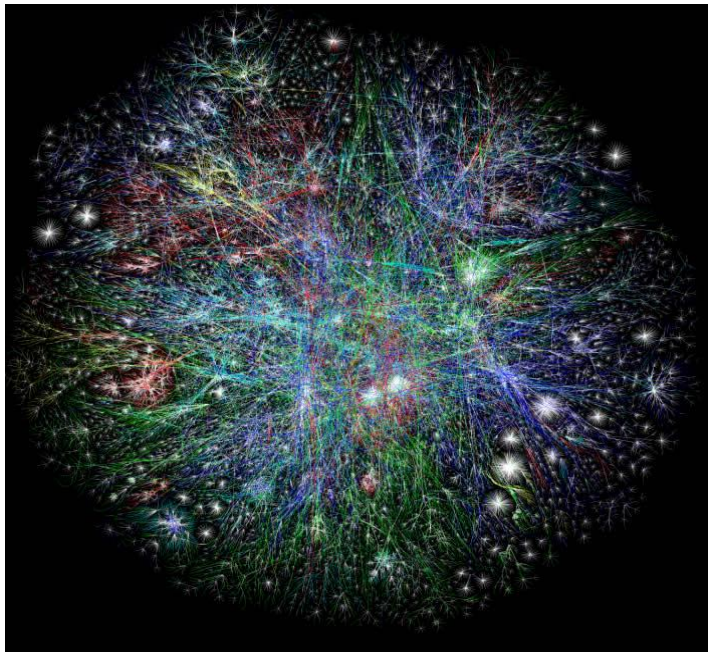
Outline

1. What's Internet of Things (IoT)
2. State of the Art of IoT
3. Challenges and Limitation of IoT
4. Future of IoT

Starting from the Internet



- Internet appears everywhere in the world
- but it is still a connection between people and people

What is the Internet of Things?

- Internet connects all people, so it is called “the Internet of People”
- IoT connects all things, so it is called “the Internet of Things”

What's the Internet of Things

- Definition

  (1) The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects, usually the network will be wireless and self-configuring, such as household appliances.

  ------Wikipedia

  (2) By embedding short-range mobile transceivers into a wide array of additional gadgets and everyday items, enabling new forms of communication between people and things, and between things themselves.

  ------WSIS 2005

What's the Internet of Things

- Definition

  (3) The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects.

  ------IoT 2008

  (4) "Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts".

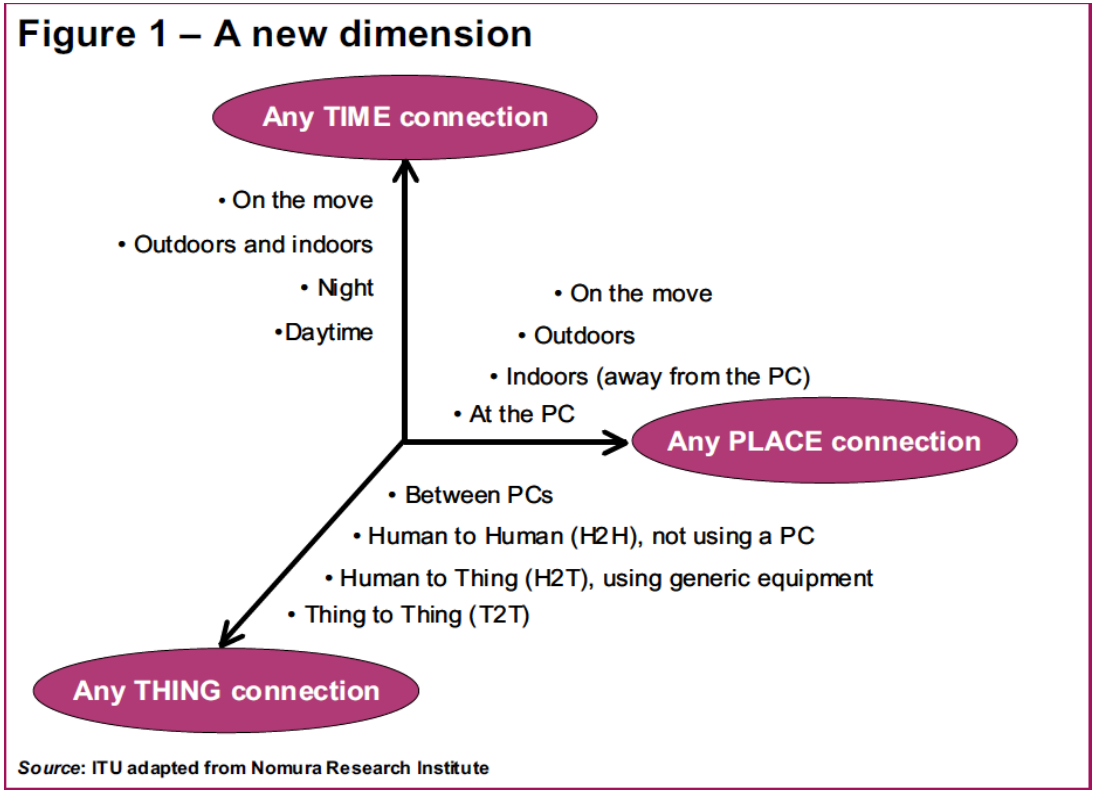
  -------IoT in 2020

What's the Internet of Things

- History
  - 1997, "The Internet of Things" is the seventh in the series of ITU Internet Reports originally launched in 1997 under the title "Challenges to the Network".
  - 1999, Auto-ID Center founded in MIT
  - 2003, EPC Global founded in MIT
  - 2005, Four important technologies of the internet of things was proposed in WSIS conference.
  - 2008, First international conference of internet of things: The IOT 2008 was held at Zurich.

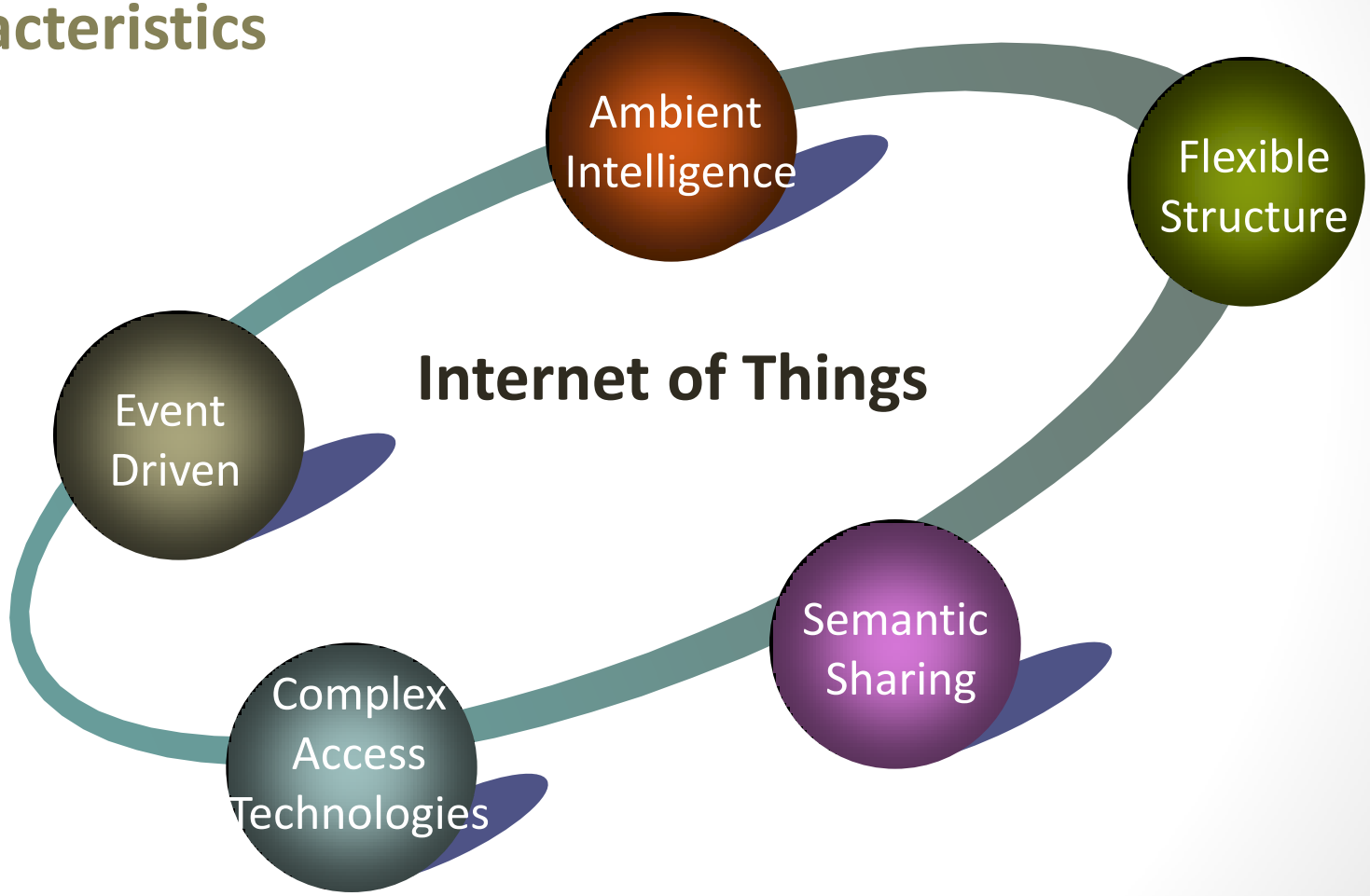
What's the Internet of Things

From any time ,any place connectivity for anyone, we will now have connectivity for anything!



What's the Internet of Things

Characteristics



Why Internet of Things

- Dynamic control of industry and daily life
- Improve the resource utilization ratio
- Better relationship between human and nature
- Forming an intellectual entity by integrating human society and physical systems

Why Internet of Things (ii)

- Flexible configuration, P&P…
- Universal transport & internetworking
- Accessibility & Usability?
- Acts as technologies integrator

Epoch of IOT

Wen Jiabao: sensing China

2009

IBM: Smart Planet, Winning in China

2009

Obama: Business Round Table

2009

IBM: Smart Planet

2008

ITU: ITU Internet Reports

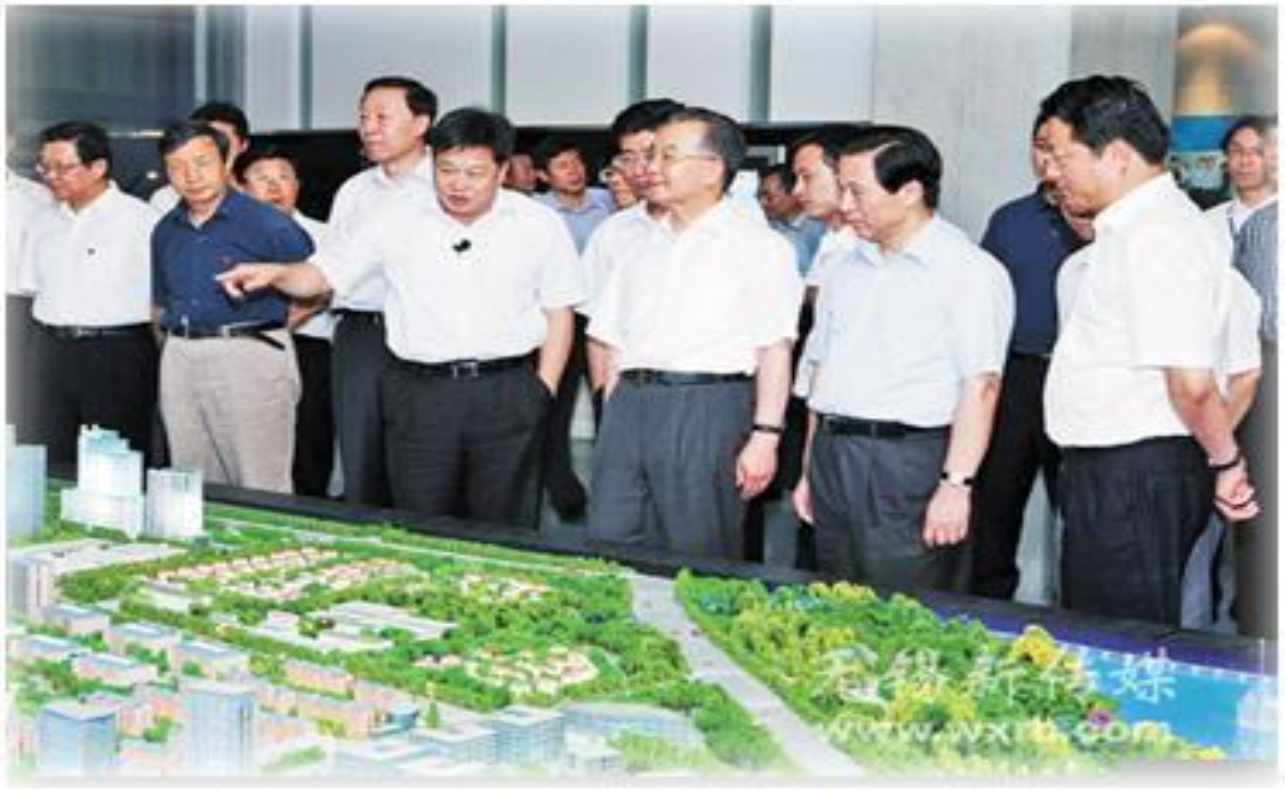
2005

AUTO-ID LABS

MIT: Auto-ID-Center

1999

Premier Wen and Sensing China



- Premier Wen visited Wuxi in August 7, 2009.
- He proposed “Sensing China”.

15-Year Law

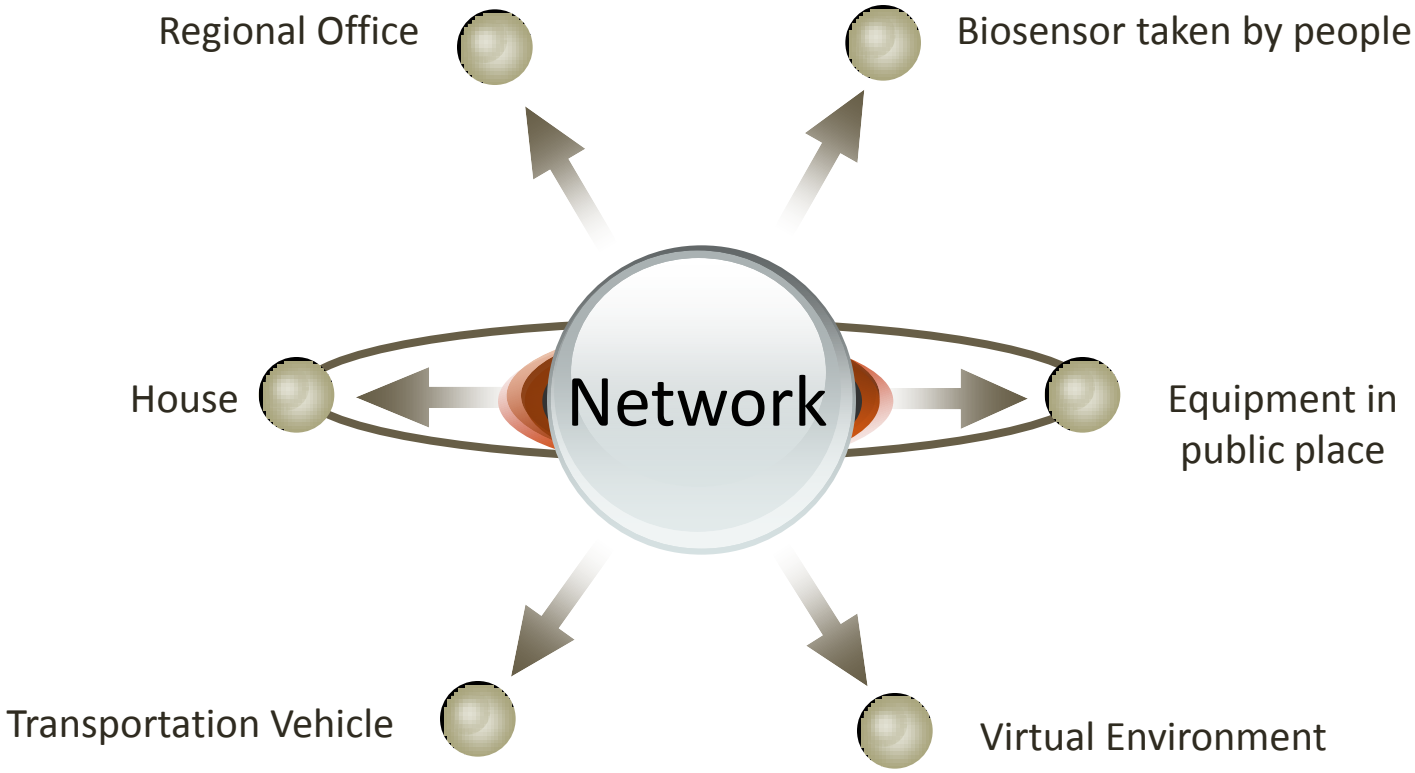
1965 Main Frame

1980 PC

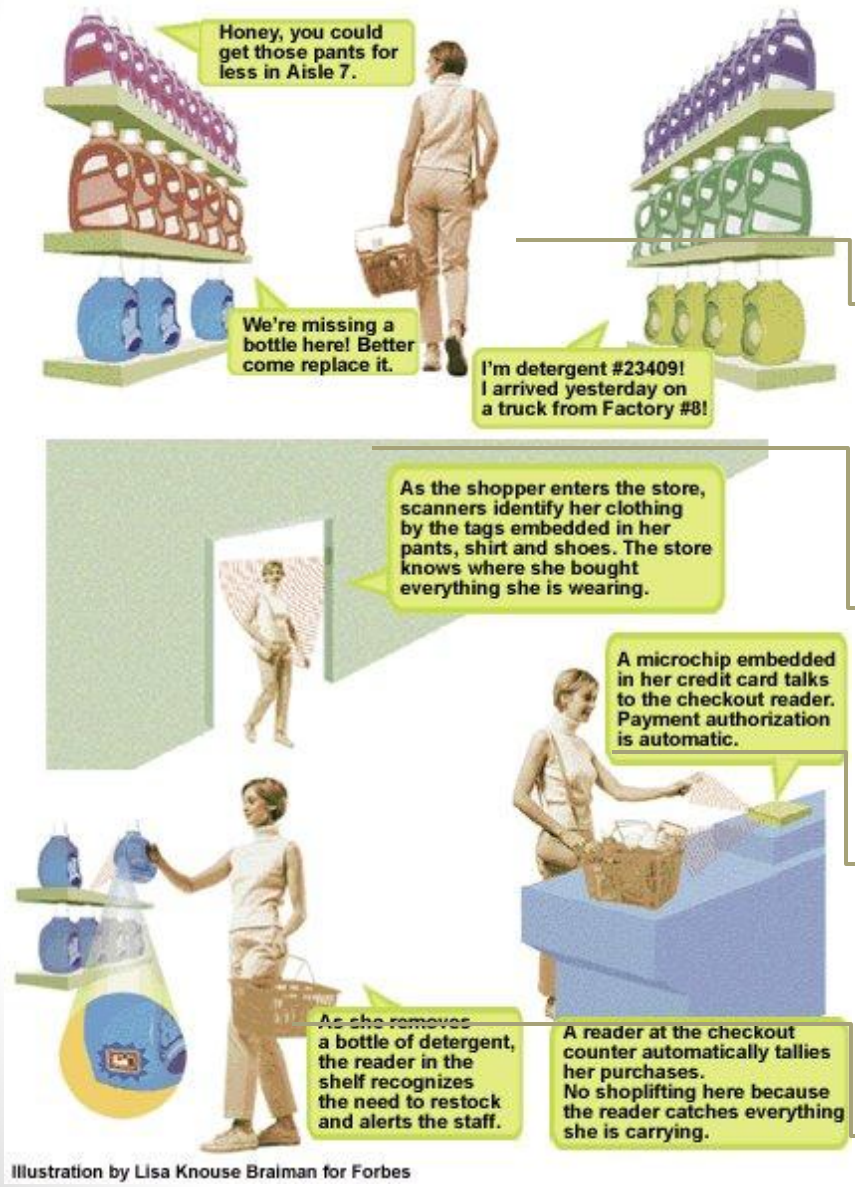
1995 Internet

2010 ?...

The Application of IoT(1)



The Application of IoT(2)



Scenario: shopping

(2) When shopping in the market, the goods will introduce themselves.

(1) When entering the doors, scanners will identify the tags on her clothing.

(4) When paying for the goods, the microchip of the credit card will communicate with checkout reader.

(3) When moving the goods, the reader will tell the staff to put a new one.

The Application of IoT(3)

Scenario: Health Care

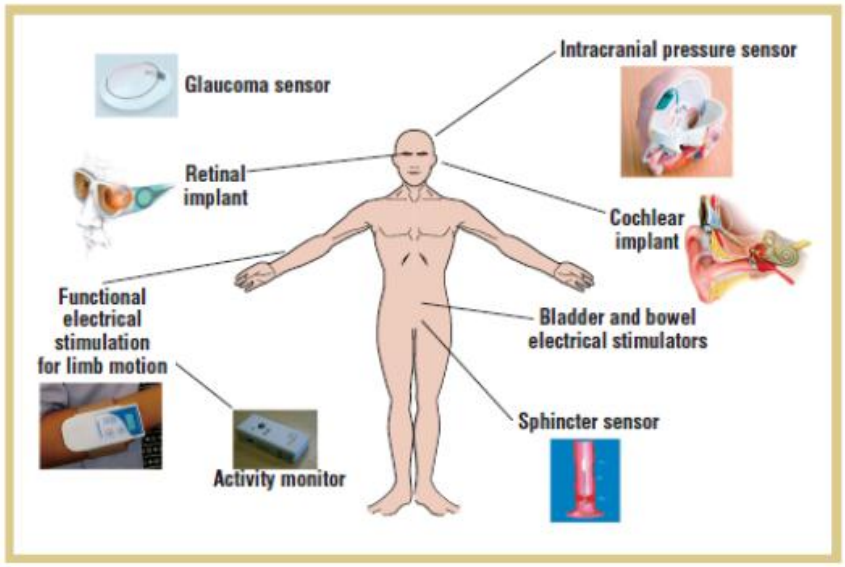


Figure 6. Fully implantable wireless sensor for the intracranial pressure monitoring system.

- Various sensors for various conditions
- Example ICP sensor: Short or long term monitoring of pressure in the brain cavity
- Implanted in the brain cavity and senses the increase of pressure
- Sensor and associated electronics encapsulated in safe and biodegradable material
- External RF reader powers the unit and receives the signal
- Stability over 30 days so far

The Application of IoT(3)

Scenario: Health Care

- National Health Information Network, Electronic Patient Record
- Home care: monitoring and control

  Pulse oximeters, blood glucose monitors, infusion pumps, accelerometers, …
- Operating Room of the Future

  Closed loop monitoring and control; multiple treatment stations, plug and play devices; robotic microsurgery

  System coordination challenge
- Progress in bioinformatics: gene, protein expression, systems biology, disease dynamics, control mechanisms

The Application of IoT(4)

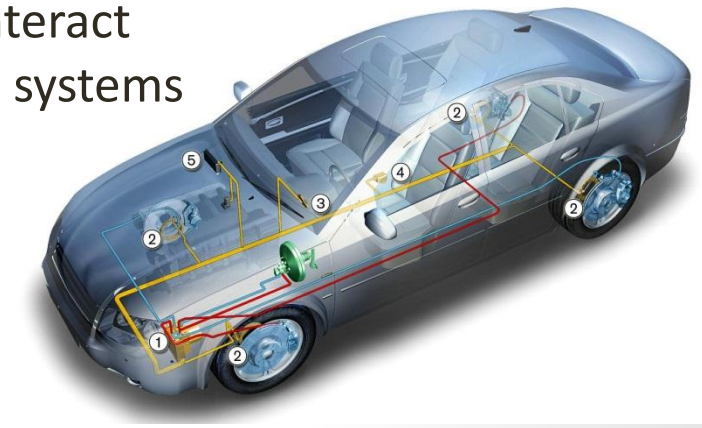
Scenario: Intelligent Home

- Remote monitor for smart house
- Remote control for smart appliance

The Application of IoT(5)

Scenario: Transportation

- A network of sensors set up throughout a vehicle can interact with its surroundings to provide valuable feedback on local roads, weather and traffic conditions to the car driver, enabling adaptive drive systems to respond accordingly
- This may involve automatic activation of braking systems or speed control via fuel management systems. Condition and event detection sensors can activate systems to maintain driver and passenger comfort and safety through the use of airbags and seatbelt pre-tensioning
- Sensors for fatigue and mood monitoring based on driving conditions, driver behaviour and facial indicators can interact to ensure safe driving by activating warning systems or directly controlling the vehicle



The Application of IoT(5)

Scenario: Transportation

- In 2005, 30 – 90 processors per car

  Engine control, Break system, Airbag deployment system

  Windshield wiper, Door locks, Entertainment system

- Cars are sensors and actuators in V2V networks

  Active networked safety alerts

  Autonomous navigation

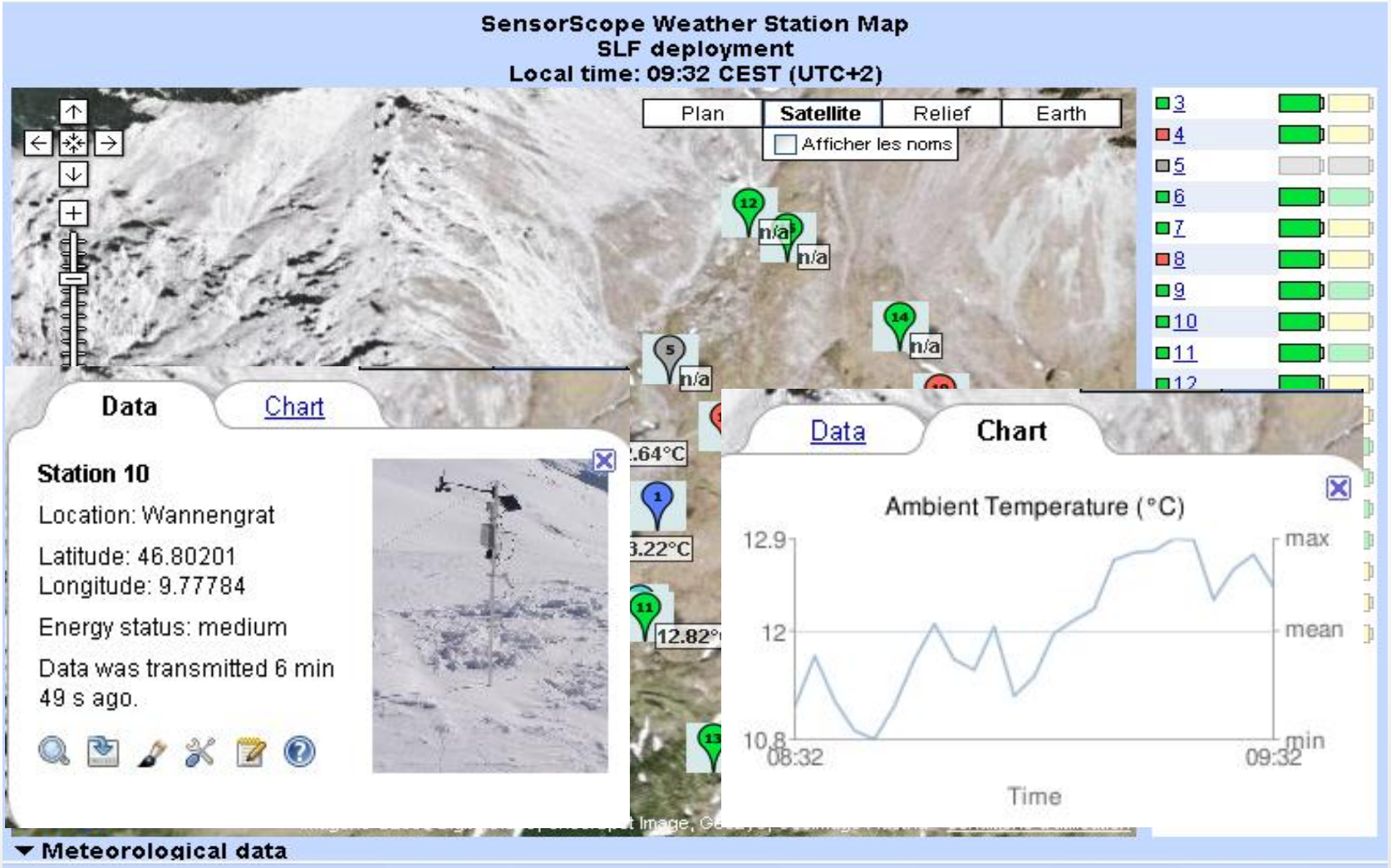
- Future Transportation Systems

  Incorporate both single person and mass transportation vehicles, air and ground transportations.

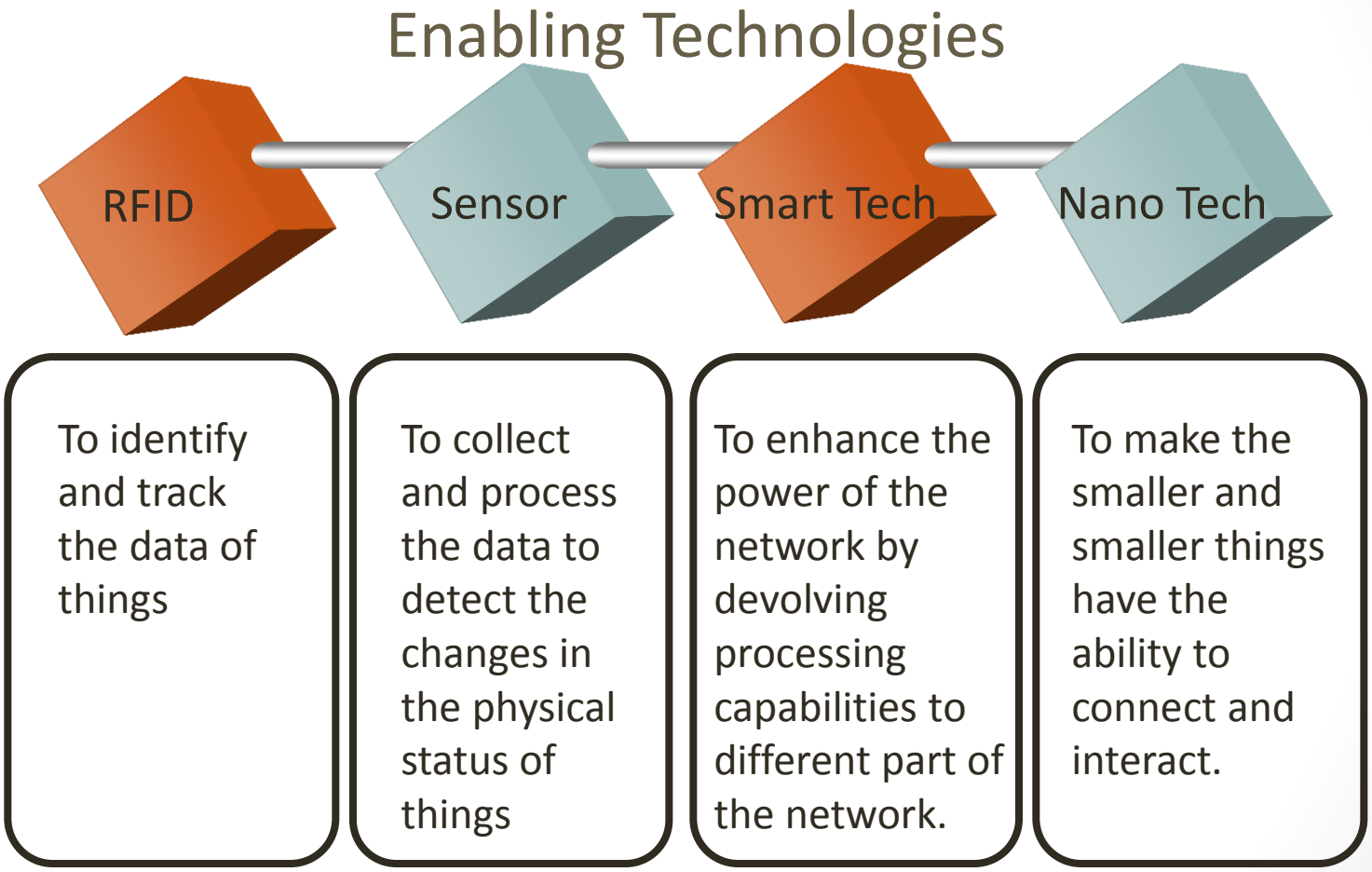
  Achieve efficiency, safety, stability using real-time control and optimization.

The Application of IoT(6)

Scenario : Monitoring the Environment



State of the Art of IoT



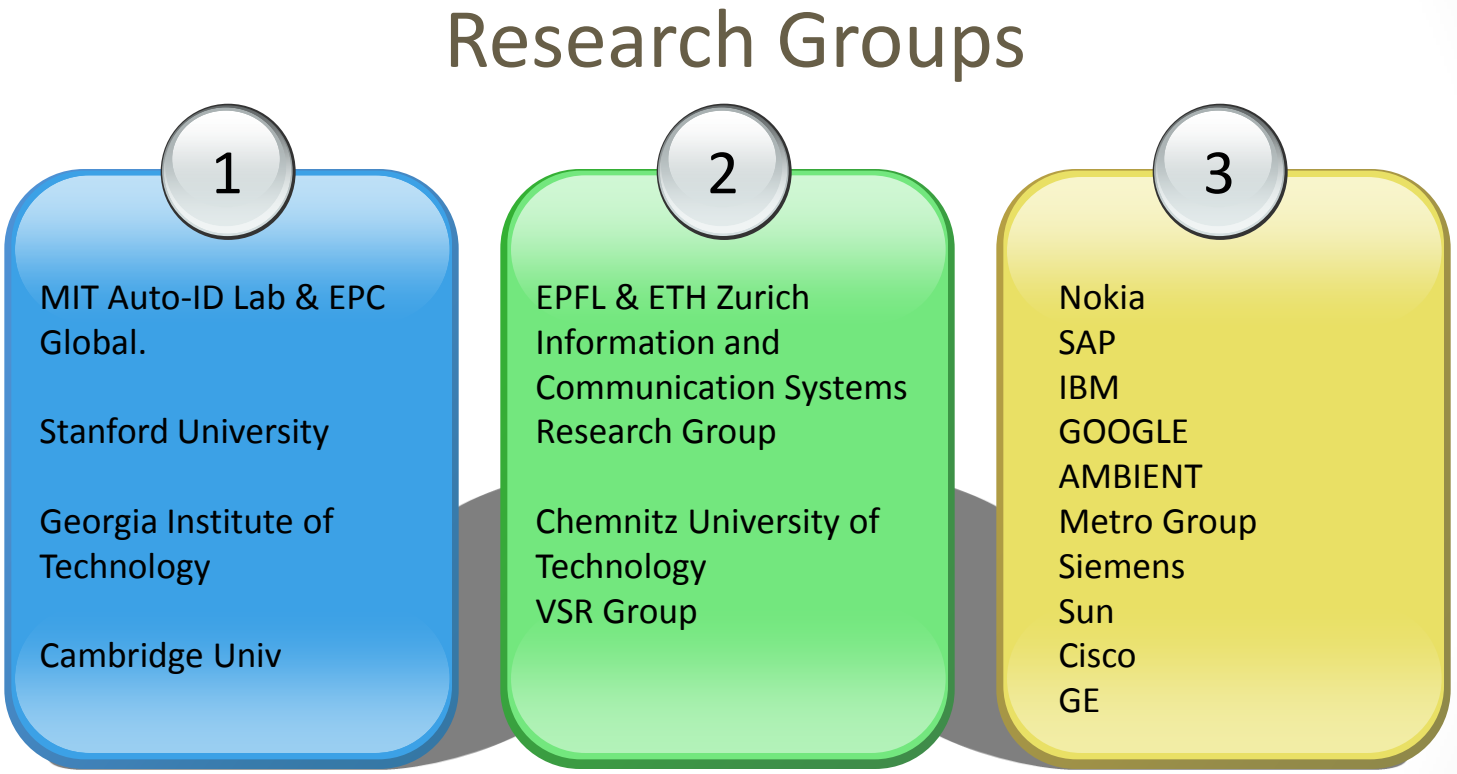
Sensor Technology

The ability to detect changes in the physical status of things is essential for recording changes in the environment.

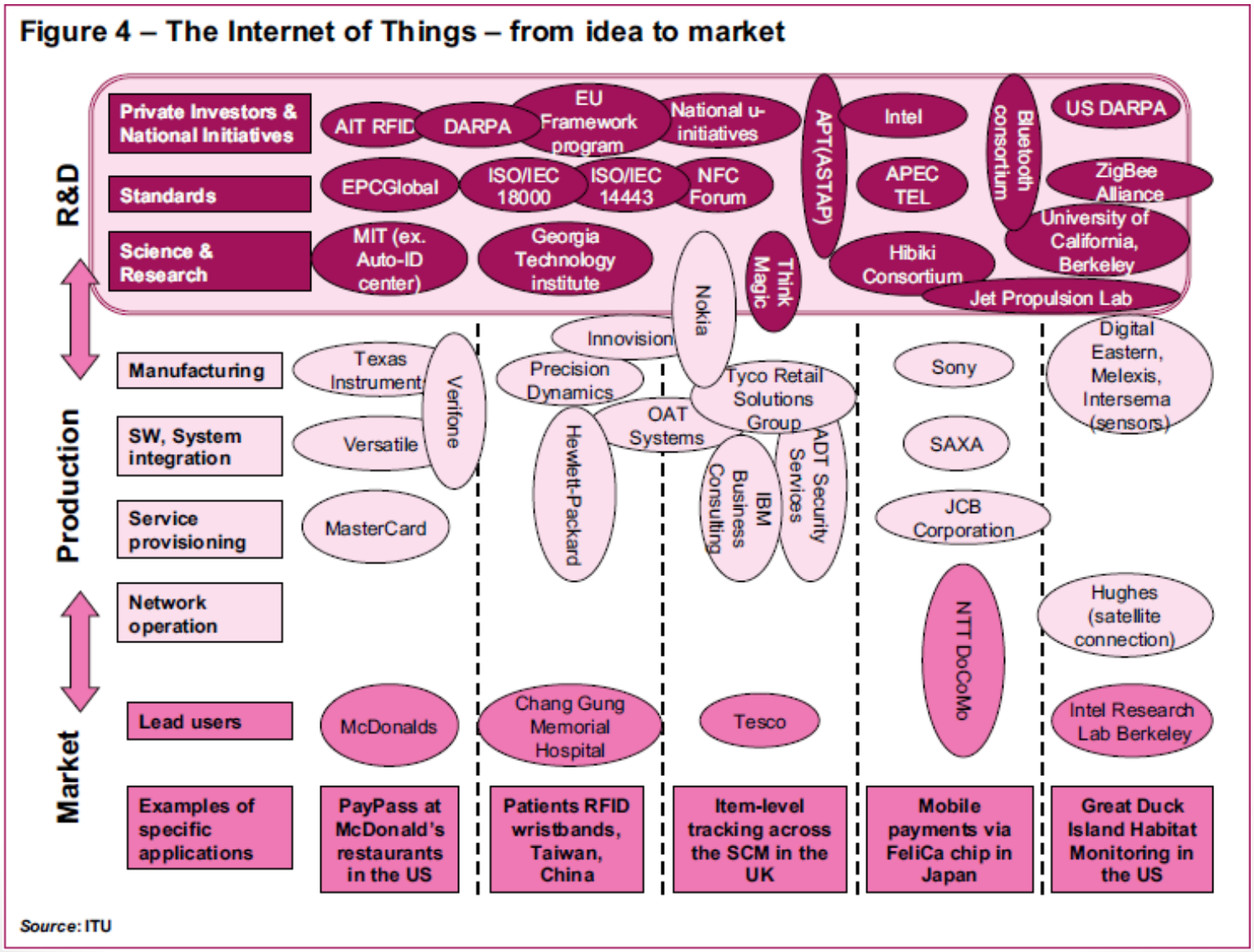
Wireless sensor technology play a pivotal role in bridging the gap between the physical and virtual worlds, and enabling things to respond to changes in their physical environment. Sensors collect data from their environment, generating information and raising awareness about context.

Example: sensors in an electronic jacket can collect information about changes in external temperature and the parameters of the jacket can be adjusted accordingly

State of the Art of IoT



State of the Art of IoT



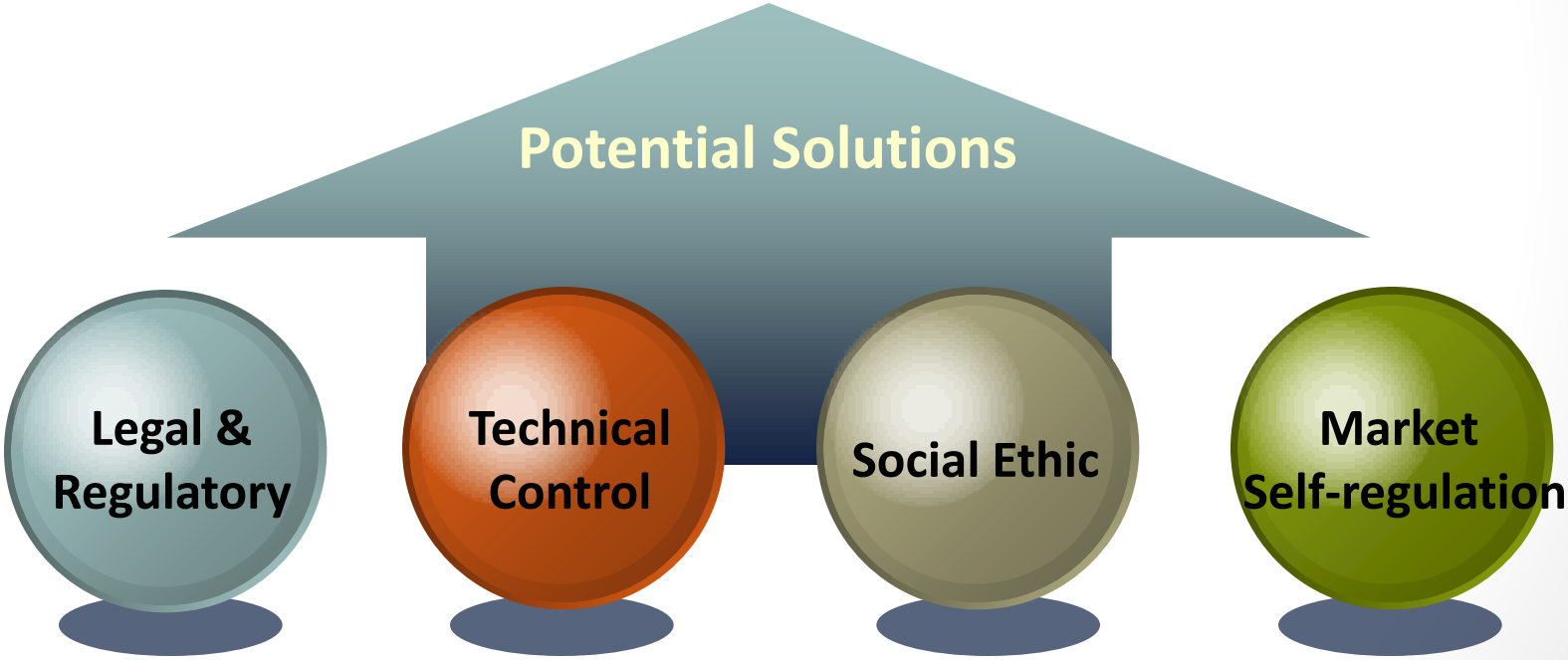
The Challenge of IoT

Total challenge of IoT

1. Technological Standardization in most areas are still remain fragmented.
2. managing and fostering rapid innovation is a challenge for governments
3. privacy and security
4. Absence of governance

The Challenge of IoT

How to convincing users that the IoT technology will protect their data and privacy when tracking



IoT and WSN

× WSN is IoT， IoT aka WSN ➔ IoT ＝ WSN

× IoT aka RFID + PerCom

√ IoT is not WSN IoT ≠WSN

IoT contains WSN IoT ≥WSN

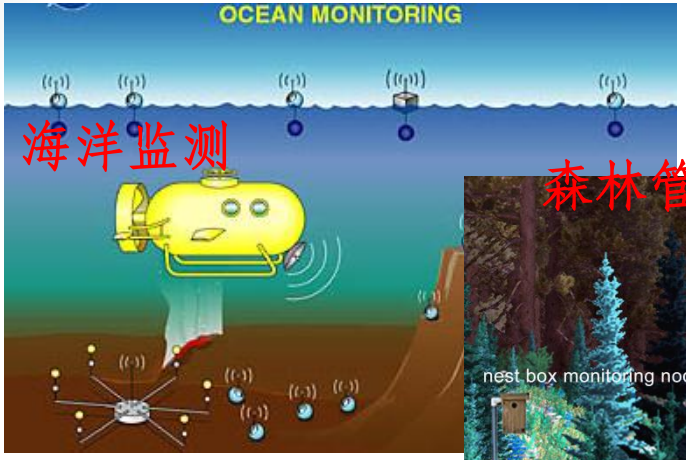
IoT and WSN

- Things are diverse
- They might be individual like water, soldiers, trees…
- They also be a set of individuals like ocean, battlefield, forest, …

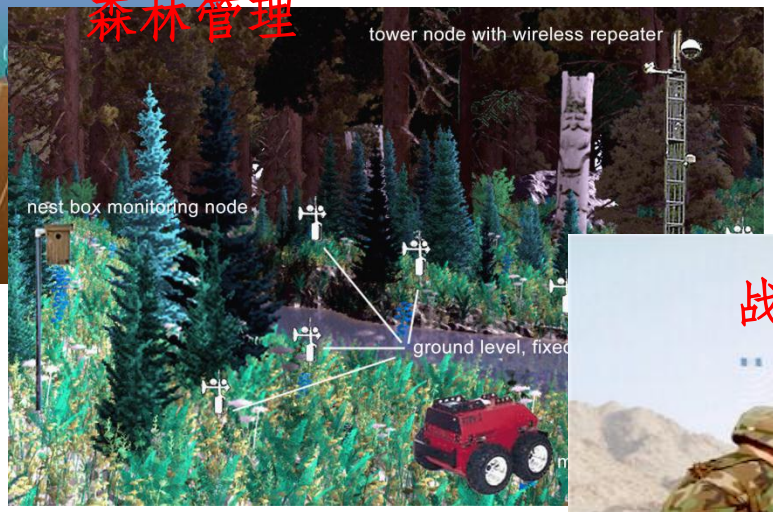
IoT and WSN

We concern not only about water, tree and soldier, but also about ocean, forest and battlefield.

IoT and WSN



海洋监测



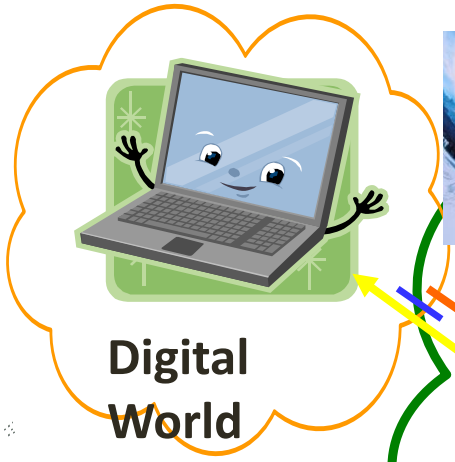
森林管理

战场指挥

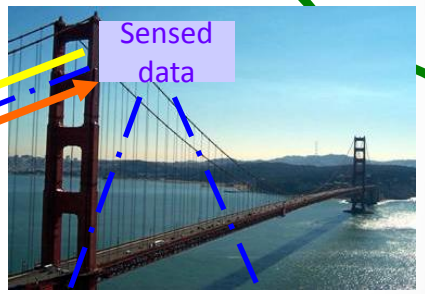
So we have ocean monitoring, Forest management, battlefield control.

When WSN is Used

To Connect digital world and physical world



Digital World



Sensed data

Sensed data

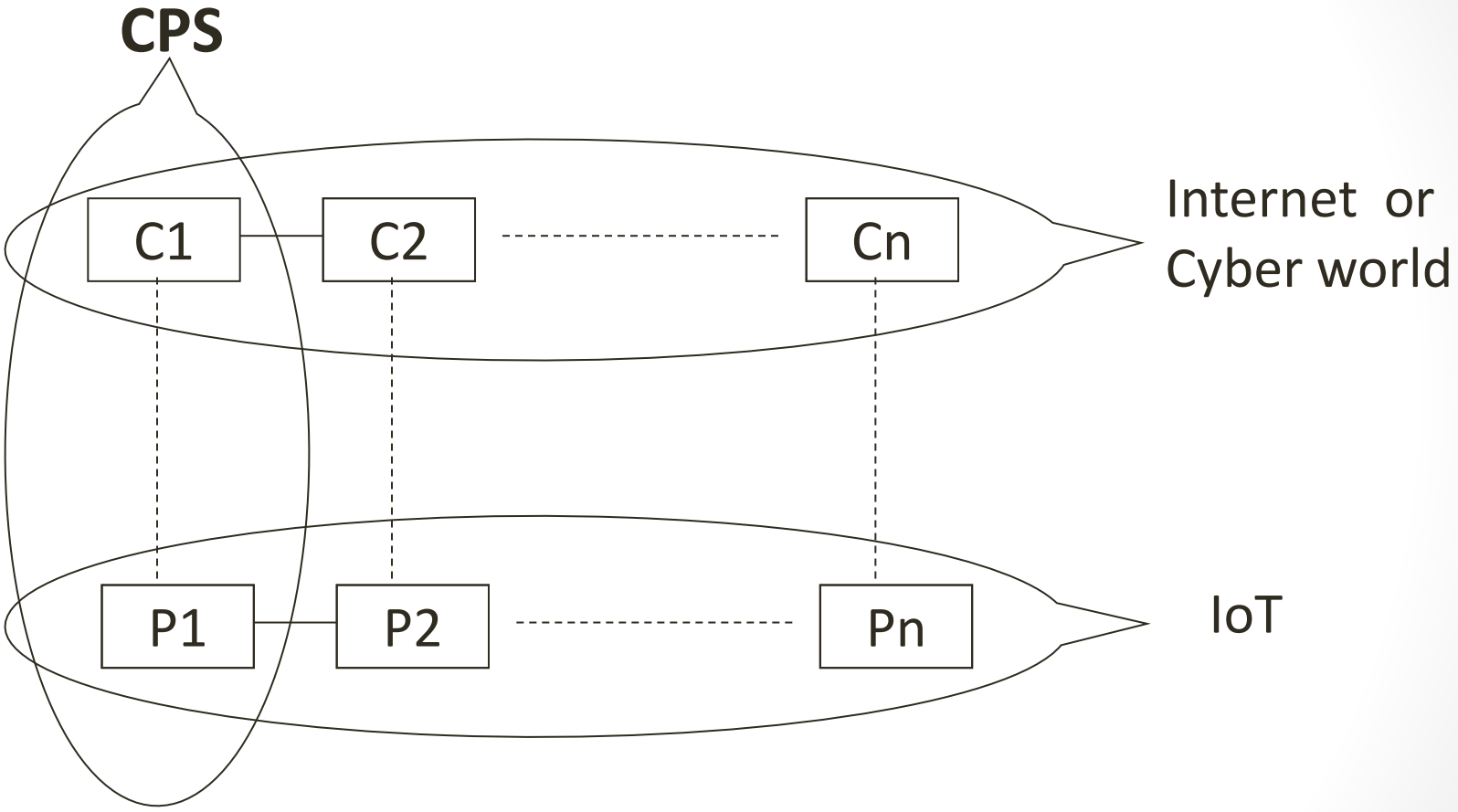
Sensed data

Sensed data

Sensed data

Physical World

IoT and CPS



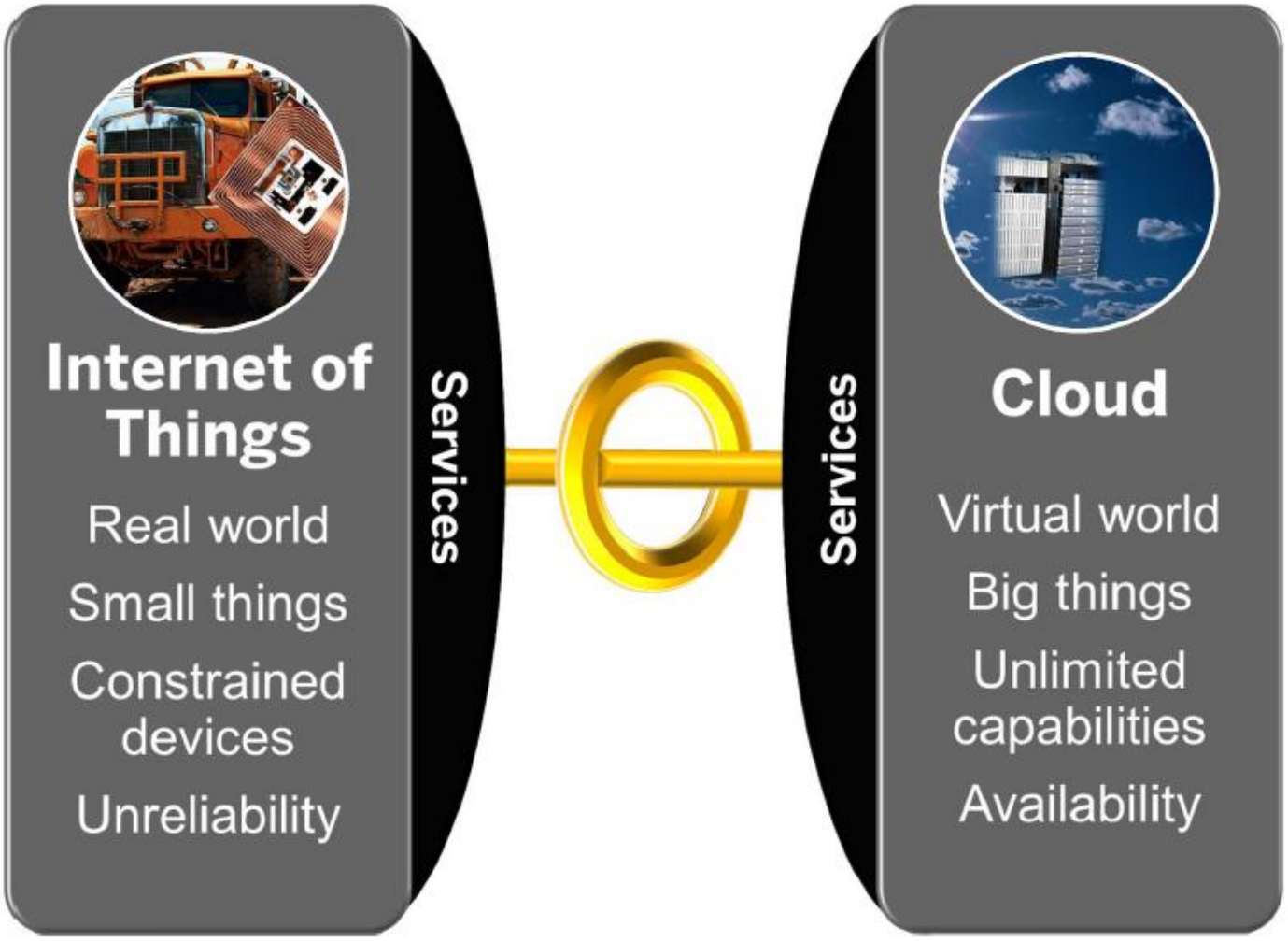
C=C1 V C2 V------V Cn

P=P1 V P2 V------V Pn

CPS and Pervasive Computing

All such buzzwords refers to the same balloon. When it is blasted to large size, it is called Smart Planet; when to middle size, it is called CPS; When to small size, it is called pervasive or embedded system.

Internet of Things vs. Cloud Properties



Internet of Things, Cloud and Services

- **Internet of Things enables**
  - High-resolution management
  - Real-world control
  - Adaptive processes

IoT Issue	Possible Solution
Heterogeneity	Services as abstraction layer
Application Development	Mash-up of services
Solution Deployment	Support through XaaS models
Producing a lot of data	Processing of large data quantities in the cloud

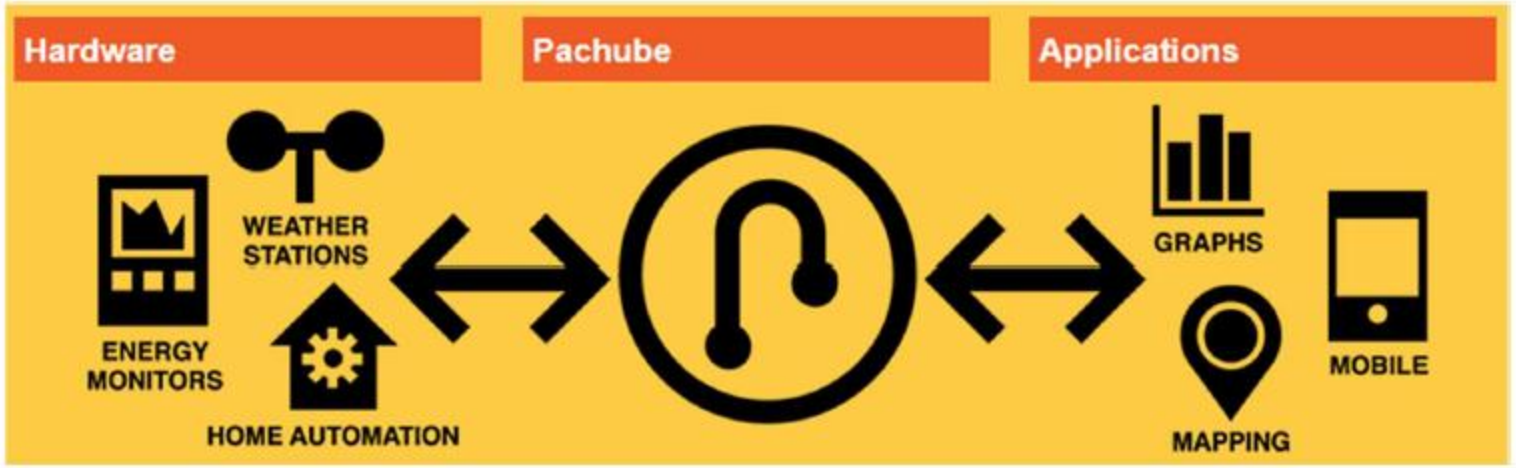
IoT, Cloud, and Services are **complementary aspects** of a Real World Internet

2 Examples

- For the public and the society
- For business and enterprises

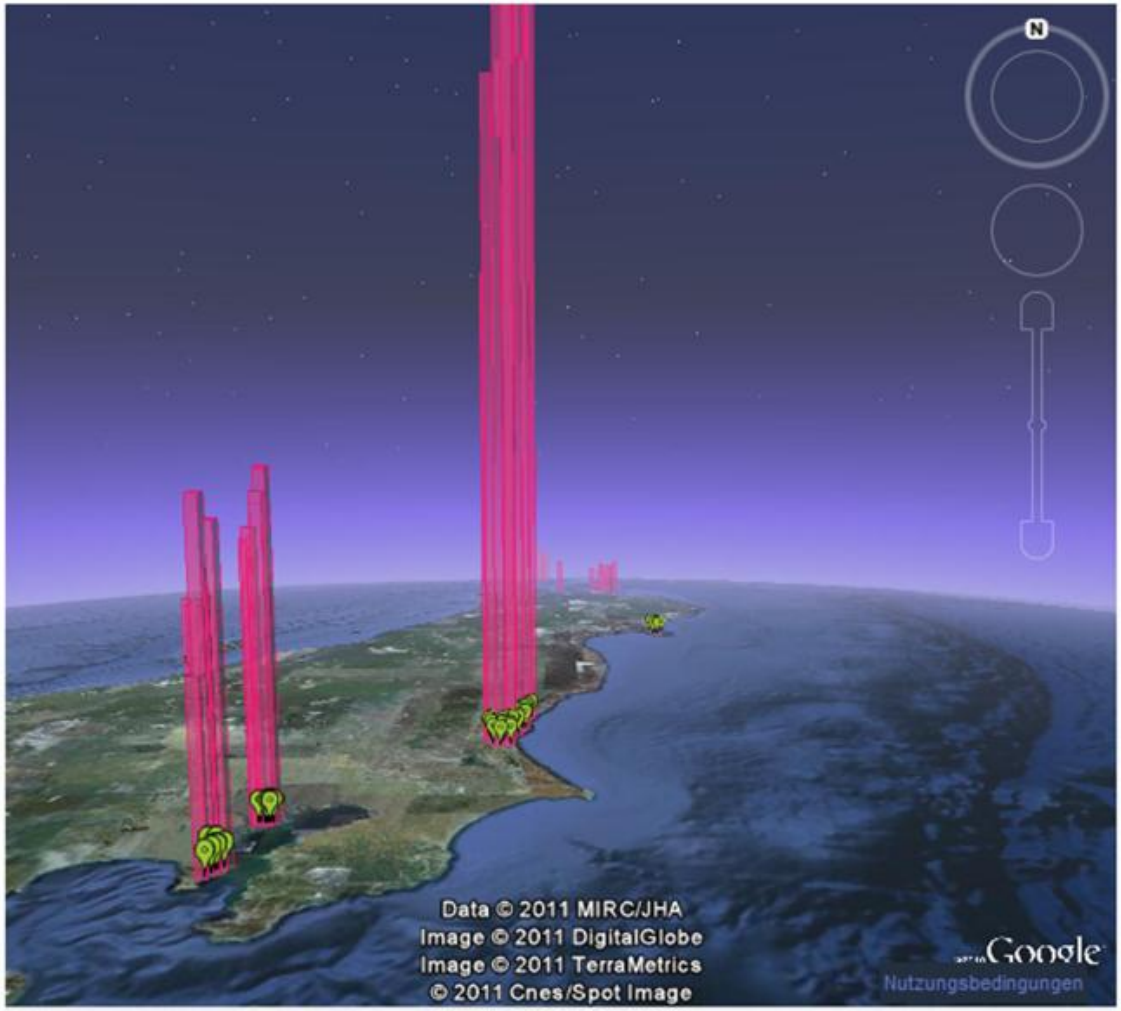
Example 1: Pachube

- **"The Internet of Things Real-Time Web Service and Applications"**
  - Platform to connect sensors and other hardware
  - Platform to build IoT services and applications
  - RESTful APIs



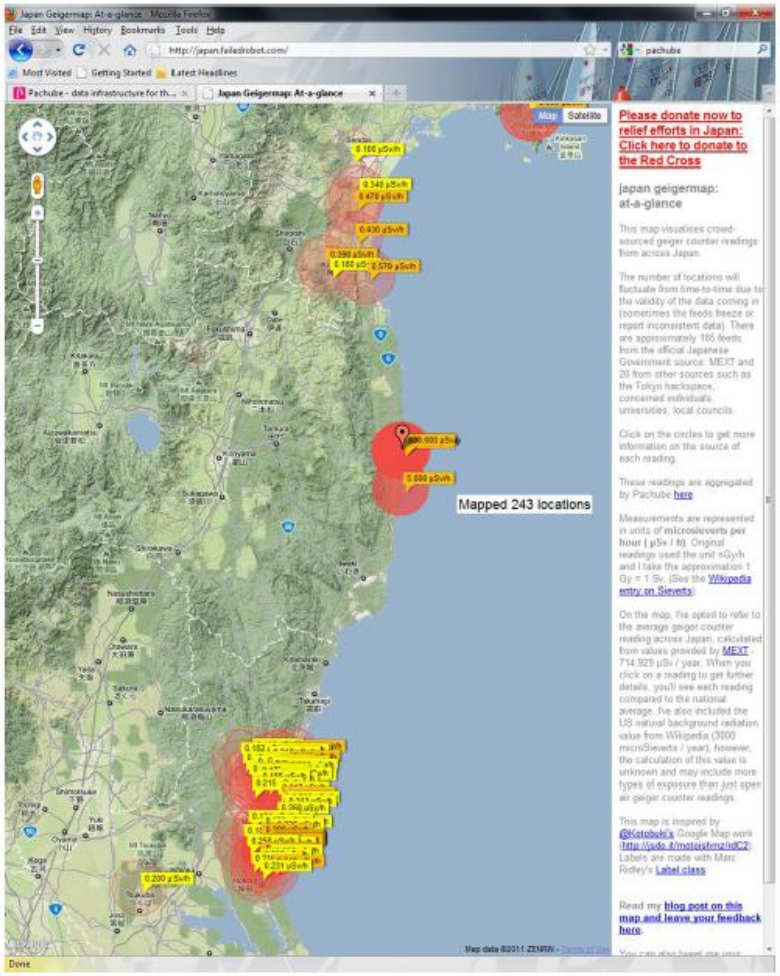
Source: https://pachube.com/

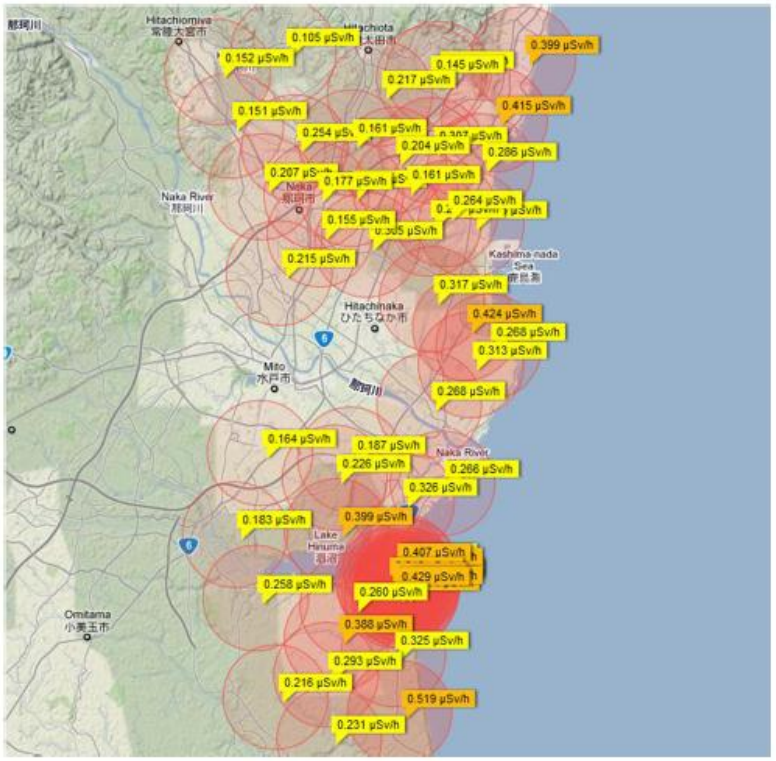
After the Fukushima Disaster on Pachube



http://community.pachube.com/node/611#3d, 31.3.2011

Many People Connected Radiation Sensors…





http://japan.failedrobot.com/, 31.3.2011

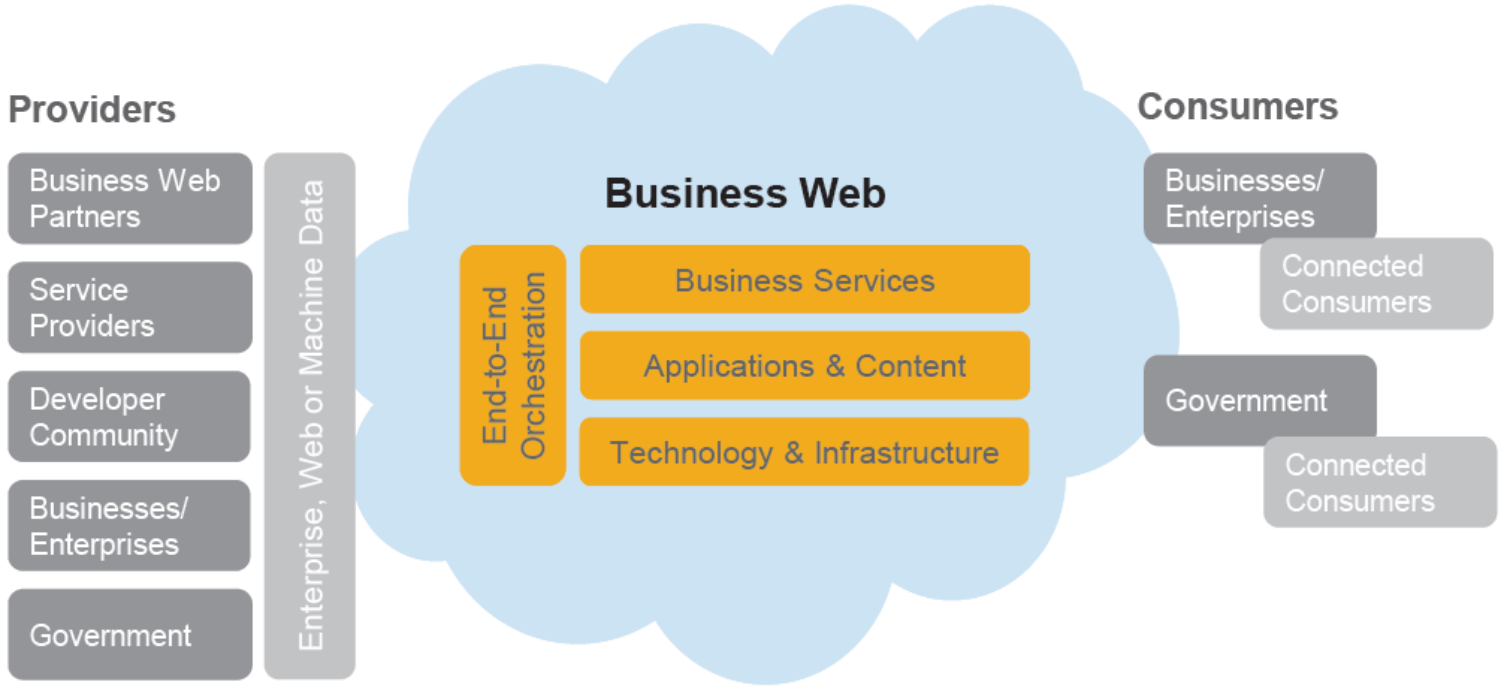
Cool, but …

- Data quality of various sources
  - Accuracy of each data point
  - Sensor reliability and availability
  - Time of measurement
  - Important for trust!
- Unit jungle:
  - nGy/s, mSv/h, □ Sv/h, Bq/kg, cpm …
  - Sometimes misleading, sometimes just hard to compare…
- Mix of data sources
  - Real sensors
  - Virtual sensors (data scraping from web pages, e.g., http://www.houshasen-pref-ibaraki.jp/present/result01.html)

Business Web

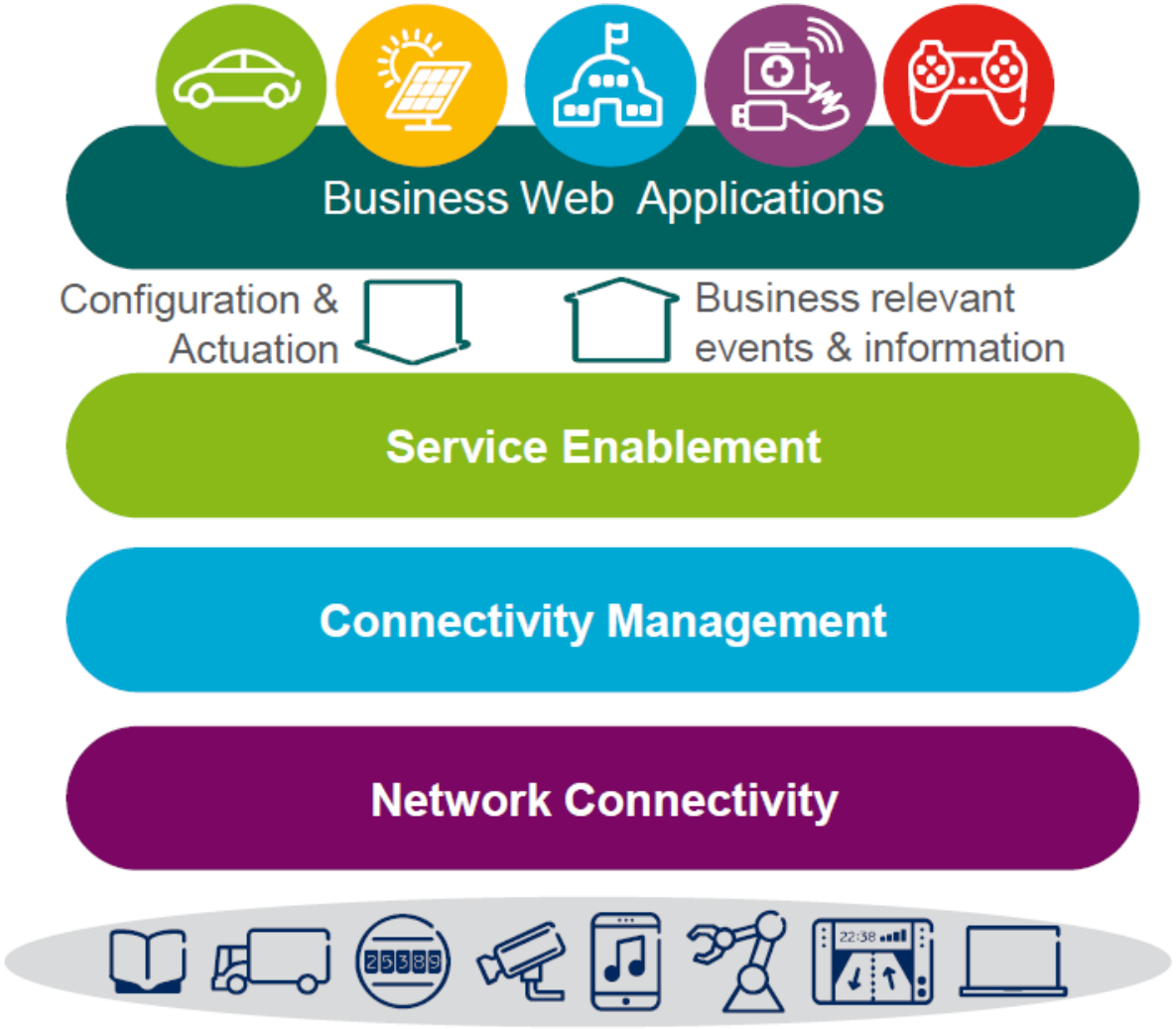
A Platform and Marketplace for Business Services

The Business Web is **a cloud-based business environment** that provides access to the necessary infrastructure, applications, content, and connectivity to deliver **end-to-end business services** optimized for **mobility** and ease of participation



Business Web:

First-class Internet of Things Integration



M2M Scenario – Ice Cream Cabinets

- The application provides consumer products companies with detailed information about the location and status of its ice cream cabinets.
- This information can be used to find these cabinets, supply them with new ice cream in time, and monitor their temperature in order to avoid ice cream becoming bad due to a defective ice cream cabinet.
- The ice cream cabinets become smart items that monitor their energy consumption, send alarms, and become an active part in the companies operation processes as well as sustainability efforts.

IoT Configuration

- 2.5 millon ice cream cabinets
  - Worldwide distributed
  - Biggest growth markets: China and India
- Sensoring
  - Need to refill
    - Avoid stock-outs
  - Location
    - Reliably find and refill
  - Temperature / power outage
    - Detect failures and avoid product loss
  - Behavioral statistics
    - Conclude conversion rate
- Estimated business value: >5% increased sales

IoT Integration into Business Processes

Roles and processes

- CPG Backend
  - Operational BI on supply chain efficiency
  - User behavior monitoring and campaign efficiency
- 3rd Party Supplier
  - Dispatcher: Improved planning of daily logistics processes
    - Get refill priorities and alarms on power outage and temperatures
  - Truck Driver: Guidance and real-time integration into process
- Store Owner
  - Push alarms to store owners for immediate actions
    - Resolve power outage / close lid to save energy
- Consumer
  - Guidance to next ice cream cabinet (source of happiness)

3rd Party Supplier

Consumer Augmented Reality App: Guide me to the next ice cream opportunity

Business Value

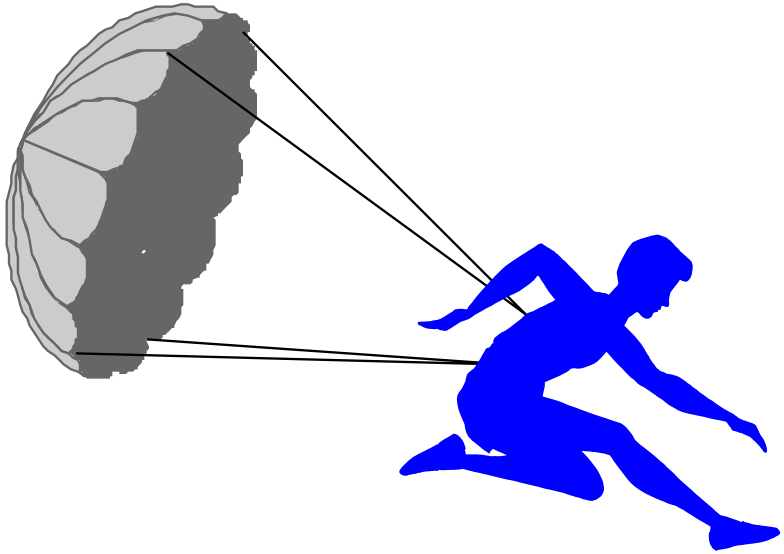
Ice Cream Business is a 60+ billion market

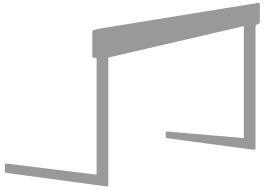
- Highest margin business in food CPG
  - 10.5%
- Unilever
  - 10+ billion in ice cream sales
  - Market leader in out-of-home ice cream business
    - 30% market share
    - 2/3 is out-of-home business
  - ICC scenario estimated benefit is 45 million additional profit per year
- Phase 1: Pilot
  - 500 ICCs in Germany, 50 mobile users
- Phase 2:
  - 10.000 ICCs in Germany, 1.000 users
- Phase 3:
  - Replacing 200.000 ICCs yearly world wide.

Short Summary

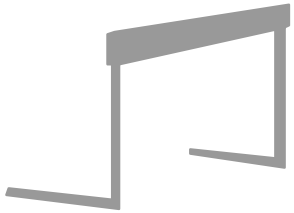
- Internet of Things, Cloud Computing and Services are all aspects of a (Future) Internet
  - Strengths of each can and should be combined
- Examples of successful combinations exist
  - Both in the public and the business domain
- We are at the beginning of an interesting journey
  - Many challenges still lie ahead

Road is Difficult, but Future is Bright

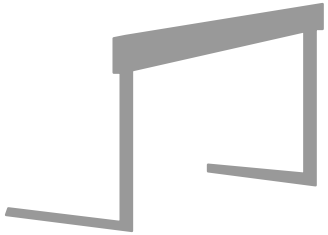




- Any TIME



- Any PLACE



- Any THING