Introduction to Internet of Things

DAVID LIU, 9/23/2014

What is Internet of Things

- A Network if interconnect objects that:
  - harvests information from the environment sensing)
  - Interacts with the physical world actuation/command/control)
  - Use existing Internet standards to provide services for information transfer, analytics, applications, and communications [1]
- K. Ashton, That "Internet of Things" thing, RFID Journal 2009

Internet of Things

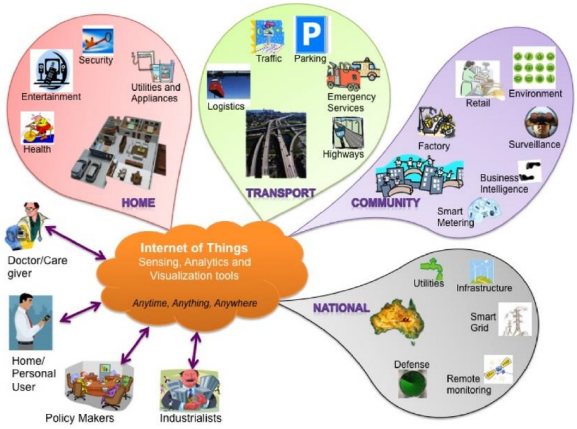


Fig. 1. Internet of Things schematic showing the end users and application areas based on data.

Technology Trend

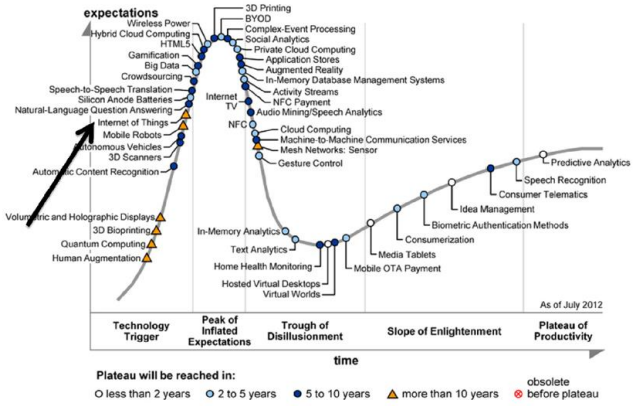


Fig. 2. Gartner 2012 Hype Cycle of emerging technologies.
Source: Gartner Inc. [10].

Enabling Technologies

- Radio Frequency Identifier (RFID)
- Wireless Sensor Networks (WSN)
- Middleware
- Applications

Middleware

- A software layer or a set of sub-layers interposed between the technological and the application levels
- Often Service Oriented Architecture (SOA) approach [2]

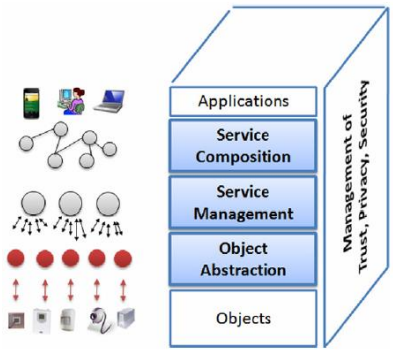


Fig. 2. SOA-based architecture for the IoT middleware.

Applications

- Transportation and logistics
- Healthcare
- Smart environment
- Personal and social
- Futuristic applications

Transportation and Logistics

- Logistics
  - real-time monitoring of almost every link of the supply chain
- Assisted driving
- Mobile ticketing
- Monitoring environment parameters
  - Food supply chain
- Augmented maps

Healthcare

- Tracking of person or object
- Identification and authentication
- Data collection
- Sensing

Smart Environment

- Comfortable homes and offices
- Industrial plants (automation)
- Smart museum and gym

Personal and social

- Social networking
- Historical queries
- Losses
- Thefts

Futuristic Applications

- Robot taxi
- City information model
- Enhanced game room
  - Not necessary video games

Research

- Computing, communication identification technologies
- Distributed system technologies
- Distributed intelligence
- Security technologies

Challenges I

- Architecture
  - WSN based
  - Cloud based
- Energy efficient sensing
- Secure reprogrammable networks and privacy
- Quality of service
- New Protocols
  - Energy efficient MAC
  - Routing protocol

Challenges II

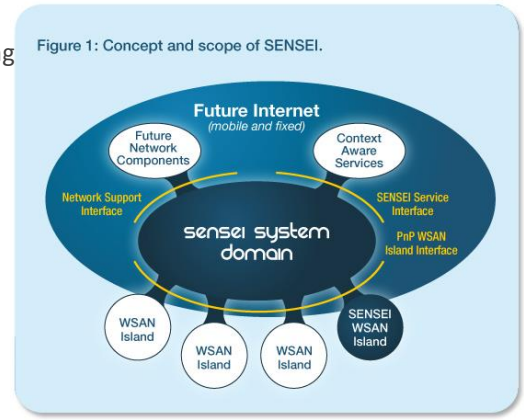
- Data mining
- GIS based visualization
- Cloud computing
- International cooperation/activities

IoT Related Projects

- US NSF Cyber-Physical Systems
- European Commission Framework Programme 7 (FP7)
  - HYDRA project: SOA middleware
  - RUNES project: large scale widely distributed heterogeneous networked embedded systems
  - IoT-A project: architecture reference model for interoperability
  - iCORE project: IoT with cognitive technologies
  - SENSI: an Integrated Project in EU Framework Programme 7
- Japan UNS (Ubiquitous Networked Society) initiative
- China National Initiative “Emerging Strategic Industry”
  - Shanghai Internet of Things Center, 2010
  - NSIC (National Sensor Information Center), Wuxi, Jiangsu Province
    - RMB 80 billion, 1000 companies (2012)

EU SENSEI

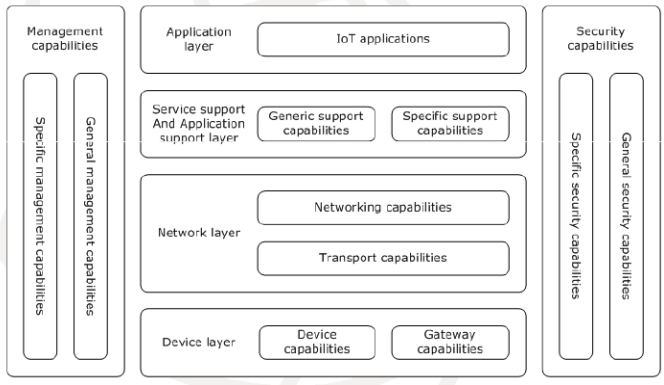
- A highly scalable architecture framework
- An open service interface and corresponding semantic specification
- Efficient WSAN island solutions (protocol stack, 5nJ/bit
- Pan European test platform



Standardization

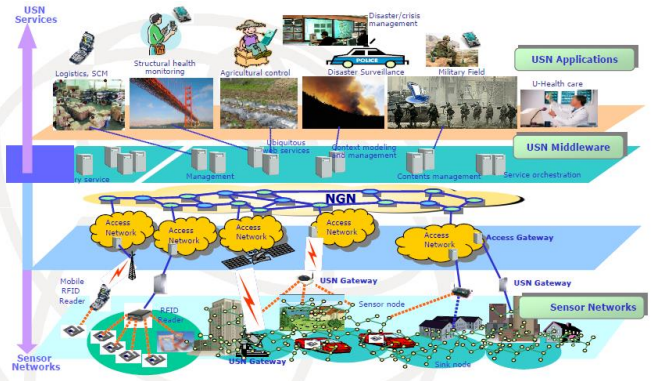
- IEEE P2413 WG, Internet of Things (IoT) Architecture
- ITU JCA-IoT) Joint Coordination Activity on Internet of Things, Feb, 2011
- oneM2M
- Open Geospatial Consortium
- Organization for the Advancement of Structured Information Standards (OASIS)
- IPSO Alliance (promote Internet Protocol as the basis for the connection of Smart Objects, not to define technologies)

ITU IoT Reference Model



Source: ITU-T Y.2060, 2012

ITU-T Ubiquitous Sensor Networks



Source: ITU-T Rec. Y.2221 - *Requirements for support of Ubiquitous Sensor Networks (USN) applications over NGN*

Industrial Efforts

- AllSeen Alliance
  - Qualcomm, Microsoft, Cisco, Dec, 2013
  - Application layer (language and protocol
- Open Interconnect Consortium
  - Intel, DELL, Samsung, July 8, 2014
  - Application layer
- Thread Project
  - Google's Nest, Freescale, ARM, Samsung, Silicon Labs, Yale, July 15, 2014
  - Specific radio and networking technologies

References

[1] Gubbi et al, "Internet of Things (IoT): A vision, architecture elements, and future directions," Future Generation Computer Systems, 29(2013), 1645-1660

[2] Atzori el al. "The Internet of Things: A survey," Computer Networks. 54 (2010), 2787-2805

[3] Miorandi et al. "Internet of Things: Vision, applications and research challenges," Ad Hoc Networks 10 (2011), 1497-1516

[4] M. Cargugi, "Introduction to the ITU-T Global Standards Initiative on IoT with focus on SG13 activities," ITU Workshop on the "Internet of Things – Trend and Challenge in Standardization," February 18, 2014