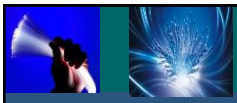

# IT321

# *Communication Technology*

## *Introduction to IoT*

**Haitham S. Hamza, Ph.D.**
Cairo University
*Fall 2017*

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## What is Internet of Things?

- **"The Internet of Things (IoT)** is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. The IoT comprises an ecosystem that includes things, communication, applications and data analysis" *Gartner*

- "A true **Internet of Things** will require IP in the tiniest devices that monitor or control real world objects, and that services and data from these devices are somehow available more openly for applications to make use of. The use of standard IP and Web technologies will ensure that device costs are driven down and that application development and use will be significantly simplified." *Ericsson*

- **"The Internet of Everything (IoE)** is bringing together people, process, data, and things to make networked connections more relevant and valuable than ever before-turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries." *Cisco*

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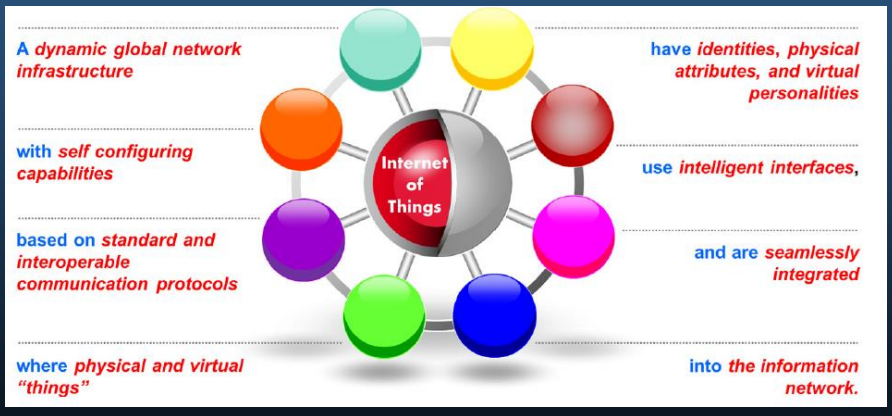
# What is Internet of Things?

- IoT is defined by ITU and IERC as

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# IoT Today!

- Telecom Operators
  - Consider M2M and IoT major business focus
- Device manufacturers
  - Consider wearables a new product segment
- R&I community
  - Invest in studying embedded and cyber-physical systems, network technologies, semantic interoperability, operating systems, security, cloud computing, future internet, big data and robotics

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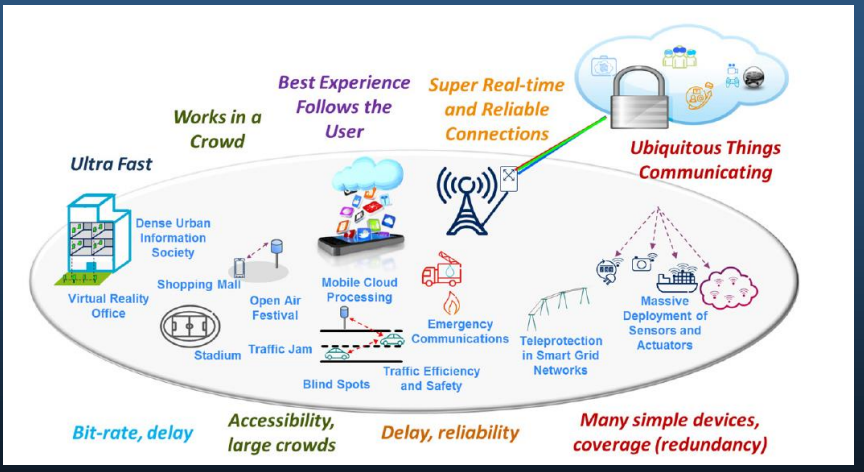
# IoT Challenges

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# IoT Tomorrow!

- Extend the current IoT into ***dynamically configured web of platforms*** for connected devices, objects, smart environments, services and persons
- Overcome the fragmentation of vertically-oriented closed systems, architectures and applications

**•Open Smart Web of Everything**

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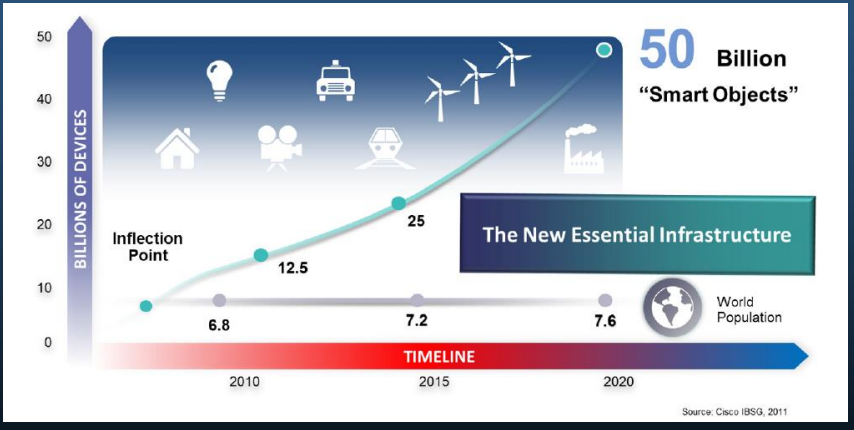
# IoT Connected Devices & Future Evolution

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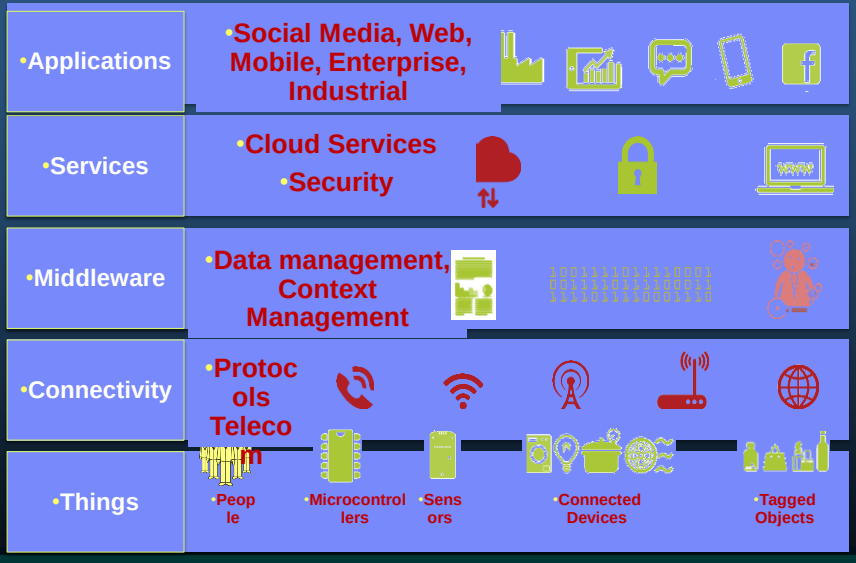
# IoT Infrastructure Main Components

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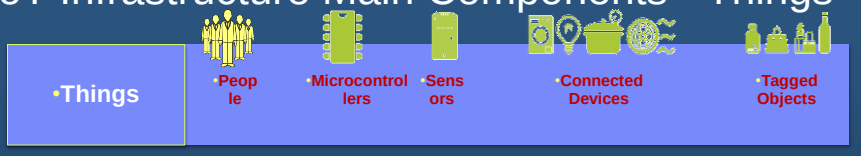
# IoT Infrastructure Main Components - Things




- Embedded Systems
- Wireless Sensor Networks
- Smart Objects
  - Tagged objects (NFC / RFID )
  - Sensor Enabled Devices
- Micro and Nano electronics
- Photonics
- Biotechnology
- Advanced Materials
- Advanced Manufacturing Systems

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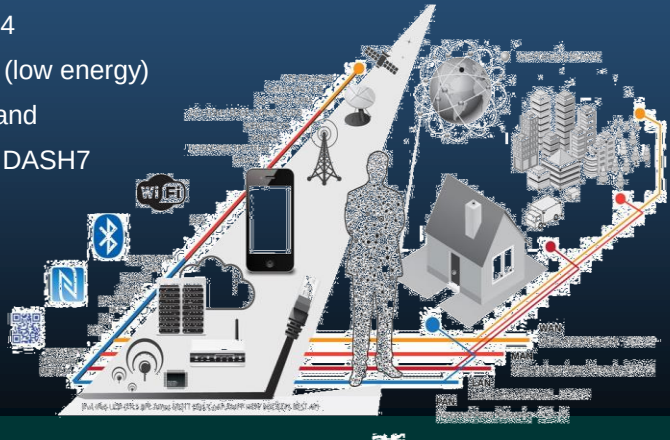
# IoT Infrastructure Main Components - Connectivity


- Main concern is low power communication
  - IEEE 802.15.4
  - Bluetooth LE (low energy)
  - Ultra Wide Band
  - ISO 18000-7 DASH7
  - RFID/NFC

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# IoT Infrastructure Main Components - Middleware

| •Middleware | •Data management, Context Management |
|---|---|

- Middleware Requirements:
  - Hide low-level sensing details
  - Device virtualization
  - Decouple producer and consumer of M2M device data
  - Extendibility & Scalability
  - Interoperability
  - Multiple remote access
  - Appropriate protocols (MQTT, CoAP, RESTful HTTP, XMPP)
  - Big data management

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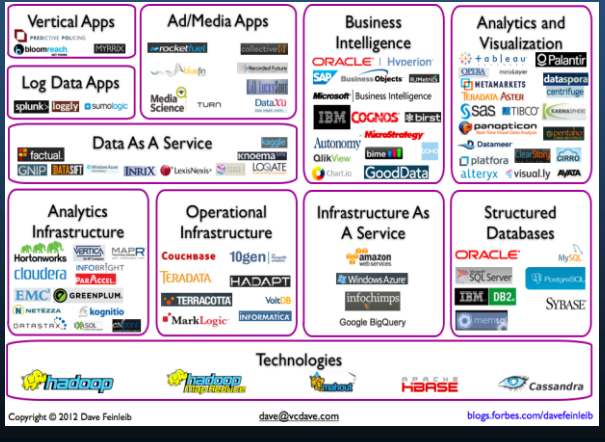
# IoT Infrastructure Main Components - Middleware

| •Middleware | •Data management, Context Management |
|---|---|

- Big Data

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# IoT Infrastructure Main Components - Middleware


- Protocols (beside well known JMS,REST)
  - MQTT: Message Queue Telemetry Transport
    - Transfer messages via central broker
  - CoAP: Constrained Application Protocol
    - Client/server protocol like HTTP but for constrained devices
  - AMQP: Advanced Message Queuing Protocol
    - Application level message-centric brokered protocol
  - DDS: Data Distribution Service
    - Data-centric middleware language
  - XMPP: Extensible Messaging and Presence Protocol
    - XML based messaging protocol

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# IoT Infrastructure Main Components - Middleware


- Semantic Sensor Networks & Semantic Annotation of Data
  - Use semantic technologies to annotate sensors with spatial, temporal semantic metadata
  - W3C Semantic Sensor Network Incubator Group is developing sensor ontology

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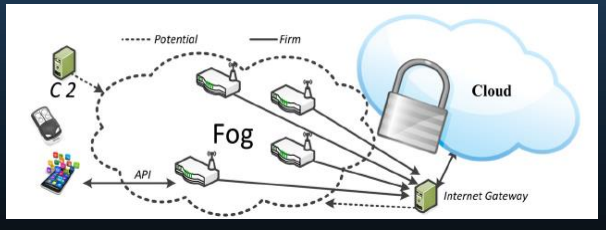
# IoT Infrastructure Main Components - Services


- Cloud Services
  - Emerging Services: Sensing-as-a-service & Object-as-a-service
  - Moving towards Fog Computing Paradigm to cope with the need for mobility, geo-distribution, context awareness and low latency

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# IoT Infrastructure Main Components - Services


- Trust, Security & Privacy
  - Shifting towards cyber-physical systems will infer security vulnerabilities and threats that require light-weight scalable solutions
  - Trust: Light-weight Public Key Infrastructure and Management systems and Access Control
  - Security: Cyber-Situation awareness
  - Privacy: Cryptographic techniques, fine-grain & self configuring access control mechanisms

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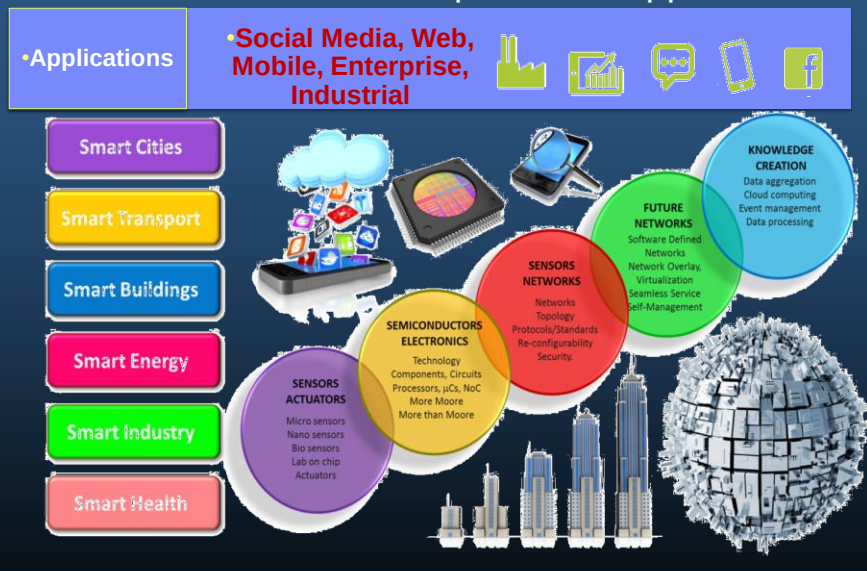
## IoT Infrastructure Main Components - Applications

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# IoT Standardization and Legislation

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# ITU and IoT – Standardization Activities

**IoT GSI- IoT Global Standard Initiative**

**JCA-IoT - Joint Coordination Activity of the IoT**

**ITU-T Focus Group on the M2M service layer**

**ITU-T Study Group 2 : Numbering Naming, Addressing**

**ITU-T Study Group 11 : Testing Architecture for tag-based identification**

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# ITU and IoT

**ITU-T Study Group 16 – requirements and architecture for multimedia information access triggered by tag-based identification**

**ITU-T Study Group 17 – security and privacy of tag-based applications**

**ITU-R : Global management of the radio frequency spectrum**

**ITU-T Study Group 13: NGN requirements and architecture for applications and services**

**Using tag-based identification**

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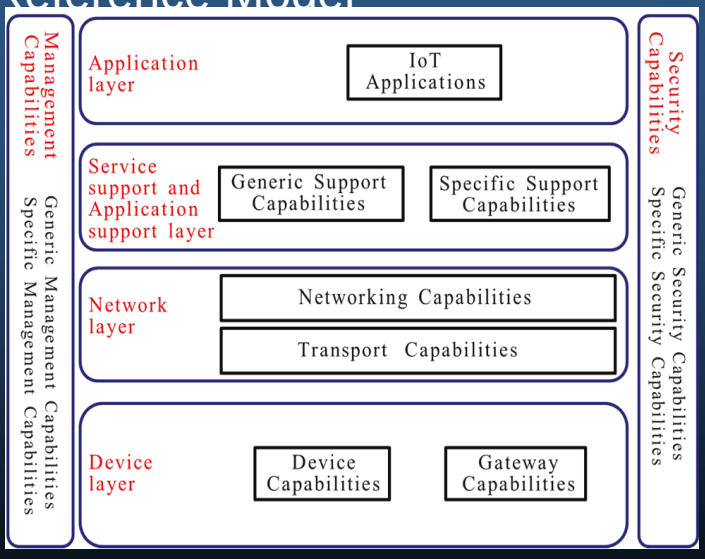
# IoT Reference Model




*(Source: ITU-T Y.2060)*

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# ISO/IEC JTC 1/SWG 5 Internet of Things (IoT)

- **ISO/IEC JTC 1/SWG 5 Internet of Things (IoT)**
  - A standardization special working group (SWG) of the Joint Technical Committee ISO/IEC JTC 1 of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC)
  - Develops and facilitates the development of standards for Internet of Things (IoT).
  - Established in 2012 as a result of growing interest in the field of IoT by other standards organizations
- Examples of standards:
  - ISO/IEC NP 19654: Internet of Things Reference Architecture (IoT RA)
  - ISO/AWI 18575: Internet of Things (IoT) in the supply chain - Products & product packages
  - ISO/IEC JTC 1/SC 6: Telecommunications and information exchange between systems
  - ISO/IEC JTC 1 Information technology

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# IEEE Standards Association (IEEE-SA)

- Develops a variety of standards for IoT including:
  - IEEE 754™-2008 - IEEE Standard for Floating-Point Arithmetic
  - IEEE 802.11™-2012 - IEEE Standard for Information Technology Telecommunications and information exchange between systems
  - IEEE 1609.2™-2013 - IEEE Standard for Wireless Access in Vehicular Environments
  - IEEE 1905.1™-2013 - IEEE Draft Standard for a Convergent Digital Home Network for Heterogeneous Technologies
- The complete list of standards in this link: http://standards.ieee.org/innovate/iot/stds.html

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# List of Internet of things (IoT) relevant organizations and forums

- **International Organizations**
  - ITU
    - ITU-T Study Groups (SG2; SG3; SG11; SG13; SG16; SG17)
    - Global Standards Initiative on Internet of Things (IoT-GSI)
    - Joint Coordination Activity on Internet of Things (JCA-IoT)
    - ITU-R Study Groups (WP1A; WP1B; WP5A)
  - ISO (TC 122/104 JWG; TC 204)
  - IEC
  - ISO/IEC JTC1 (SC6; SC31; WG7 on Sensor Networks)
  - IEEE Standards Association (IEEE-SA)
- **Regional and National Organizations**
  - ARIB
  - CCSA
  - CEN
  - ETSI (TC M2M, 3GPP)
  - GISFI
  - TIA
  - TTA
  - TTC
- **Global Standards Collaboration**
  - M2M Standardization Task Force (MSTF)
- **Forums, consortia, others**
  - ECMA
  - GS1 / EPC Global
  - IETF
  - IERC
  - NFC
  - Open Geospatial Consortium (OGC)
  - OMA
  - oneM2M
  - W3C
  - YRP Ubiquitous Networking Laboratory
  - ANEC and BEUC

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