JOSE: Japan-wide orchestrated smart ICT testbed for future smart society

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Provide a Japan-wide open testbed consists of a large number of wireless sensors, storage and computation resources in distributed data centers connected via high-speed network with SDN feature to establish technologies for practical large-scale smart ICT service platform for future smart society (Starts from Apr. 2014 / Currently under procurement)

Examples of new technologies to verify:
- Analysis method of real world situation
- M2M/IoT/sensor network algorithms
- Large-scale stream processing methods
- Large-scale network/storage algorithms

Field trials

Provide facilities to verify & evaluate new smart ICT service technologies by the practical field trials on large-scale real environment
Smart ICT service related projects and testbeds

- **EU**
  - FI-PPP: derive innovative business models that strengthen the competitive position of European industry in sectors such as telecommunication, mobile devices, software and services, and content provision and media
  - SmartSantander: Provides the experimentation facility among the scientific community, end users and service providers in order to reduce the technical and societal barriers that prevent the IoT concept to become an everyday reality

- **Japan**
  - Ubiquitous service platform R&D projects (MIC 2008-2010): R&D on ubiquitous service platform utilizing sensors, IC-tags, etc. Some smart-city field trials are conducted on closed shopping malls.
  - *No Japan-wide testbed*. Field trials that have been conducted so far use dedicated and closed facilities

*We need new open, wide-area testbed for future smart ICT services*
System overview of JOSE

Big data archive for cross-domain mining

Analysis/Processing for each sensor type

Servers for data processing

Store sensor data for each location

Servers for data storage / access

Main part of JOSE
Facilities provided by JOSE (1/2)

- Distributed computer facilities
  - 400 servers are available at 3 locations = 1,200 computers
  - 10 VMs (KVM/VMware) run on each computer = 12,000 VMs are provided
- Distributed storage facilities
  - 10 servers are available at 5 locations = 50 servers
  - IEEE1888 is used as a sensor data access protocol
  - PIAX is used for sensor / computation resource discovery
- Wide-area network facilities
  - 100Gbps backbone (JOSE uses 10Gbps network interface)
  - SDN by JGN-X / RISE
    - Construct a closed, secure network for each field trial experiment
    - OpenFlow controller is open for each experiment
- Wireless network facilities
  - Virtualized wireless network facilities are available for dynamic changes on wireless resource allocation for each experiment
- Sensor network facilities
  - Environmental sensor network devices (920MHz/950MHz/2.4GHz)
    - Programmable type / Easy-to-deploy type
    - Mobile type (ID/Locator separation + 6lowPAN)
  - Congestion control facilities
  - Camera sensor network devices (Wired/WiFi)
    - Camera with shape / human detection
    - Multi-eyed camera devices
  - Social infrastructure sensor network devices (920MHz/3G)
    - Water-level sensors for floods/tsunami observation
    - Vibration sensors for structure observation
      - Programmable type / High-resolution type
      - In-vehicle type (for road observation)
IEEE1888 is used as a sensor data access protocol

IEEE1888 is a simple but powerful standard to access sensor / facility data. The basic protocol is defined on top of HTTP/XML. Each sensor network need to implement GW (gateway) to conform IEEE 1888.

Example sequence of IEEE1888

GW

Storage

APP

Registry

WRITE

FETCH

data

query

data

query (type="storage")

query (type="stream")

data

data

Example sequence of IEEE1888
PIAX is used for sensor discovery & data delivery

PIAX enables ‘objects’ to deliver/collect data to/from other ‘set of objects’ specified by an ‘attribute condition’ when huge number of objects dynamically appear/disappear on network and change their attributes.

Examples of sensor object attributes:
Identifier, observation area, observation cycle, geo-location, type of sensor (temperature, humidity, CO2, etc.), attribute by sensor data (‘danger’ when temperature > 40°C)

Examples of sensor object’s data collection:
Object 1 collects data from sensor objects which have ‘type’ attribute that equals to ‘CO2’. Object 1 collects data from sensor objects which located inside a certain rectangle area.

Collect data from objects which satisfies location inside rectangle(134,33,1,1)

Discover objects which satisfies location inside rectangle(134,33,1,1)

owner="X corp." type="humid" Location=(136,34)

owner="X corp." type="co2" Location=(134,33)

owner="Y corp." type="light" Location=(135,32)

owner="Z inc." type="co2" Location=(134,33)

owner="Z inc." type="co2" Location=(134,34)
Virtual wireless network facilities

- Runs as a base station of software-controllable WiFi (22 modules) and Zigbee (8 modules)
- Realizes high speed handover between virtual interfaces
A camera sensor network is constructed using PIAx (basic pattern) on a station city (under negotiating) for smart city experiments such as usual security services, marketing services, event navigation services, etc.
Example scenarios of field trial experiments using camera sensor network embedded in the city

- Analyzes images on camera and detects face of human, identifies each person to calculate the flow of people, keeping anonymity
- Navigate users according to the estimated ‘congested’ situation
- Detects a ‘suspicious person’ by illegal action, discovers and activates appropriate camera sensors to track the person
Summary

- *The first testbed in Japan* which enables large-scale field trials using actual wireless sensor networks to evaluate various sensing, networking and processing technologies for smart ICT services
- Provides facilities of abundant calculation resources, fast data storages, sensor networks with newest features, flexible and high-speed network
  - Open data access protocol by IEEE1888
  - Management of distributed sensor networks by PIAX
  - Secure and flexible network by Virtual wireless network and SDN

*We encourage challenging experiments!*