

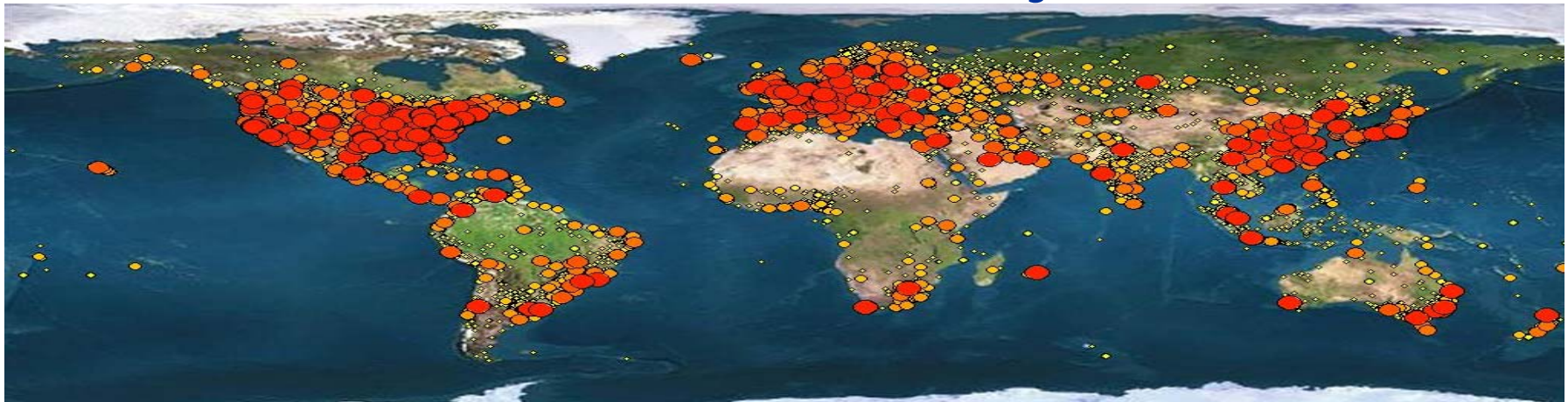


The Future Internet

Internet of Services | Internet of Things | Internet of Media
International Workshop - 10-11 September, Oslo, Norway

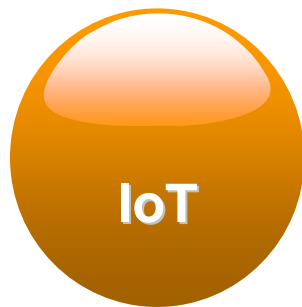
Internet of Things Vision and the Technology Behind Connecting the Real, Virtual and Digital Worlds

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Future Internet

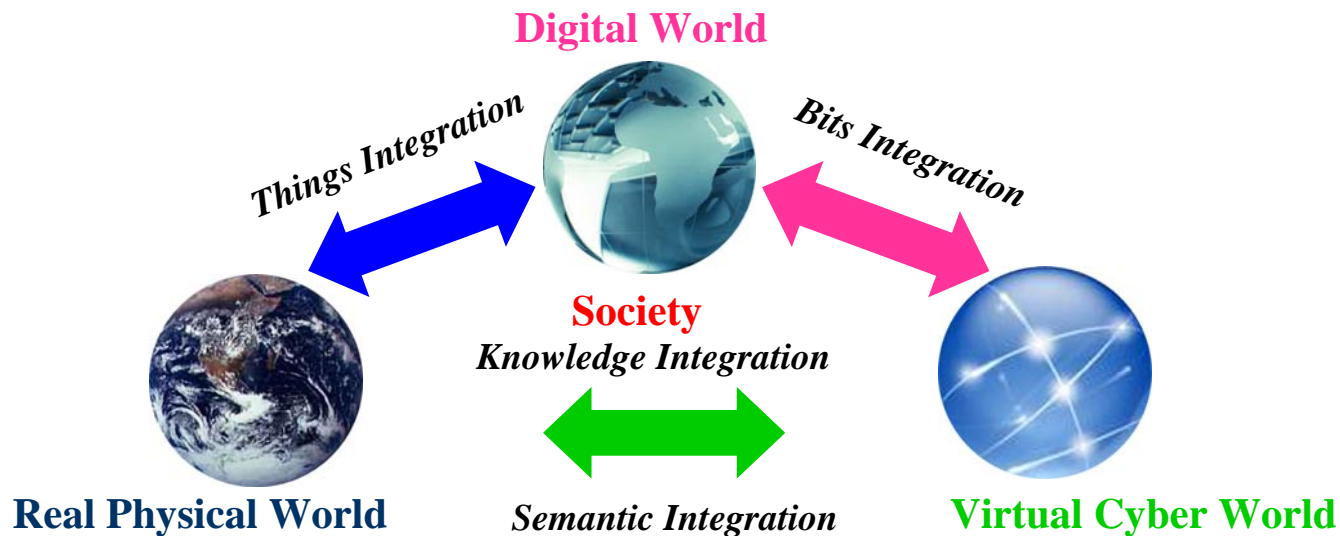
Society



- IoT – Internet of Things
- IoM – Internet of Media
- IoS – Internet of Services
- IoE – Internet of Enterprises

Internet of Things

- Internet of Things is an integrated part of Future Internet.



- A dynamic global network infrastructure with self configuring capabilities based on standard and interoperable communication protocols where physical and virtual “things” have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network.

Internet of Things



- In the IoT, “things” are expected to become active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information “sensed” about the environment, while reacting autonomously to the “real/physical world” events and influencing it by running processes that trigger actions and create services with or without direct human intervention.



Source: Internet of Things - Strategic Research Roadmap, CERP-IoT 2010

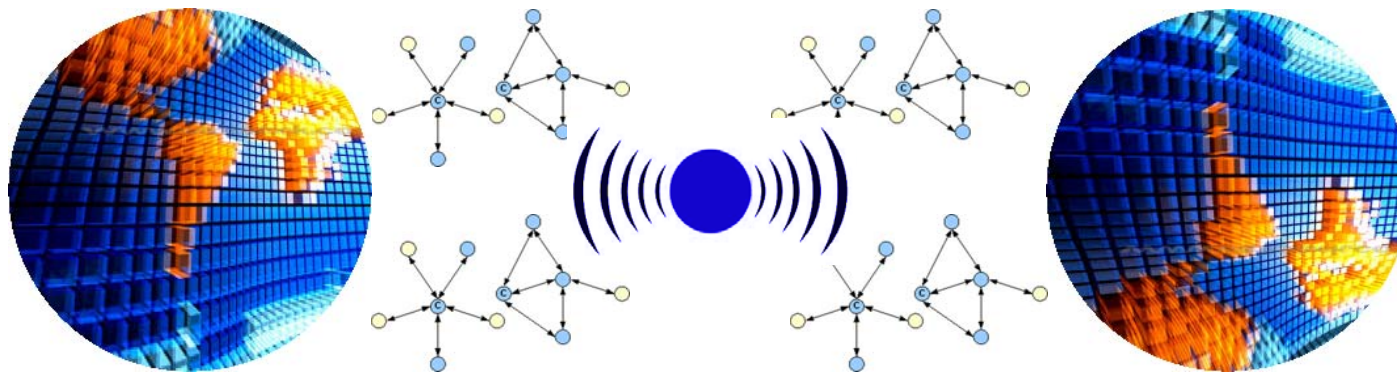
Internet of Things

- Interfaces in the form of services facilitate interactions with these “smart things” over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues.



Internet of Things

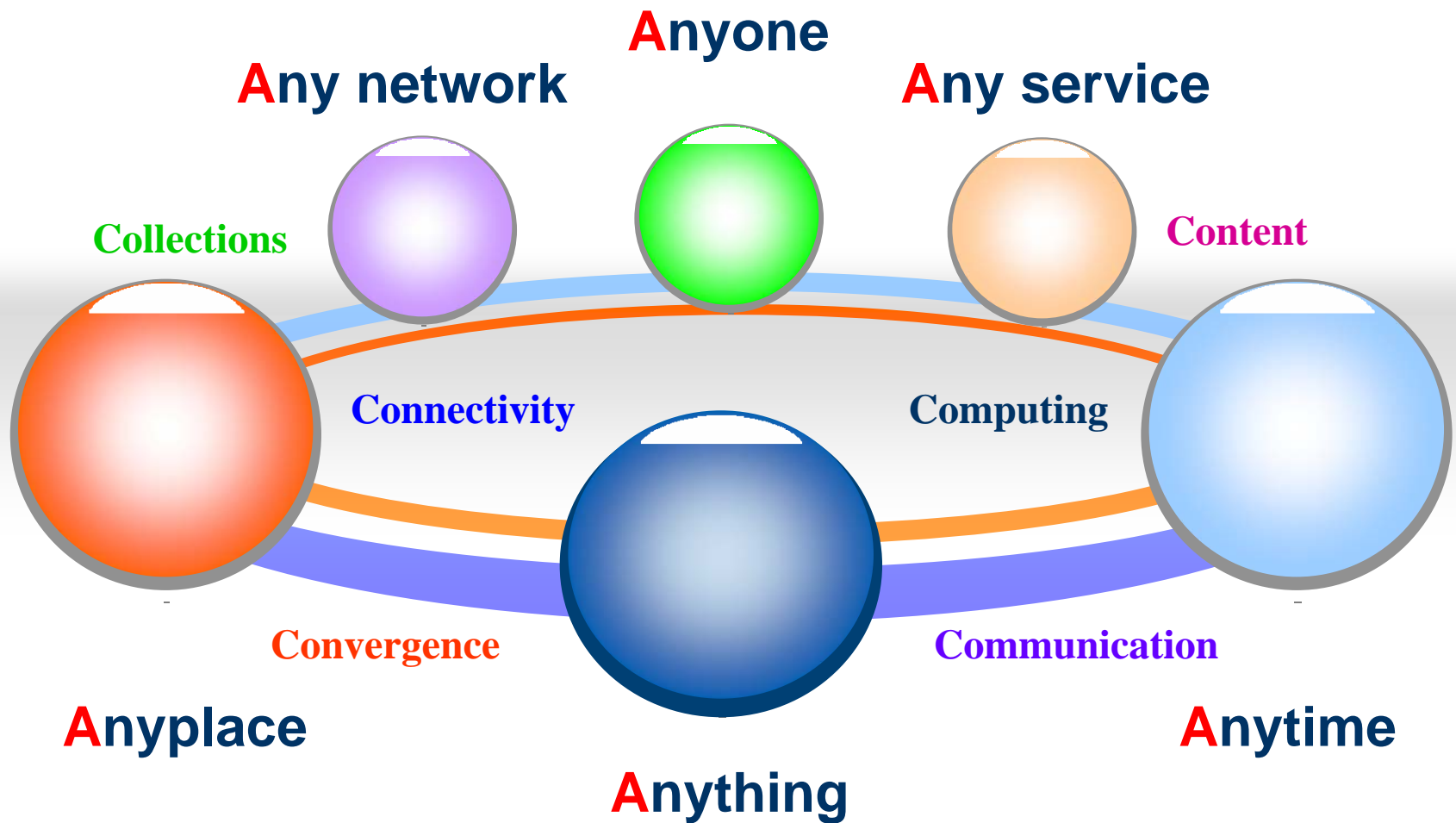
- Connect objects and devices to repositories and networks using simple, and cost effective systems of item identification so data about things can be collected and processed.
- Ability to detect changes in the physical and environmental status of things, using sensor technologies.



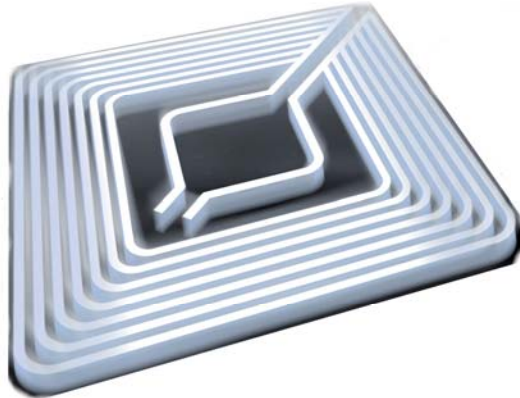
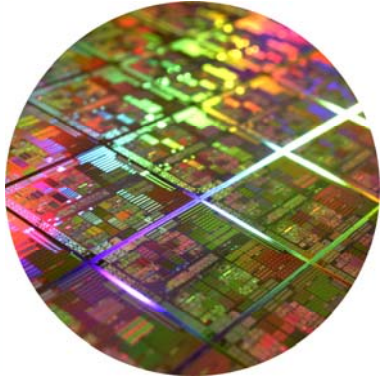
- Devolving information processing capabilities to the edges of the network using embedded intelligence in the things.
- Miniaturization and use of nanotechnology so smaller and smaller things will have the ability to interact and connect.

Internet of Things

■ Connecting:

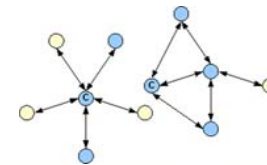
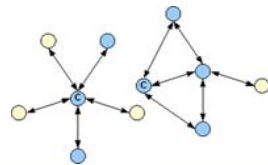
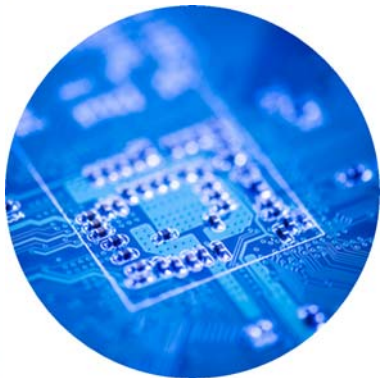


Smart Systems on Tags



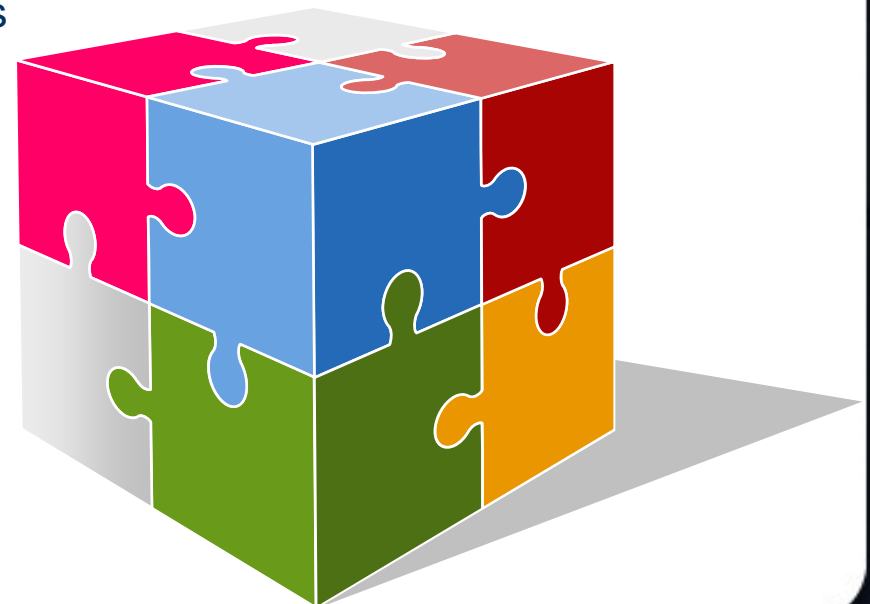
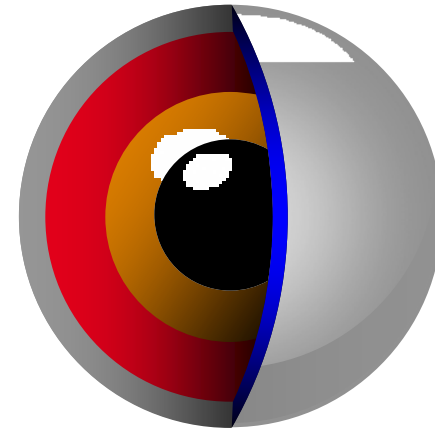
Sense

Actuate



Smart Systems on Tags

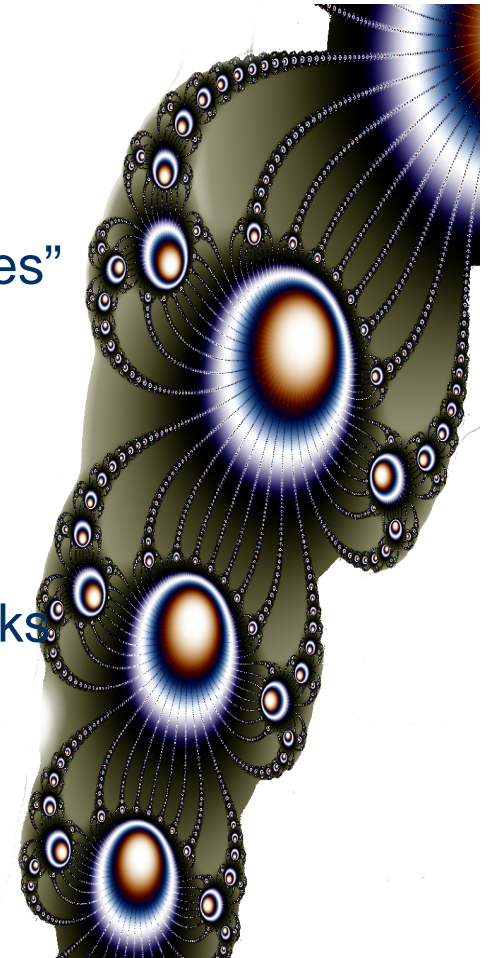
- Identification Technology
- Internet of Things Architecture Technology
- Communication Technology
- Network Technology
- Software, Services and Algorithms
- Hardware
- Data and Signal Processing Technology
- Discovery and Search Engine Technologies
- Relationship Network Management Technologies
- Power and Energy Storage Technologies
- Security and Privacy Technologies
- Standardisation



Scalability, modularity, extensibility and interoperability among heterogeneous things and their environments are key design requirements for the Internet of Things.

Things Attributes

- “Things” can initiate communication
- “Things” can communicate with other “things”, computing devices and with people
- “Things” can be “real world entities” or “virtual entities”
- “Things” have identity; there are means for automatically identifying them
- “Things” may have sensors attached, thus they can interact with their environment
- “Things” can collaborate to create groups or networks
- “Things” can do many tasks autonomously
- “Things” are involved in the information exchange between real/physical, digital and virtual worlds
- “Things” can selectively evolve and propagate information



Things Attributes

- “Things” would be competing with other “things” on resources, services and subject to selective pressures
- “Things” can create, manage and destroy other “things”
- “Things” can use services that act as interfaces to “things”
- “Things” respect the privacy, security and safety of other “things” or people with which they interact
- “Things” use protocols to communicate with each other and the infrastructure
- “Things” can negotiate, understand and adapt to their environment
- “Things” can extract patterns from the environment or to learn from other “things”
- “Things” are environmentally safe
- “Things” can take decisions through their reasoning capabilities



Ubiquitous Sensor Network

- Any place, any thing using wireless tags/nodes-**Ubiquitous**
- Sensing ID and environmental information-**Sensor**
- Real time monitoring and control using a-**Network**

RFID Node
On-Body

Sensor Node

Ad-hoc Sensor

Adaptive Wireless

In-body

MEMS Sensors

In-Home

Neuro-stimulators

dynamicArm

closed loop

Integrated Circuit
Controller
Connection
Logic

Prosthetic
Substrate
(Distal
Sensor
Region)

Distributing
wire

Dynamic Arm

Wireless Systems Characteristics

■ Wireless

- Limited bandwidth, high latency
- Variable link quality and link asymmetry due to noise, interference, disconnections
- Easier snooping
 - Signal and protocol processing



Source: Momena

■ Mobility

- Determine variability in system design parameters:
- Connectivity, bandwidth, security domains, location awareness
 - Protocol processing

■ Portability

- Limited capacities (battery, CPU, I/O, storage, dimensions)
 - Energy efficient signal and protocol processing



Source: Momena neck-worn PC

Smart Wireless Systems

■ Beyond RF ID - Functionality

■ Multi Antennas

- On Chip Antenna –OCA
- Coil on Chip (HF)
- Printed antennas
- Embedded antennas
- Multiple antenna substrates
- 3D structures

■ Integrated Circuit

Micro/Nanoelectronics/Polymer

- Multi RF Front Ends
 - HF/UHF/MW/Radar
- Memory – EEPROM/FRAM/Polymer
- ID 128 bits + other type ID
- Multi Communication Protocols
- UWB
- Digital Processing
- Security

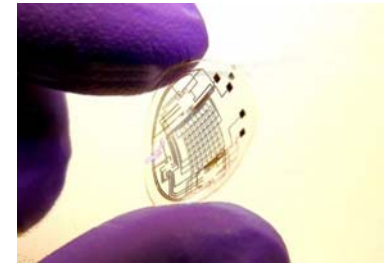


Source: Toshiba

■ Displays

- Bi-stable
- Flexible
- Transparent

Combined flexible contact lens with an imprinted electronic circuit



Source: University of Washington

■ Sensors/Actuators

- MEMS/NEMS
- Sensors on Chip
- Molecular sensors



Source: Siemens

■ Assembly

■ Power Generation

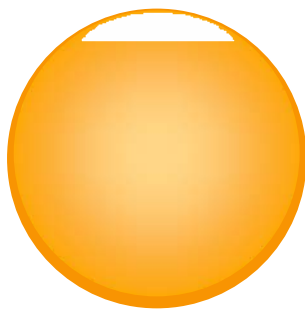
- RF
- Solar
- Harvesting (vibration, temp, etc.)
- Batteries printed/polymer
- Fuel cells

Challenges and Constraints

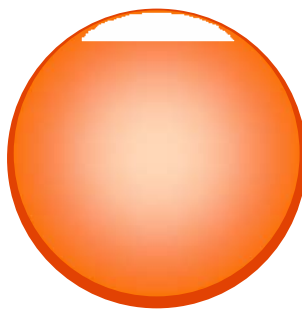
- Semiconductor technology scaling gives rise to three key challenges:
 - Challenge of scalability
 - the need to extend communications and processing to large data, over heterogeneous channels
 - Challenge of adaptation
 - the need to reuse and retarget both hardware and software
 - Challenge of integration
 - the need to more optimally exploit heterogeneous component technologies with respect to cost, performance, energy tradeoffs
- Fundamental technology *constraints*:
 - Energy (limitations of batteries, sensors)
 - Bandwidth (limited speed of semiconductor devices)
 - Non-scalability of analog circuits
 - Scaling of on- and off-chip interconnects

IoT and Cloud Computing

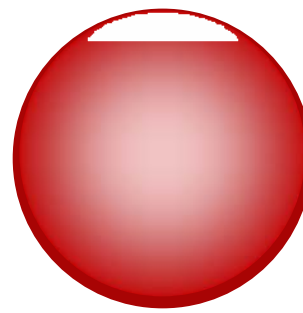
- Computing paradigm where data and services reside in massively scalable data centers and can be ubiquitously accessed from any connected device over the Internet.
- Physical location and underlying infrastructure details are transparent to users
- **A**n anytime, **A**n anywhere access to IT resources delivered dynamically as a service



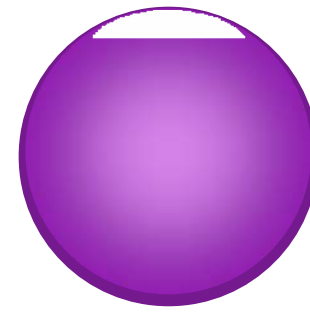
Virtual



Scalable

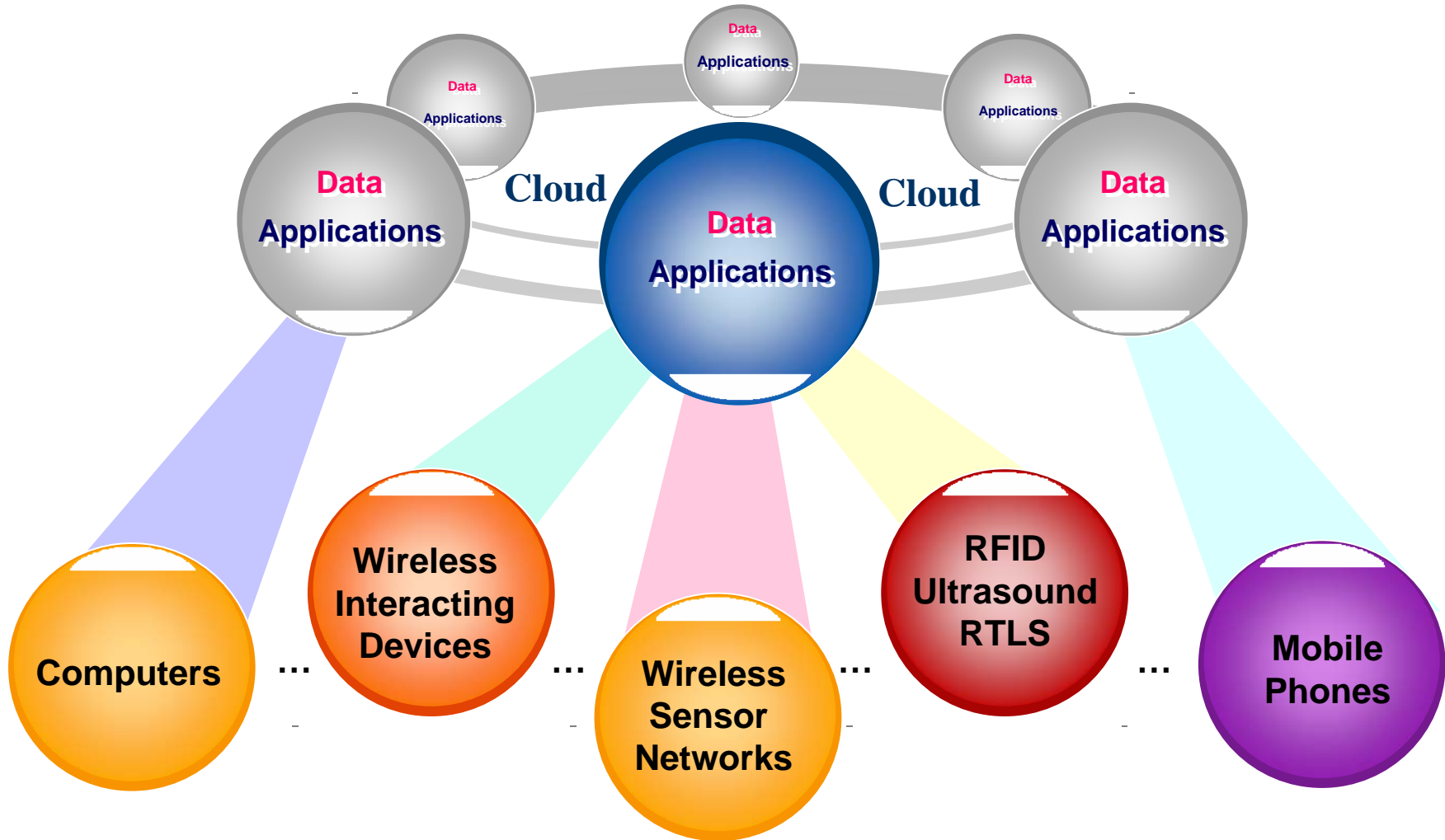


Efficient



Flexible

IoT and Cloud Computing



Real virtual and digital worlds

Bridging the real, virtual and digital worlds by using wireless connectivity.

*Wireless
Connectivity*



Source: University of Tokyo -Virtual-reality system

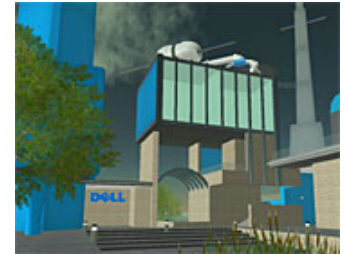
Real virtual and digital worlds

- Connecting real, virtual and digital worlds
- The challenge:
 - Linking smart wireless identifiable devices and RFID data with virtual worlds software programs
- Transfer positions of real persons and real things into the virtual world.
- Enable the smart wireless devices to trigger actions in the real world. **“Connecting Consumers Virtual Lives with Their Real World Needs”**

“Connecting virtual reality with real world commerce”

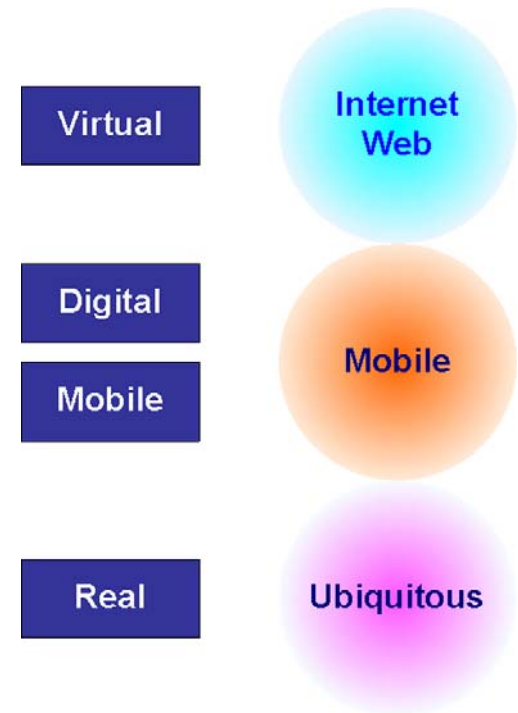
Residents can go to the virtual factory, customize their Dell and purchase, and their PC arrives at their real-life door.

Source: Dell



Real virtual and digital worlds

- Physical world embedded with:
 - RFID, smart wireless identifiable devices, novel materials, processing units.
 - MEMS, NEMS, micro/nano robots, computational particles
 - Wired and wireless networks
- Ubiquitous smart/intelligent things/objects
 - Things capable of computing and communicating
 - Things able to be connected to everything
 - Smart things behaving with certain “intelligence”



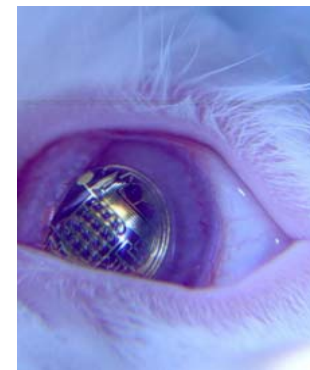
Ubiquitous intelligence

Being a ubiquitous existence
Residing in everyday objects, environments, etc.

Man-made and natural things

Wireless Smart System Applications

- Automotives
- Aeronautics
- Information and Telecommunication (ITC)
- Medical Technologies
- Logistics and object mobility and management





Real virtual and digital home

SMART HOME Intel expects a wireless network of sensors, called **motes**, to help older people live on their own longer. The motes pass information among themselves and to a PC. The data they gather is analyzed to infer activities of daily living, which can give important clues to a person's state of health and allow for intervention.

Motes in shoes and other clothing tell the system what a person is wearing. If he's getting dressed to go for a walk, the system might inform his walking partner that he is ready to go.



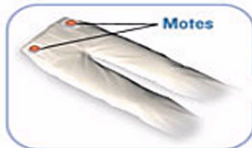
A mote on a pill bottle scale can tell whether a person took her medication.

Motes on cups can tell if they have been taken out of the cabinet.



Motes monitor a person's bathroom use.

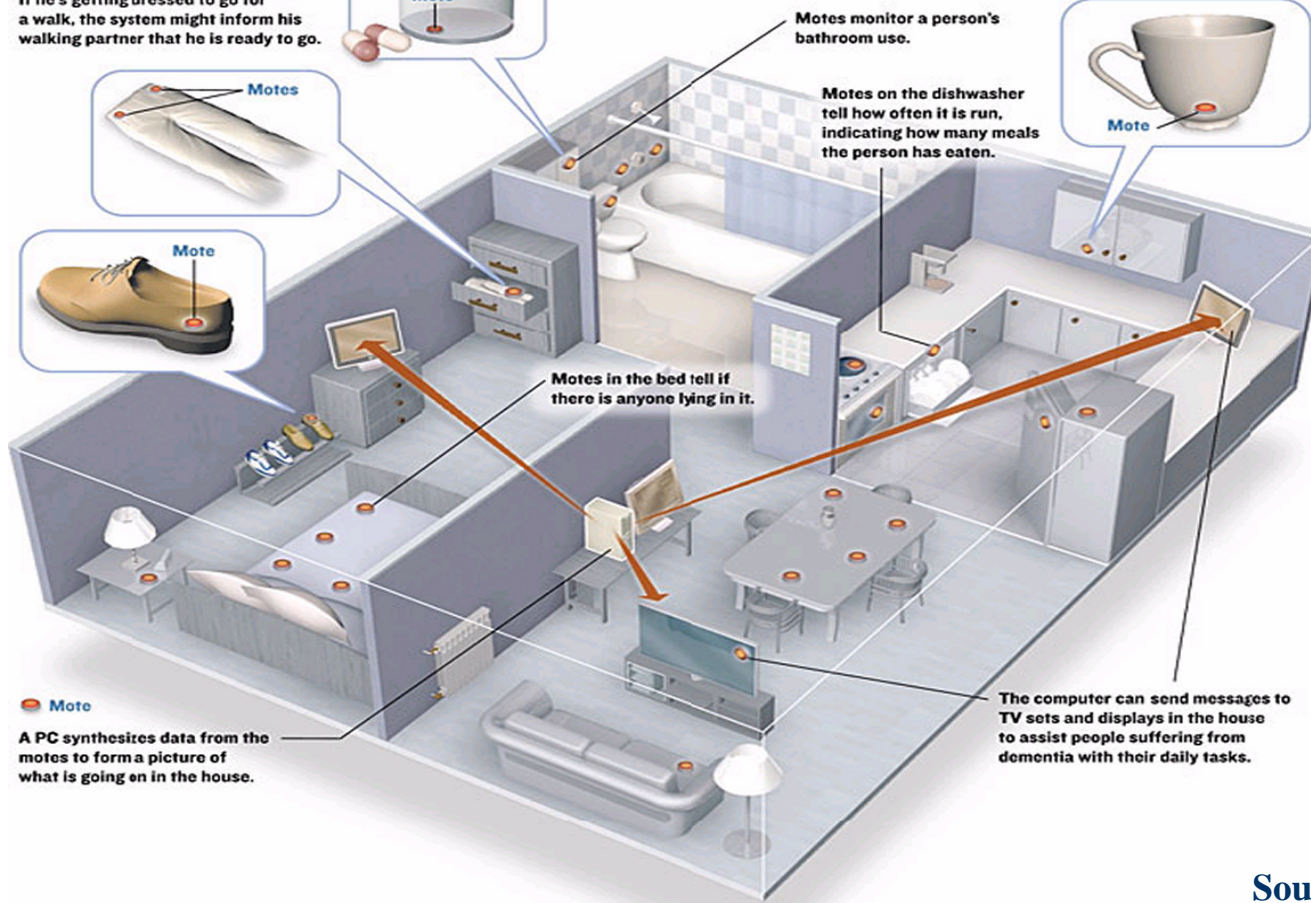
Motes on the dishwasher tell how often it is run, indicating how many meals the person has eaten.



Motes in the bed tell if there is anyone lying in it.

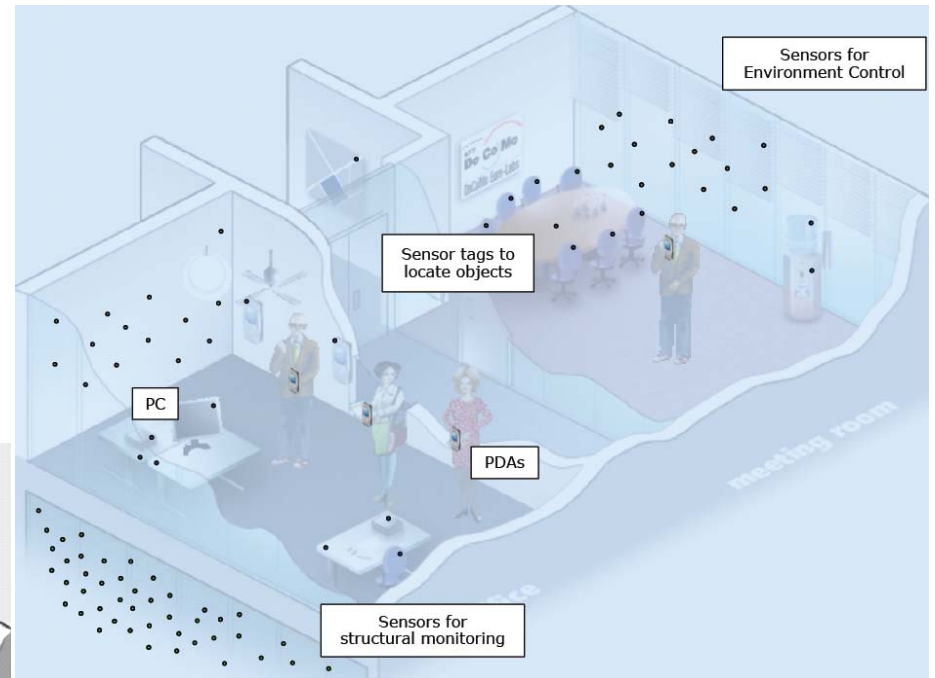
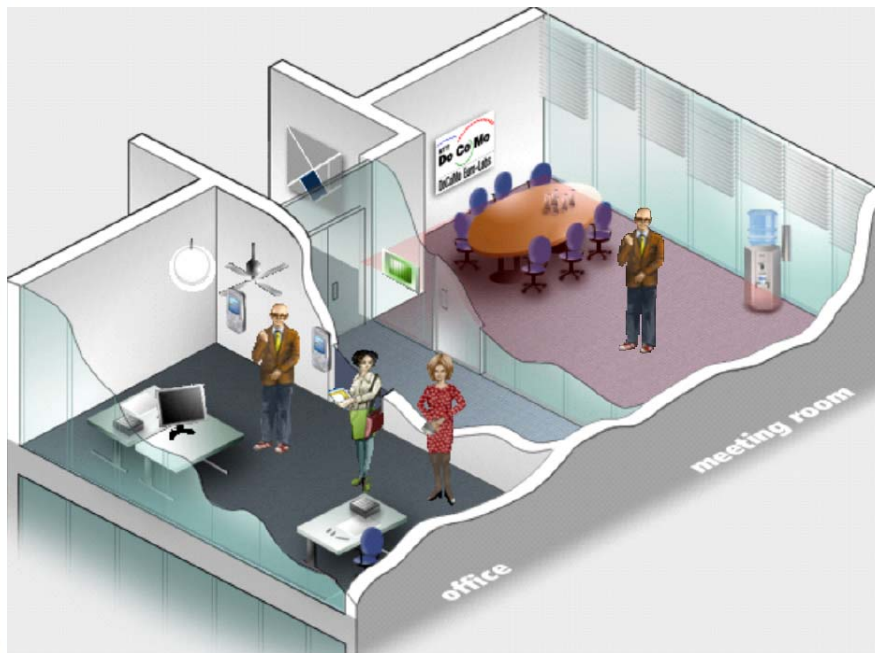
 Mote
A PC synthesizes data from the motes to form a picture of what is going on in the house.

The computer can send messages to TV sets and displays in the house to assist people suffering from dementia with their daily tasks.



RFID in the Office and Buildings

- Sensor data collection
- Exploit moving nodes
- Exploit network coding for efficiency



- Intelligent Buildings
- RFID Integration

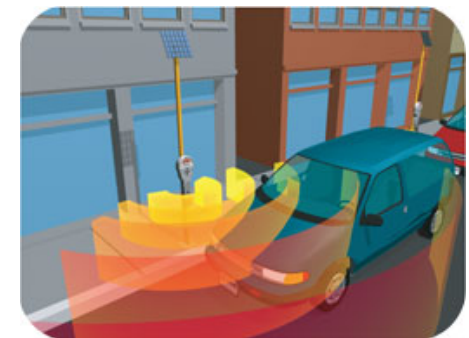
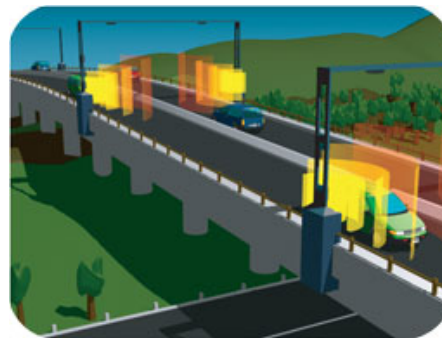
Real virtual and digital car

- RFID derived position among vehicles (V2V)
- RFID for communication between the vehicle and infrastructure (V2I and I2V),
- LANE LEVEL position

<http://www.compexinc.com/>

Vehicle Identification System

- Determine if a vehicle registration has expired.
- Monitor traffic and vehicle speed in construction zones or other pertinent areas.
- Ticketing parking.



WSN RFID in Oil and Gas Industry

- Wireless instrumentation for
 - Installations in remote and hostile areas
 - Temporary installations
 - Ease of scalability
 - Redundant data collection for production optimization
- RFID and WSN for
 - Personnel
 - Equipment
 - Containers
 - Drilling tools
 - Monitoring
 - Maintenance



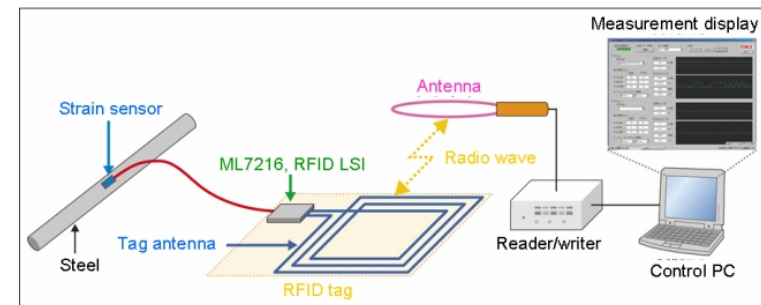
Source: StatoilHydro

Roads Bridges and RFID

- Strain Sensing System Using 13.56MHz passive-type Sensor-Integrated RFID.
- The system, measures the changes and deformation caused by various types of deterioration and loading on the structure, without using a battery.
- Embedded RFID sensor that is integrated within the concrete
- Measurements at a strain resolution level of approximately 10×10^{-6} .
- Using a thermistor, the system simultaneously measures temperature and can account for deformation caused by temperature.



Measures the sensor (white taping area on steel) from RFID tag (in blue) with a portable reader/writer with control PC

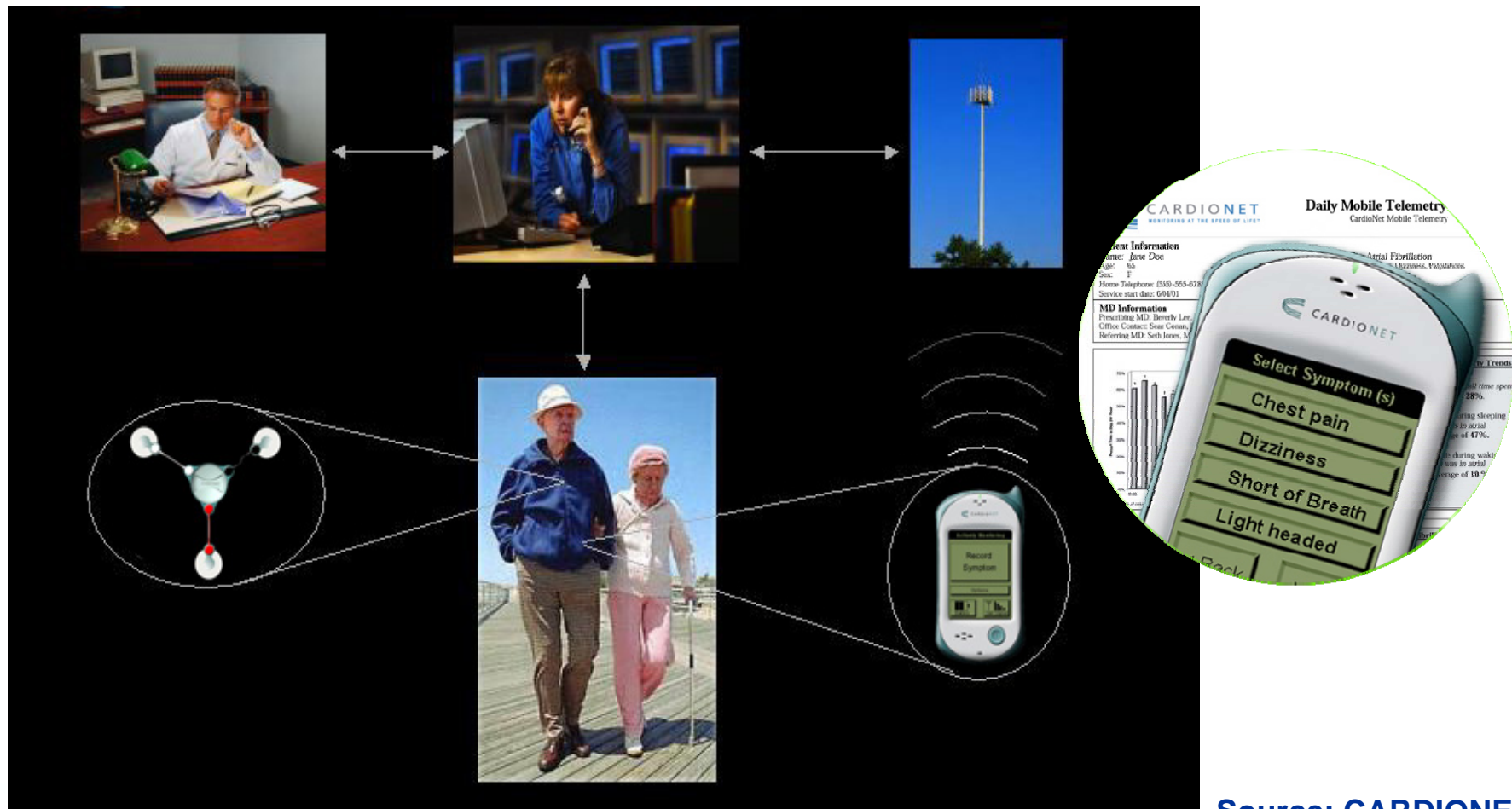


Efficient maintenance and management of roads, bridges and public housing. Concrete and steel structures monitoring due to everyday traffic, wind and earth pressure and earthquakes

Source: Oki Electric Industry Co., Ltd.

Real virtual and digital healthcare

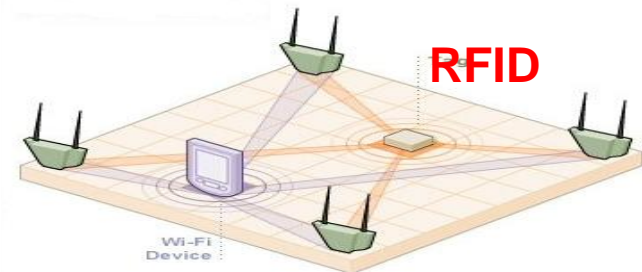
- Mobile cardiac telemetry monitoring platform
- 24/7/365 patient freedom to go anywhere at anytime



Source: **CARDIONET**

Real Time Location Systems

- Intelligent long range active RFID systems to identify, locate and track assets at a distance of up to 100m and to deliver superior real time visibility in dynamic, demanding environments.
- Long range (100m) RFID tag not with read/write capability, and 360° visibility of wireless regardless of tag orientation.
- Features:
 - Sensor location layout map
 - Planned number of readers and access point antennas
 - Placement of active RFID Tags on the assets.



Future Internet

Knowledge Integration

New “social networks”



New “things”

New “communication”

New “services”



New “business”

