



National Institute of Information and Communications Technology

The 28th APAN Meeting in Malaysia



Federating Live E! with IP-USN by PIAX Overlay Network



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In the last meeting, federation of own local sensor networks had been discussed.

- Introduction of Live E! Project
 - Outline of Live E! Project
 - System Architecture of Live E!
- Issues for the Federation
- Our Plan for Federating w/ IP-USN & Live E!
 - Utilizing PIAX overlay network
 - Develop the ongoing project “Live E! on PIAX”



What is Live E! Project?

- Research project for Internet-based sensor networking
 - Multi-domain (multiple-organizations)
 - Global-scale (sensor data on the Earth)
- Data platform of sensor readings
 - Operates more than 100 weather sensors and archives sensing data over 3 years
- Testbed for sensor applications
 - Disaster management application, business model trial, etc



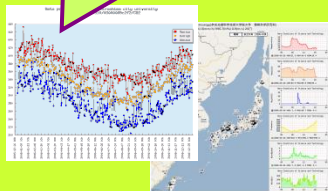
<http://www.live-e.org/en/>

Live E! System Architecture

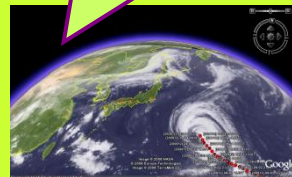
Disaster Management



Science



Education / Agriculture



Facility Management



Applications

Multi-Attribute search

Sensor & Overlay

Live E! on PIAX

In-Network Data Processing

Multi-Domain Sensor Networking

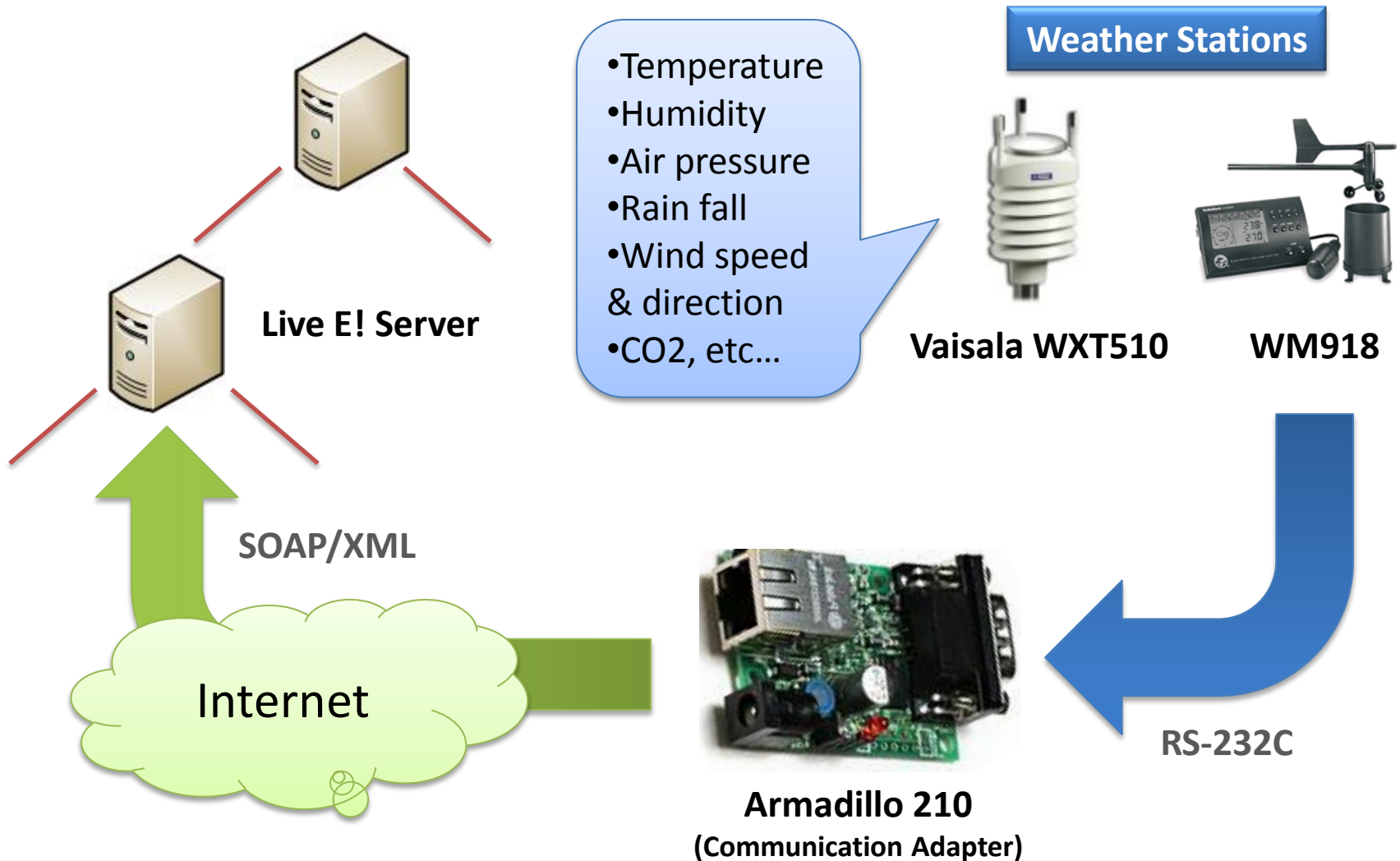
Data Management

Delay Tolerant Network

Embedded gateway

Sensors





1. Organization A, B, C
2. Server deployment
& Link configuration

3. Management

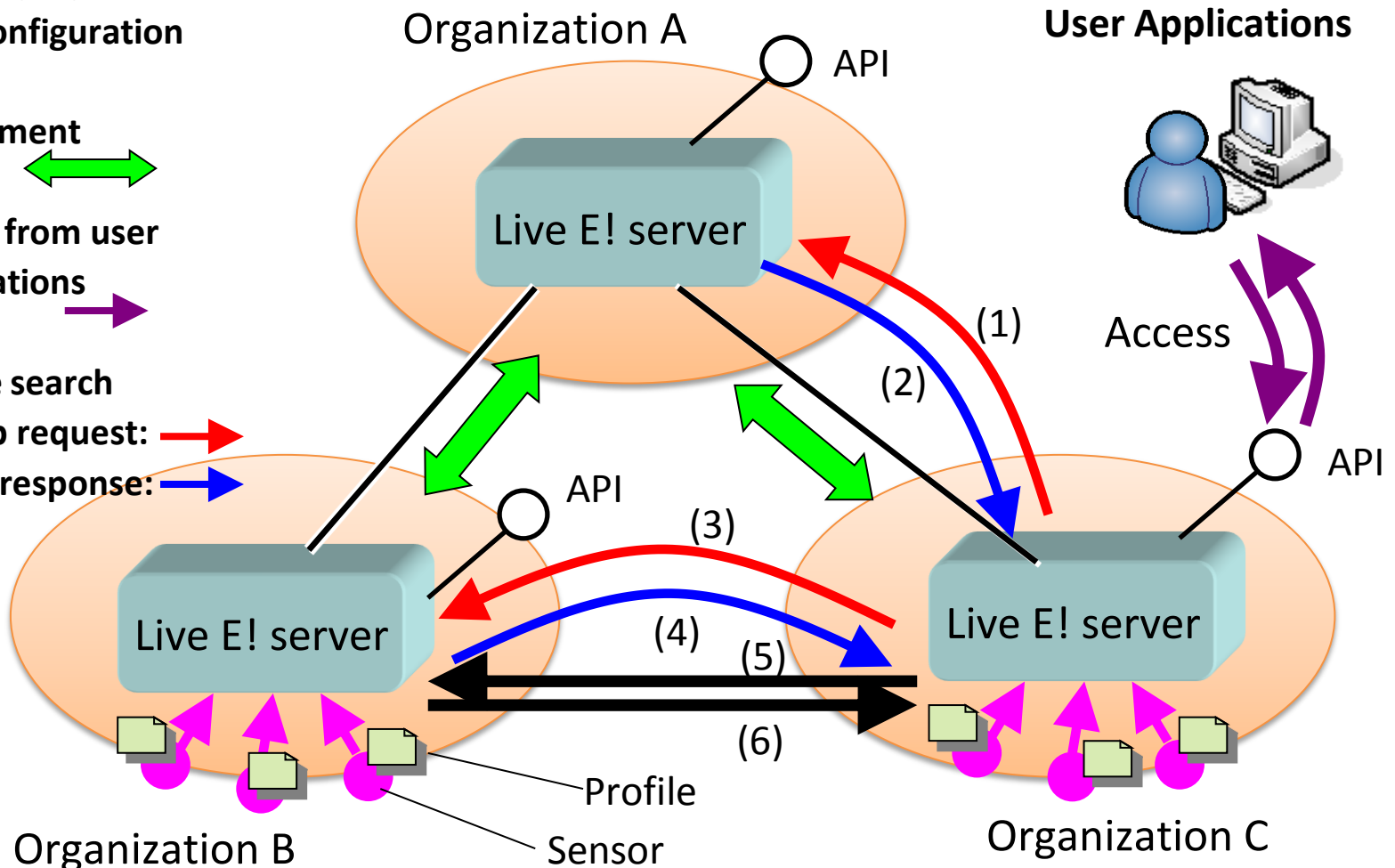


4. Request from user applications



5. Iterative search

lookup request: 
lookup response: 



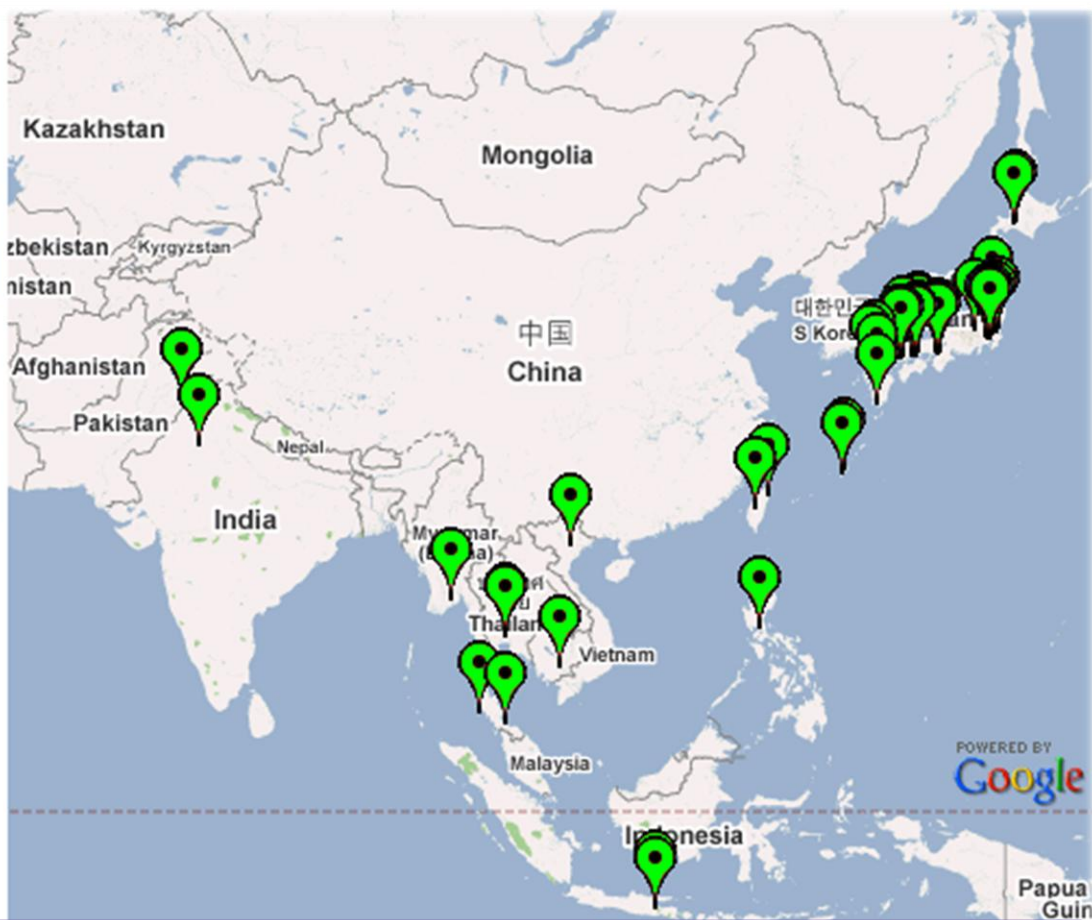
Deployed Live E! Sensors (Dec. 2008)



Europe & Africa



North America



Deployed countries

Japan, Taiwan, Thailand, Indonesia, Pakistan, India, Philippines, Vietnam, Cambodia, France, Canada, Egypt

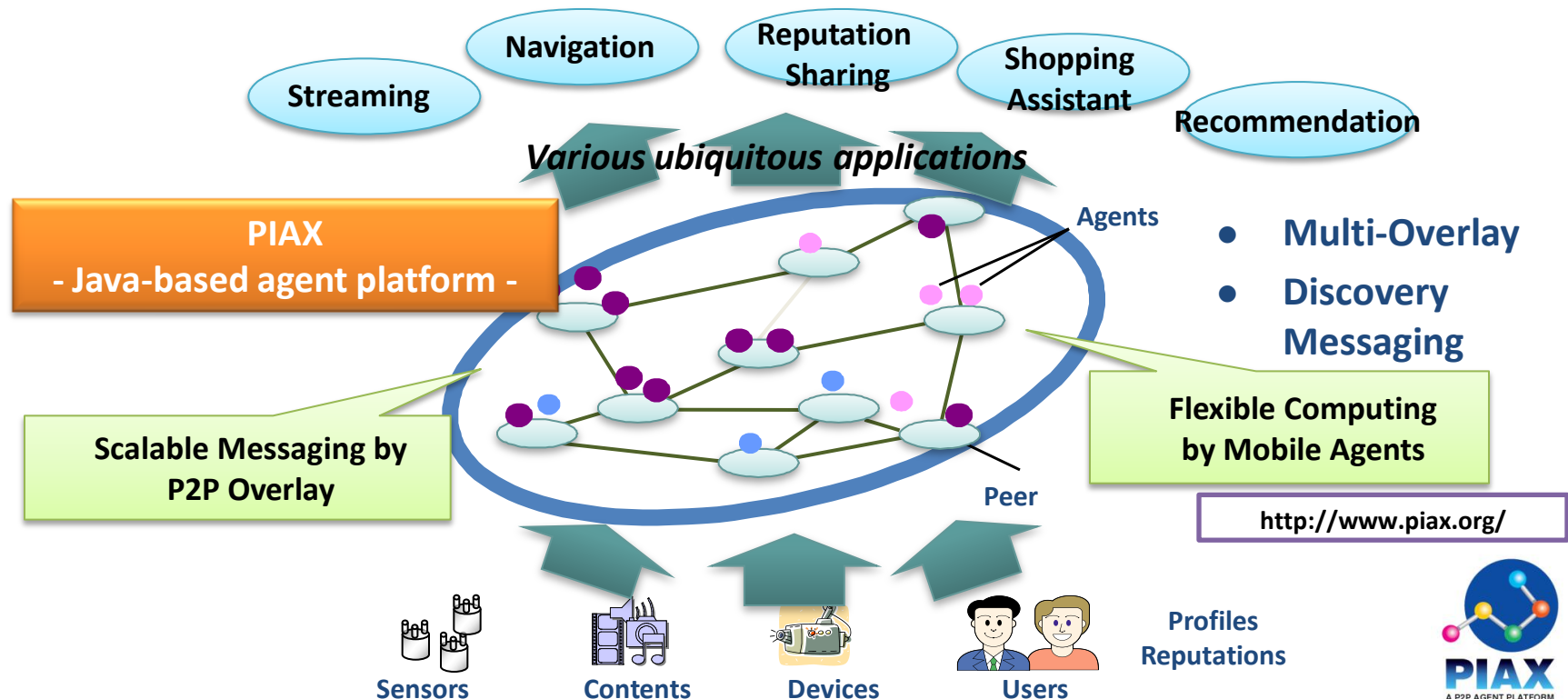
1. Management of the federation mechanism

- Preparing a data collection server for sharing sensing data requires management cost
- For observing the transition of sensing data, collecting data constantly is required

2. Metadata of the sensing data

- Meaning of the data is different between SNs, so that the data cannot be utilized directly
 - Sensing interval (e.g., every 1 min/1 hour)
 - Difference of the units (e.g., meter/mile)

- Federating IP-USN & Live E! on PIAX
 - P2P agent platform “PIAX” has been developing to support *loosely-coupled* ubiquitous applications



- **PIAX distributed P2P multi-overlay network:**
 - Conceals the differences of architectures, and
 - Different networks would be connected w/o servers.
 - Optimizes message distribution.
 - Multi-overlay messaging, pub/sub messaging, etc...
- **PIAX mobile agent platform:**
 - Mediates the meaning of sensing data from the applications.
 - Complement and prediction of data, conversion of the units, etc...

- Developed an agent for enabling other PIAX agents to connect Live E! sensor stations by SOAP protocol



Browse deployed sensors
on Web browser

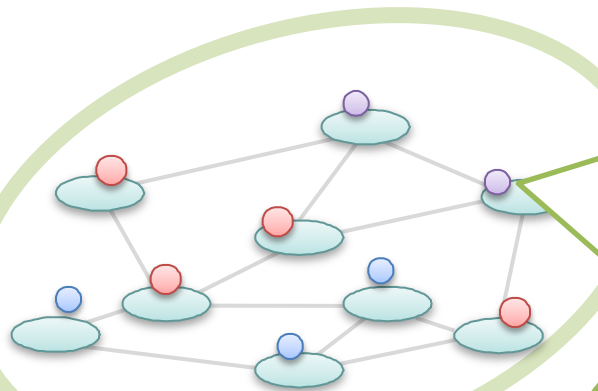
Web I/F

SOAP

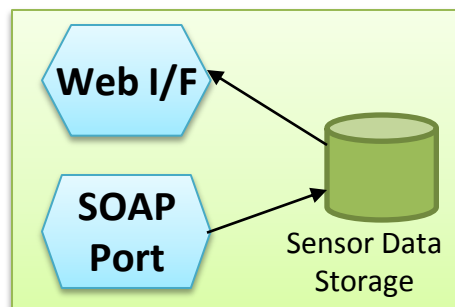
20 PIAX Peers with Live E! sensors



PIAX Overlay Network



Live E! Agent on PIAX



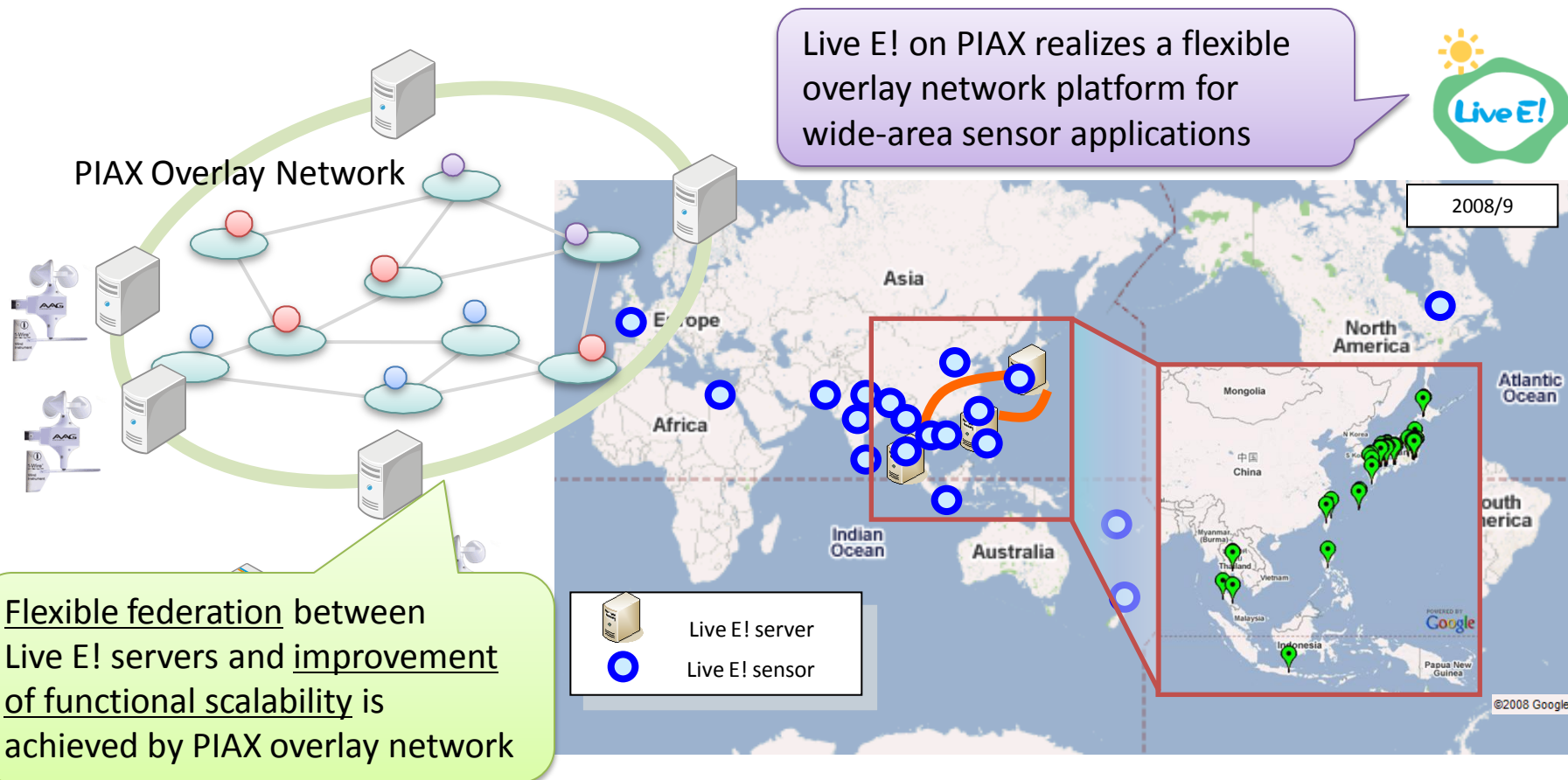
Live E! Weather Sensor Station



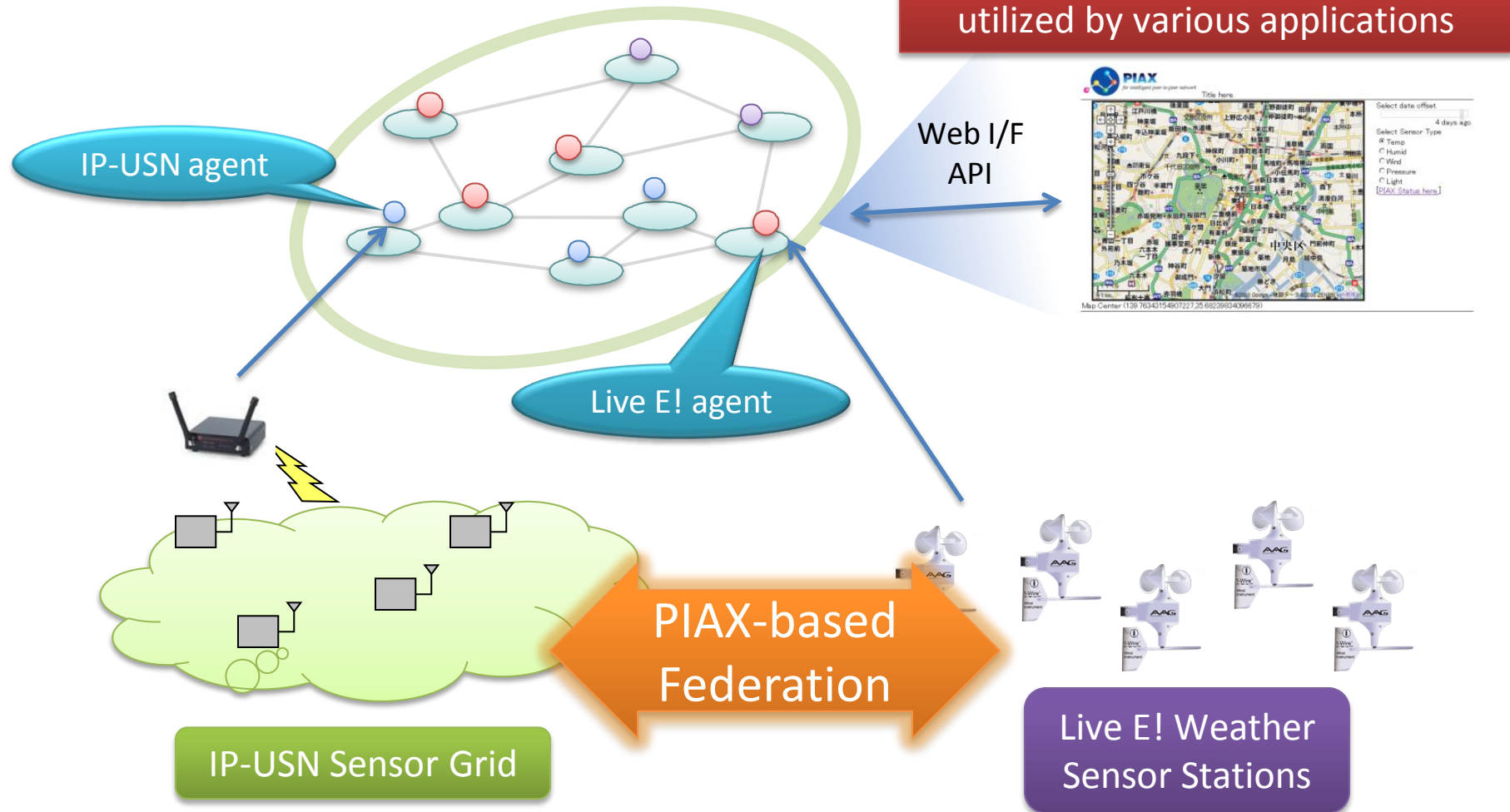
SOAP I/F
Sensors:
- Temperature
- Humidity
- Raindrop
- Wind speed etc.

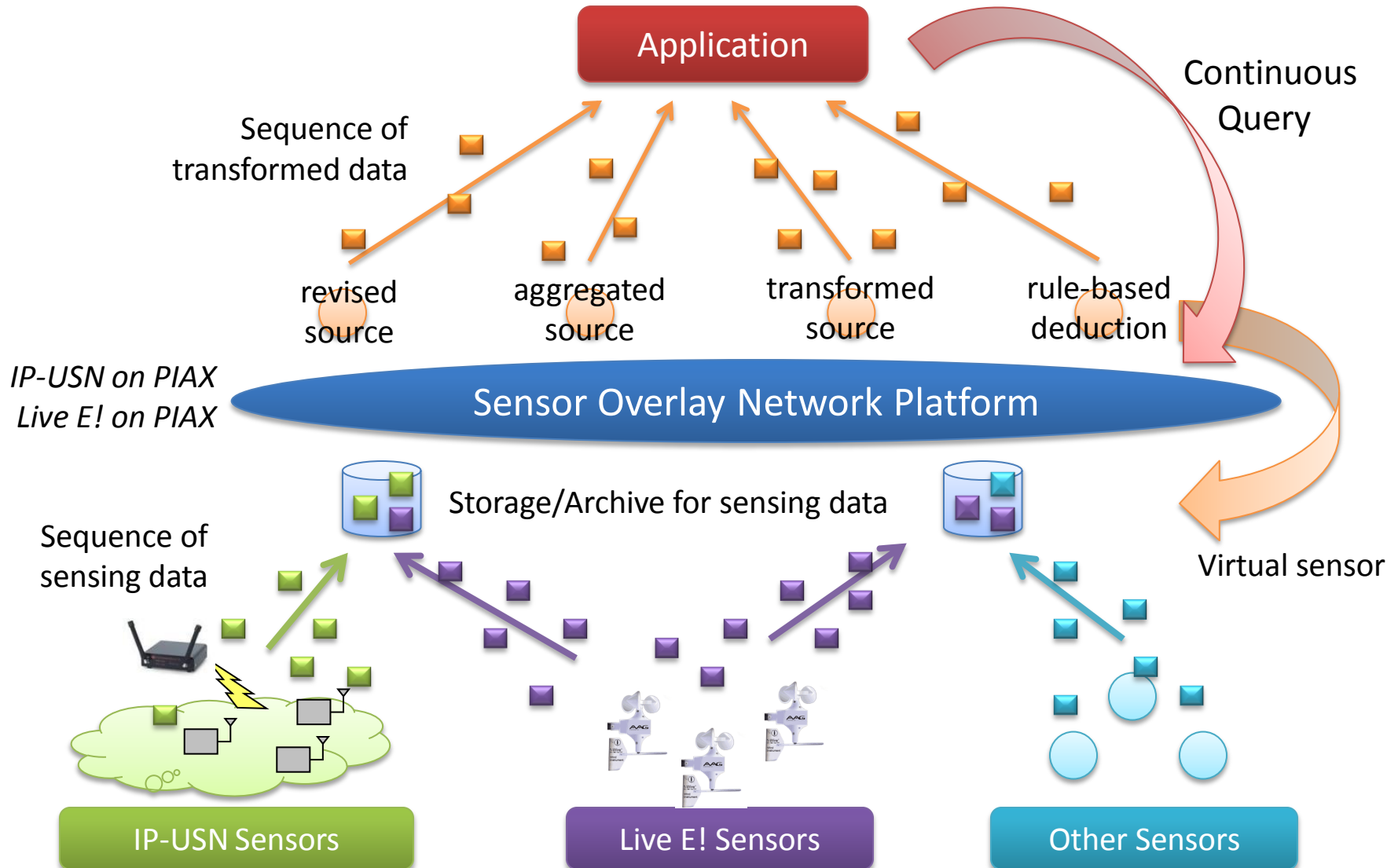
Deploying Live E! on PIAX

- For federating with PIAX overlay network, PIAX search agent will be installed on distributed servers of Live E! project



PIAX Overlay Network



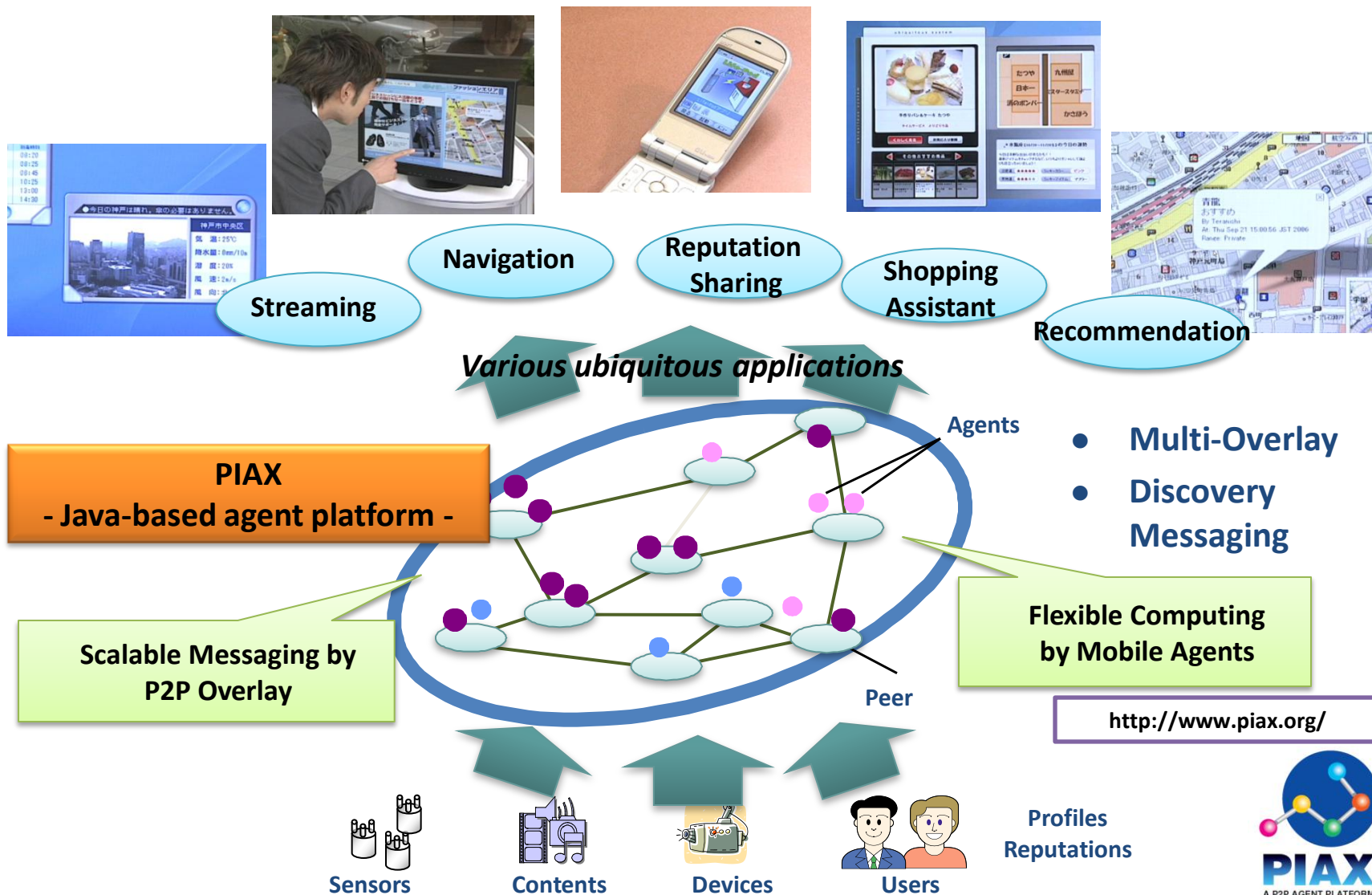


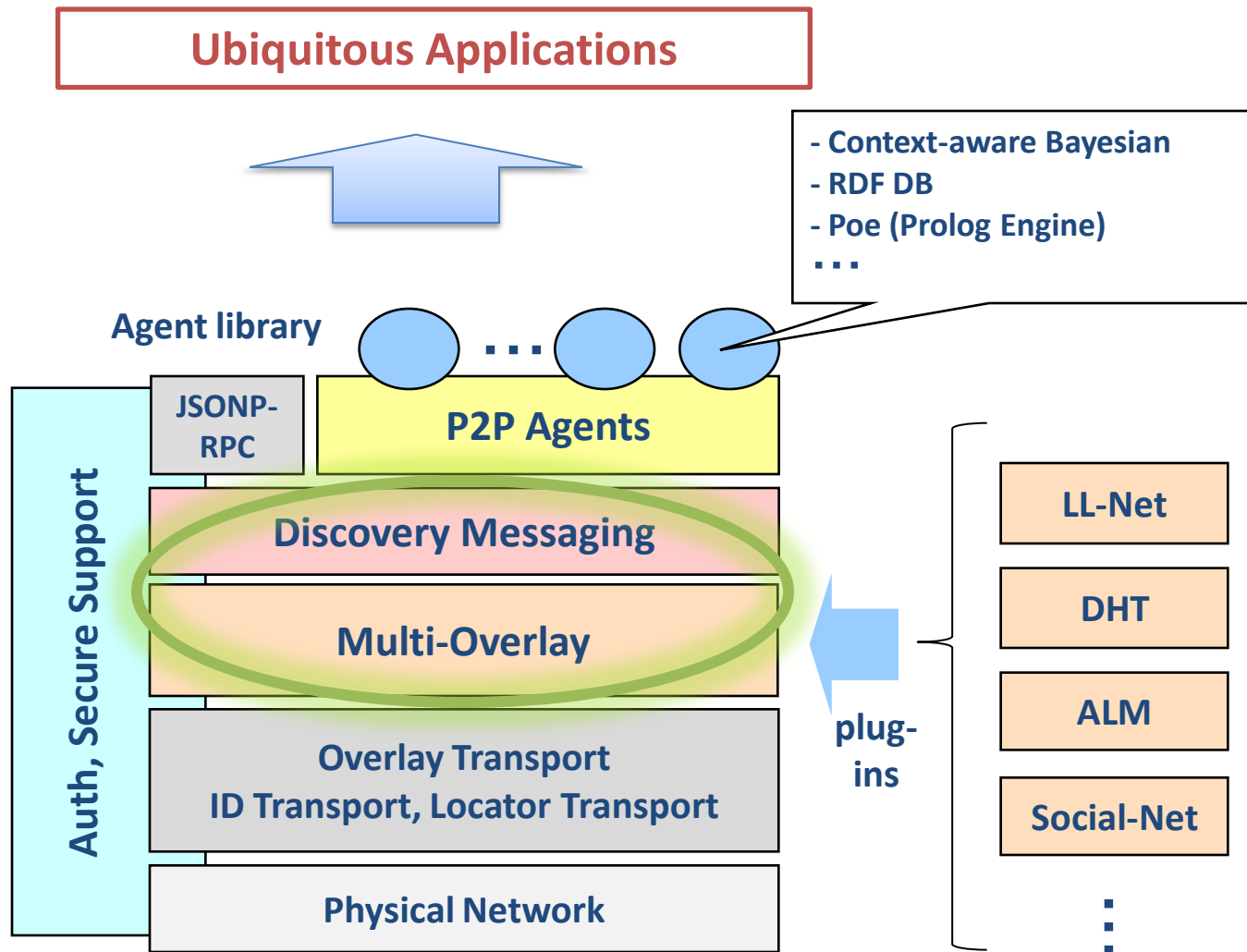
- Introduction of Live E! Project
 - Issues for the federation
- Federating IP-USN & Live E! on PIAX
 - Live E! on PIAX
 - Sensor overlay network platform
- Appendix: Resources
 - Please refer to the following Web sites.
 - PIAX
 - <http://www.piax.org/en/>
 - Live E!
 - <http://www.live-e.org/en/>



:: APPENDIX ::

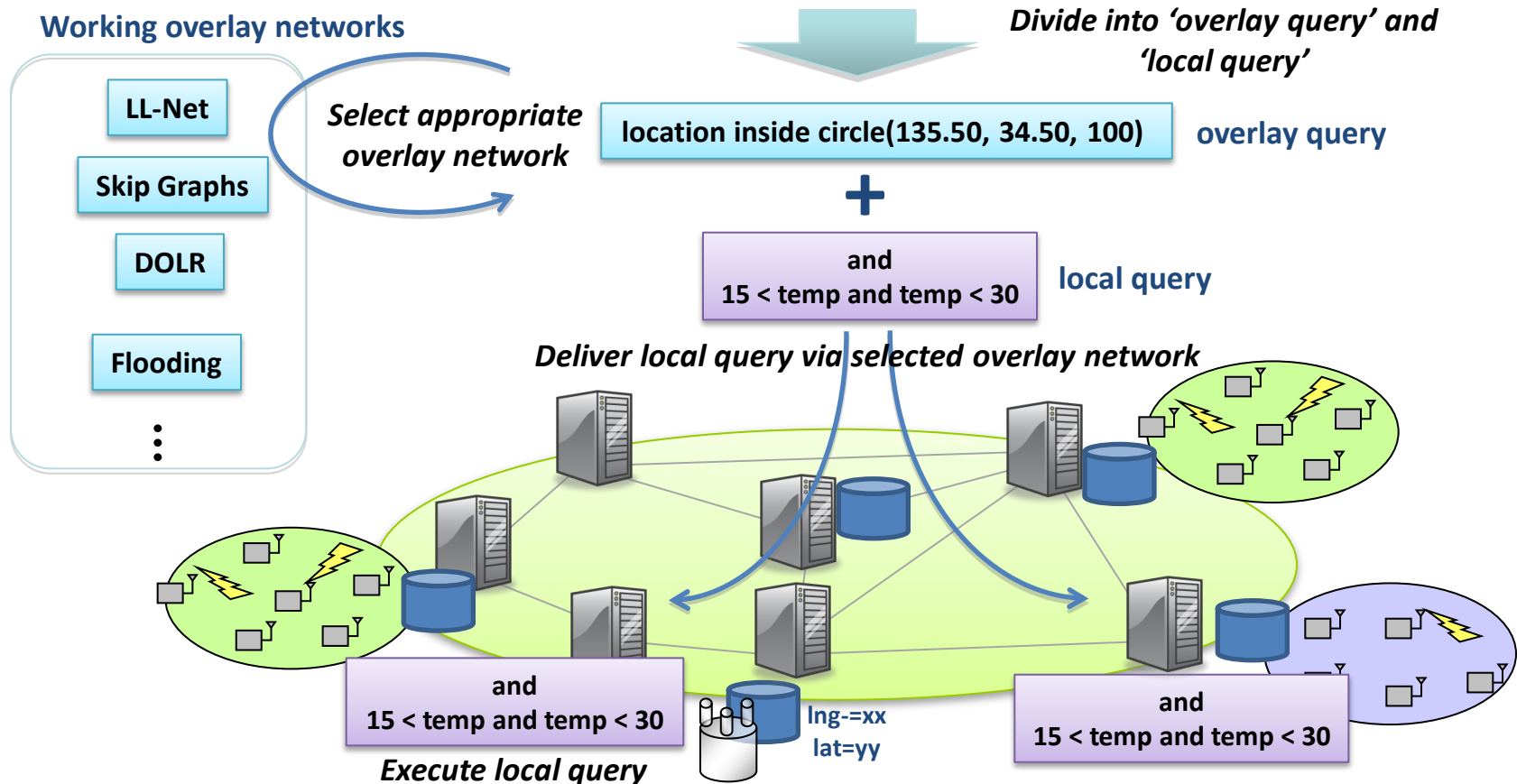
- Federating IP-USN & Live E! on PIAX
 - P2P agent platform “PIAX” has been developing to support *loosely-coupled* ubiquitous applications
 - Flexible collaboration is inadequate for the federation between the heterogeneous frameworks
 - PIAX overlay network will support:
 - Distributed P2P overlay network
 - Only force the operators to manage their own domain
 - Agent platform
 - Can conceal the meaning of sensing data and can adapt to the operators’ policies
 - » Complement and prediction of data, conversion of the units, pub/sub support, access control etc...





- Discovery messaging layer encourages an application to send a query without considering multiple overlay networks implemented in PIAX

“location inside circle(135.50, 34.50, 100) and $15 < \text{temp}$ and $\text{temp} < 30$ ”



- P2P common platform should support the varieties of the requirements of various ubiquitous applications
 - Each overlay network (e.g., unstructured, DHT) has own benefits

Pattern of a query	Appropriate overlay
Exact matching	DHT, DOLR, (Skip Graph)
Part matching	Skip Graph
Range (1 or N dimensions)	LL-Net (ZNet)
Others (ex. associative)	Flooding (unstructured)



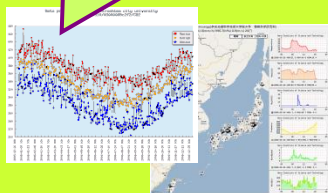
- PIAX is designed to manage multiple overlay networks
 - Any overlay network can be plug-in, if necessary

- Supports various discovery messaging
 - Exact matching, part matching, range search etc is supported
 - ALM (Application Level Multicast) is also supported
 - DHT, ALM and LL-Net (Location-based Logical Network) is implemented, and they are selected based on a query
- Low cost
 - Query cost is similar to the other P2P frameworks
 - Current overlay networks are implemented on Multi-key Skip Graph (MKSG)
 - MKSG is faster than the original Skip Graph
 - Routing table can be minimized though various discovery messaging is supported

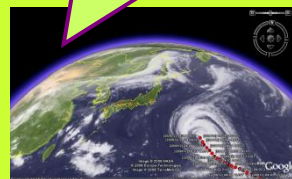
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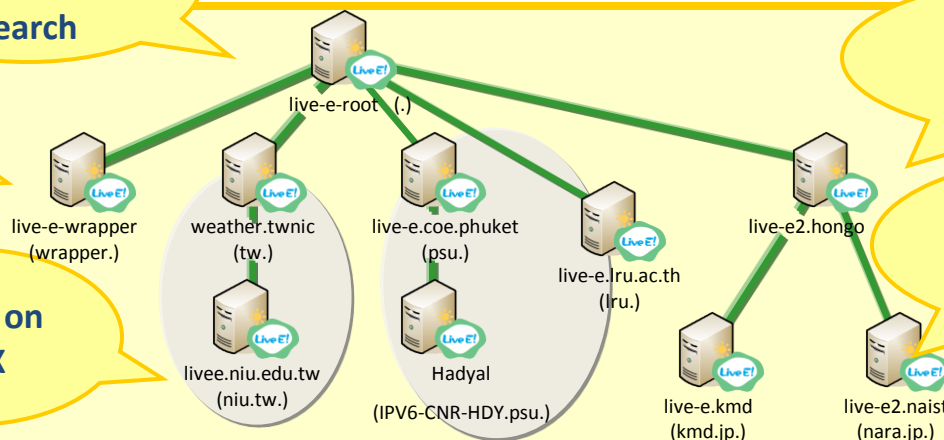


Applications

Multi-Attribute search

Sensor & Overlay

Live E! on PIAX



In-Network Data Processing

Multi-Domain Sensor Networking

Data Management

Delay Tolerant Network



Embedded gateway

Sensors

1. Message distribution for collecting data
 - Operating policy of SNs is different because environment and operators are different, so collecting data among SNs will cause a problem
 - Collecting sensing data constantly for observing the transition of data is inefficient