

From RFID to the Internet of Things
Brussels, Belgium, March 6-7, 2006

Ubiquitous Sensor Networks (USN)



Public and **EPC** Sensor Network

Daeyoung Kim

Professor

**Real-time & Embedded Systems Lab., Auto-ID Labs Korea
Information and Communications University (ICU)**

CEO

Sensor Networks Research (SNR), Inc.

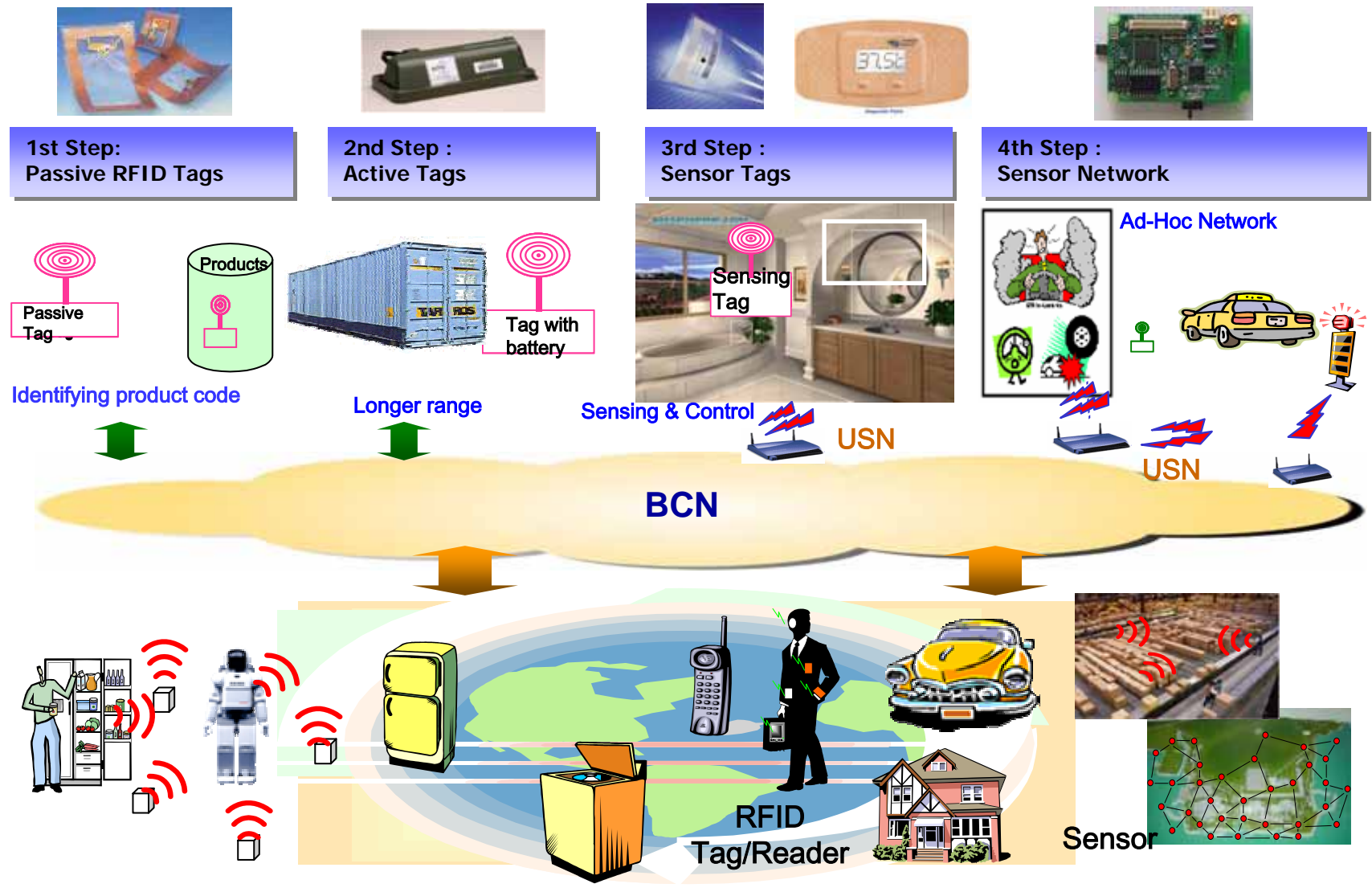


kimd@icu.ac.kr, <http://resl.icu.ac.kr>, <http://www.snre.co.kr>

Contents

- What is Ubiquitous Sensor Network?
- Public Sensor Network
- EPC Sensor Network
- Summary

RFID meets Sensor Network



A
N
T
S

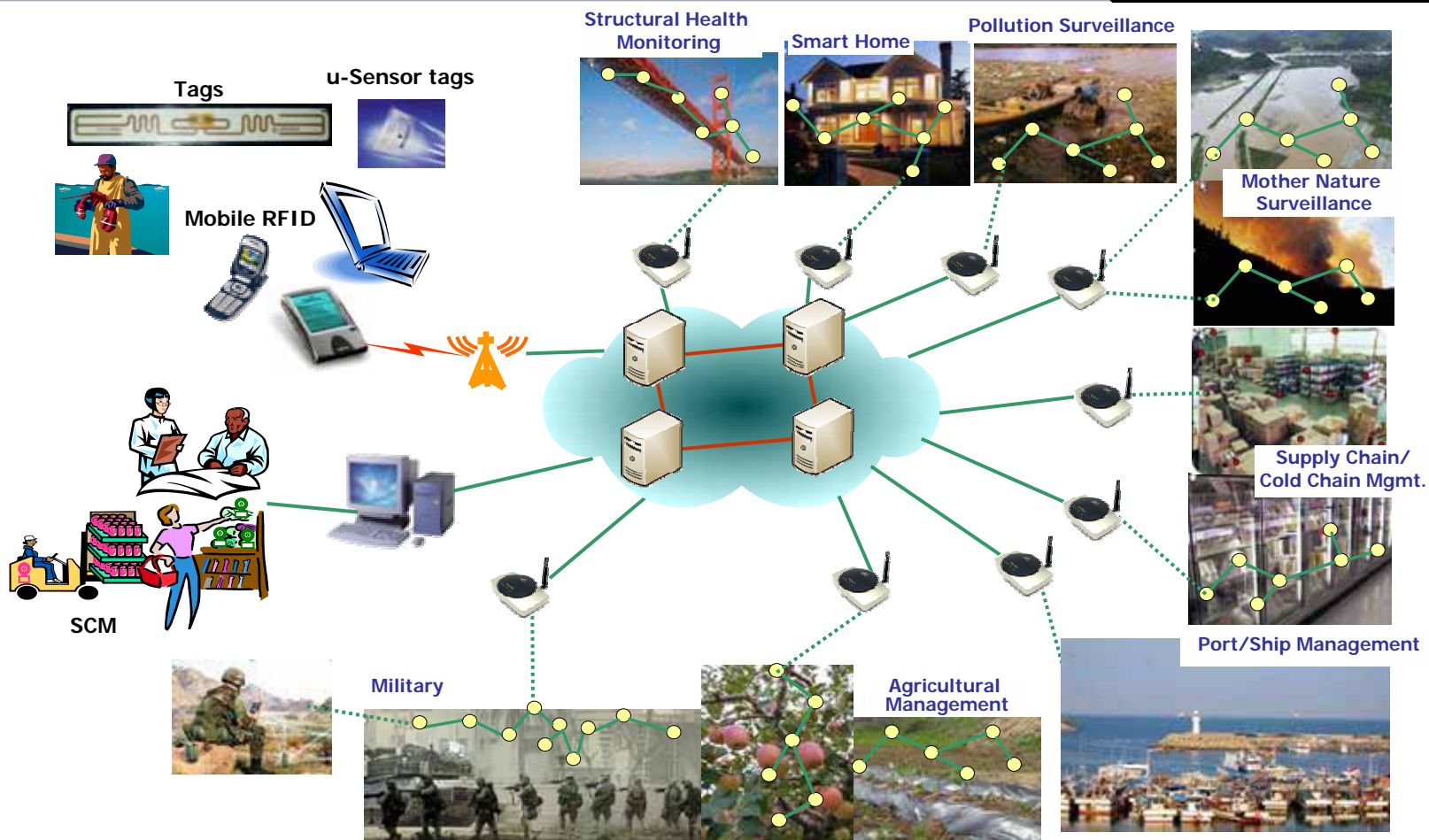
Ubiquitous Sensor Network

- Everywhere, everything with RFID tags
- Sensing ID and environmental information
- Real-time monitoring & control via network

Ubiquitous

Sensor

Network



Vision of Korean u-IT839 Strategy

u-IT839 Strategy

A master plan for the IT industry, in an effort to gain more growth momentum from the IT sector in Korea.

Introducing and promoting 8 Services

- 2.3 GHz mobile Internet (WiBro) **8**
- DMB/DTV service
- u-Home service
- Telematics service
- **RFID** based service
- W-CDMA service
- IT service
- VoIP service

Building 3 infrastructures

- **3**
- BcN/IPv6
(Broadband Convergence Network)
- **USN**
(Ubiquitous Sensor Network)
- Software Infra

Developing 9 IT New Growth Engine

- NG Mobile Phone **9**
- Digital TV
- Home Network
- IT SoC
- Post PC
- Embedded S/W
- Digital Contents
- **RFID/USN**
- Intelligent Robot

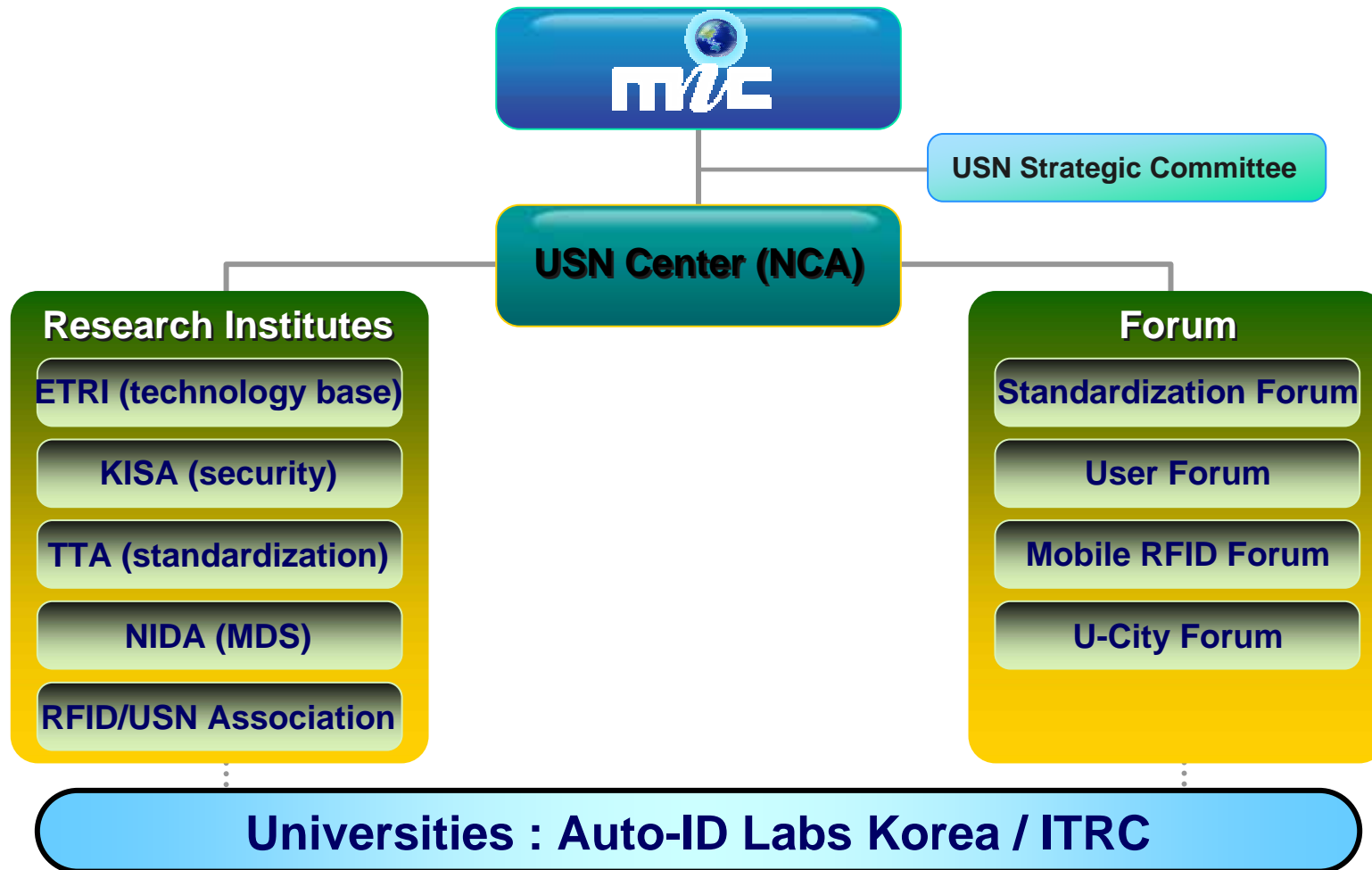
USN Vision & Objectives

Realize U-Life By applying RFID/USN Technology

- **Secure State-of-the-Art U-Life Technology by 2007**
 - Occupy 5% of world RFID/USN market
 - Key technology development for U-life
- **Realize U-Life by 2010**
 - Occupy 7% (\$53.7 million) of world RFID/USN market

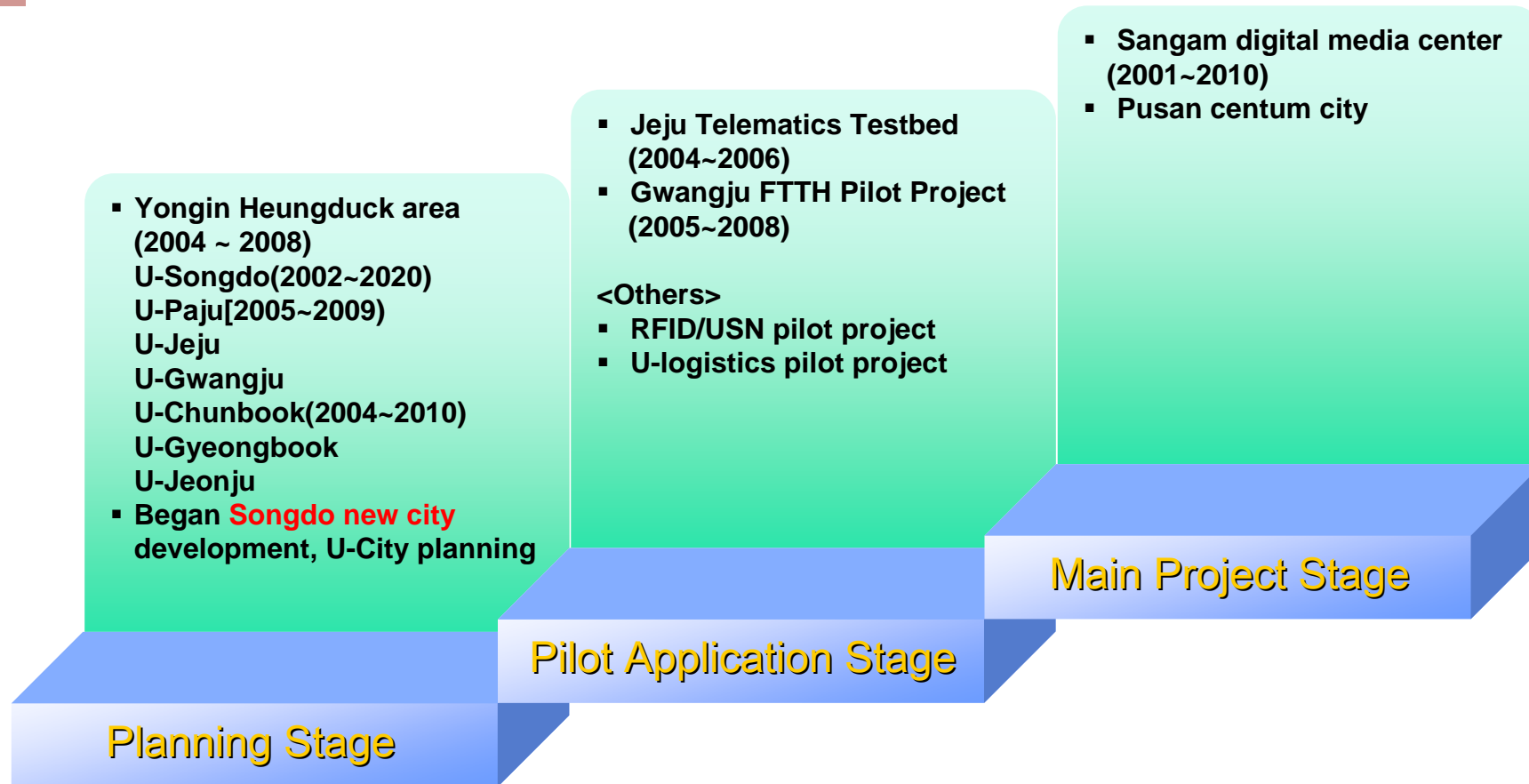


Organization for Promoting USN



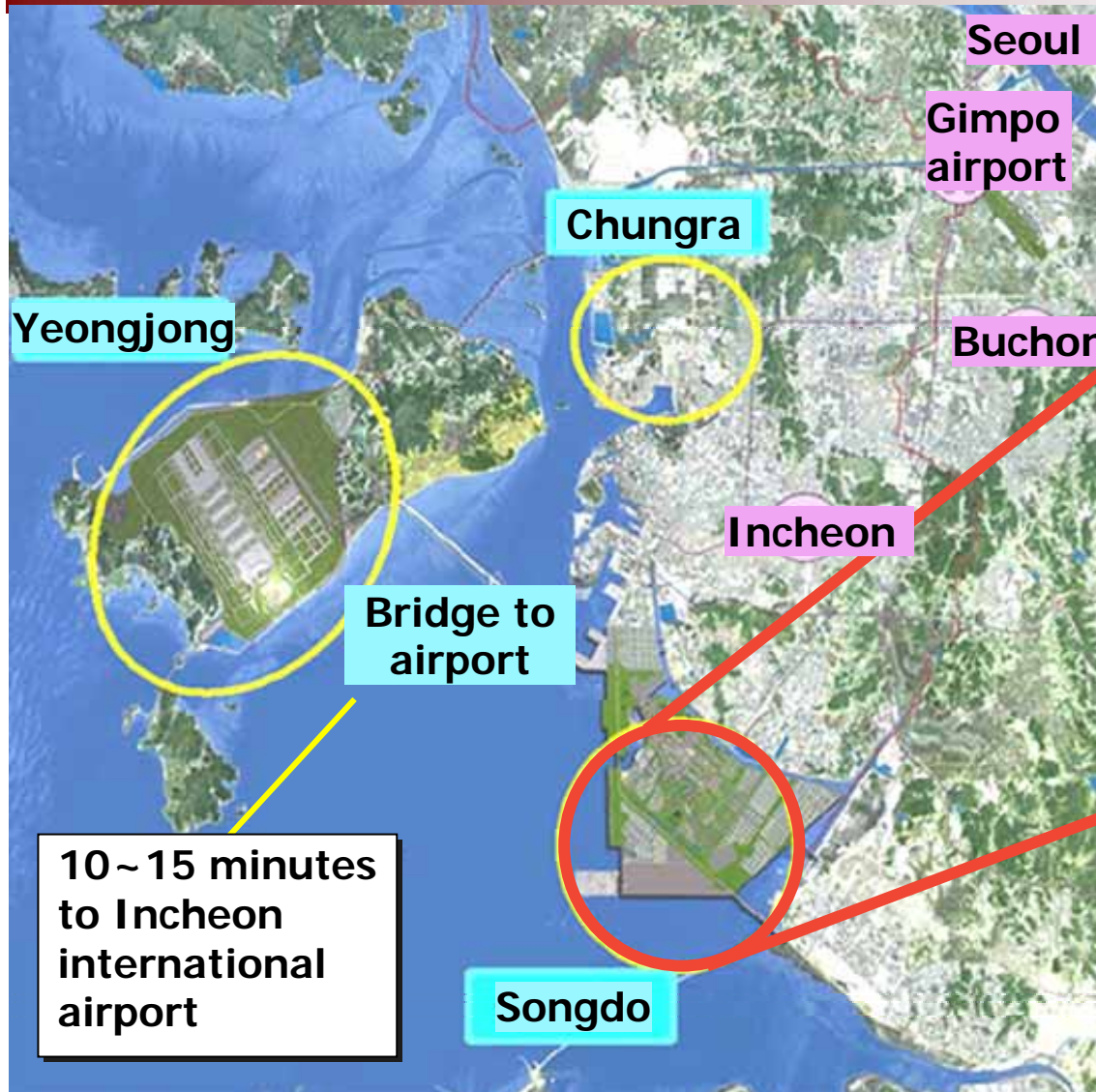
※ USN Strategic Committee : CEO association from industry, university, research institute, and government, chaired by minister of MIC

U-City/U-Province Project



A
N
T
S

U-City Project : Songdo Special Economic Zone



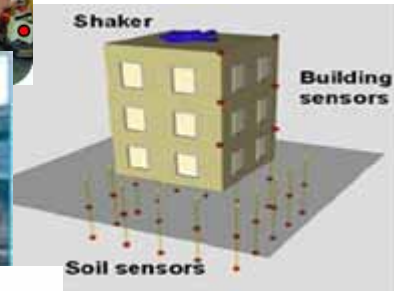
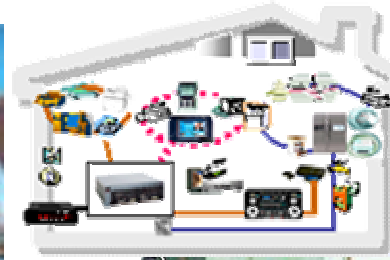
Songdo District

- Planned population of 250,000
- 53 square kilometers
- International affairs, knowledge-based industry, R&D center, center of RFID/USN development
- Ubiquitous City with RFID/USN applied

10~15 minutes to Incheon international airport

Public Ubiquitous Sensor Networks – Nationwide Infrastructure

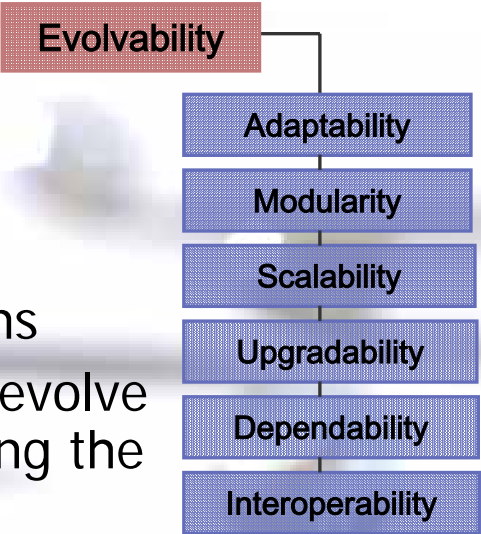
- Extend current local sensor networks to public
 - Sensor Information Sharing
 - Road, Bridge
 - Meteorological
 - Gas, Oil pipes
 - Environmental Monitoring
 - Port/Airport
 - Etc.
 - Standardization
 - Sensor ID, profile
 - Management
 - Network protocols
 - Etc.



ICU/SNR ANTS Platform

Evolvability in Public Sensor Networks

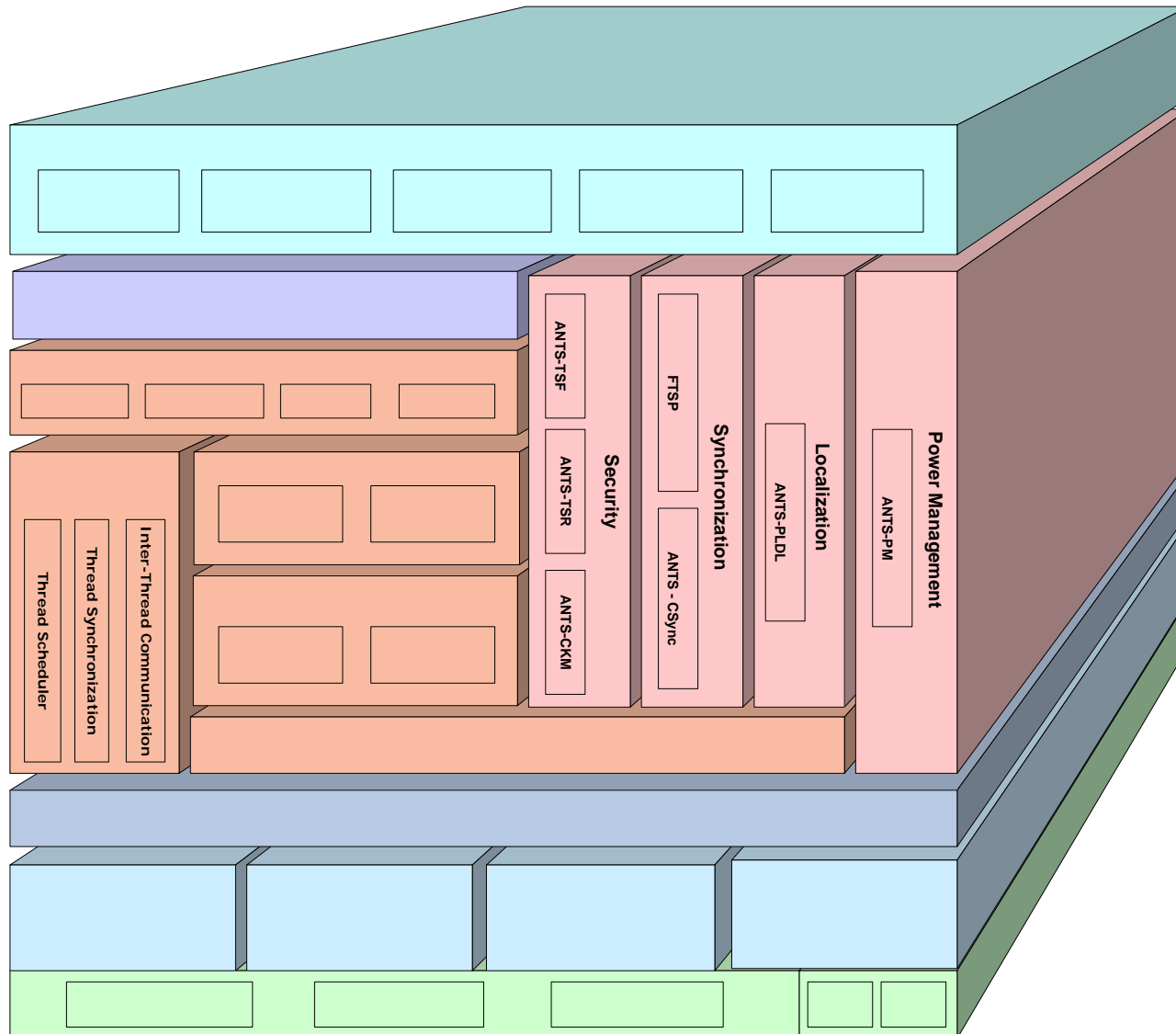
- Sensor networks will populate the world as the present Internet does
- Facing a deeply dynamic Future. We need *evolvability*:
 - Adapt to new environments and applications
 - Support of present tendencies and able to evolve according to market innovations, anticipating the future



ANTS Functionality	Evolvability Relation
Hardware	<i>Adaptability</i> (different nodes for different requirements), <i>Modularity & scalability</i> (component based), <i>Upgradability & dependability</i> (fault-tolerant dynamic upgrades), <i>adaptability</i> (by allowing HW and SW updates)
Operating system	<i>Adaptability</i> (different nodes for different requirements), <i>Modularity & scalability</i> (component based), <i>Upgradability & dependability</i> (fault-tolerant dynamic upgrades), <i>adaptability</i> (by allowing HW and SW updates)
Network Architecture	<i>Scalability</i> (with number of micro or macro nodes), <i>Interoperability</i> (providing easy access to gateways)
Communication Protocols	<i>Scalability</i> (with number of nodes) <i>adaptability & dependability</i> (to new or dead nodes and moving nodes or sub-networks)
Localization	<i>Scalability and adaptability</i> (for new generations of nodes) <i>dependability</i> (dead nodes, whichever reason)
Security	<i>Adaptability</i> (new trust values dependent on incoming traffic) <i>scalability & modularity</i> (new security option at applications level) <i>dependability</i> (activity values for dead nodes)
Synchronization	<i>Scalability & adaptability</i> (for new HPLs or LPNs)
Context Awareness	<i>Interoperability</i> (to other networks through BOSS), <i>adaptability & dependability</i> (delivering context data through a secondary context overly network), <i>scalability</i> (not dependent on size of network)

A
N
T
S

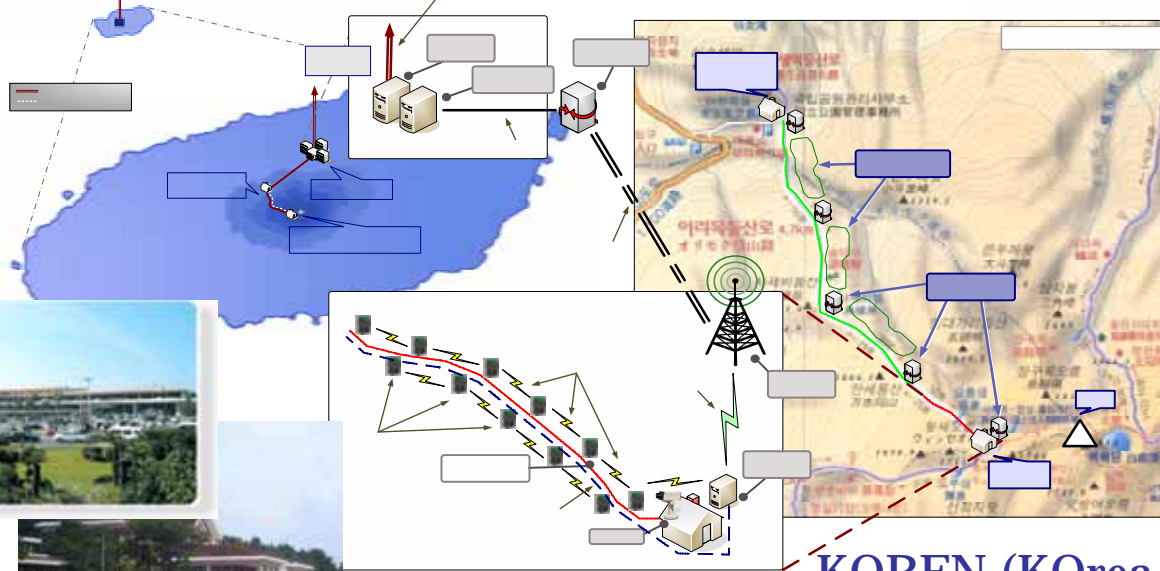
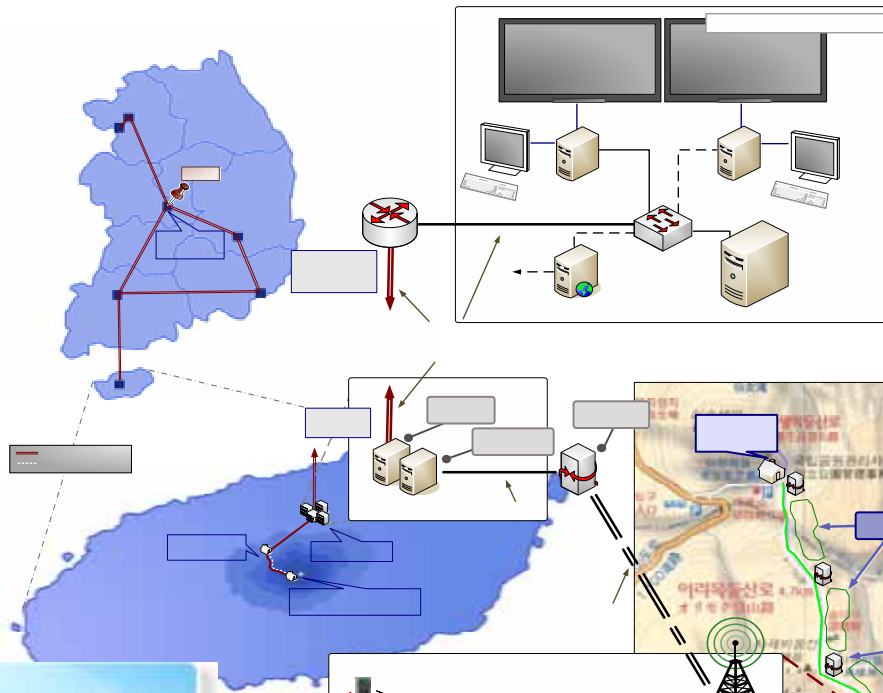
ANTS Hardware/Software Platform



A

N

ANTS Pilot Project - Haroobang (Aug. 22, 2005 - Oct.31, 2006)



KOREN (KORea advanced REsearch Network)

IPv6

USN

BCN

A
N
T
S

ANTS Pilot Project – Haroobang for Disaster management & U-tourism



Field Test in Halla Mountain (1950m high)
– Jeju Island



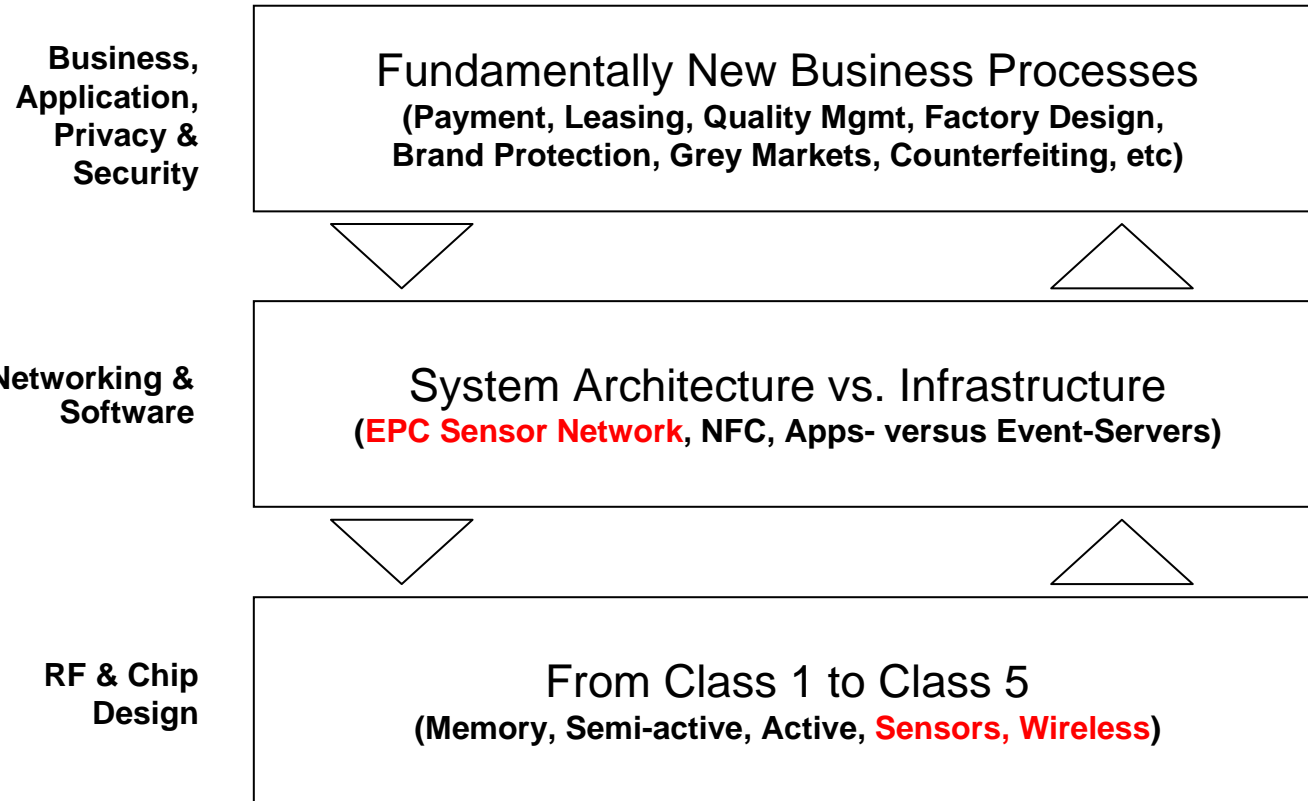
A
N
T
S

ANTS Pilot Project – Haroobang for Disaster management & U-tourism



**Test Site in Cheju University in Jeju Island
(Jan. 5, 2006)**

Auto-ID Labs Research Focus

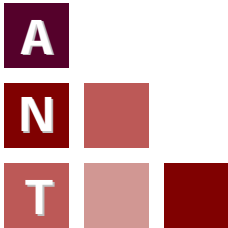


Basic Research

Deployment

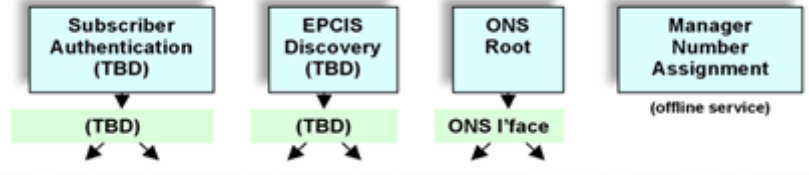
EPC Tag Classification

EPC Tag Class	Tag Class Capabilities
Class 0	Read only, (i.e., the EPC number is encoded onto the tag during manufacture and can be read by a reader, not written to)
Class 1	Read, write once (i.e., tags are manufactured without the EPC number which can be encoded onto the tag later in the field)
Class 2	Read / write / Higher functionality
Class 3	Class 2 capabilities plus a power source to provide increased range and/or advanced functionality, e.g., sensors
Class 4	Class 3 capabilities plus active communication and the ability to communicate with other tags
Class 5	Class 4 capabilities plus the ability to communication with passive tags as well



EPC Sensor Network Components

EPCglobal Core Services



- Link sensor data with corresponding master data to change it to valuable information
- Store and maintain updated sensor data with the help of EPCIS repository
- EPCIS provides decision point to react sensor data give commands to Sensor Tag actuator throughout backward communication channel

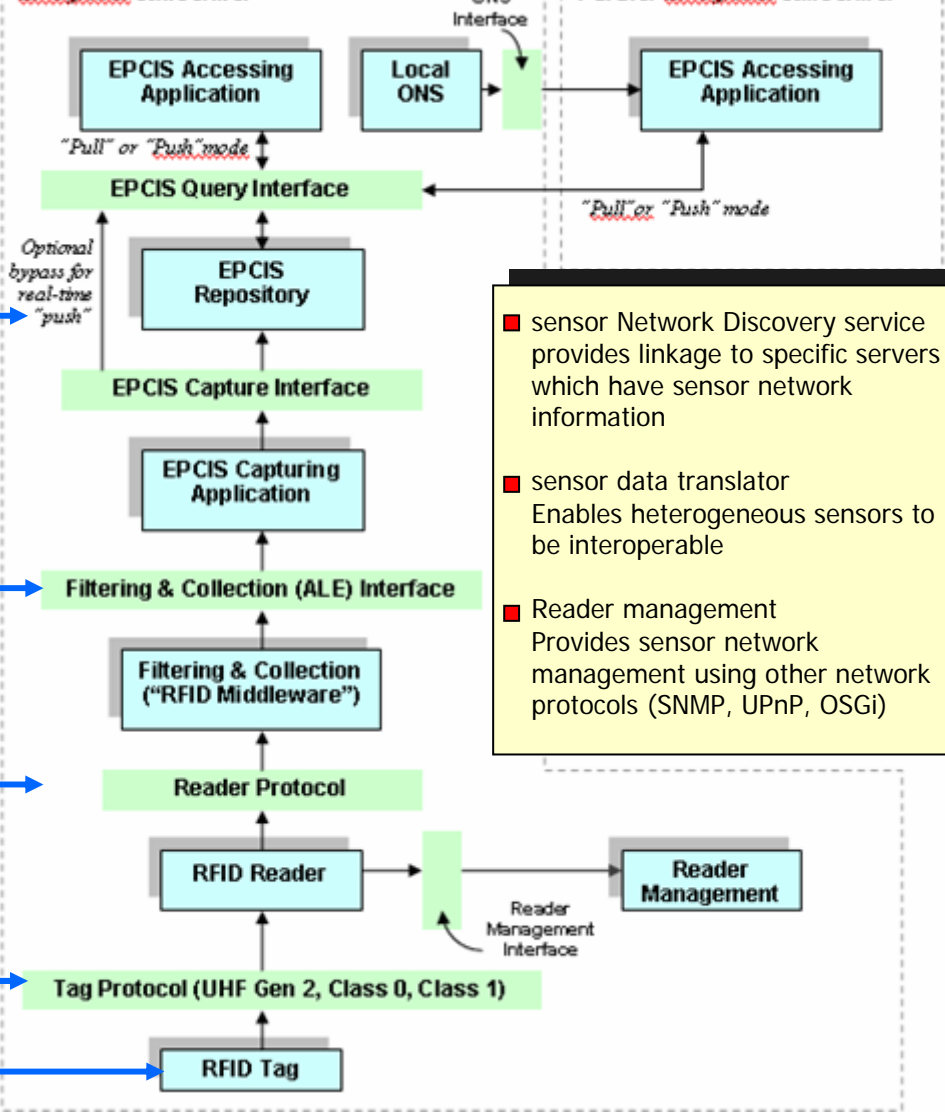
- Sensor data filtering & aggregation according to type, effective distance, periods, threshold, unit
- Sensor data accumulating (average, reliability)

- Sensor Event manipulation, Sensor Tag Selection, Sensor data Smoothing
- Translate complex sensor data query from IS to Sensor Tag specific query/operation to inject into BS

- Sensor Identification Memory for Sensor data reading and sensor operation air interface

- Sensor Tag, Active Sensor Tag, Active Sensor Tag Network

EPCglobal Subscriber



- sensor Network Discovery service provides linkage to specific servers which have sensor network information
- sensor data translator Enables heterogeneous sensors to be interoperable
- Reader management Provides sensor network management using other network protocols (SNMP, UPnP, OSGi)

Optional bypass for real-time "push"

"Pull" or "Push" mode

Reader Management Interface

Summary

- RFID & Sensor Network is a key enabling technology for building Ubiquitous Life
- In Korea, we put lots of efforts into building “ubiquitous sensor networks”
- We need a:
 - Complete & Standard architecture
 - Flexible and adaptable
 - Prepared for the future
 - *for Public and EPC Sensor Networks*