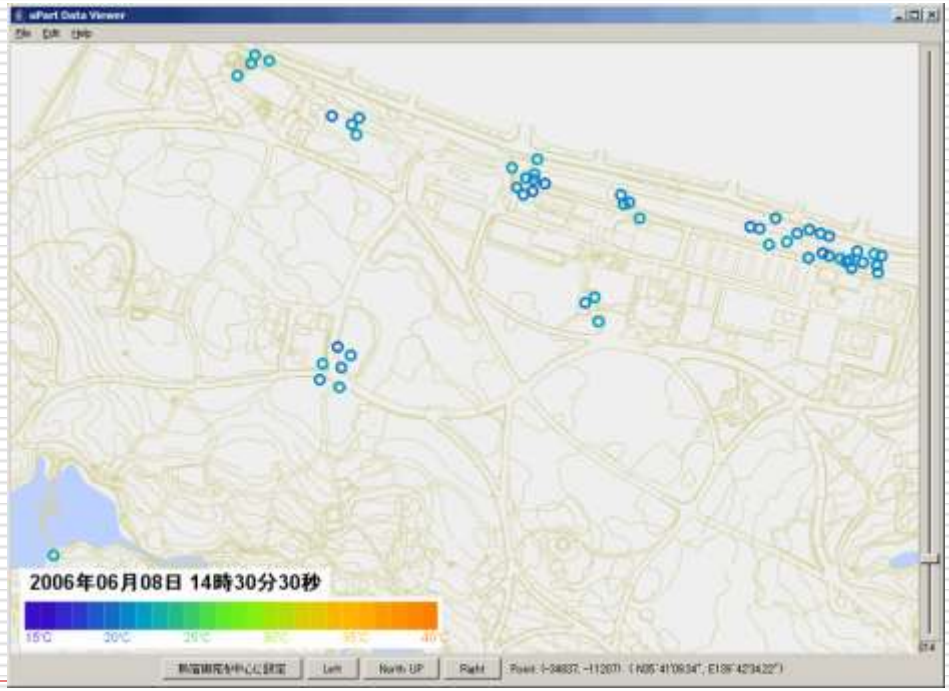


Visualization of Shinjuku City Park with Airy Notes

Real-time Visulalization on a PC

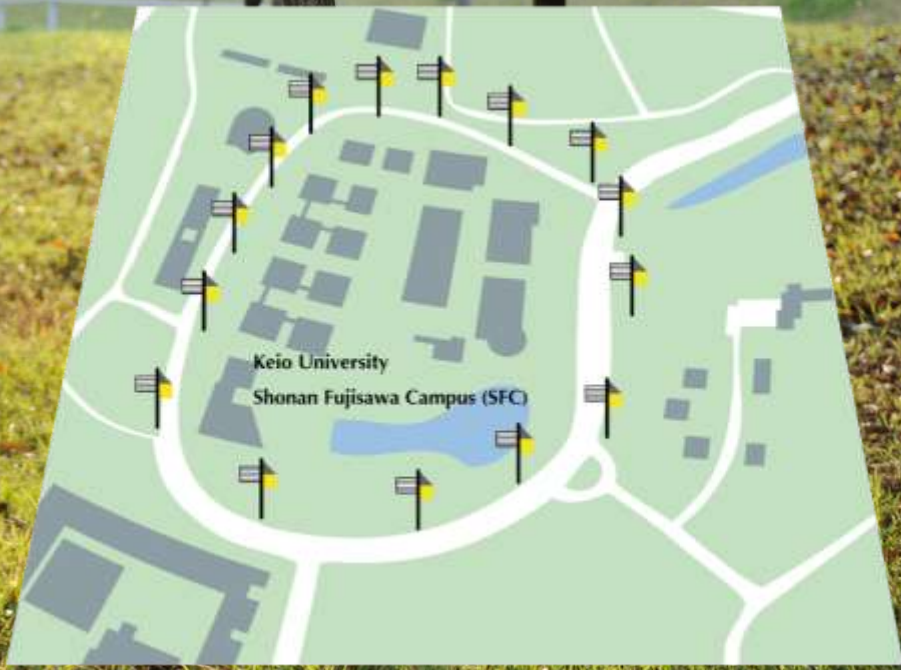
- City park view with a map (logging history)
- Daily histograph





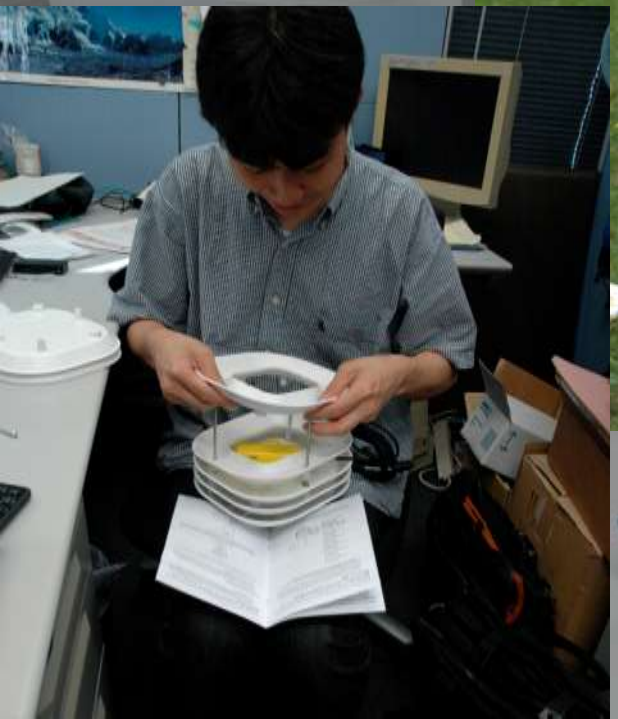
© H.Tokuda 2010

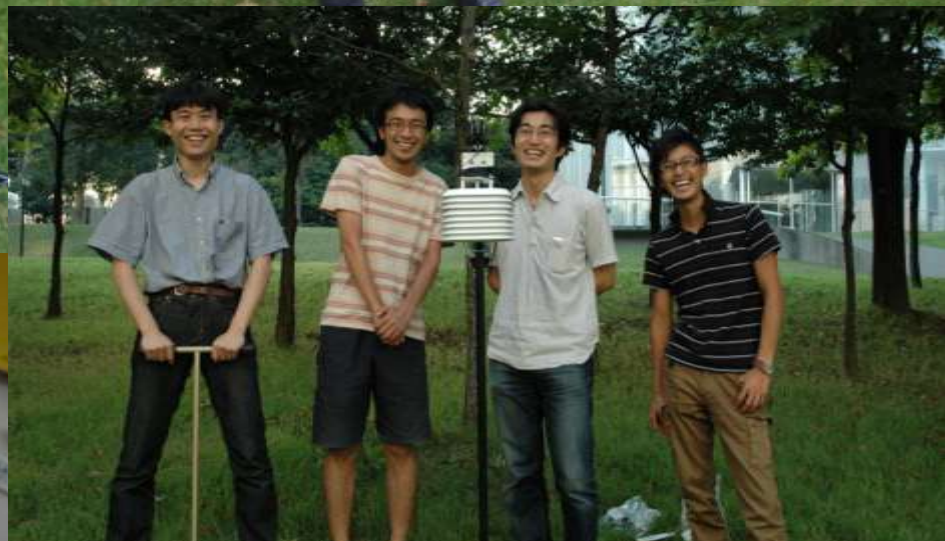
Mebius Sensor Project



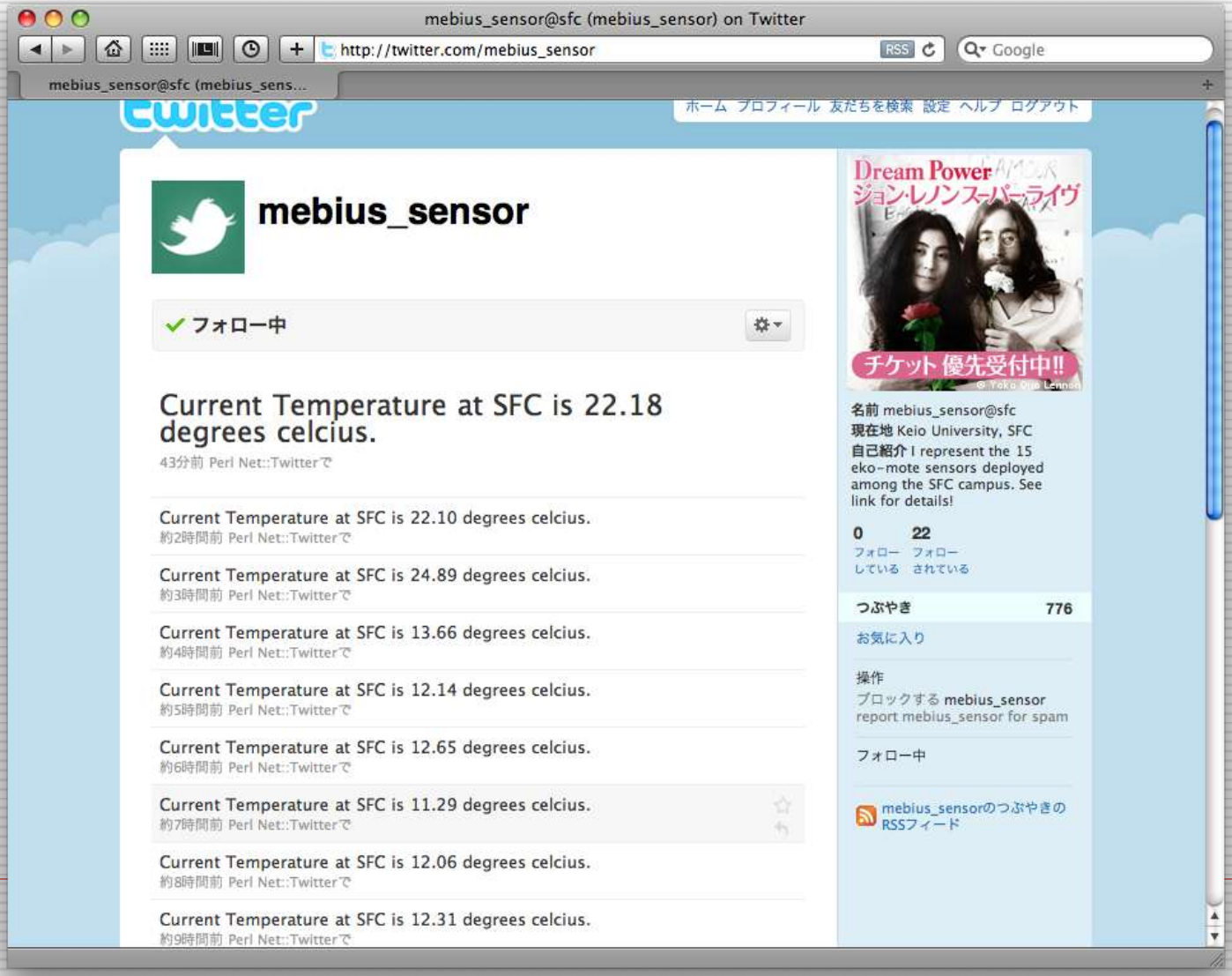
- Campus Sensing with 15 Sensor Poles in SFC

Sensor Pole Deployment





Follow “mebius_sensor” on Twitter



Outline

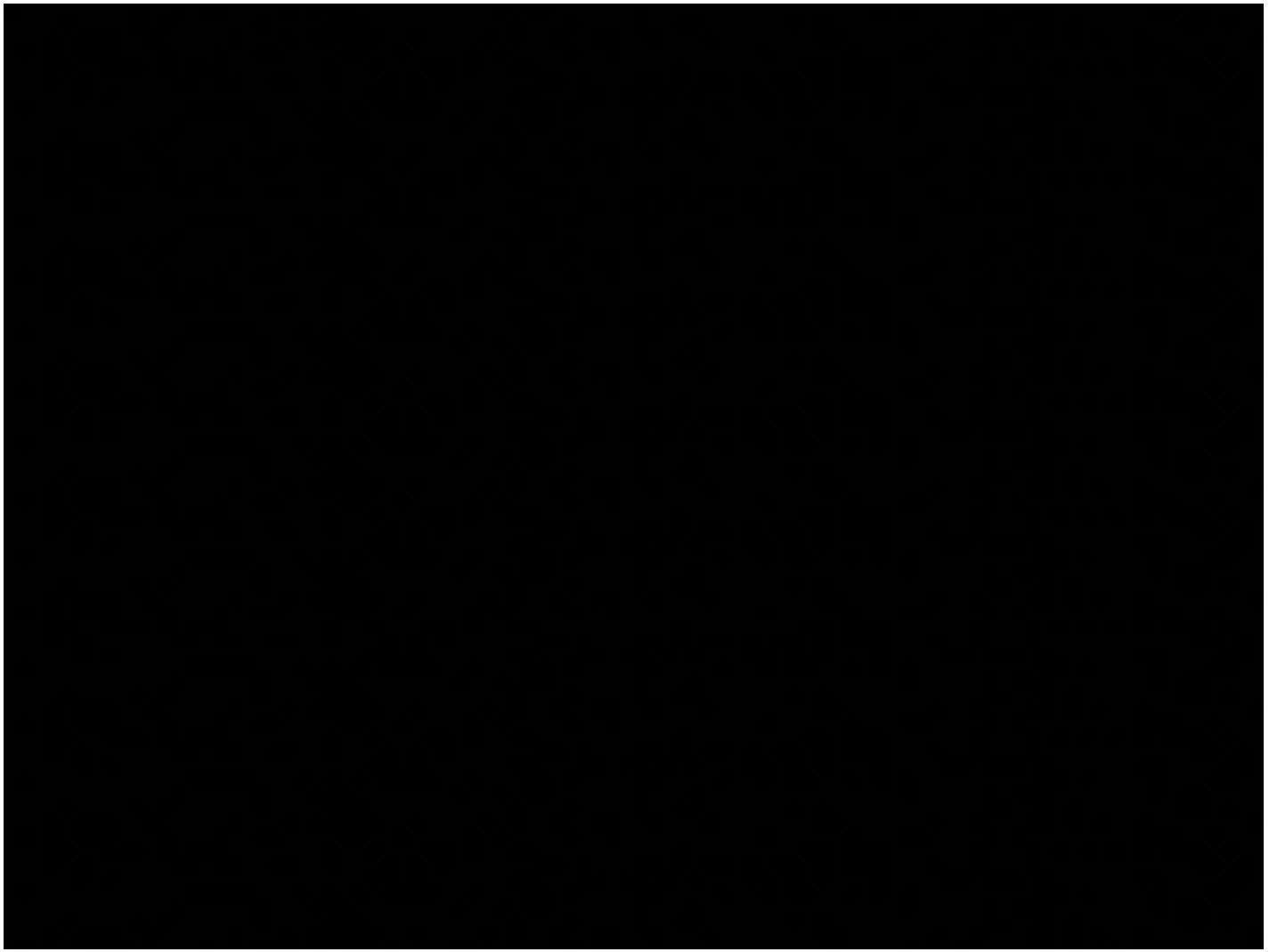
- A bit of History
  - Ubiquitous Network Project in Japan
- What are Ubiquitous Services?
  - Ubiquitous Services with Sensor enabled smart phones
- Creation of Ubiquitous Services
  - Case Studies with Sensors and Mobile Devices
- Challenges in Mobile Sensing Systems
  - Technology Shaping and Social Innovation
- Summary

Mobile Sensing Systems: What are Challenges?

Mobile Sensing in Large

NTT DoCoMo Mobile Space Statistics

NTT DoCoMo Mobile Space Statistics (2010)



Weather News: Collaborative Sensing Model

Defense forces for Guerrilla Thunderstorm

Mobile Sensing in Large

- Global Sensing Infrastructure
  - Federated Global Ubiquitous Networks
    - SenseWeb, SensingCloud, etc.
  - Self-organized, -optimized, -monitored, -repaired Networks
    - Model and Theory
  - International GUN testbed
    - Urban Challenge for GUN
  - Standardization
- Security and Privacy Control
  - Secure Transaction and Anonymization Technology
- Participatory Sensing Model
  - Collaborative sensing

Mobile Sensing in Small

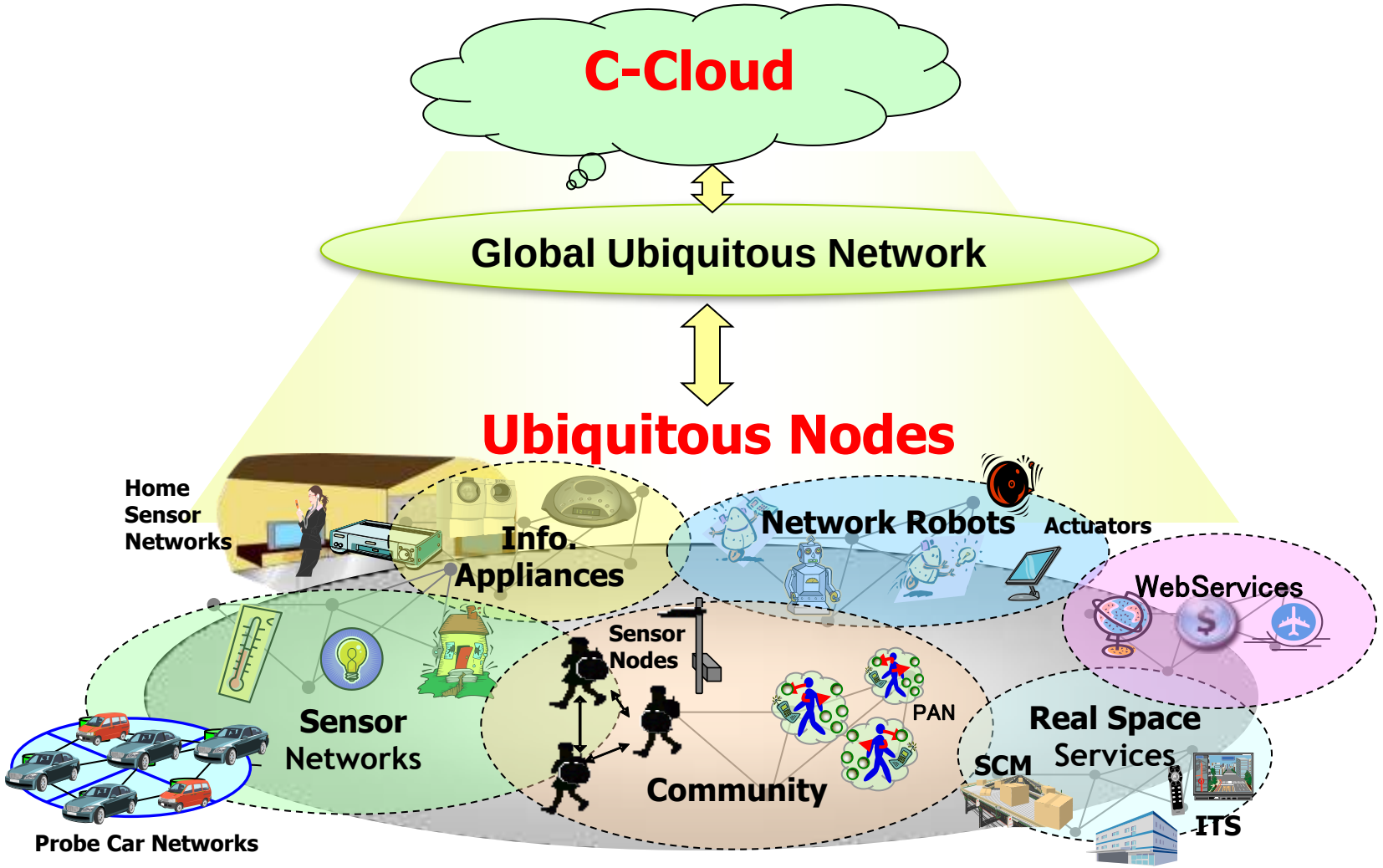
Mobile Sensing in Small

- Ultra Low Cost Wireless Sensor Nodes
  - Interoperability between ULC-WSN and Smart Phones
  - Standardization
- Context Capturing
  - Translating Data-tsunami to useful context
- Cross Domain Service Mash up
  - Service Coodination
- Human-Service Interaction Methods
    - Multiple Displays and Terminals
- Security and Privacy Management
  - Anonymization Technology

Context Capturing with a Network Robot

at Universal City Walk in Osaka by ATR

Ubiquitous Nodes and C-Cloud



Summary

- Challenges in Creating Ubiquitous Services with Mobile Sensing Systems
  - Global Sensing Infrastructure and Ubiquitous Network Environment
  - Participatory Sensing Model
  - ULC-WSN
  - Context Capturing
  - Cross-domain Service Mash up
  - Security and Privacy Management
- Ubiquitous Network Technology provides empowerment of people, organization, community and space & environment
- Social and Technological Innovation together

Thank you!

www.ht.sfc.keio.ac.jp