IIT KHARAGPUR

NPTEL ONLINE CERTIFICATION COURSES

Introduction to IoT – Part I

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IoT

- ✓ Internet technology connecting devices, machines and tools to the internet by means of wireless technologies.
- ✓ Over 9 billion ‘Things’ connected to the Internet, as of now.
- ✓ ‘Things’ connected to the Internet are projected to cross 20 billion in the near future.
- ✓ Unification of technologies such as low-power embedded systems, cloud computing, big-data, machine learning, and networking.

Origin of Terminology

In the 2000s, we are heading into a new era of ubiquity, where the “users” of the Internet will be counted in billions and where humans may become the minority as generators and receivers of traffic. Instead, most of the traffic will flow between devices and all kinds of “things”, thereby creating a much wider and more complex Internet of Things.

(“The Internet of Things”, ITU Internet Report 2005)

- ✓ The title of the report was “Internet of Things”
- ✓ Discussed the possibility of internet connected M2M connectivity networks, extending to common household devices.
- ✓ Some areas identified as IoT enablers:
  - RFID,
  - Nanotechnology,
  - Sensors,
  - Smart Networks.

Reference: International Telecommunications Union (ITU). (2005). *The Internet of Things. Executive Summary [Online]*

Alternate Definition

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.

Gartner Research

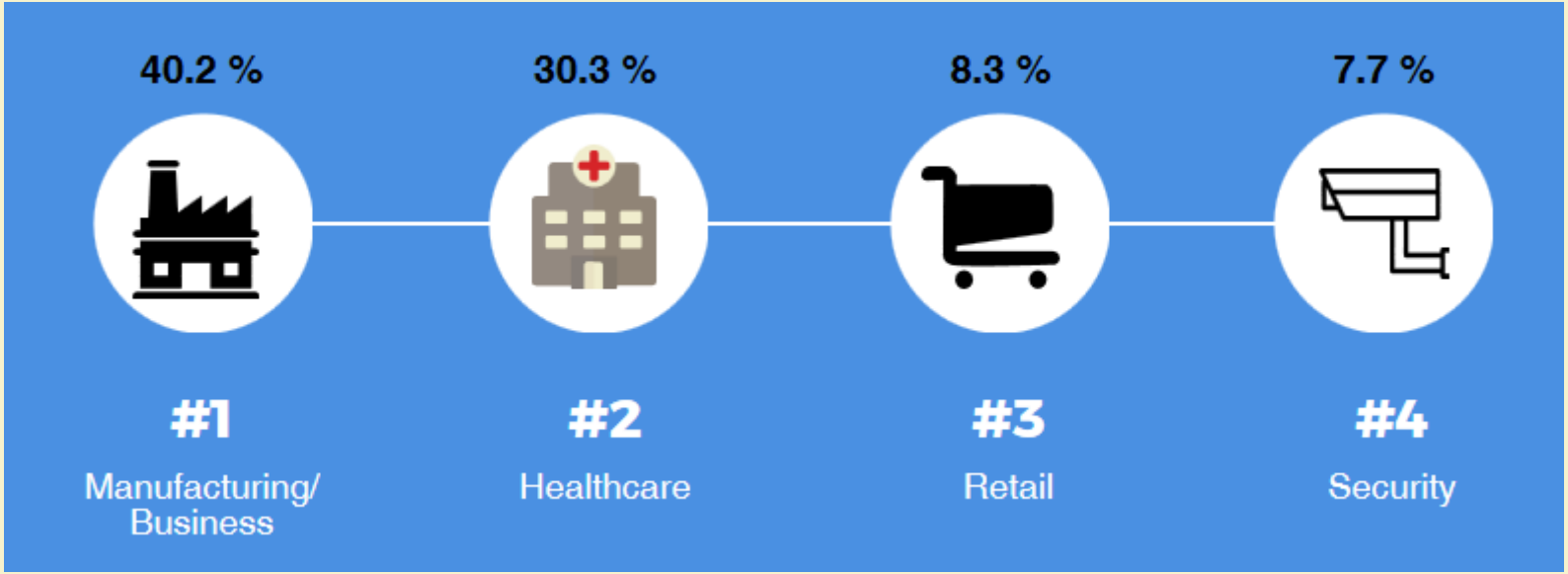
Reference: http://www.gartner.com/it-glossary/internet-of-things/

Characteristics

- ✓ Efficient, scalable and associated architecture
- ✓ Unambiguous naming and addressing
- ✓ Abundance of sleeping nodes, mobile and non-IP devices
- ✓ Intermittent connectivity

Reference: Teemu Savolainen, Jonne Soininen, and Bilhanan Silverajan,*"IPv6 Addressing Strategies for IoT",* IEEE SENSORS JOURNAL, VOL. 13, NO. 10, OCTOBER 2013

IoT Market Share



Source: Intel

- ✓ Business/Manufacturing
  - Real-time analytics of supply chains and equipment, robotic machinery.
- ✓ Healthcare
  - Portable health monitoring, electronic recordkeeping, pharmaceutical safeguards.
- ✓ Retail
  - Inventory tracking, smartphone purchasing, anonymous analytics of consumer choices.
- ✓ Security
  - Biometric and facial recognition locks, remote sensors.

Evolution of Connected Devices

- ✓ ATM
  - These ubiquitous money dispensers went online for the first time way back in 1974.
- ✓ WEB
  - World Wide Web made its debut in 1991 to revolutionize computing and communications.
- ✓ SMART METERS
  - The first power meters to communicate remotely with the grid were installed in the early 2000s.
- ✓ DIGITAL LOCKS
  - Smartphones can be used to lock and unlock doors remotely, and business owners can change key codes rapidly to grant or restrict access to employees and guests.

- ✓ SMART HEALTHCARE
  - Devices connect to hospitals, doctors and relatives to alert them of medical emergencies and take preventive measures.
- ✓ SMART VEHICLES
  - Vehicles self-diagnose themselves and alert owners about system failures.
- ✓ SMART CITIES
  - City-wide infrastructure communicating amongst themselves for unified and synchronized operations and information dissemination.
- ✓ SMART DUST
  - Computers smaller than a grain of sand can be sprayed or injected almost anywhere to measure chemicals in the soil or to diagnose problems in the human body.

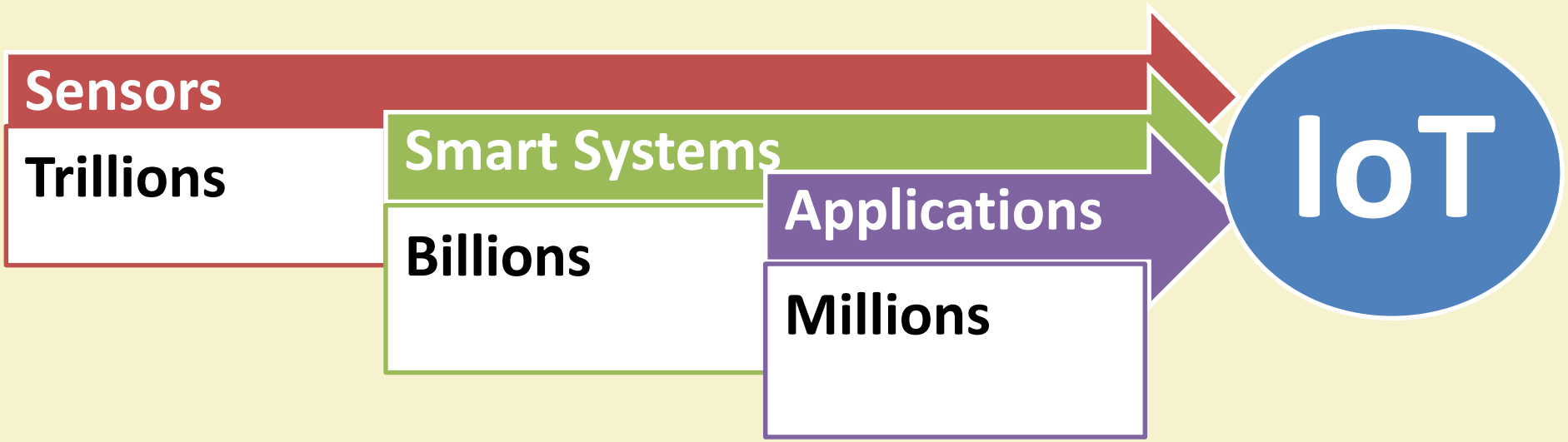
Modern Day IoT Applications

- ✓ Smart Parking
- ✓ Structural health
- ✓ Noise Urban Maps
- ✓ Smartphone Detection
- ✓ Traffic Congestion
- ✓ Smart Lighting
- ✓ Waste Management
- ✓ Smart Roads
- ✓ River Floods
- ✓ Smart Grid
- ✓ Tank level
- ✓ Photovoltaic Installations
- ✓ Water Flow
- ✓ Silos Stock Calculation
- ✓ Perimeter Access Control
- ✓ Liquid Presence

Modern Day IoT Applications

- ✓ Forest Fire Detection
- ✓ Air Pollution
- ✓ Snow Level Monitoring
- ✓ Landslide and Avalanche Prevention
- ✓ Earthquake Early Detection
- ✓ Water Leakages
- ✓ Radiation Levels
- ✓ Explosive and Hazardous Gases
- ✓ Supply Chain Control
- ✓ NFC Payment
- ✓ Intelligent Shopping Applications
- ✓ Smart Product Management

Expected!!


Sensors
Trillions
Smart Systems
Billions
Applications
Millions
IoT

IoT Enablers

IMPLEMENTATION

ZigBee

RFID

INSTEON

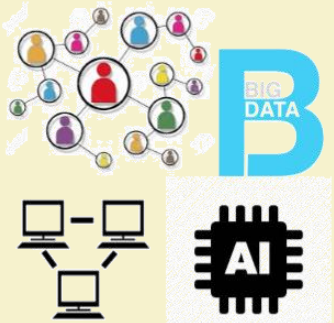
LoWPAN

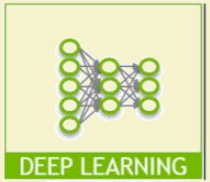
IPv6-based Low-power Wireless Personal Area Networks

LoRa

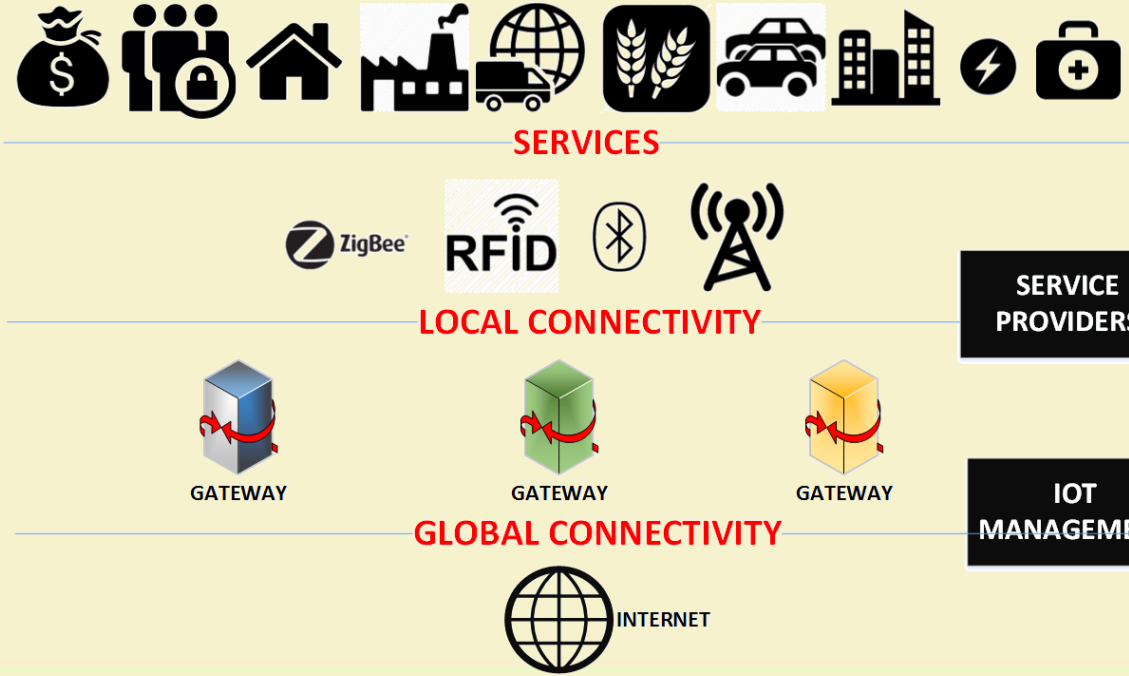
CONNECTIVITY

ENABLING TECHNOLOGIES





Connectivity Layers



Baseline Technologies

- ✓ A number of technologies that are very closely related to IoT include
  - Machine-to-Machine (M2M) communications,
  - Cyber-Physical-Systems (CPS)
  - Web-of-Things (WoT).

IoT vs. M2M

- ✓ M2M refers to communications and interactions between machines and devices.
- ✓ Such interactions can occur via a cloud computing infrastructure (e.g., devices exchanging information through a cloud infrastructure).
- ✓ M2M offers the means for managing devices and devices interaction, while also collecting machine and/or sensor data.
- ✓ M2M is a term introduced by telecommunication services providers and, pays emphasis on machines interactions via one or more telcom/communication networks (e.g., 3G, 4G, 5G, satellite, public networks).

IoT vs. M2M

- ✓ **M2M is part of the IoT, while M2M standards have a prominent place in the IoT standards landscape.**
- ✓ However, IoT has a broader scope than M2M, since it comprises a broader range of interactions, including interactions between devices/things, things and people, things with applications and people with applications.
- ✓ It also enables the composition of workflows comprising all of the above interactions.
- ✓ IoT includes the notion of internet connectivity (which is provided in most of the networks outlined above), but is not necessarily focused on the use of telcom networks.

IoT vs. WoT

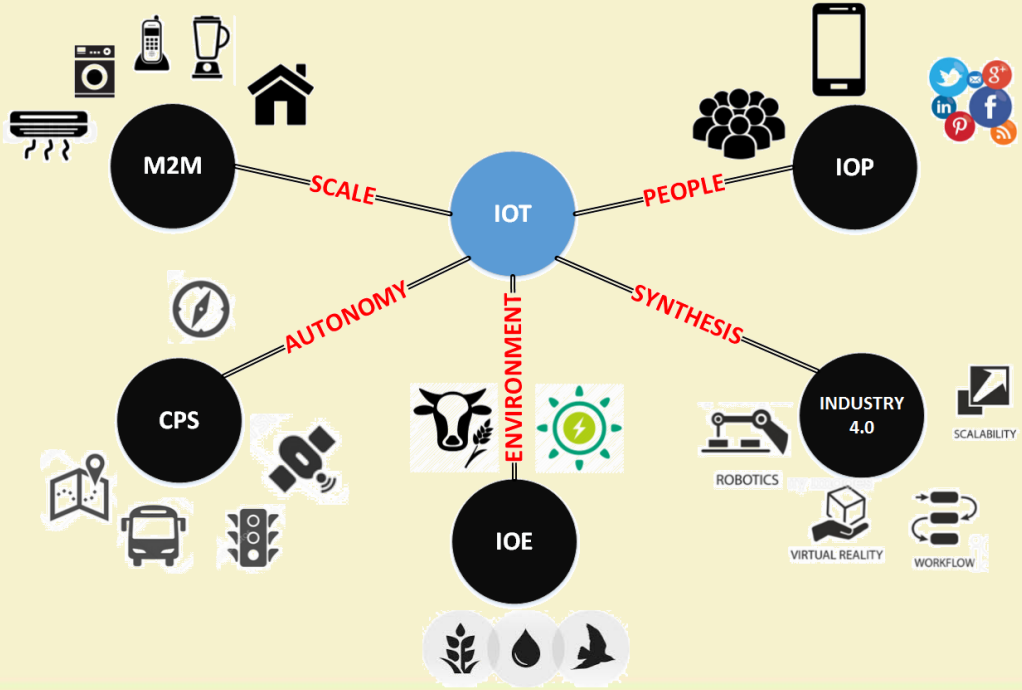
- ✓ From a developer's perspective, the WoT enables access and control over IoT resources and applications using mainstream web technologies (such as HTML 5.0, JavaScript, Ajax, PHP, Ruby n' Rails etc.).
  - The approach to building WoT is therefore based on RESTful principles and REST APIs, which enable both developers and deployers to benefit from the popularity and maturity of web technologies.
  - Still, building the WoT has various scalability, security etc. challenges, especially as part of a roadmap towards a global WoT.

IoT vs. WoT

- ✓ While IoT is about creating a network of objects, things, people, systems and applications, WoT tries to integrate them to the Web.

- ✓ Technically speaking, WoT can be thought as a flavour/option of an application layer added over the IoT's network layer. However, the scope of IoT applications is broader and includes systems that are not accessible through the web (e.g., conventional WSN and RFID systems).

Terminological Interdependence



Thank You!!