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Issues for IoT Interoperability

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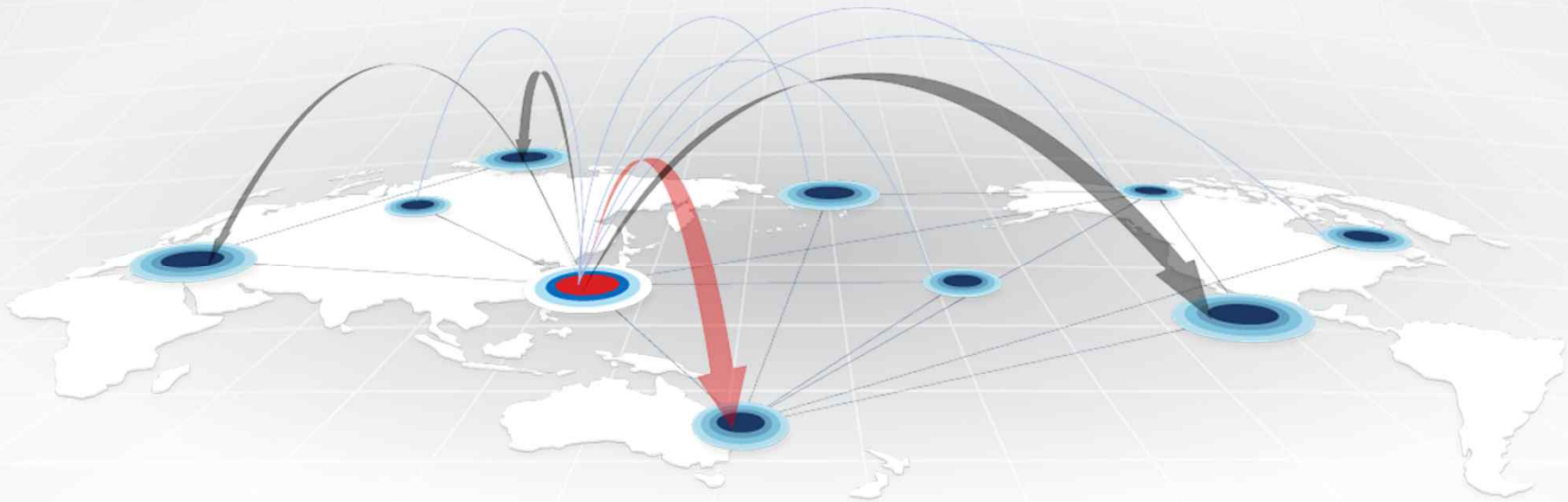
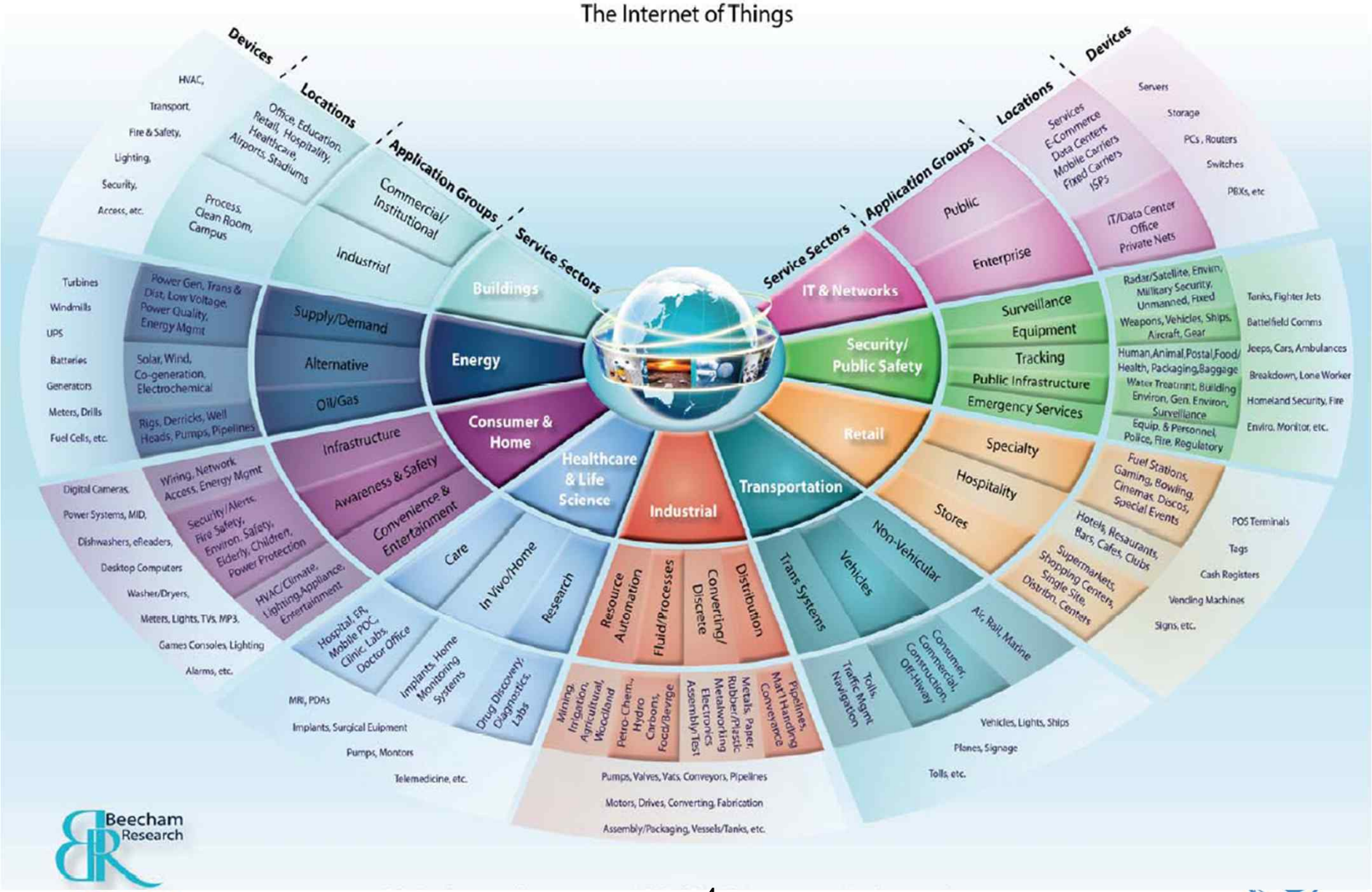
IoT Eco-Society



The Internet of Things



Beecham Research

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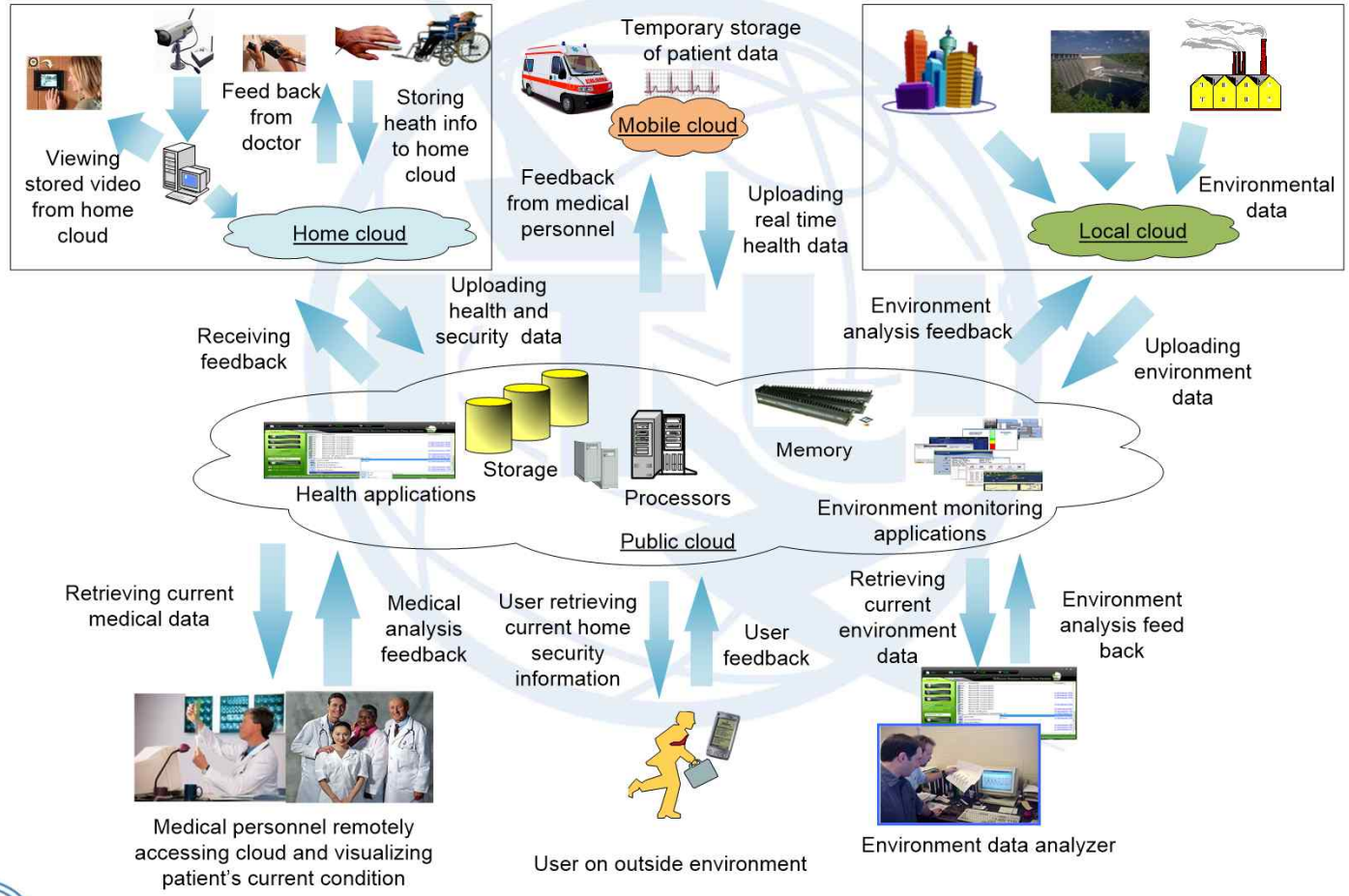
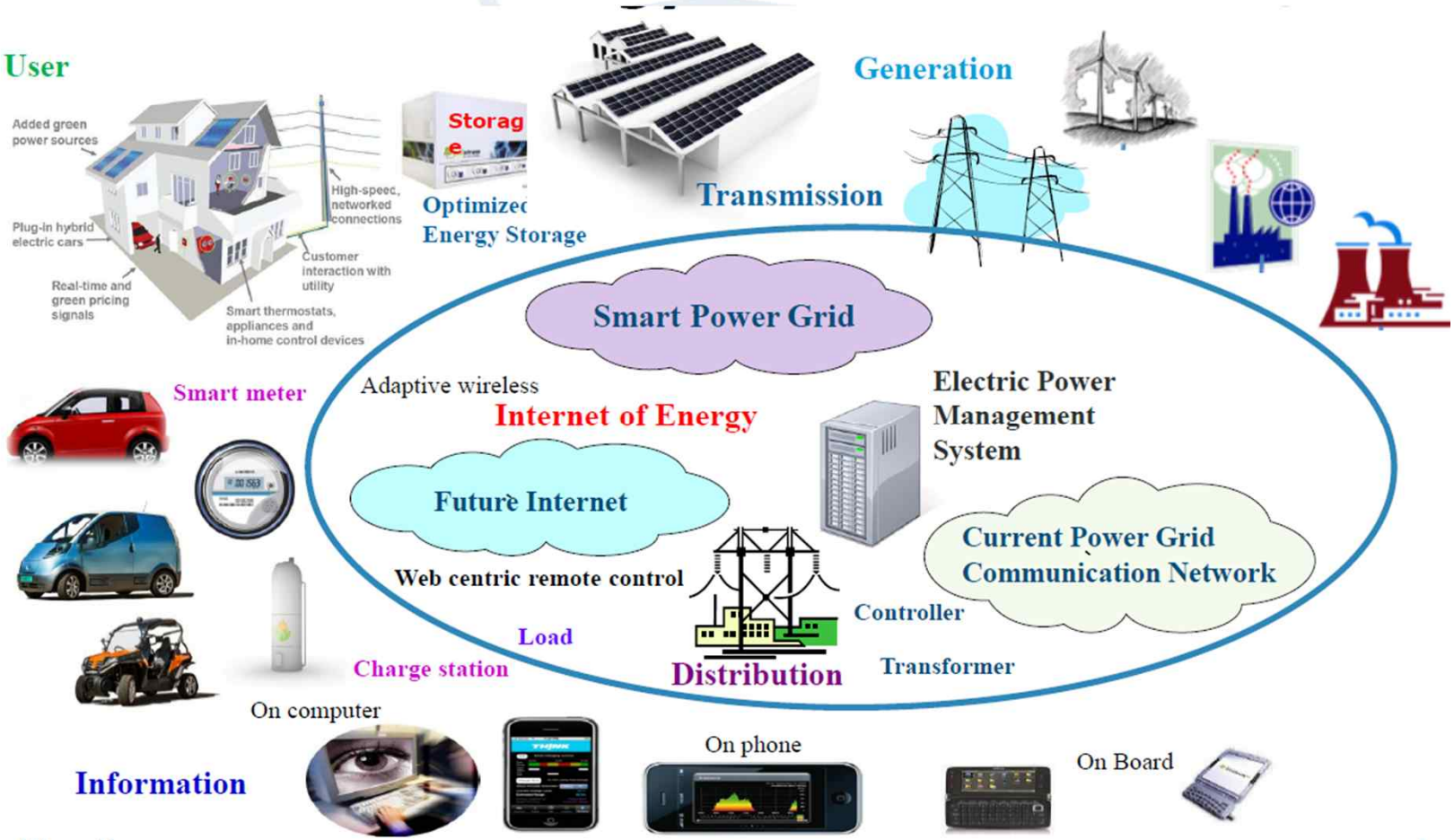
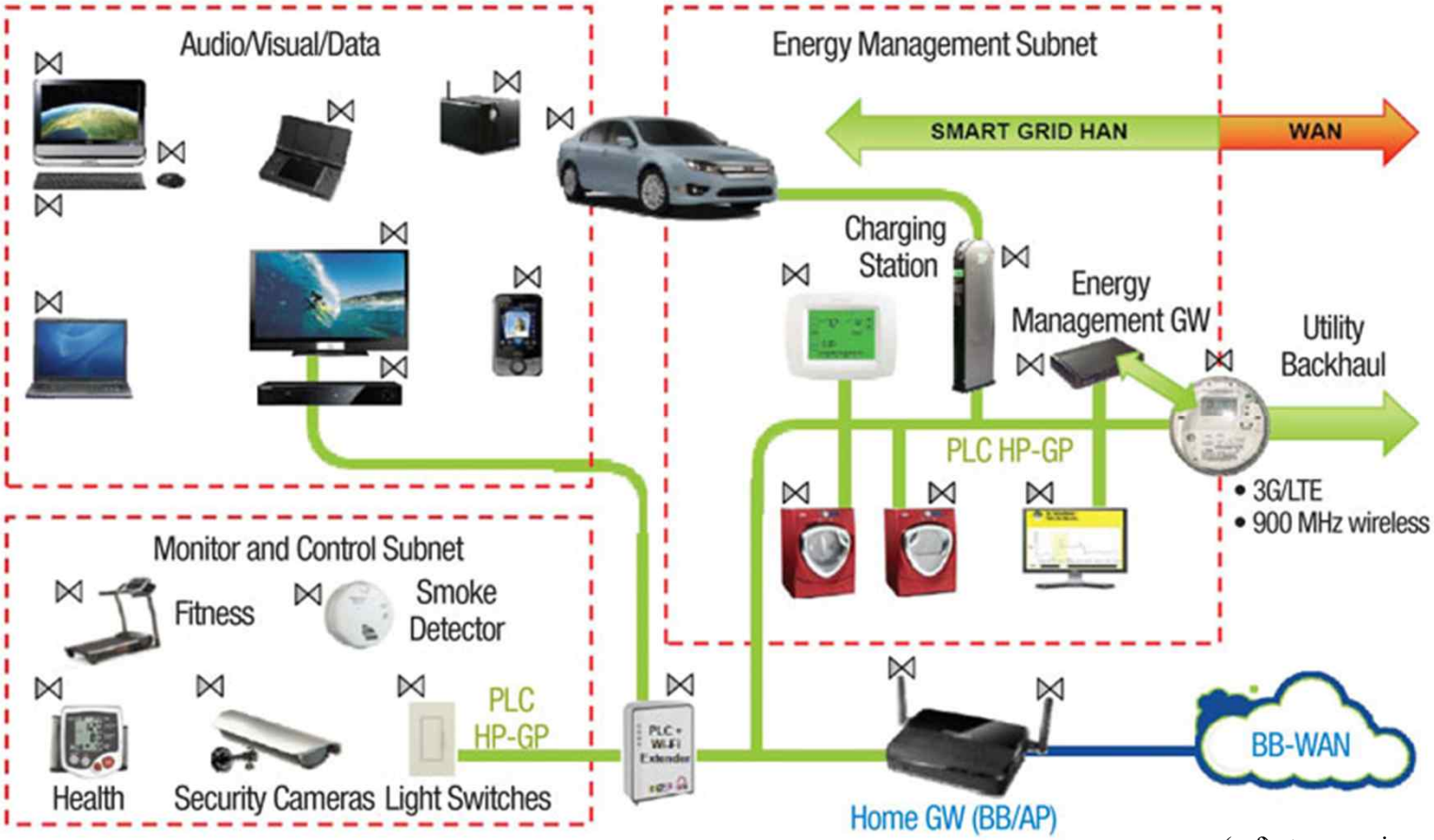
Use Cases for Cloud-based IoT



Internet of Energy

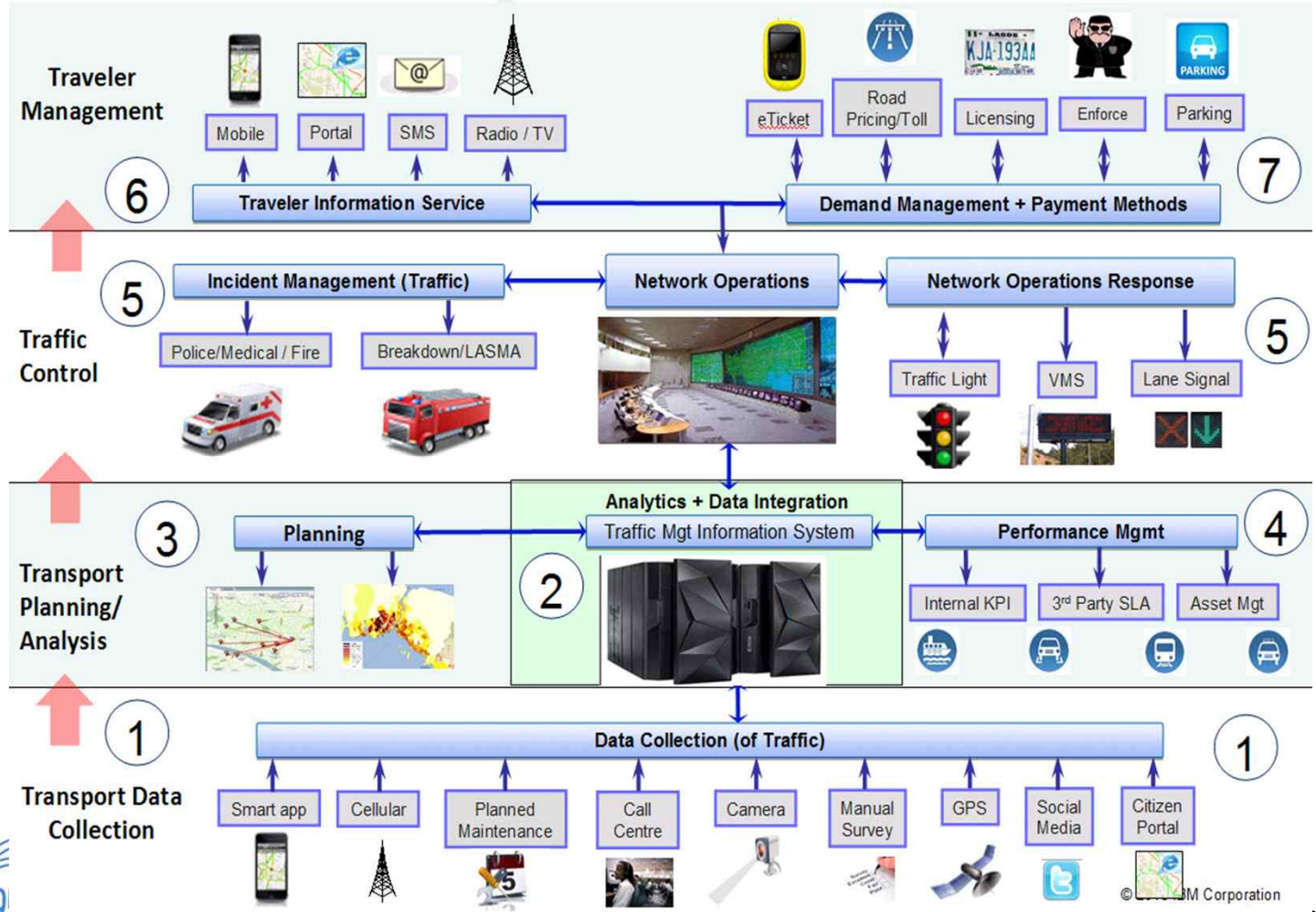


What is a Smart Home?



(ref) rtcmagazine.com

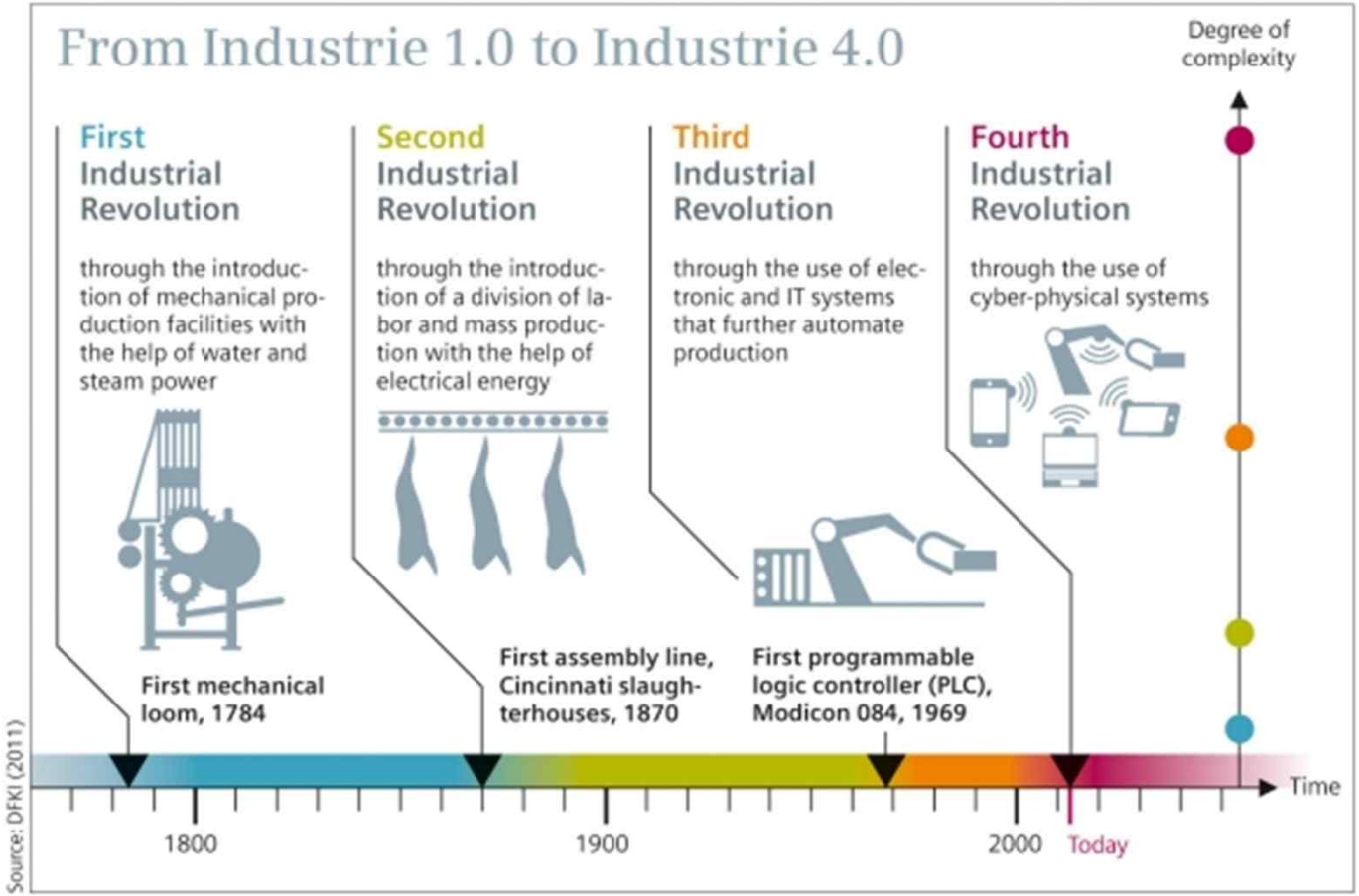
Vision of Intelligent Transport System



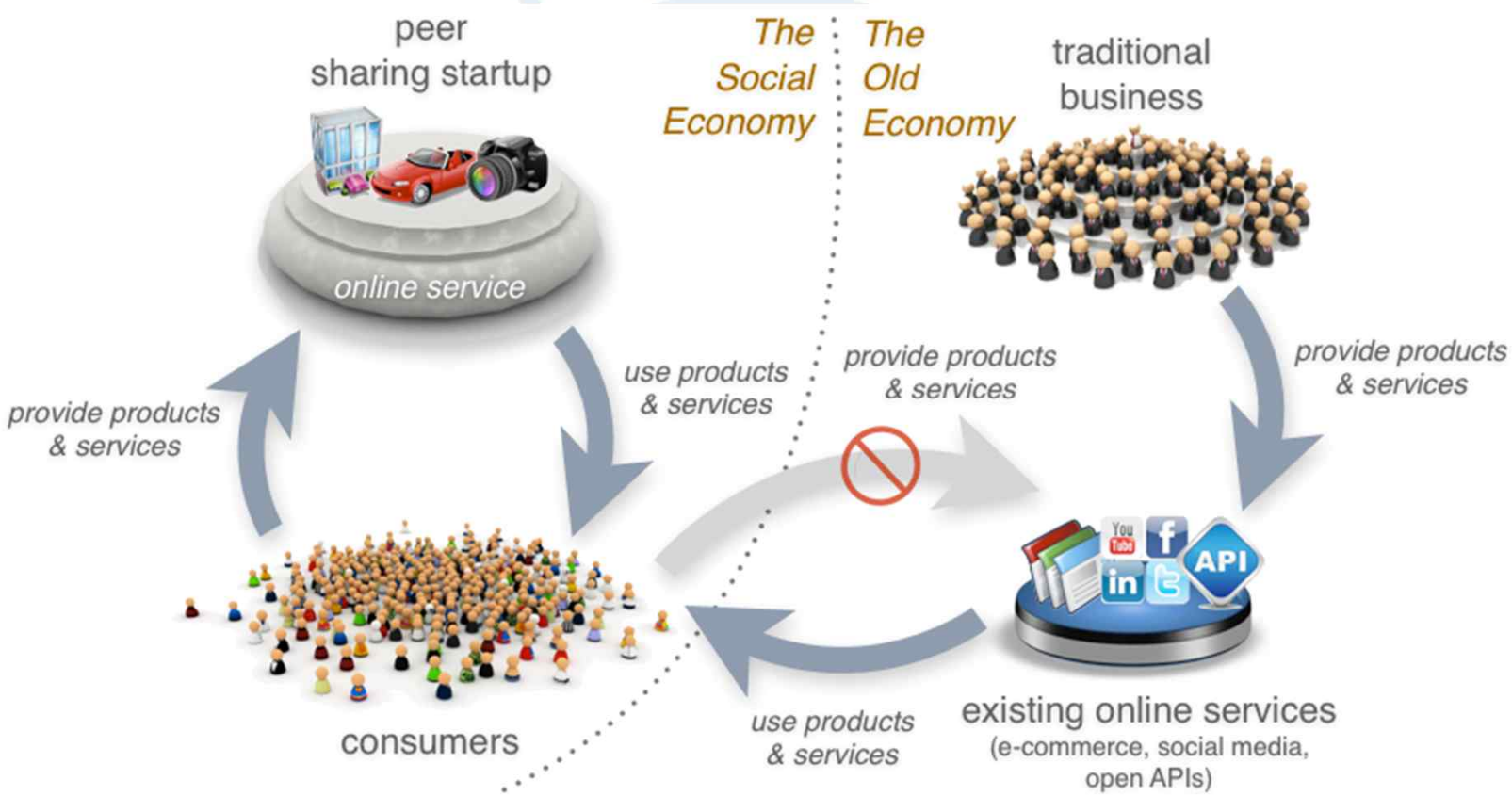
(ref) https://smartercitieschallenge.wordpress.com/category/lagos-nigeria/

Industry 4.0

(ref) http://nexasnet.blogspot.kr/



New Social Economy



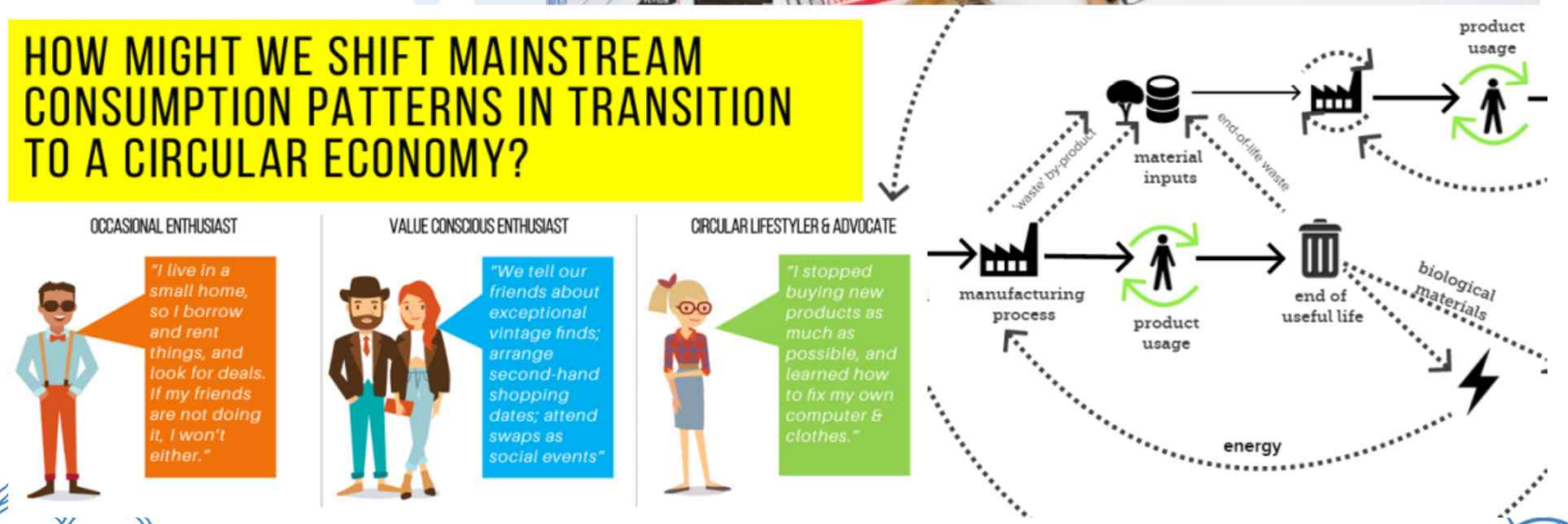
(ref) http://zdnet.com/blog/hinchcliffe

Sharing Economy Spans Multiple Sectors

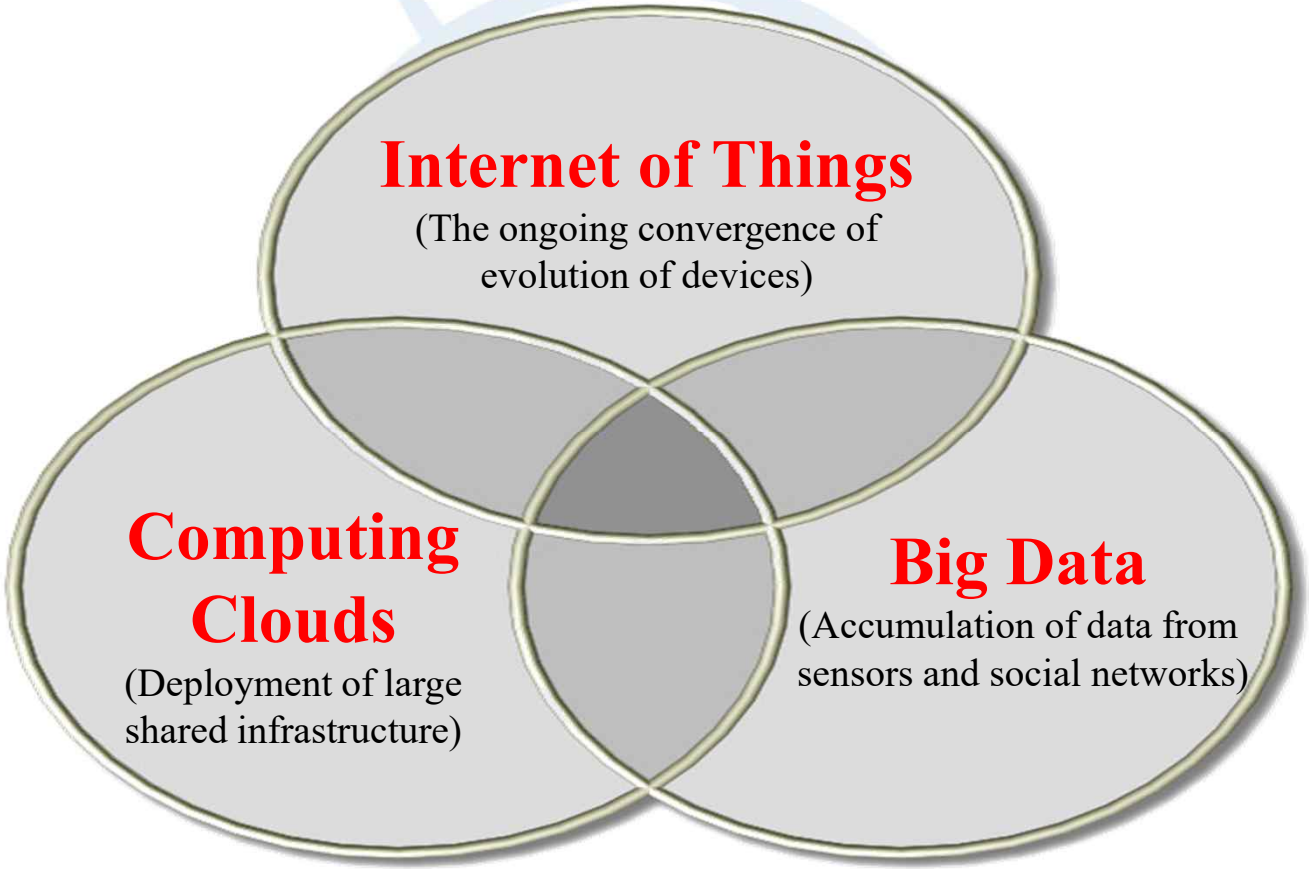
- Smart retailers to exploit the sharing economy
  - Waste is minimized through recycling, repairing, repurposing, and even reinventing products and materials
  - Wider sustainability and environmental issues

Circular Economy

(note) European Commission launched the final draft of the Circular Economy Package in 2015



New Research Challenges for ICT

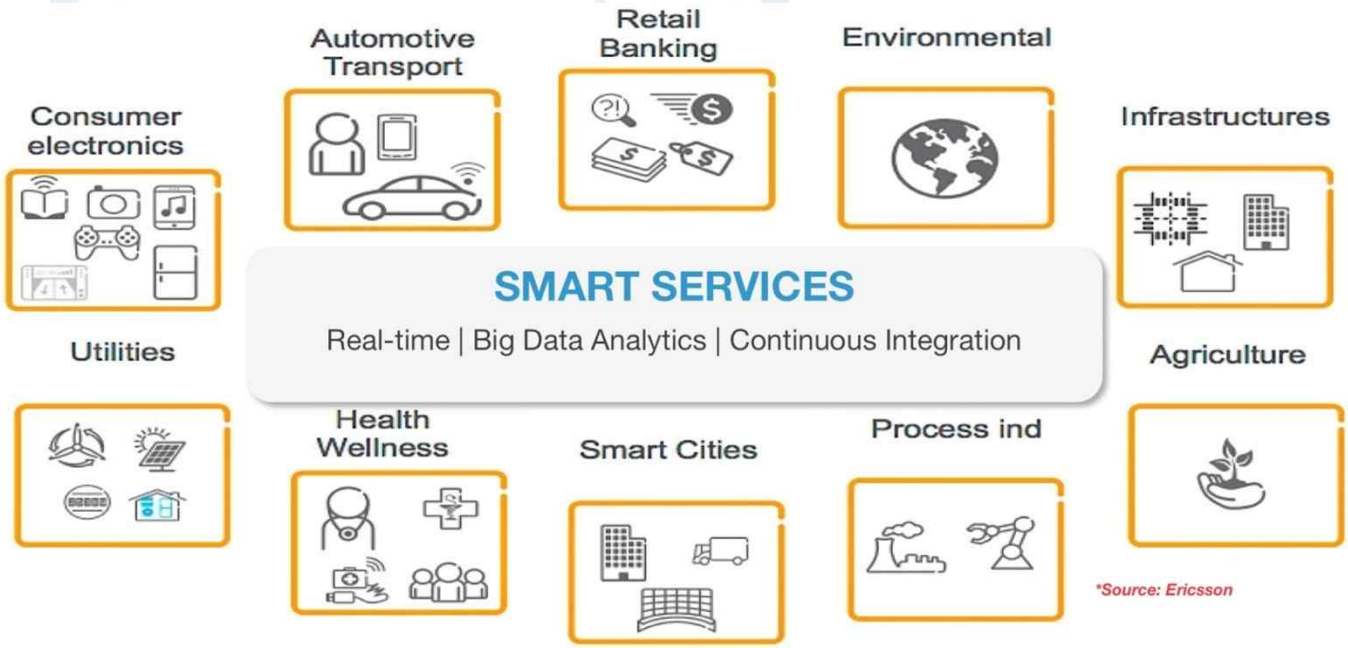


How many HW Devices and SW Applications ?

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

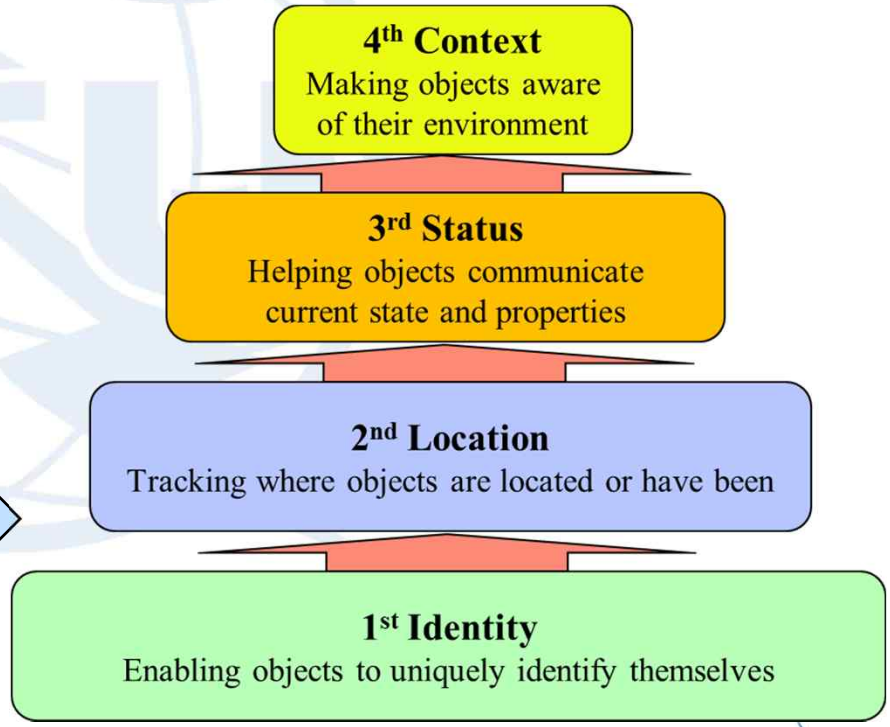


*Source: Ericsson

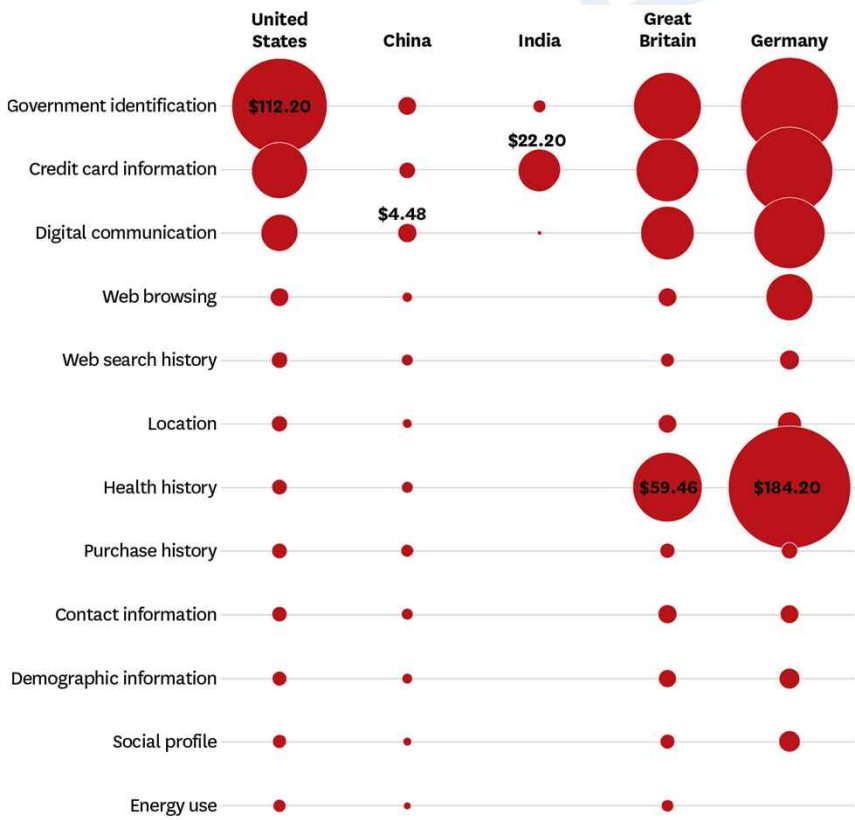
Networking and Services for the IoT

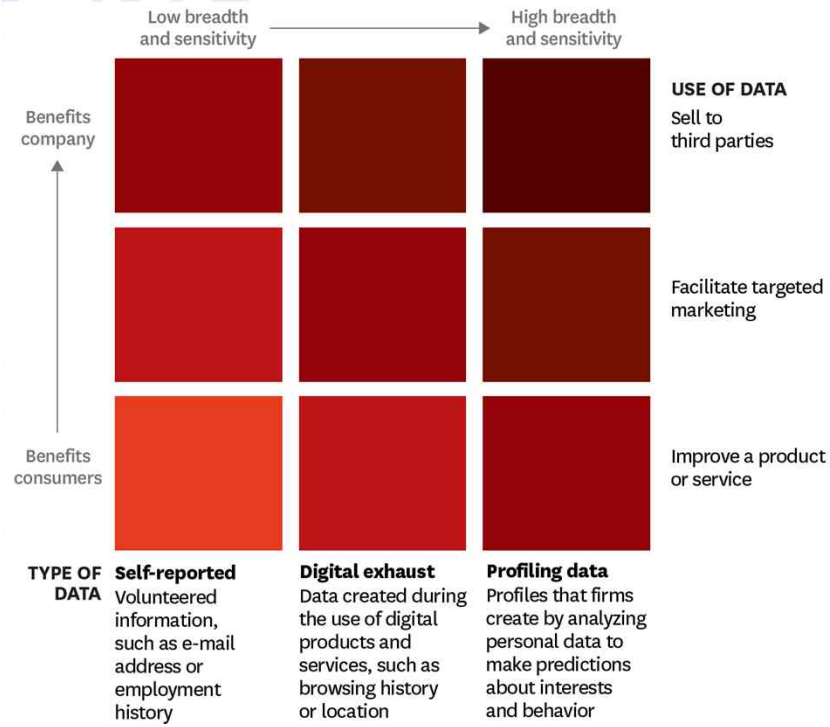
- Characteristics of the IoT
  - Connectivity
  - Personalization
  - Intelligence
  - Tagging objects

Evolution of Smart Objects



Value of Data



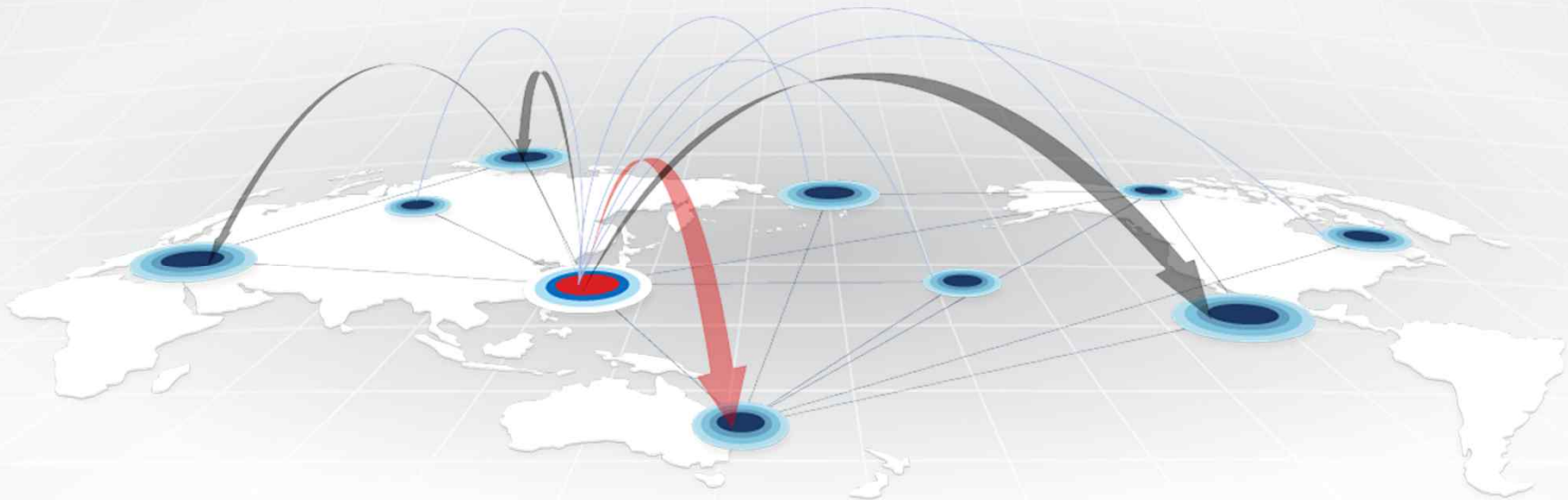


https://hbr.org/2015/05/customer-data-designing-for-transparency-and-trust

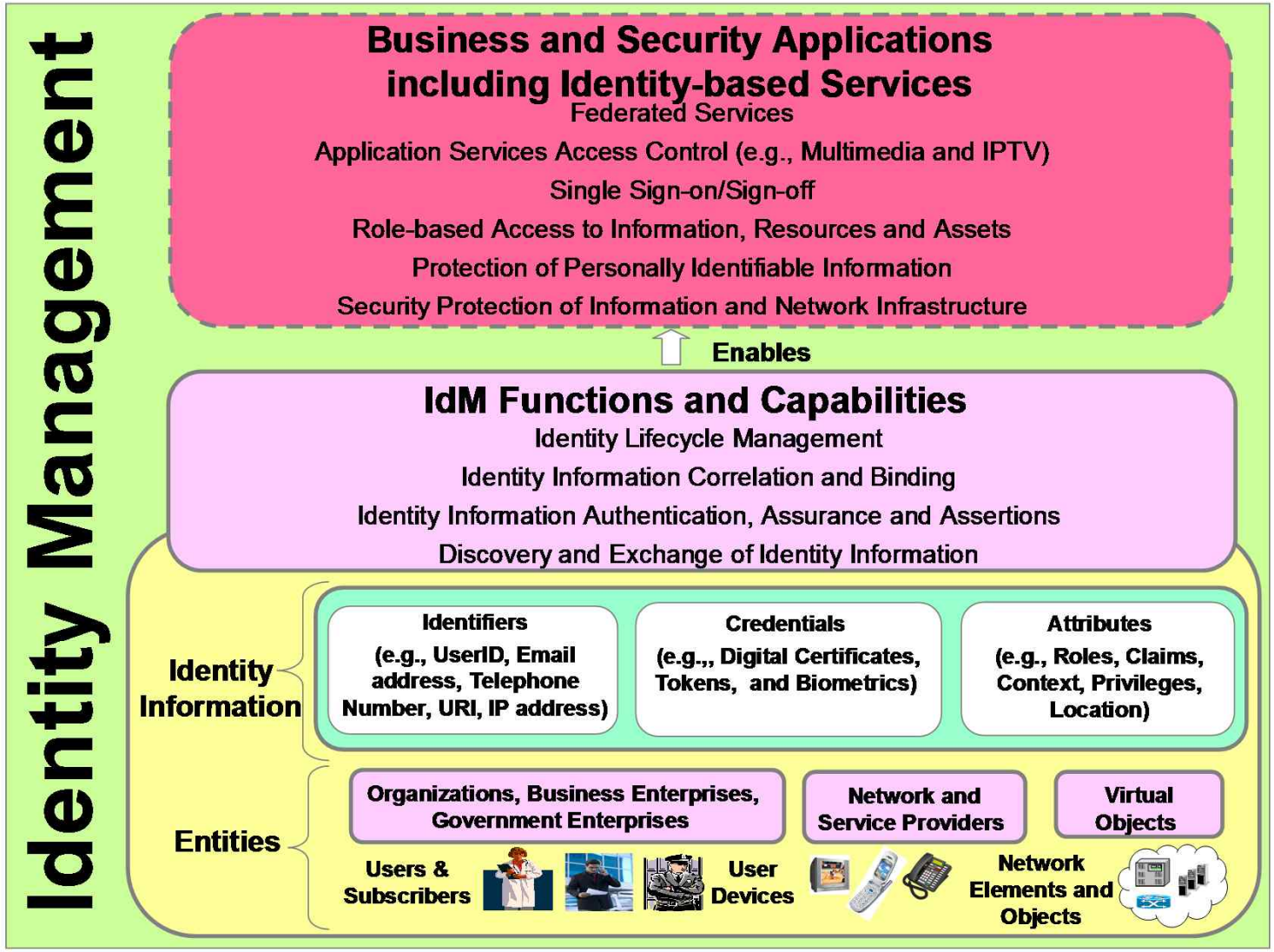
Key Questions for IoT Eco-Society

- **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

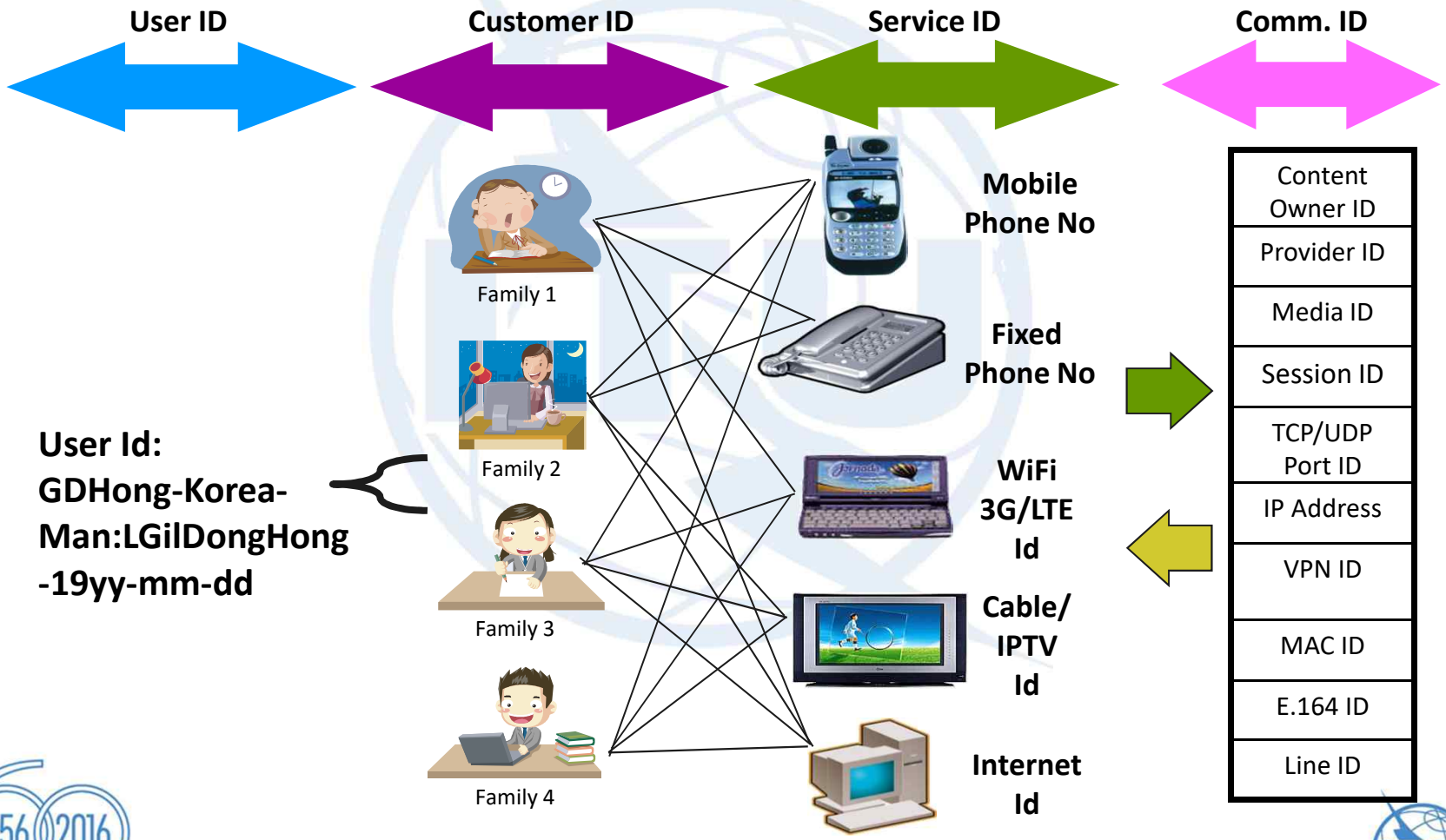
Digital Identity Management for IoT



Identity Management Framework (Y.2720)



Identity Management Processing



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

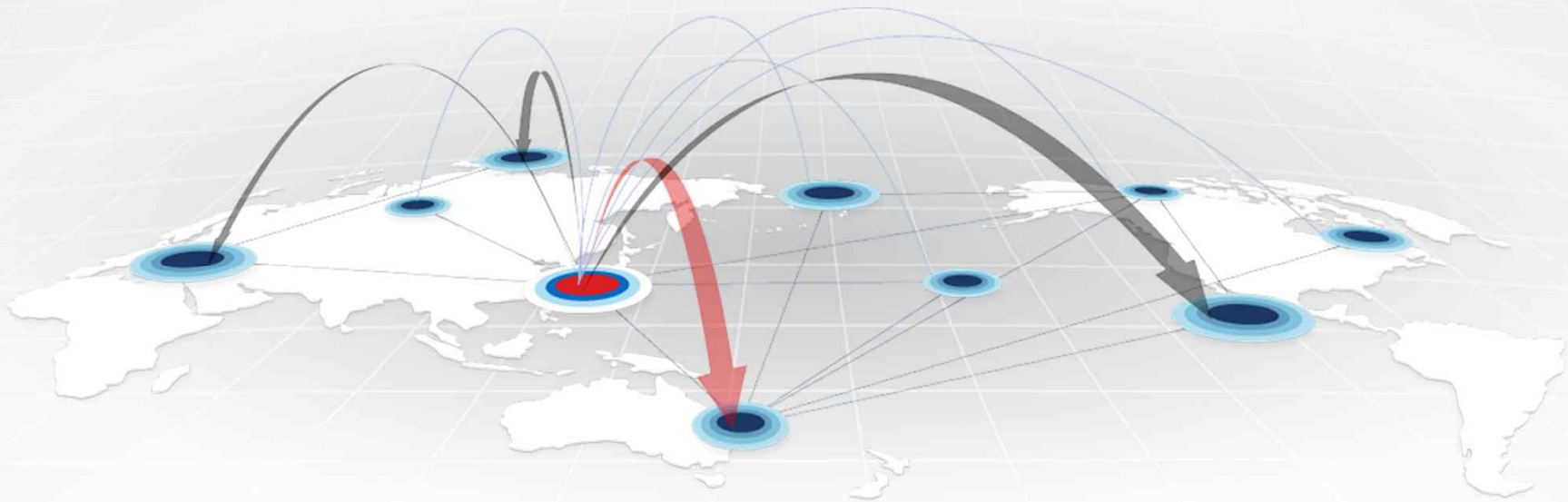
Key Issues for Digital Identity

- **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

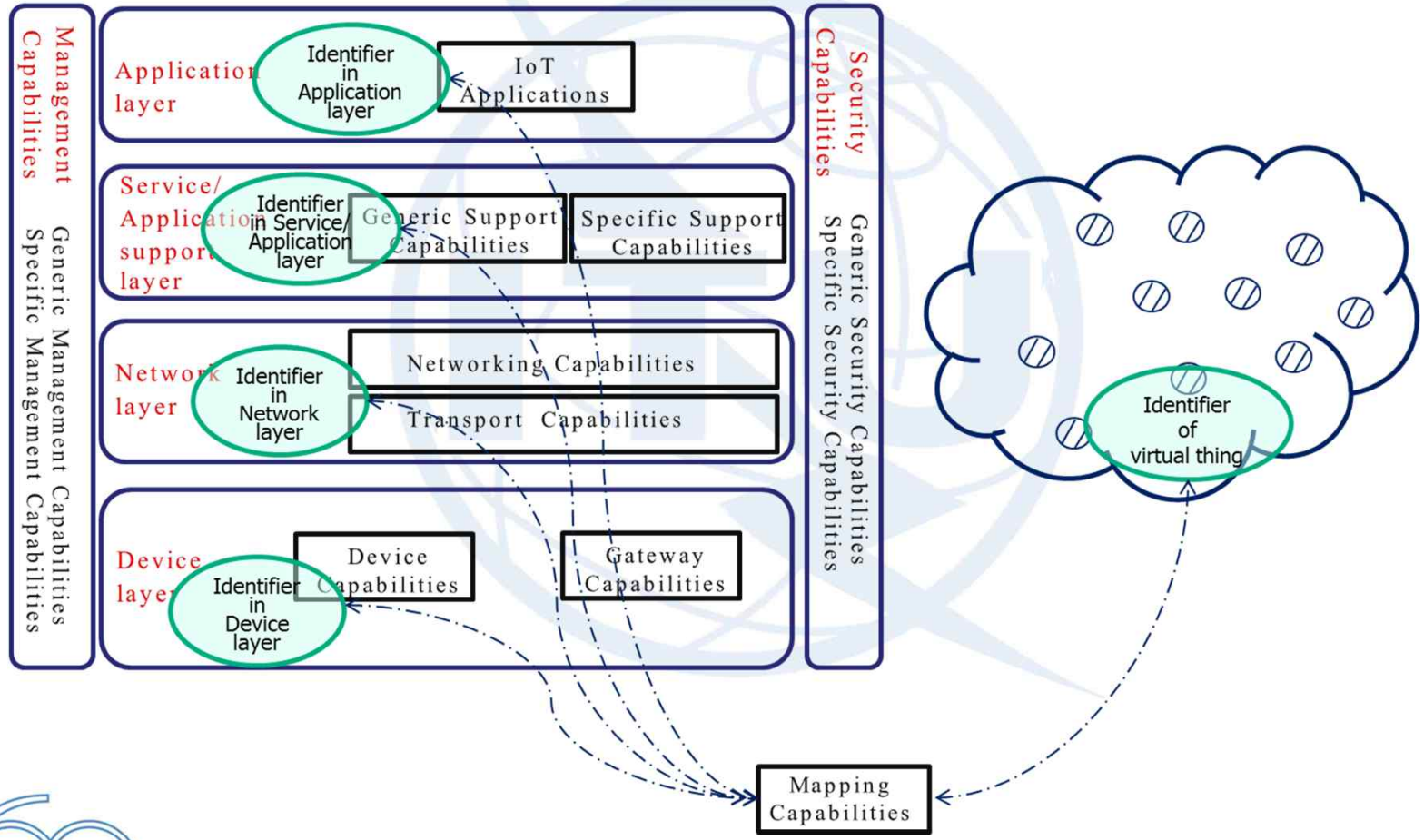
IoT Protocols

- 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

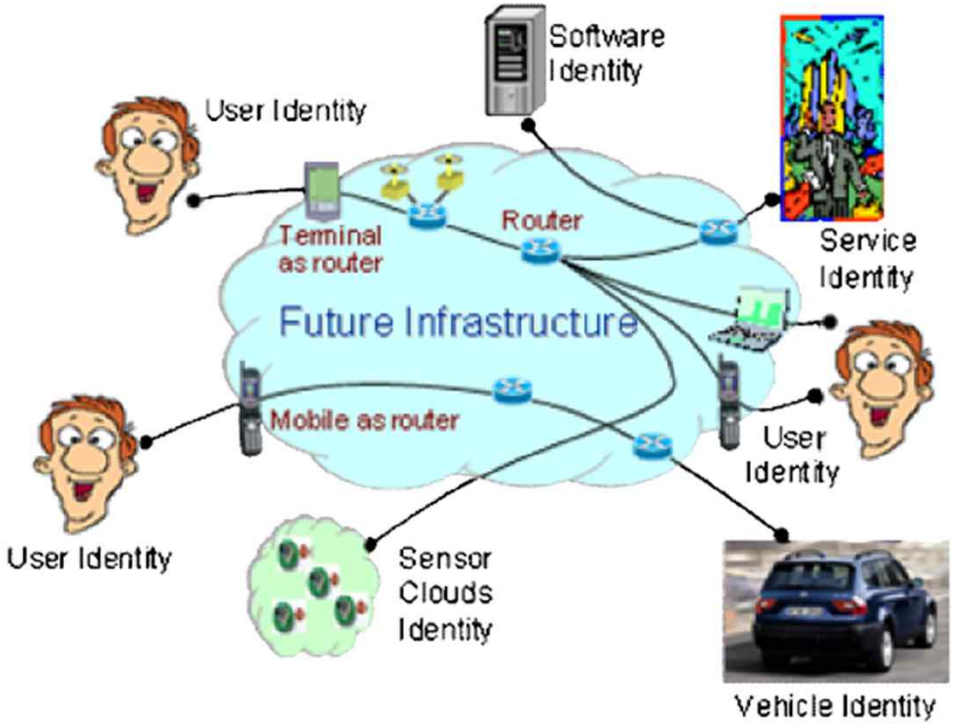
- Bluetooth® Wireless Technology
- ZigBee (IEEE 802.15.4)
- Ultra-Wideband (UWB)
- Certified Wireless USB
- Wi-Fi (IEEE 802.11)
- Radio Frequency Identification (RFID)
- Near Field Communication (NFC)
- LTE-M (KT), LoRa (SKT), Z-wave (LGU+)

IoT Identifier



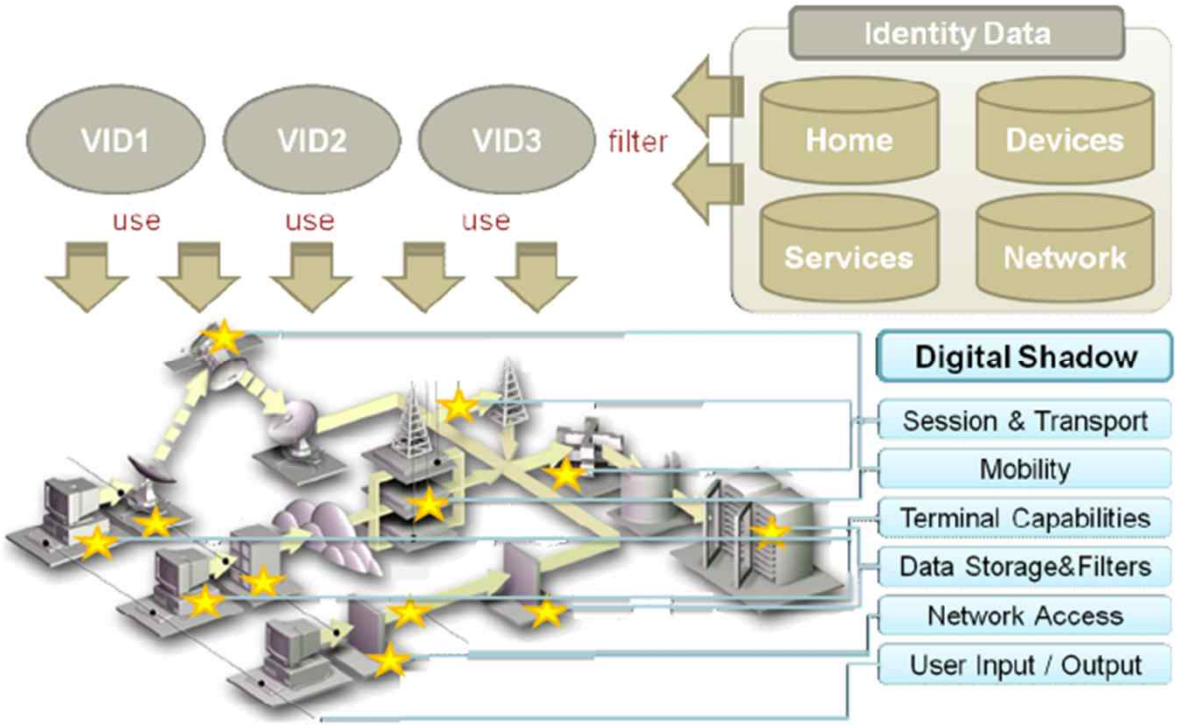
Identities in the Future Web of Things – 1

- 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