Course Title
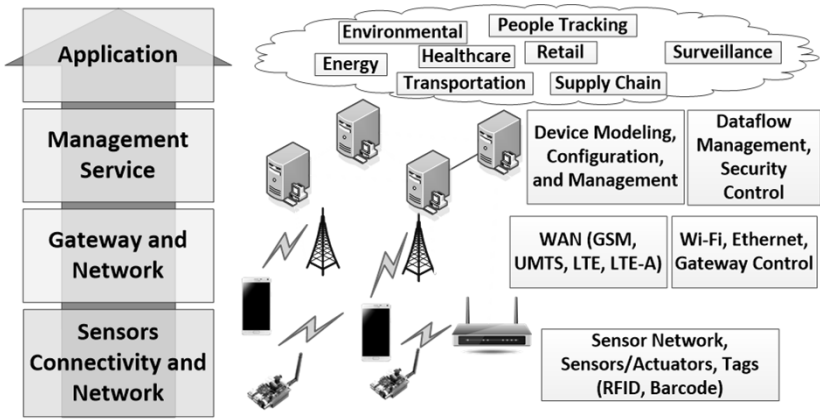   **IoT Wireless & Cloud Emerging Technologies**

❖ **Modules**

- 1. IoT Business & Products
- 2. IoT Architecture & Technologies
- 3. IoT Networks
- 4. Wi-Fi & Bluetooth
- 5. Cloud Technology
- 6. IoT Bluetooth & Wi-Fi and EC2 Cloud Projects
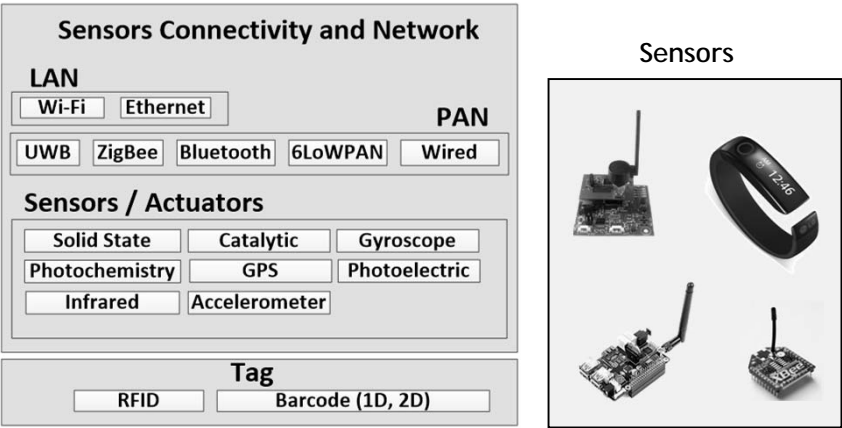
IoT Architecture & Technologies

IoT Architecture

IoT Architecture

❖ IoT Architecture Layers

IoT Architecture

❖ Sensor Layer

IoT Architecture

❖ Sensor Layer

- Made up of sensors and smart devices
- Real-time information to be collected and processed
- Sensors use low power and low data rate connectivity
- WSN (Wireless Sensor Network) formation
- Sensors are grouped according to their purpose and data types
  - Environmental sensors, Military sensors, Body sensors, Home sensors, Surveillance sensors, etc.
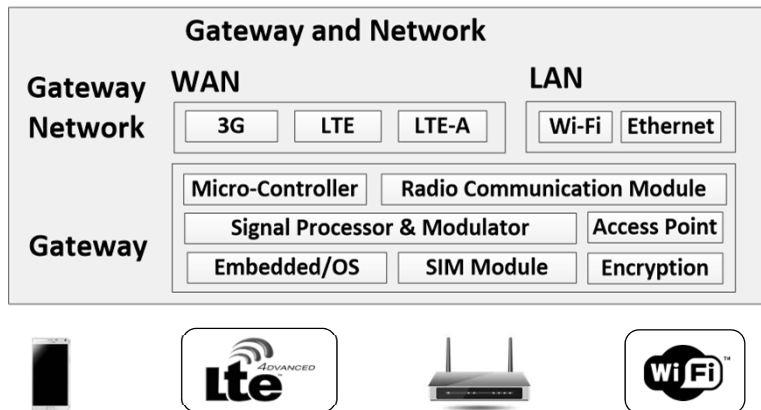
IoT Architecture

❖ Sensor Aggregators (Gateways)

- LAN (Local Area Network)
  - Ethernet and Wi-Fi connections
  - WLAN (Wireless LAN)➔ Wi-Fi
- PAN (Personal Area Network)
  - WPAN (Wireless PAN)
    - Bluetooth, ZigBee, and 6LowPAN
- Sensors that do not require connectivity to a LAN gateway can be directly connected to the Internet through a WAN (Wide Area Network) interface

IoT Architecture

❖ Gateway & Network Layer

Gateway and Network

Gateway Network	WAN			LAN	
	3G	LTE	LTE-A	Wi-Fi	Ethernet

Gateway	Micro-Controller	Radio Communication Module	
	Signal Processor & Modulator		Access Point
	Embedded/OS	SIM Module	Encryption

IoT Architecture

❖ Gateway & Network Layer

- Must support massive volumes of IoT data
  produced by wireless sensors and smart devices

- Requires a robust and reliable performance

- Supports private, public, hybrid network models

- Network model QoS requirements
    - Low Latency & Error Probability
    - High Throughput & Energy Efficiency
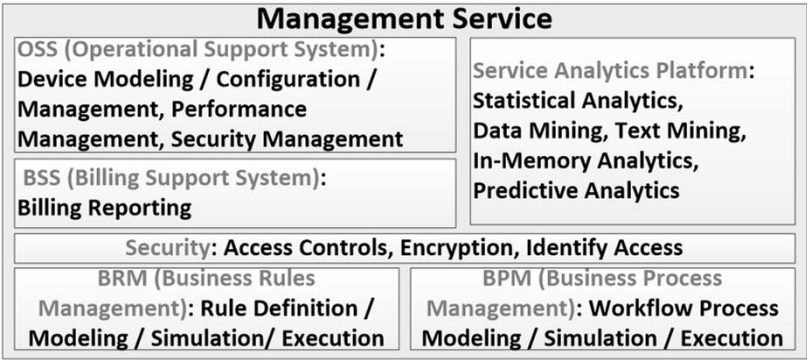   - High Levels of Security & Scalability

IoT Architecture

❖ Gateway & Network Layer

- It is important to integrate different types of networks into a single IoT platform

- IoT sensors are aggregated with various types of protocols and heterogeneous networks using different technologies

- IoT networks need to be scalable to efficiently serve a wide range of services and applications over large scale networks

IoT Architecture

❖ Management Service Layer

Management Service

OSS (Operational Support System): Device Modeling / Configuration / Management, Performance Management, Security Management	**Service Analytics Platform:** Statistical Analytics, Data Mining, Text Mining, In-Memory Analytics, Predictive Analytics
BSS (Billing Support System): Billing Reporting	

Security: Access Controls, Encryption, Identify Access

BRM (Business Rules Management): Rule Definition / Modeling / Simulation/ Execution	BPM (Business Process Management): Workflow Process Modeling / Simulation / Execution

IoT Architecture

❖ **Management Service Layer**

- Management Service Layer is in charge of
  - Information Analytics
  - Security Control
  - Process Modeling
  - Device Management

- Data Management
  - Periodic IoT sensor data requires filtering
  - Aperiodic event triggered IoT sensor data may require immediate delivery & response
    - Example: Patient medical emergency sensor data

IoT Architecture

❖ **Management Service Layer**

- Data Management
  - Manages data information flow
  - Information access, integration, control

- Data Abstraction
  - Information extraction processing
  - Used as a common business model

IoT Architecture

❖ **Application Layer**

Applications					
Sector					
Environmental	Energy	Transportation	Healthcare	Retail	Military
Horizontal Market					
Fleet Management	Asset Management	Supply Chain	People Tracking	Surveillance	

IoT Architecture

❖ **Application Layer**

- Various applications from industry sectors can use IoT for service enhancement

- Application Classification
  - Business Model, Type of network
  - Availability, Heterogeneity
  - Coverage, Size
  - Real-Time or Non-Real-Time requirements

IoT Architecture

❖ Application Layer

- Personal and Home
  - IoT at the scale of an individual or home
- Enterprise
  - IoT at the scale of a company or community
- Utility
  - IoT at a national or regional scale
- Mobile
  - Devices are usually spread across other domains mainly due to their mobility

IoT Architecture

❖ Application Layer

- Smart Environment Application Domains

	Smart Home	Smart Office	Smart Retail	Smart City	Smart Agriculture	Smart Energy & Fuel	Smart Transportation	Smart Military
Network Size	Small	Small	Small	Medium	Medium /Large	Large	Large	Large
Network Connectivity	WPAN, WLAN, 3G, 4G, Internet	WPAN, WLAN, 3G, 4G, Internet	RFID, NFC, WPAN, WLAN, 3G, 4G, Internet	RFID, NFC, WLAN, 3G, 4G, Internet	WLAN, Satellite Comm., Internet	WLAN, 3G, 4G, Microwave links, Satellite Comm.,	WLAN, 3G, 4G, Satellite Comm.	RFID, NFC, WPAN, WLAN, 3G, 4G, Satellite Comm.
Bandwidth Requirement	Small	Small	Small	Large	Medium	Medium	Medium~Large	Medium~Large

- WLAN: Wi-Fi, WAVE, IEEE 802.11 a/b/g/p/n/ac/ad, etc.
- WPAN: Bluetooth, ZigBee, 6LoWPAN, IEEE 802.15.4, UWB, etc.

IoT Architecture

❖ Application Layer

- ▪ Smart Environment Application Domains

Service Domain	Services
Smart Home	Entertainment, Internet Access
Smart Office	Secure File Exchange, Internet Access, VPN, B2B
Smart Retail	Customer Privacy, Business Transactions, Business Security, B2B, Sales & Logistics Management
Smart City	City Management, Resource Management, Police Network, Fire Department Network Transportation Management, Disaster Management
Smart Agriculture	Area Monitoring, Condition Sensing, Fire Alarm, Trespassing
Smart Energy & Fuel	Pipeline Monitoring, Tank Monitoring, Power Line Monitoring, Trespassing & Damage Management
Smart Transportation	Road Condition Monitoring, Traffic Status Monitoring, Traffic Light Control, Navigation Support, Smart Car Support, Traffic Information Support, ITS (Intelligent Transportation System)
Smart Military	Command & Control, Communications, Sensor Network, Situational Awareness, Security Information, Military Networking

IoT Architecture & Technologies

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