



KYUSHU UNIVERSITY



KYUSHU UNIVERSITY 2011  
100th Anniversary

# CPS Research Activities at Kyushu University

**Rin-ichiro TANIGUCHI**  
**Hiroto YASUURA**

**Graduate School of Information Science and  
Electrical Engineering**

*Laboratory for* **LIMU**  
*Image and Media Understanding*

# *A New Campus as an Experimental Field of Social Information Infrastructure*



# Strategy of CPS research at Kyushu Univ.

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## ■ 1<sup>st</sup> step

- Feasibility study for smart city in suburban city with a large-scaled university campus
  - Finding and analyzing various key issues



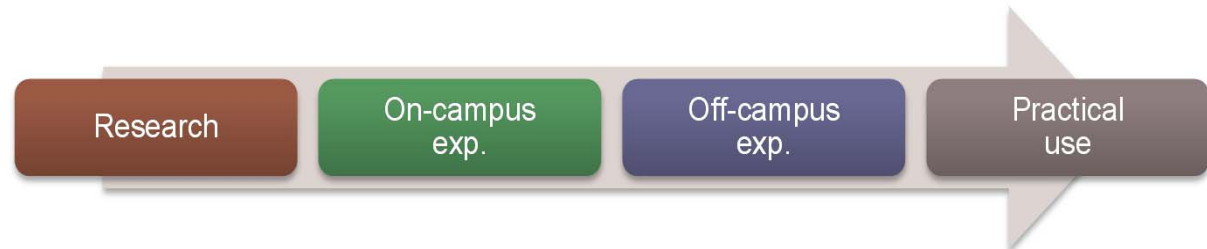
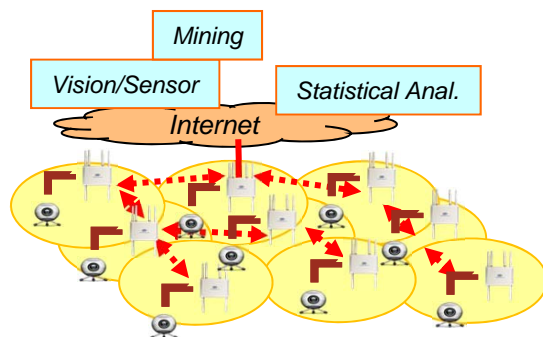
## ■ Further strategic research/development plan

- Short-term: campus as a showcase of new technology and advanced culture
- Mid-term: platform for pilot program coordinating university campus with its surrounding town
- Long-term: Smart city balancing nature/culture with various industries

## ■ Key issue examples: Fusion of various cyber-physical sensory data

Flexible and resilient sensor network

Personalization based on smart ID card



# Cyber-Physical Smart Campus (est bed)

Energy Sensors



ID System



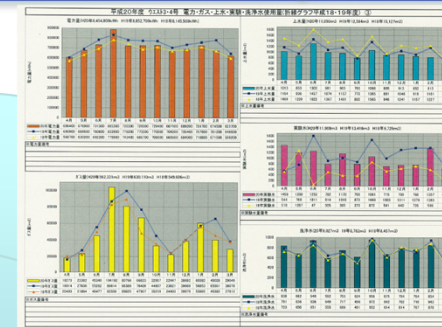
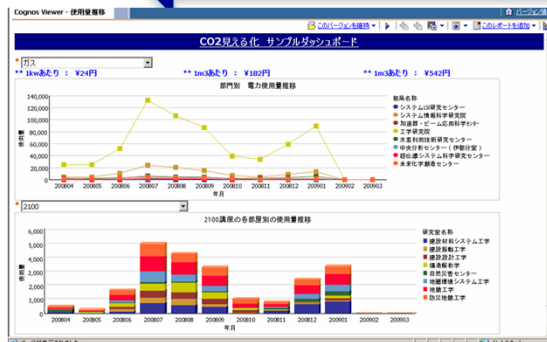
Security Sensors



Bio-Sensors



**Cloud Computing**  
 Collection of Sensing Data  
 Knowledge Discovery  
 Visualization of Knowledge  
 Optimization of Energy and Resources



Visualization

Commercial Grid



Database

Campus Energy Grid



Hydrogen Energy



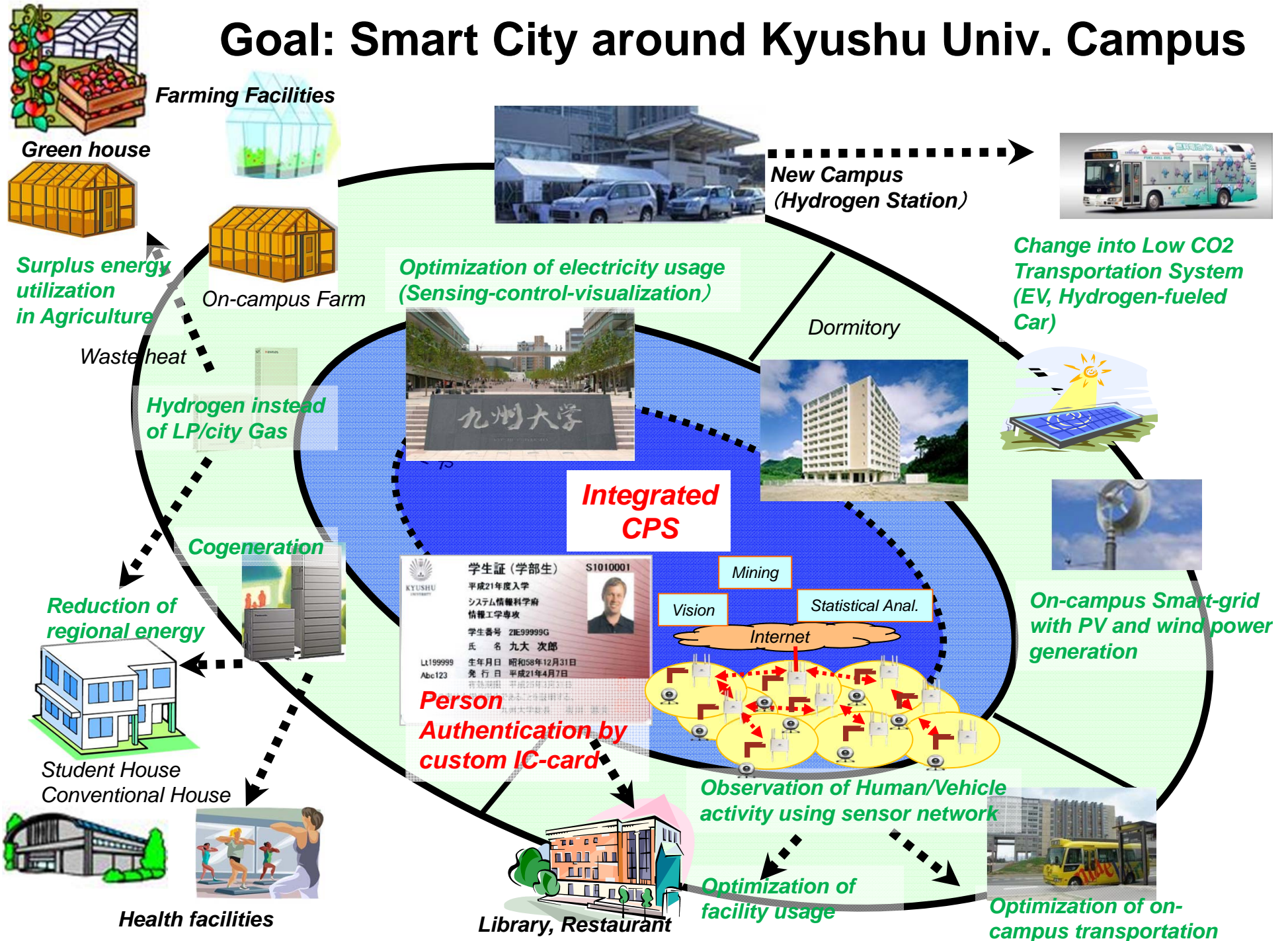
Solar



Wind

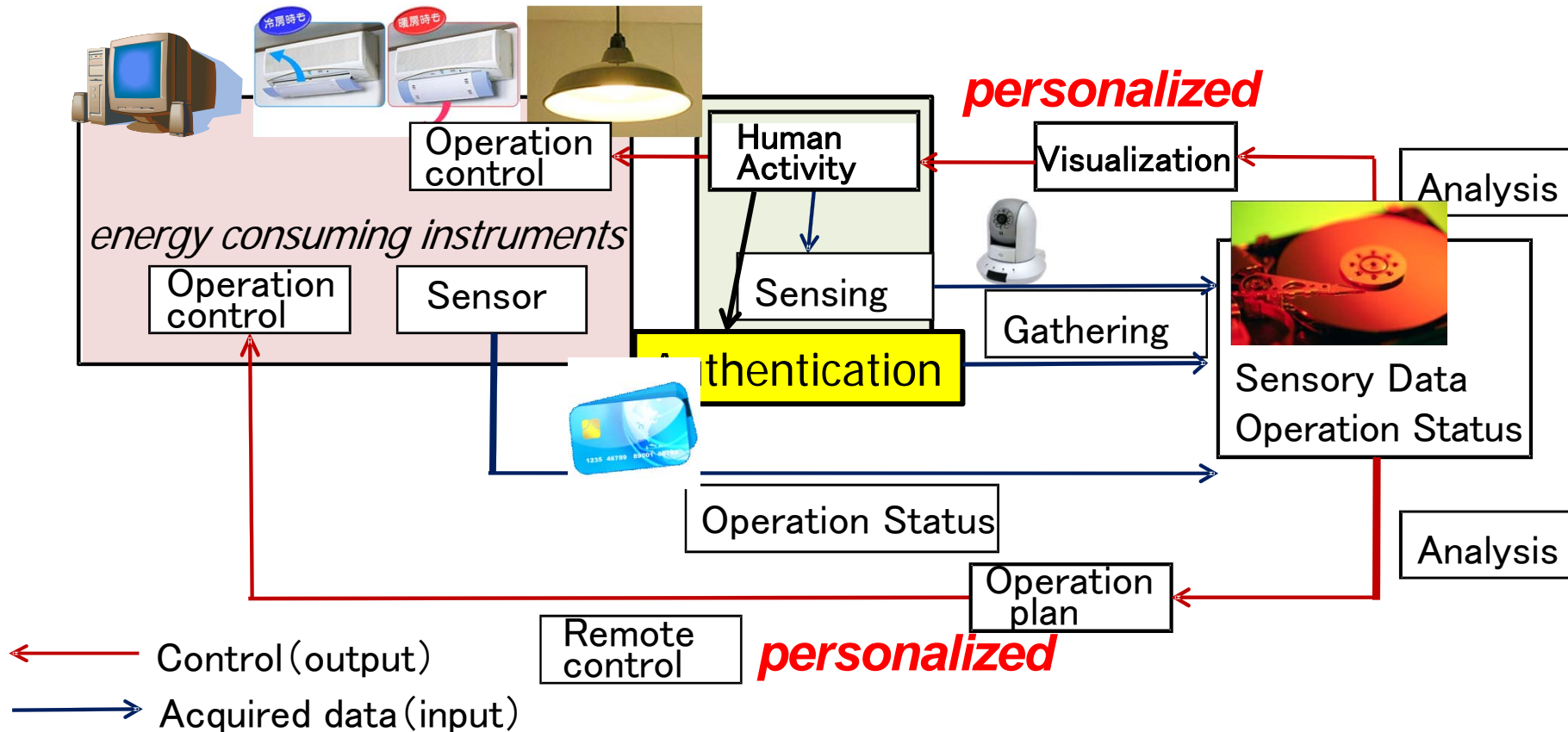


# Goal: Smart City around Kyushu Univ. Campus



# FS: Personalized Eco System

- Automatic control of energy consuming instruments
- Manual control led by visualized notification
- Optimization based on personal attribute, environment,...

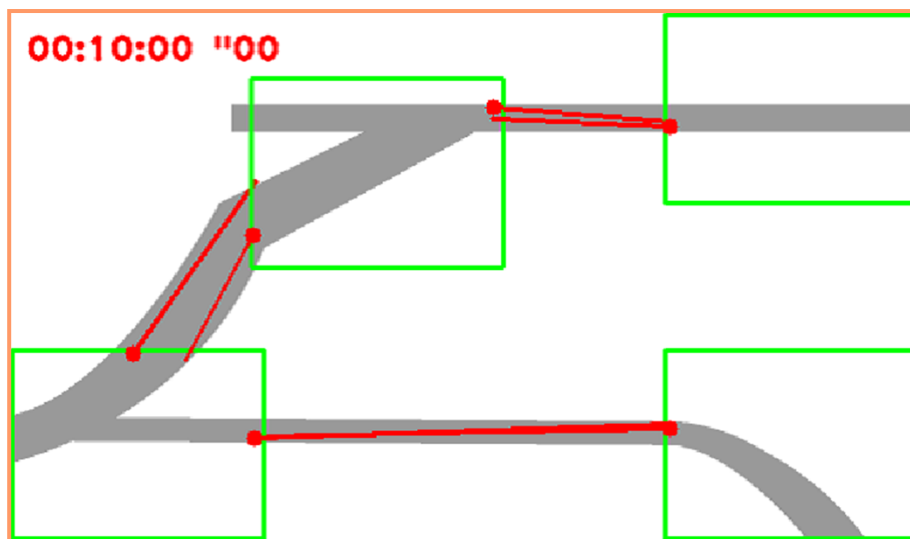
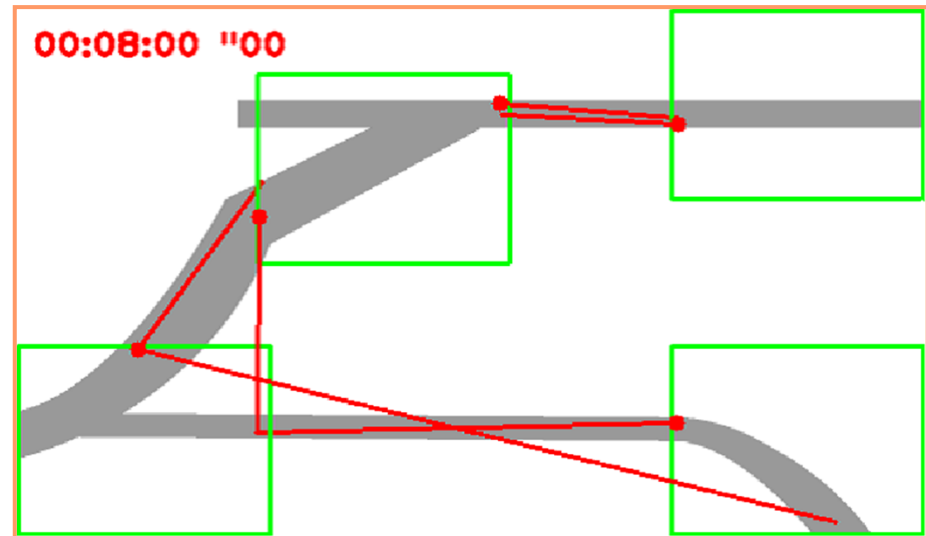
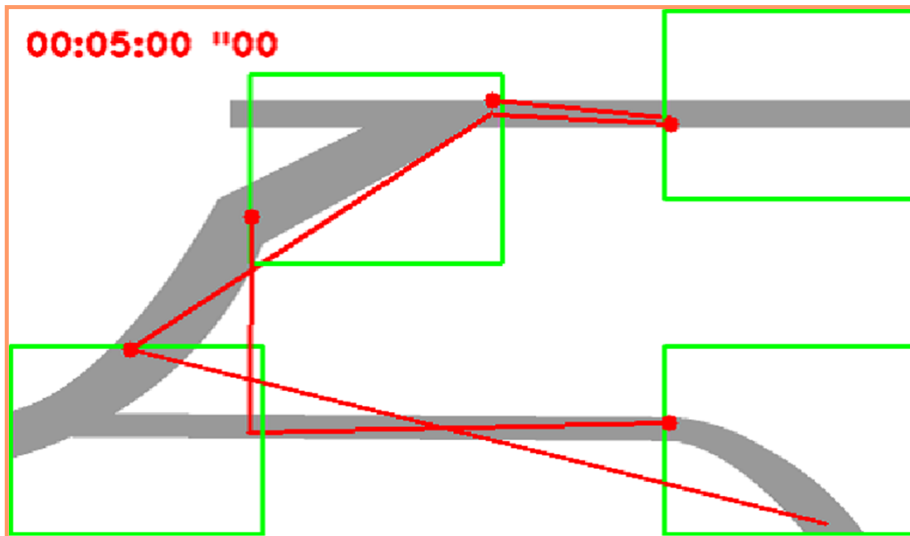


# Object Tracking in Wide-area Environment

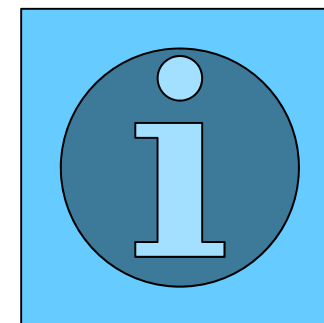
- Object tracking in a single view
  - There are many good techniques
    - Continuity based algorithm
- How should we do when a target-area is quite large?
  - We have to use multiple cameras, i.e., multi-view image.
  - Usually cameras are sparsely installed.
- Object tracking in sparsely installed multiple cameras
  - No continuity is assumed!
  - We have to identify the objects in the multiple views.



# Vehicle tracking in a wide area by distributed multiple cameras

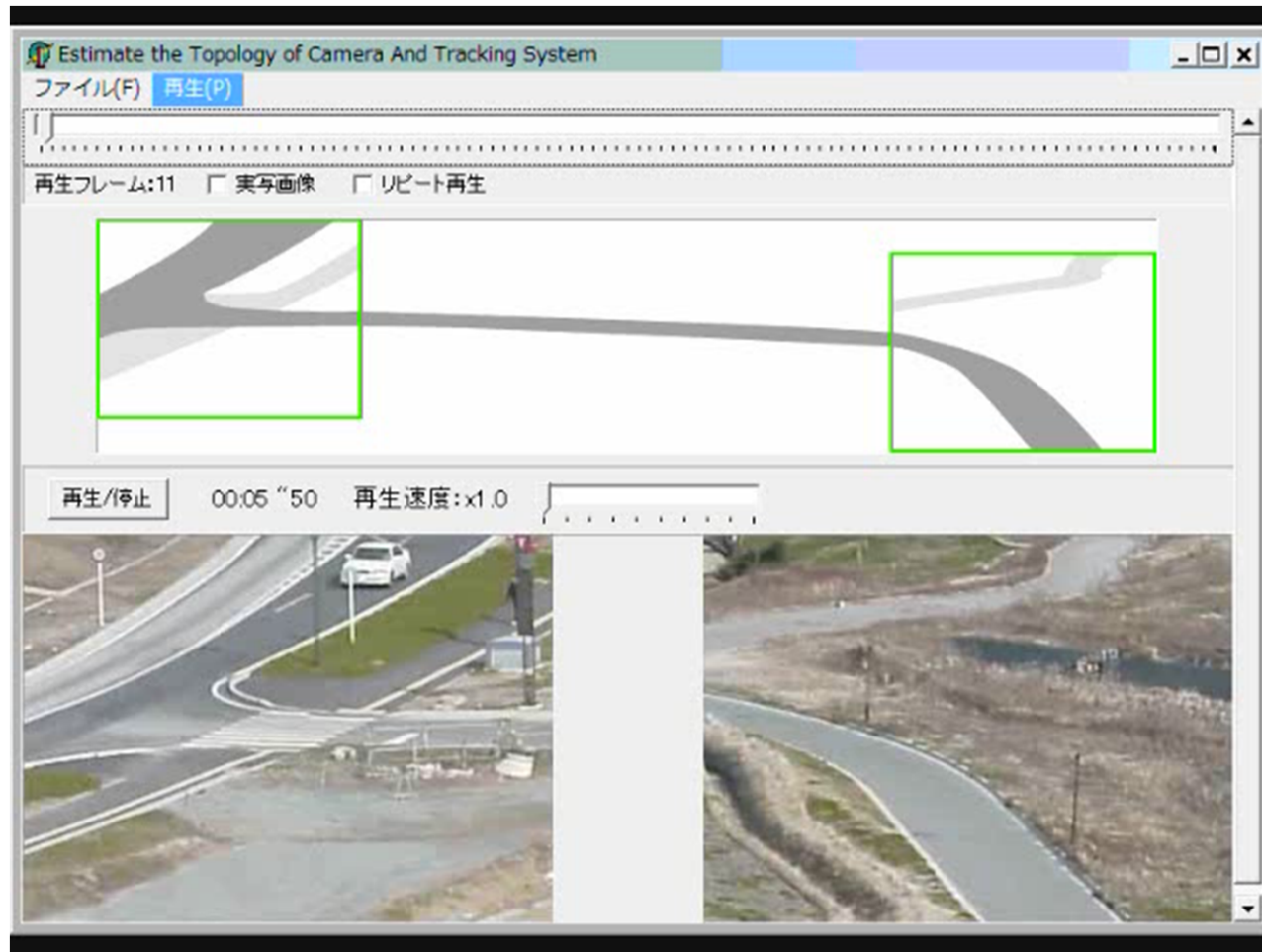


*Disappear*      *Appear*



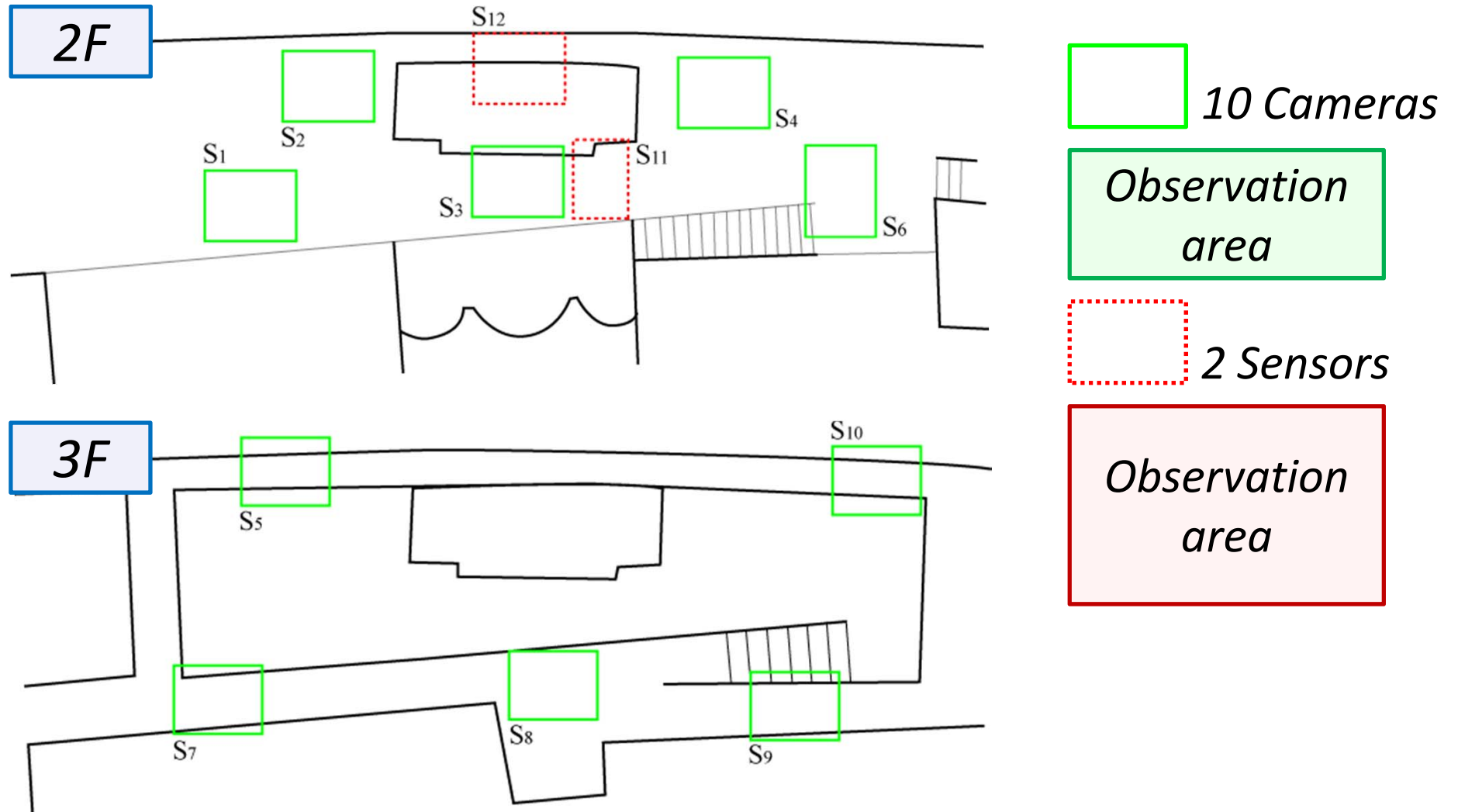


# Object Tracking in Distributed Vision

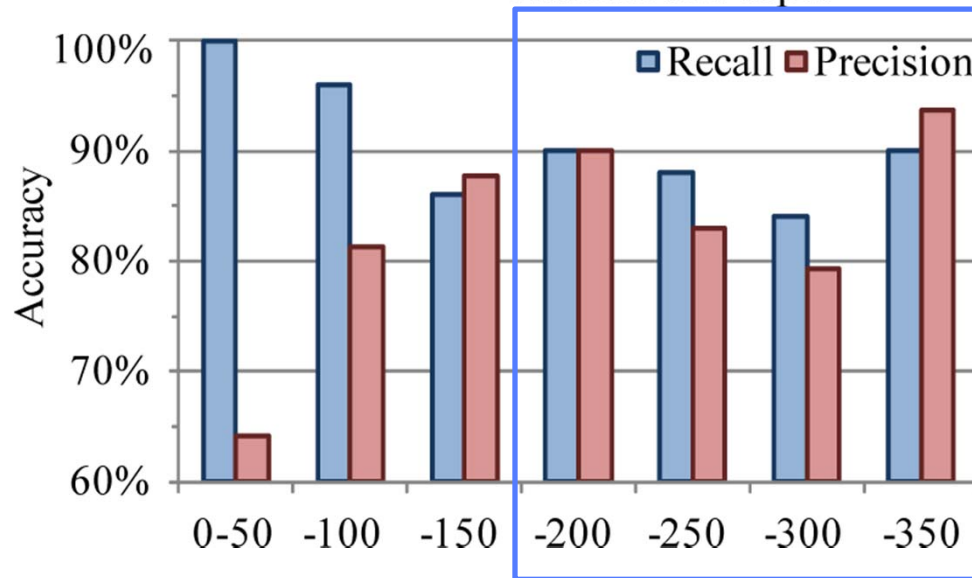
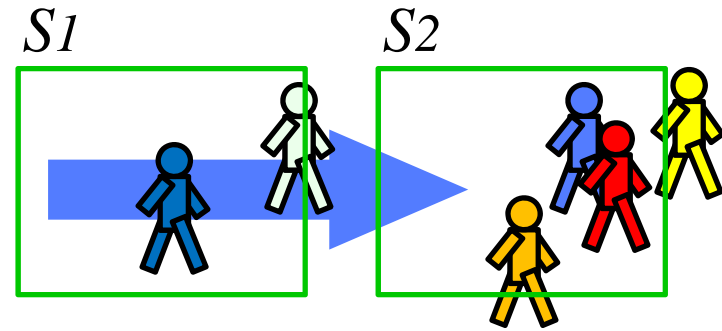
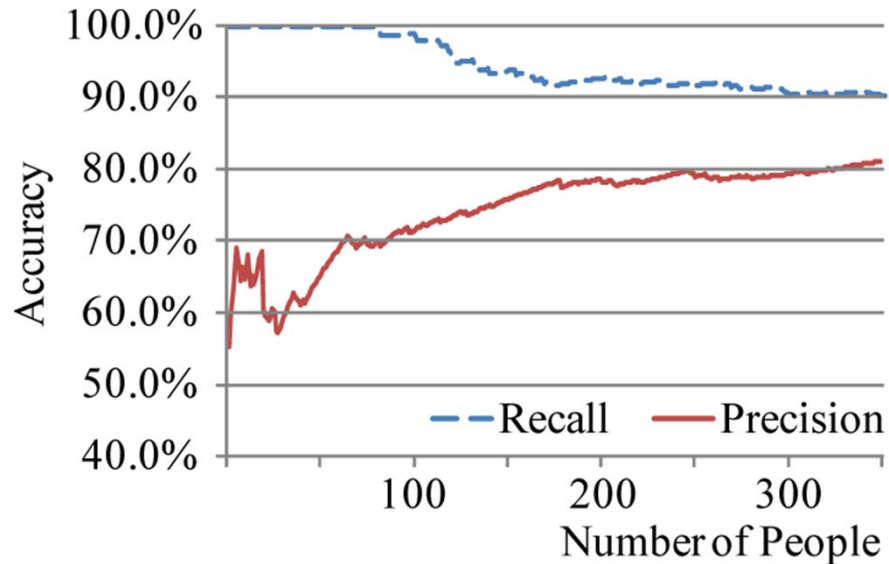


# People tracking in a wide area by distributed multiple sensors

## ■ Inside of our building



# Performance evaluation (Indoor Env)



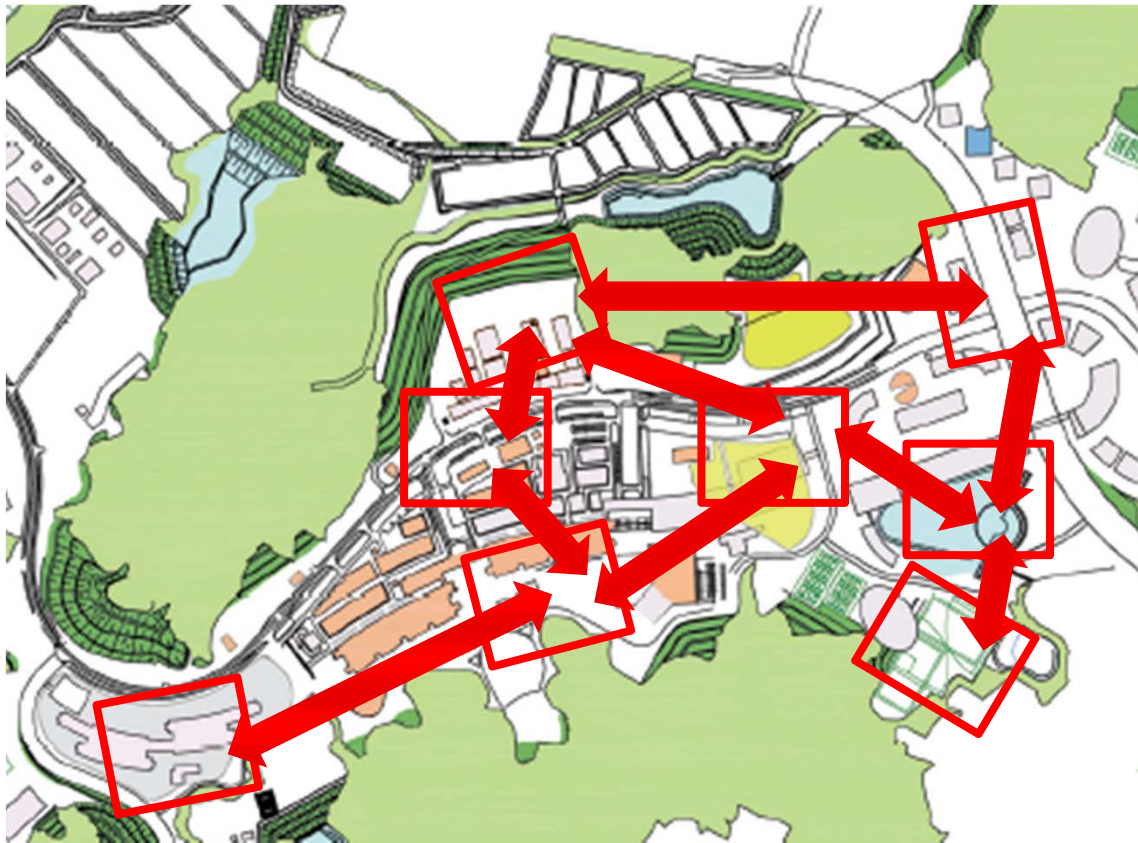
*Total* recall : 90.3%  
precision : 81.6%

*Last half* recall : 90.4%  
precision : 85.3%



# Macro-level Transfer Model in a Large Scaled Environment

- Areas where object flows occur are detected
- Correlation of those areas are evaluated



Sparse Camera Set

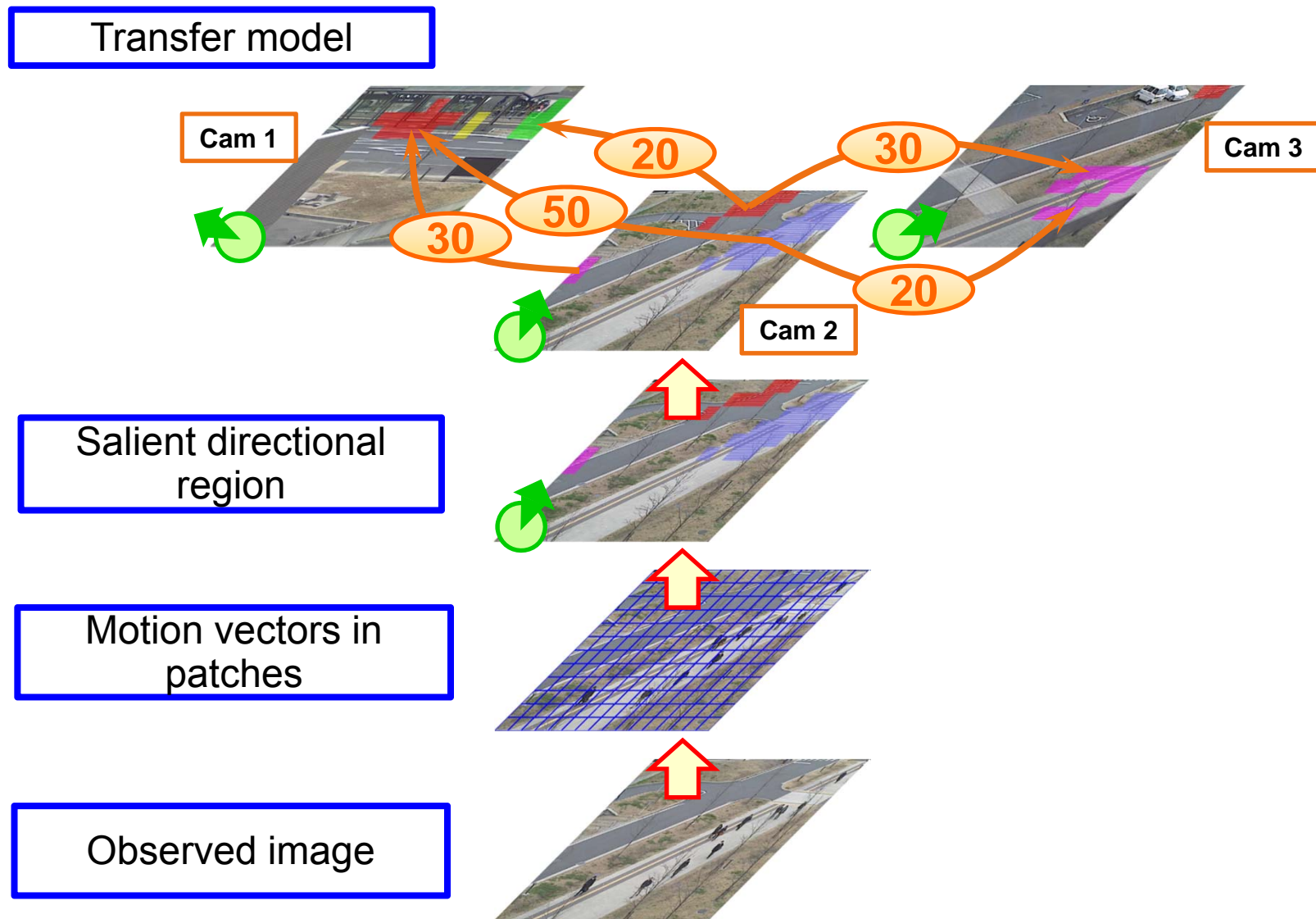


*Without explicit tracking*

*O Simple computation  
O Spatio-temporal  
relation among flow areas*



# Macro-level Transfer Model in a Large Scaled Environment

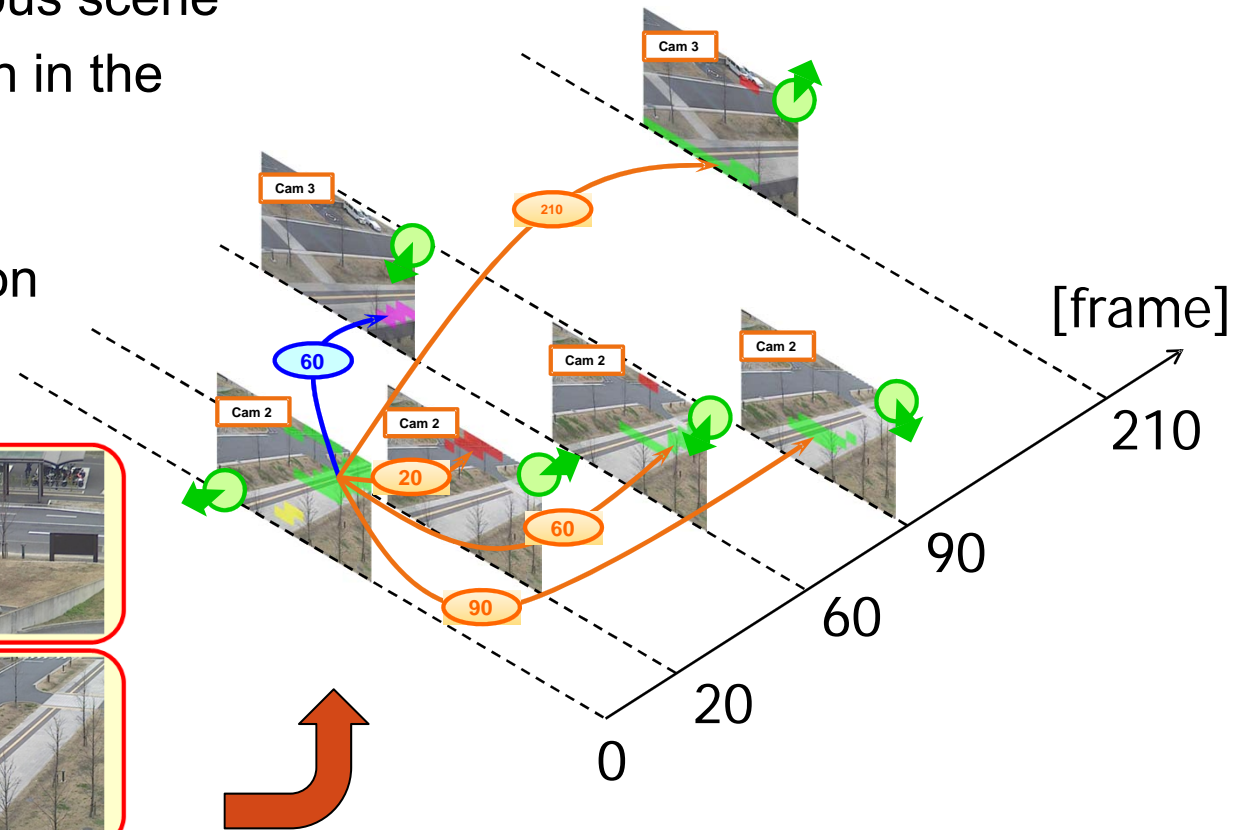
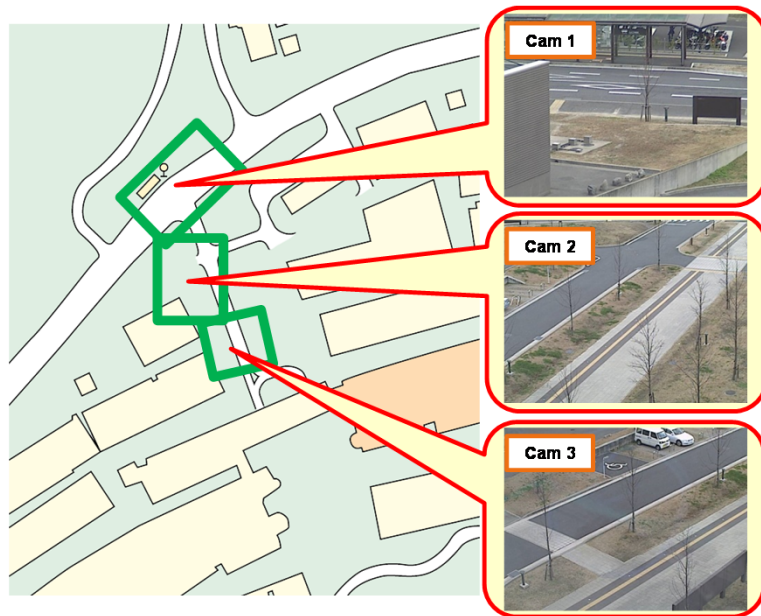


# Estimated Transfer Model (Preliminary)

- Three views in a campus scene
- Human walking pattern in the morning

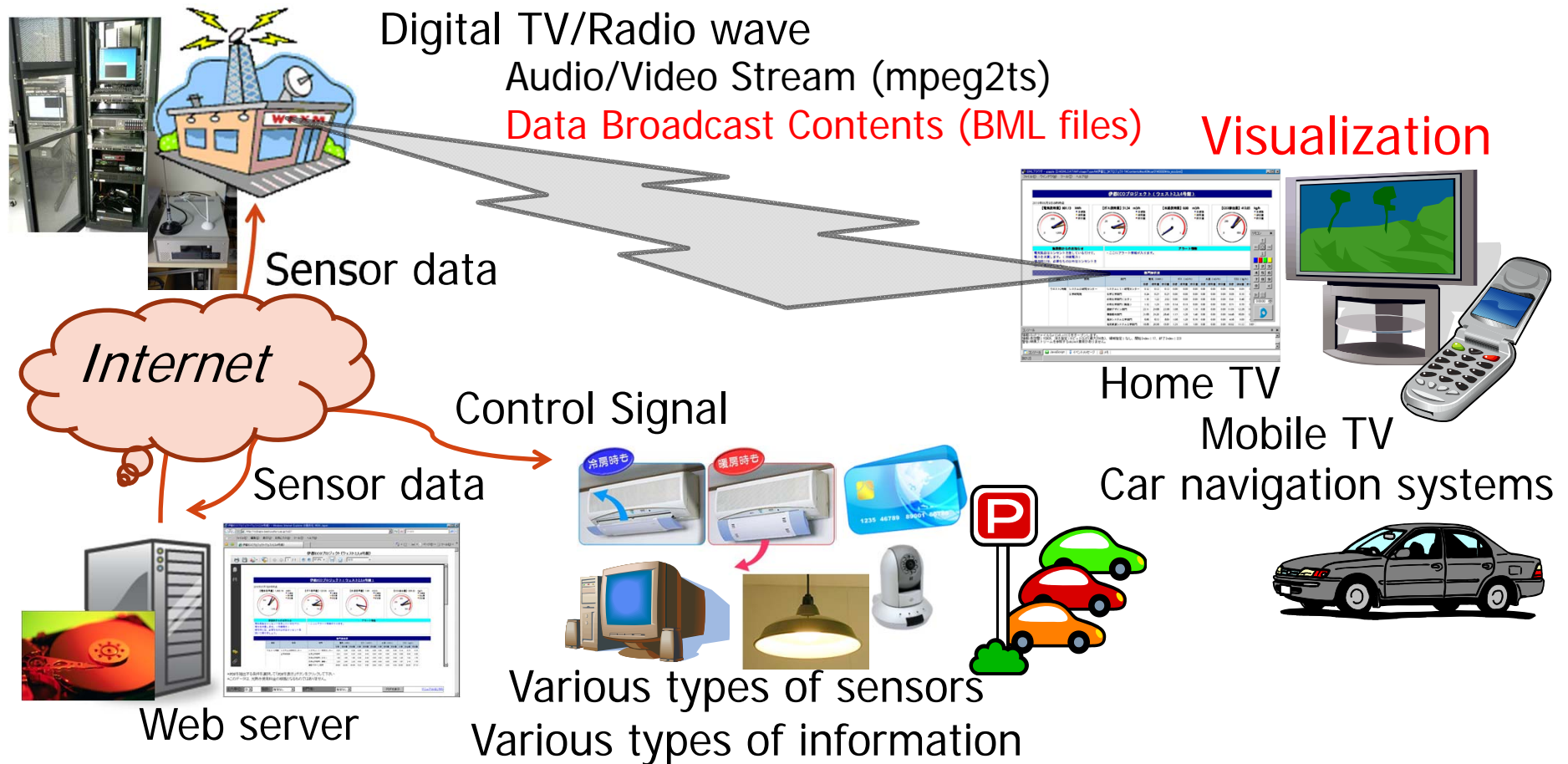


- Spatio-temporal relation among salient directional region



# Sensor Data Visualization of Ito Campus Eco Project

- Data Broadcasting Service on Digital TV of Ito Campus
- Receivable everywhere inside the campus using car navigation systems, mobile TV and home TV



# PicoMESH: A flexibly area-extensional WLAN infrastructure for ubiquitous sensors and actuators

- Wireless backhauled WLAN access points
  - AP allocation, reallocation and deletion are simply done without LAN cabling
- Ultra-large scale wireless multihop relay by statistical mesh and IPT forwarding
  - More than 10 hops relay
- Commercial grade
  - WiFi hotspot operators deploy APs based on the PicoMESH technology as their network infrastructures

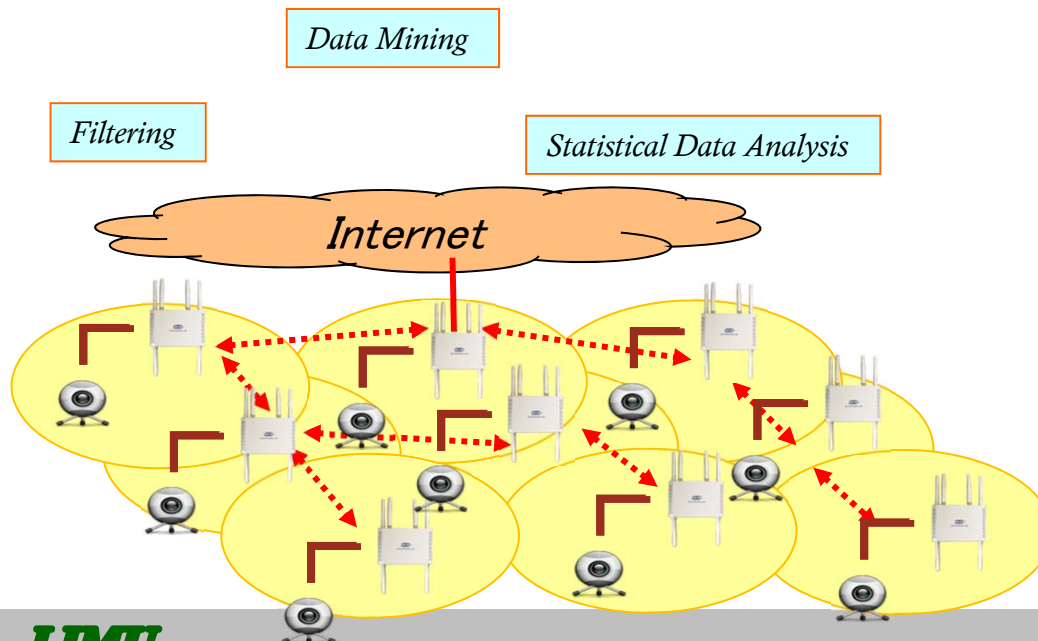


*PicoMESH, as a gateway to internet, can accelerate introduction of numerous sensors and actuators*





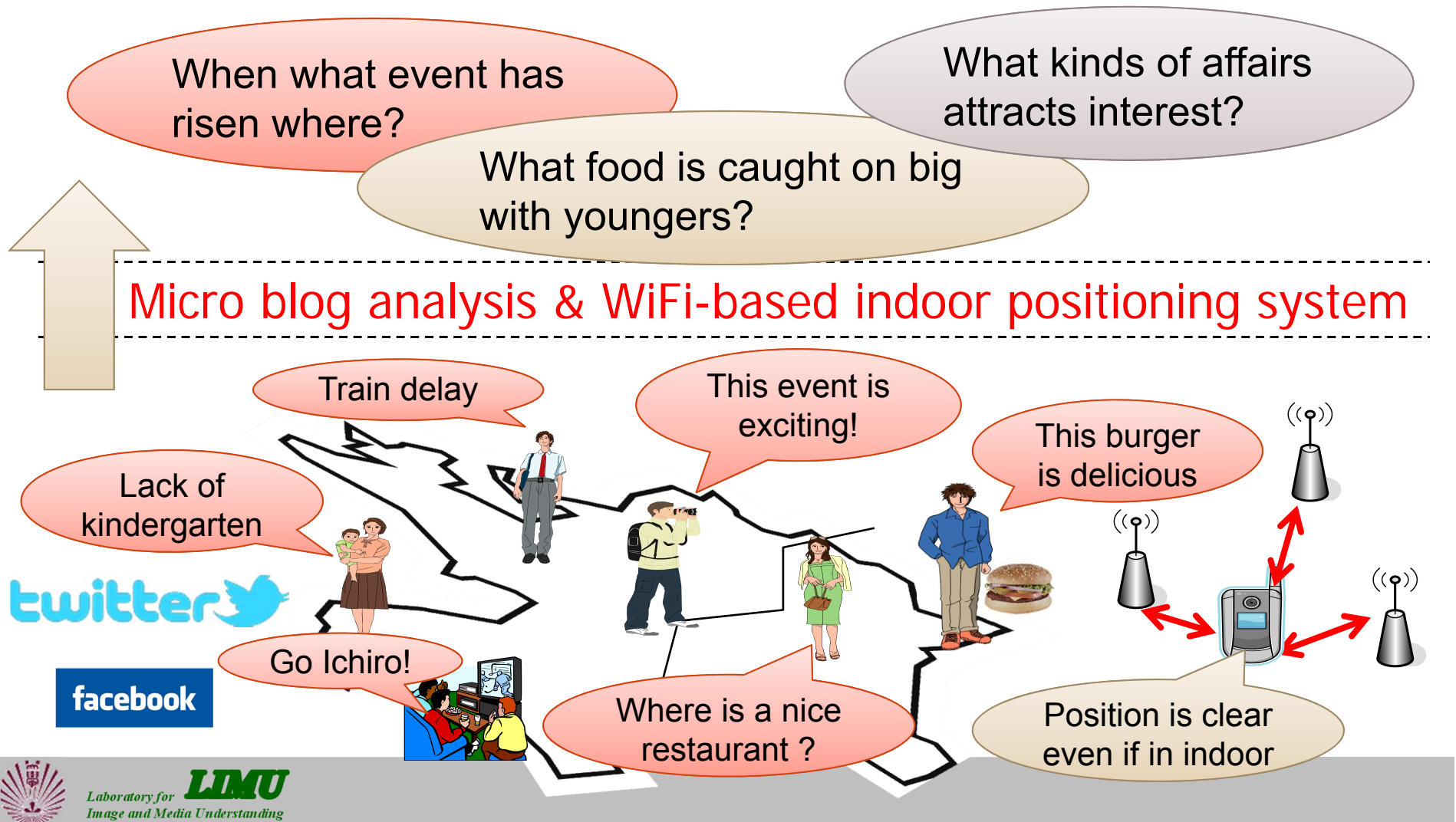
- Efficient processing over streaming data.
  - Based on fast pattern-matching/mining algorithm.
  - A huge number of queries can be processed simultaneously **in one pass through the data.**
- Efficient processing over stored data in compressed form.
  - Based on fast pattern-matching/mining algorithm over compressed data.
  - Compressed data can be processed efficiently **without explicit decompression.**



# Crowd sensing through micro blog

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- Use “Twitter” as human sensor to know the real world.
- Use “WiFi signals from APs” to grasp the position in the indoor.

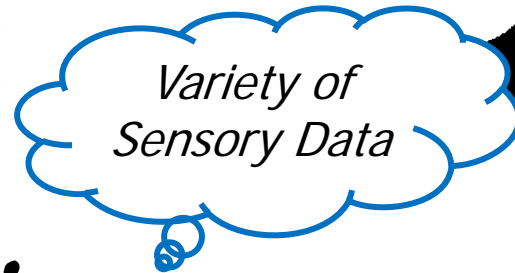


# Application to Agriculture

## Action Recognition

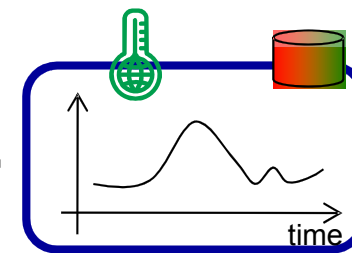
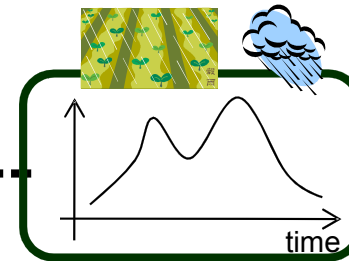
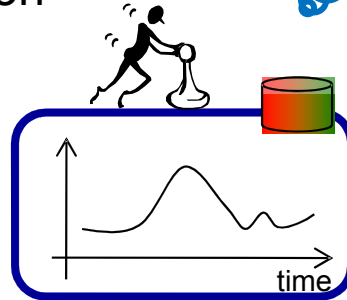
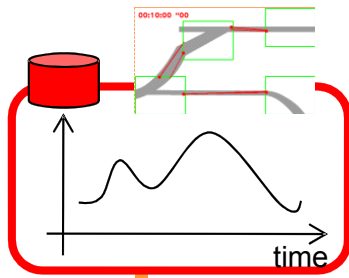


## Farming Environment Observation



Feature detection

Feature detection



Sensor Fusion  
Data Mining

Recording of Farming  
Activities



- Specification of API for sensor/actuator access
  - Establish standard API?
- Sensory data should be Open as much as possible
  - Expect good applications for ECO by students, staffs
- More Extensive Involvement to ECO
  - Introduction of Rewards?
  - Good Education in the university?



Thank you for listening!

