Issues for IoT Interoperability

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IoT Eco-Society
Use Cases for Cloud-based IoT

- **Home cloud**: Viewing stored video from home cloud, receiving feedback from medical personnel.
- **Mobile cloud**: Storing health info to home cloud, temporary storage of patient data, feedback from medical personnel, uploading real-time health data.
- **Local cloud**: Environmental data, uploading environment data.

- **Public cloud**: Health applications, storage, processors, environment monitoring applications, retrieving current medical data, medical analysis feedback.
- **User on outside environment**: User retrieving current home security information, user feedback, retrieving current environment data, environment analysis feedback.
- **Environment data analyzer**: Environment data analyzer.
Internet of Energy

- User
  - Added green power sources
  - Plug-in hybrid electric cars
  - Real-time and green pricing signals
  - Smart thermostats, appliances, and in-home control devices

- Generation

- Transmission

- Storage
  - Optimized Energy Storage

- Smart Power Grid

- Future Internet
  - Adaptive wireless Internet of Energy
  - Web centric remote control

- Current Power Grid
  - Communication Network

- Electric Power Management System

- Distribution
  - Controller
  - Transformer
  - On computer
  - Information
  - On phone
  - On Board

- On computer
- Information
- On phone
- On Board

- Transformer

- Controller

- On computer
- Information
- On phone
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1956-2016
CCITT / ITU-T
What is a Smart Home?
Vision of Intelligent Transport System

1. Data Collection of Traffic
   - Smart app
   - Cellular
   - Planned Maintenance
   - Call Centre
   - Camera
   - Manual Survey
   - GPS
   - Social Media
   - Citizen Portal

2. Traffic Mgt Information System
   - Internal KPI
   - 3rd Party SLA
   - Asset Mgt

3. Planning
   - Incident Management (Traffic)
   - Police/Medical/Fire
   - Breakdown/LASMA

4. Performance Mgmt
   - Network Operations Response
   - Traffic Light
   - VMS
   - Lane Signal

5. Traffic Control
   - Network Operations
   - Network Operations Response
   - Incident Management (Traffic)
   - Police/Medical/Fire
   - Breakdown/LASMA

6. Traveler Information Service
   - Traveler Management
   - Mobile
   - Portal
   - SMS
   - Radio/TV
   - eTicket
   - Road Pricing/Toll
   - Licensing
   - Enforce
   - Parking

7. Demand Management & Payment Methods
   - Traveler Information Service
   - Traveler Management
   - Mobile
   - Portal
   - SMS
   - Radio/TV
   - eTicket
   - Road Pricing/Toll
   - Licensing
   - Enforce
   - Parking

8. (ref) https://smartercitieschallenge.wordpress.com/category/lagos-nigeria/
Industry 4.0

From Industrie 1.0 to Industrie 4.0

First Industrial Revolution
- through the introduction of mechanical production facilities with the help of water and steam power
  - First mechanical loom, 1784

Second Industrial Revolution
- through the introduction of a division of labor and mass production with the help of electrical energy
  - First assembly line, Cincinnati slaughterhouses, 1870

Third Industrial Revolution
- through the use of electronic and IT systems that further automate production
  - First programmable logic controller (PLC), Modicon 084, 1969

Fourth Industrial Revolution
- through the use of cyber-physical systems

Degree of complexity over time from 1800 to Today.

(ref) http://nexasnet.blogspot.kr/
New Social Economy

(ref) http://zdnet.com/blog/hinchcliffe
Sharing Economy Spans Multiple Sectors

• Smart retailers to exploit the sharing economy
  – Waste is minimized through recycling, repairing, repurposing, and even reinventing products and materials
  – Wider sustainability and environmental issues
Circular Economy

(note) European Commission launched the final draft of the Circular Economy Package in 2015
New Research Challenges for ICT

Internet of Things
(The ongoing convergence of evolution of devices)

Computing Clouds
(Deployment of large shared infrastructure)

Big Data
(Accumulation of data from sensors and social networks)
How many HW Devices and SW Applications?

- M2M Module = 6* x
- Wearable Device = 7* x
- Smartphone = 49* x
- Tablet = 127* x
- Laptop = 227* x

* Monthly basic mobile phone data traffic
Source: Cisco VNI Mobile, 2014

SMART SERVICES
Real-time | Big Data Analytics | Continuous Integration

Source: Ericsson

[Image of various icons representing different sectors such as Consumer electronics, Automotive transport, Retail banking, Environmental, Utilities, Health wellness, Smart cities, Process ind, Infrastructures, Agriculture]
Networking and Services for the IoT

• Characteristics of the IoT
  – Connectivity
  – Personalization
  – Intelligence
  – Tagging objects

Evolution of Smart Objects
Value of Data

https://hbr.org/2015/05/customer-data-designing-for-transparency-and-trust
Key Questions for IoT Eco-Society

• **How many IoT platform ?**
  – Large spectrum for multiple and heterogeneous applications
  – A plentiful standard activities or research groups

• **What is the real value of IoT Platform ?**
  – Help human life and business environments
  – Reduce resources and operation costs
  – New eco-business such as sharing economy and collective intelligence

• **Effects of IoT Technologies**
  – Simple metering has no meaning without interpretation
  – Mashup applications for intelligence (e.g., private and personal information from id and location, business critical information from sensing data, etc.)
  – Other industries with their own domain knowledge
Digital Identity Management for IoT
Identity Management Framework (Y.2720)

**Business and Security Applications**
including Identity-based Services
Federated Services
Application Services Access Control (e.g., Multimedia and IPTV)
Single Sign-on/Sign-off
Role-based Access to Information, Resources and Assets
Protection of Personally Identifiable Information
Security Protection of Information and Network Infrastructure

**IdM Functions and Capabilities**
Identity Lifecycle Management
Identity Information Correlation and Binding
Identity Information Authentication, Assurance and Assertions
Discovery and Exchange of Identity Information

**Identity Information**
Identifiers (e.g., UserID, Email address, Telephone Number, URI, IP address)
Credentials (e.g., Digital Certificates, Tokens, and Biometrics)
Attributes (e.g., Roles, Claims, Context, Privileges, Location)

**Entities**
Organizations, Business Enterprises, Government Enterprises
Users & Subscribers
User Devices
Network and Service Providers
Network Elements and Objects
Virtual Objects
Identity Management Processing

User ID:
GDHong-Korea-Man:LGilDongHong-19yy-mm-dd
Naming, Addressing and Identification

• According to application or industry
  – Telecommunication, broadcast, and internet applications
    • Network interface ID (IPv4/v6, MAC, EUI-64, etc.), User ID (E.164), application ID (Email address, SNS id, etc.)
    – U-city, transport, health, publication, energy, logistics, etc.
    • Their own classification and identification structure.

• According to storage and discovery mechanism
  – Geolocation database including GPS
  – Digital library, cloud platform, and on-line channels

• According to type of intelligence or knowledge
  – Linked logic among health and medical data
  – Type of metadata (descriptive, procedural, etc.)
  – Index, tag, and annotation structure of data applications
Technical Issues for Web-based Identification

- **Web-based identification**
  - URI/URL/URN
  - DNS extension with device information
  - Communication information: Email, SMS/MMS, Call id, etc.

- **Device information including metadata**
  - Device name, product code, serial no., location, and time, etc.
    - aligned with Electric Product Code like EPCglobal

- **Events information**
  - system level (on/off), status, date and time, etc.

- **Application information**
  - Query, discovery, identify, initiate, create, and terminate, etc.

- **Security information**
  - security code
How Many Types of Digital Identity

- GS1/EPCglobal
- EUI-64
- MAC address
- Bar and QR code, ISBN/ISSN
- URI/URL/URN
- Others
Key Issues for Digital Identity

• **Scope of Identifications**
  – **Physical id**: sensor, component, device, system, platform, etc.
  – **Logical id**: audio/video file, channel, image, file, key, document, software, service, application, business type, mechanism, algorithm, and human, etc.

• **How to create digital identifiers**
  – Classification rules according to applications
  – Assignment rule (e.g., domain, location, property)
How to find Digital Identity

• **Search Engine**
  – Based on URI/URL/URN
  – Key words, tag/index, or specific data types, etc.

• **Database (e.g., DNS or Yellow books)**
  – Management principles (from authority)
    • Registration, subscription
    • Authority, authentication, accounting, security, etc.
    • Access, ranking, sorting, and filtering
IoT Data Format
Data Syntax and Schema

• Depending on applications
  – Telecommunication, broadcast, game, and web
  – Energy, health, transport, logistics, etc.
  – Public safety, monitoring, surveillance, etc.

• Depending on transport protocol
  – RESTful, optical/3G/LTE/Wireless, etc.
  – MPEG, metering/sensing tools, etc.
Data Format and Device API

- **HTML5-based**
  - XML/RDF, HTTP, COAP/RESTful, etc.
- **Metadata Format**
  - Media object and media resource model
  - Media Ontology, Media Annotation
  - Device Data Format for Mashup?
- **Web-based open API**
  - Open, Auto-configurable, and future flexible
  - But, Security and manageability is in question?
Web-based IoT Data Format

- **XML/RDF Schema**
  - DTD, schema, semantics, etc.
  - Hash Tag, Index, Summary, Thumbnail, Preview, etc.
  - Microformat (e.g., vCard, hCalendar), ATOM/RSS
  - Well-known data format?

- **IoT Service Format (WSDL, UDDI, etc.)**
  - URI/URL/URN-based
  - Microservice
  - Mashup format for semantic or context-aware?
Thank you!
<Appendix>

IoT Standardizations
IoT Standards

- ITU-T, ITU-R
- ISO/IEC
- CEN
- OMA
- ETSI
- YRP
- ECMA
- GSIFI
- TIA
- GSM MSTF
- GS1/EPCglobal
- OGC
- IEEE
- oneM2M
- W3C/OASIS
- Open IoT (eclipse)
IoT Platforms

- IoT-GSI (ITU-T)
- OIC (Open Internet Consortium)
- AllJoyn (Allseen Alliance)
- Brillo OS with WEAVE (Google)
- Azure (Microsoft), Bluemix (IBM), Freescale (Oracle), etc.
- Xively, ThingWorx, Ayla Networks, etc.
- “ThingPlug” (SKT), IoT@Home (LGU+), GiGA IoT (KT)
- OGC (Open Geospatial Consortium)
  - Global geospatial community
- GS1 (Global Standards)
  - Supply and demand chains
IoT Protocols

- CoAP (Constrainted Application Protocol)
- MQTT (Message Queuing Telemetry Transport)
- TIA TR-50
- HTTP as RESTful API
- XMPP (eXtensible Messaging and Presence Protocol)
- WebSocket
- Bluetooth Wireless Technology
- Data Distribution Service (DDS) for Real-Time Systems
- Modbus Protocol, DNP3 Protocol, UPnP Cloud
- RESTful Network API (OMA & GSMA)
- ISA 100.11a Protocol
- WirelessHART Protocol
Radio Technologies for IoT

- Bluetooth® Wireless Technology
- ZigBee (IEEE 802.15.4)
- Ultra-Wideband (UWB)
- Certified Wireless USB
- Wi-Fi (IEEE 802.11)
- Radio Frequency Identification (RFID)
- Near Field Communication (NFC)
- LTE-M (KT), LoRa (SKT), Z-wave (LGU+)
IoT Identifier
Identities in the Future Web of Things – 1

• Identities as the end-point of communications
Identities in the Future Web of Things – 2

• Virtual identity model
IoT/WoT Implementation - 1

• **Environment issues**
  – Runtime environments (at constrained node, broker, server side)
  – Role of scripting language for 3D physical information and user behaviors
  – How many APIs
  – Management of Identification, Addressing, and Naming (locally and globally)
  – Combined with existing Applications and web services

• **Semantic issues relating to IoT/WoT**
  – Interpretation, contexts, and access of sensor data, control system (e.g., date, location, instance, task, state, people, etc.)
  – Interoperability issues with standards for various physical spaces and with device-dependent services/applications

• **Security and Trust issues**
  – Identifiers for people, device, services, and applications
  – Web of Trust for identity provider
  – Active monitoring for handling privacy with encryption, authentication, access control
  – Fault tolerance and isolation, protection of attack, defense level, etc.
IoT/WoT Implementation - 2

• Very cheap and unstable devices
  – Availability is in question (out-of-service, power failure, etc.)
  – Easily intercepted and no good privacy

• Lossy and Noisy Channel
  – Communication channel is very unstable and fluctuated

• Simple Protocol
  – Stateless protocol without cookie
  – Auto-configuration and restoration without help of people
  – Controlled by simple logic

• Time critical and Real time control
  – Pre-installed logic and response
  – Control triggered and activated by people