Ch. 01: IoT Introduction

Section 1 - IoT Components & Definition

Section 2 - IoT Revolution

CS 244p: Internet-of-Things. Software and Systems

IOT COMPONENTS?

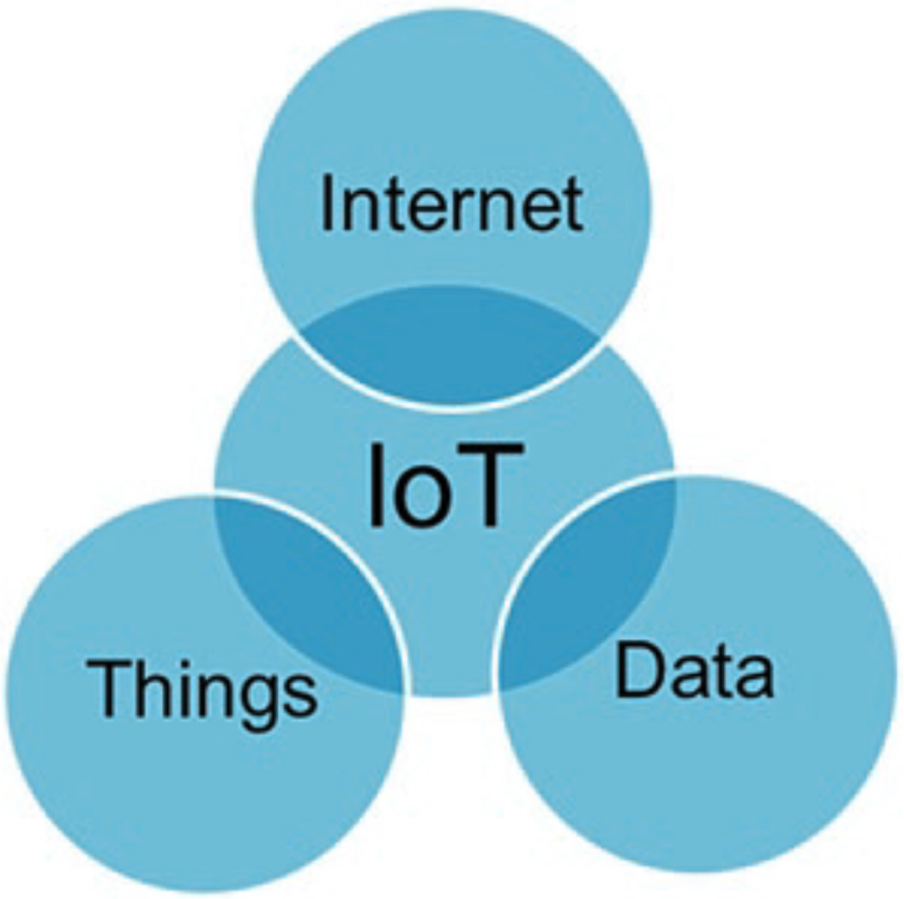
- A **network** of **physical** elements empowered by:
  - **Sensors**: to collect information
  - **Identifiers**: to identify the source of data (e.g., sensors and devices)
  - **Software**: to analyze data
  - **Internet connectivity**: to communicate and notify

WHAT IS IOT?

Definition 1:

- IoT is the **network** of **things**, with clear element **identification**, embedded with **software intelligence**, **sensors**, and **ubiquitous** **connectivity** to the **Internet**.

WHAT IS IOT?



Definition 2:

IoT is the **network** of **physical objects** (devices, vehicles, buildings and other items) embedded with **electronics**, **software**, **sensors**, and **network connectivity** — that enables these objects to **collect** and **exchange** data.

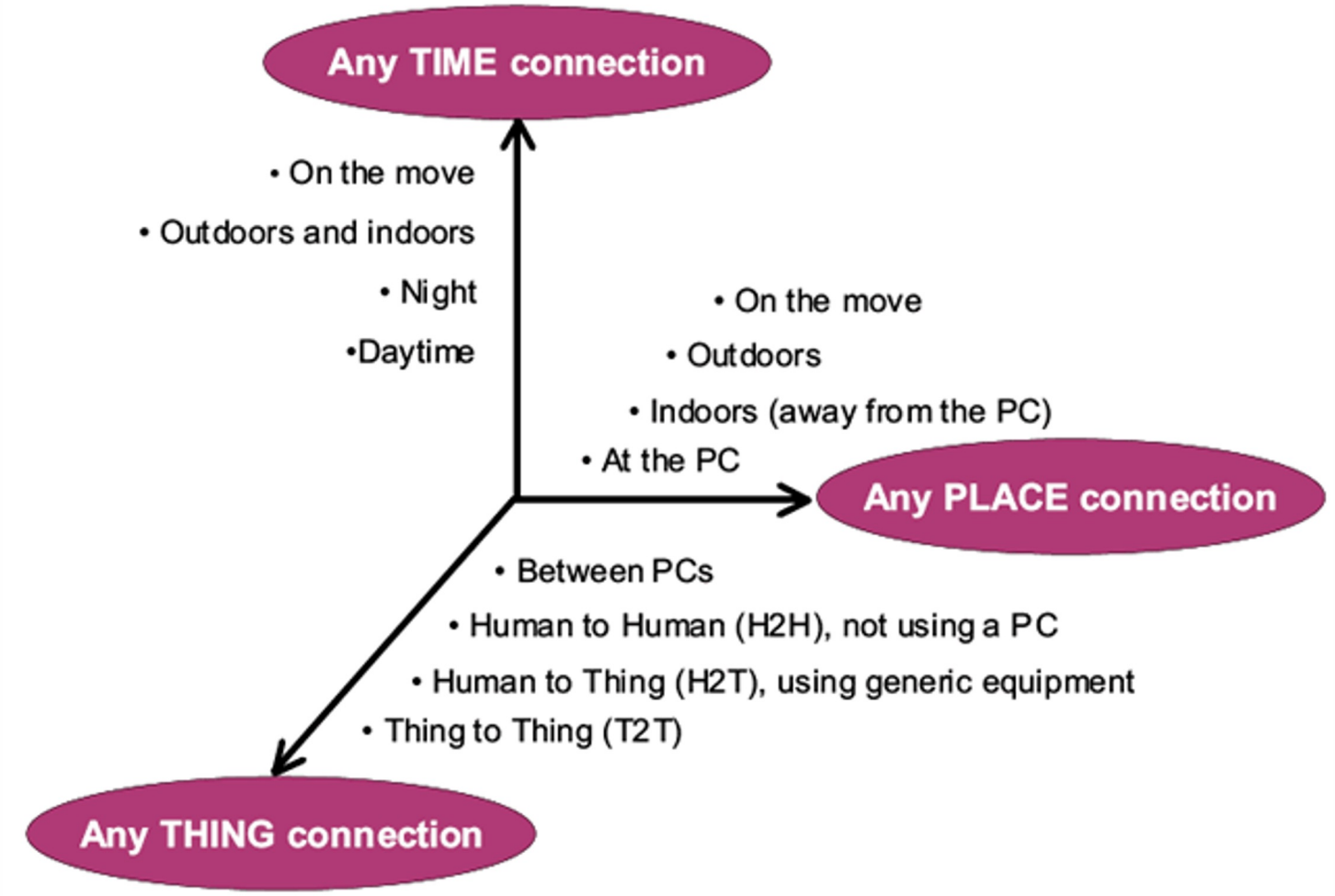
TERMINOLOGIES LIKE IOT

1. USN (Ubiquitous Sensor Networks)
2. M2M (Machine-to-Machine)
3. IoE (Internet of Everything) – Cisco's favorite term
4. Cloud of Things
5. Web of Things
6. World Size Web (Bruce Schneier)
7. Skynet (Terminator movie)

WHERE IS IOT?

It's everywhere!

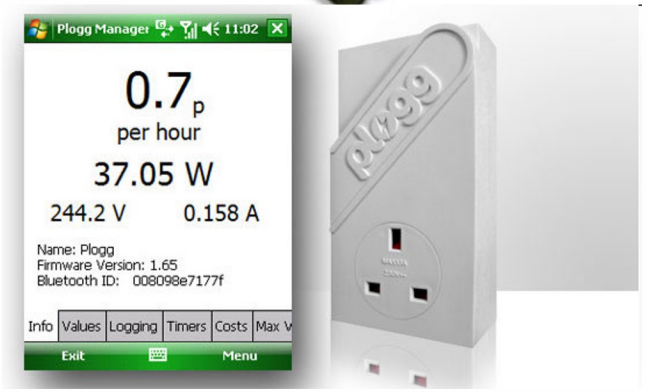
INTERNET-OF-THINGS



Source: ITU adapted from Nomura Research Institute

SENSOR DEVICES ARE BECOMING WIDELY AVAILABLE

- Programmable devices
- Off-the-shelf gadgets/tools



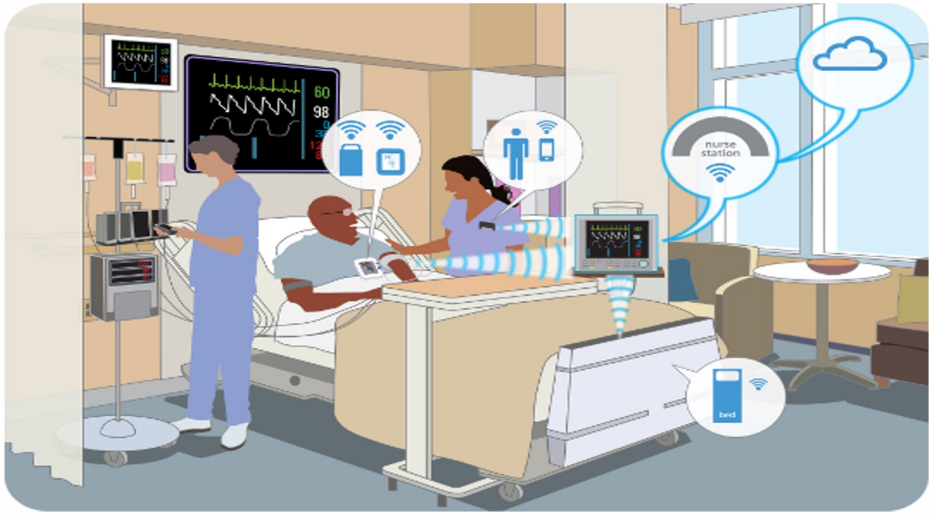
Linker Intel Group

Image Sensor Device

SEVERAL DEMANDING MARKETS

Wearable Tech

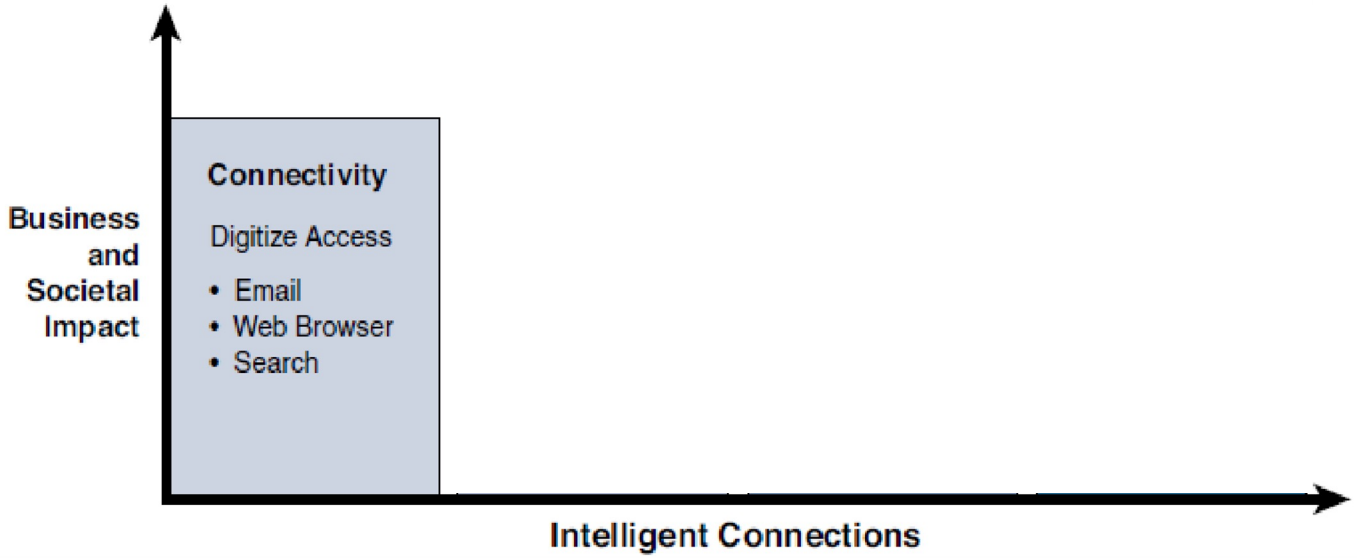
Smart



Healthcare

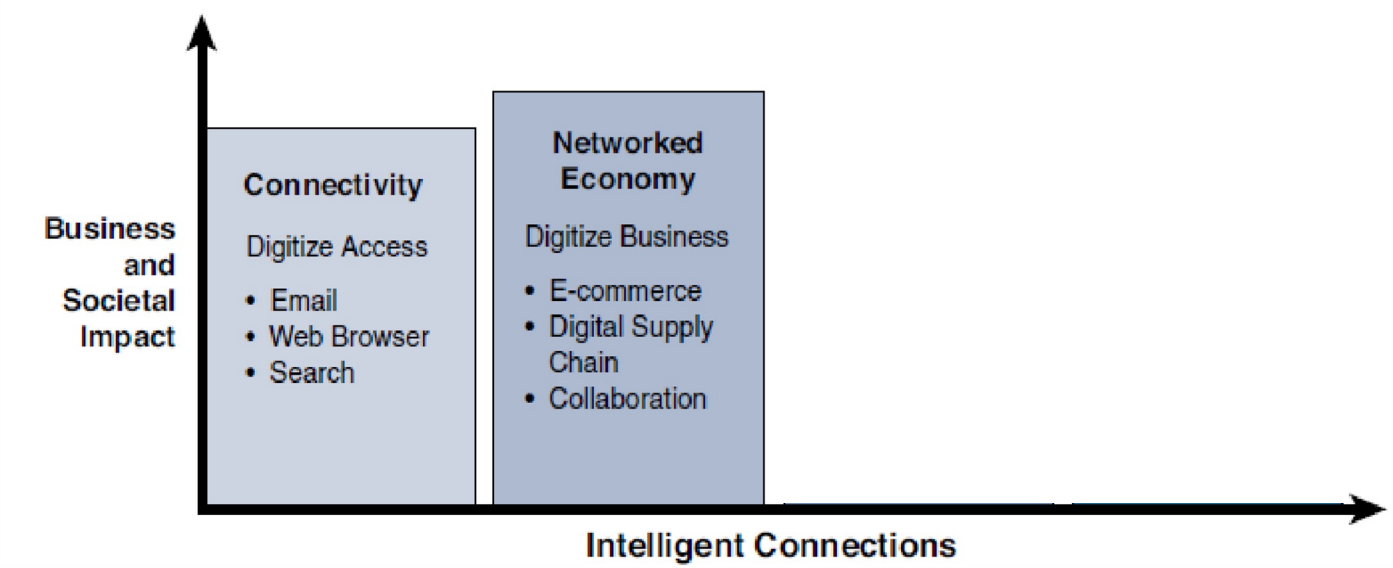
EVOLUTIONARY PHASES OF THE INTERNET

- Connectivity => Digitize access to resources



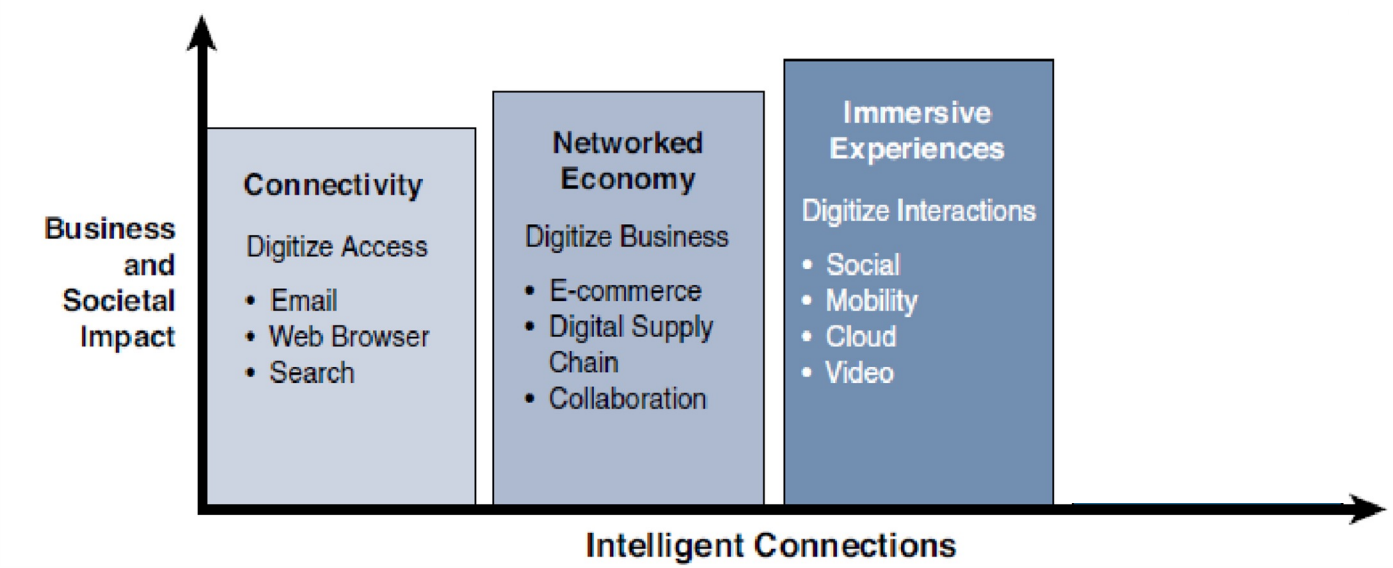
EVOLUTIONARY PHASES OF THE INTERNET

- Connectivity => Digitize access to resources
- Networked Economy => Digitize business



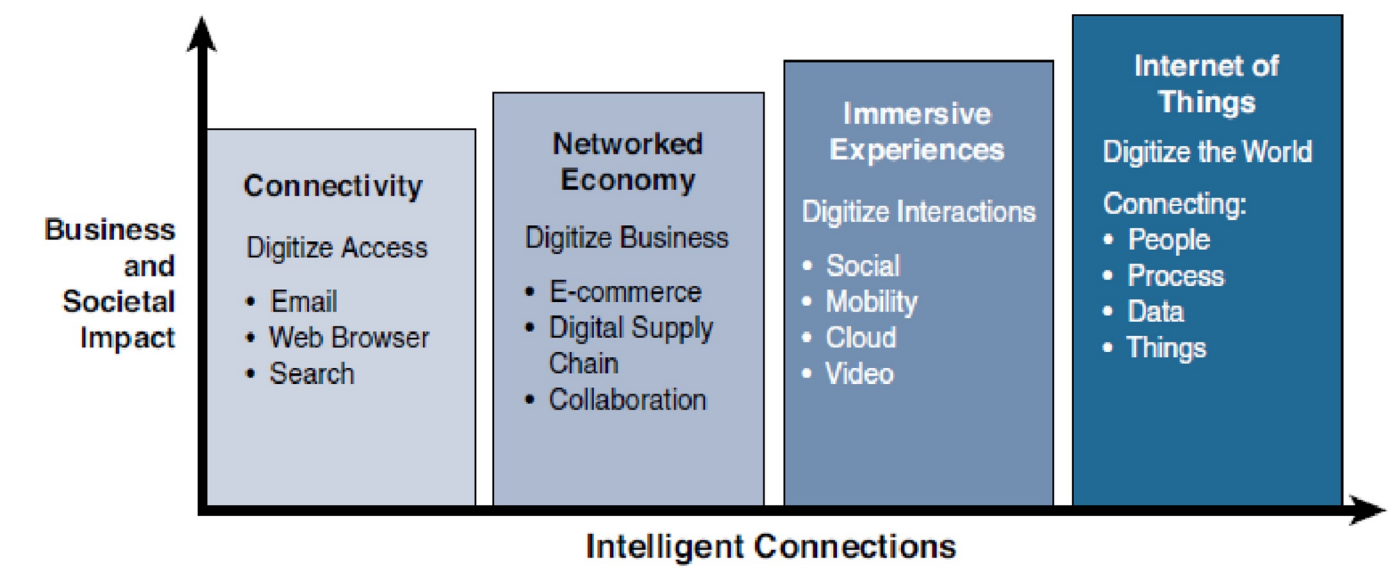
EVOLUTIONARY PHASES OF THE INTERNET

- Connectivity => Digitize access to resources
- Networked Economy => Digitize business
- Immersive Experiences => Digitize interactions

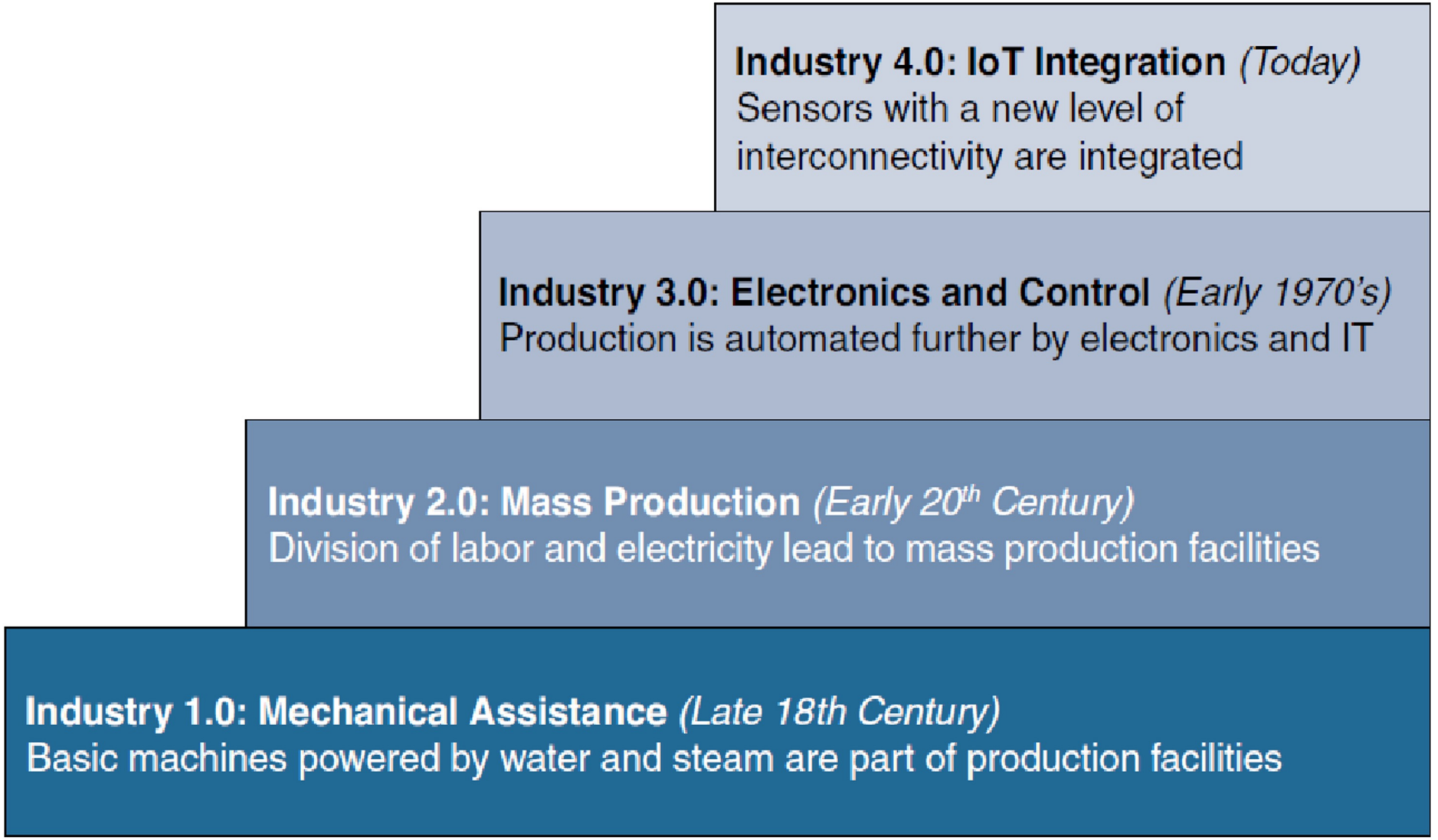


EVOLUTIONARY PHASES OF THE INTERNET

- Connectivity => Digitize access to resources
- Networked Economy => Digitize business
- Immersive Experiences => Digitize interactions
- Internet of Things => Digitize the world



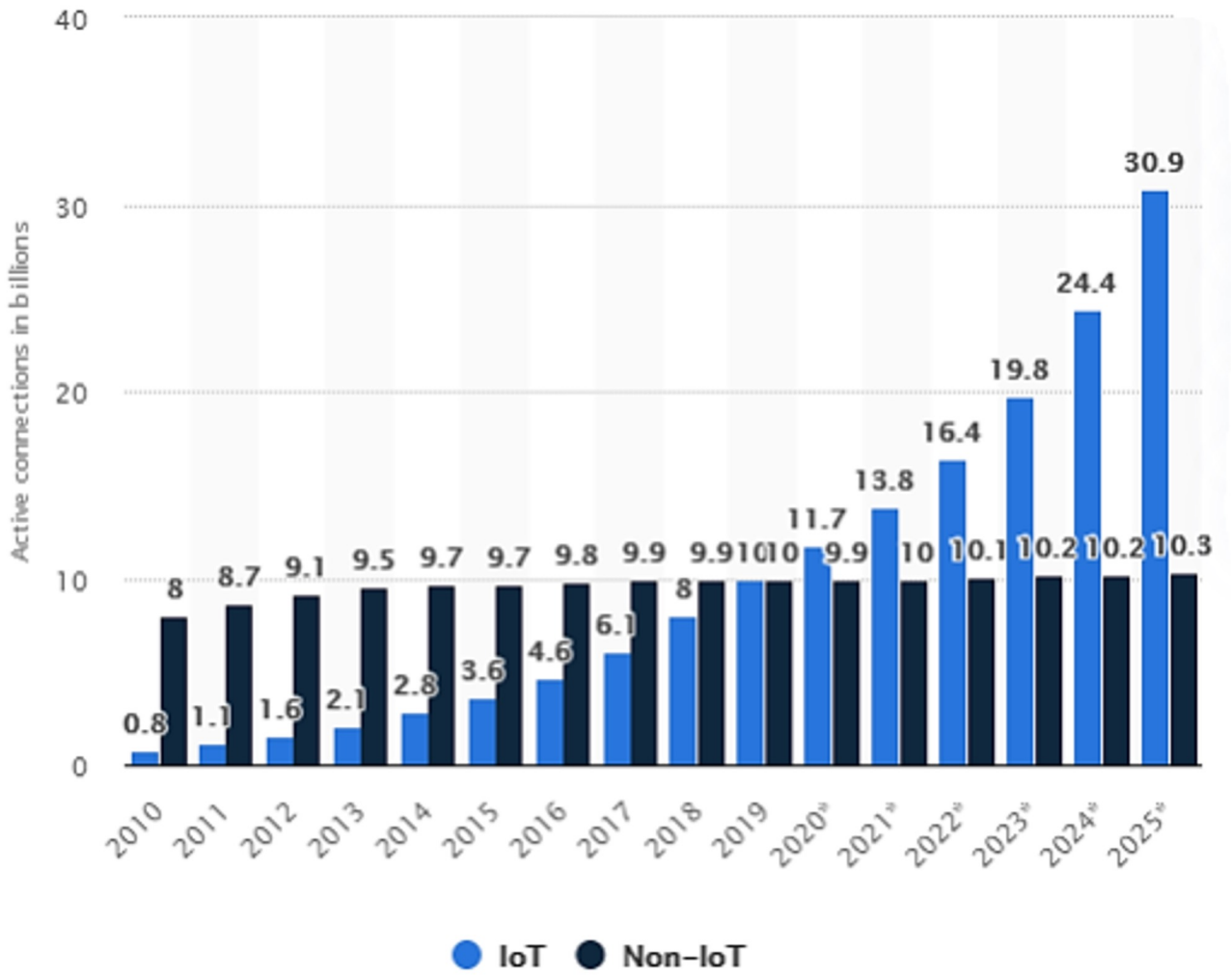
THE FOUR INDUSTRIAL REVOLUTIONS



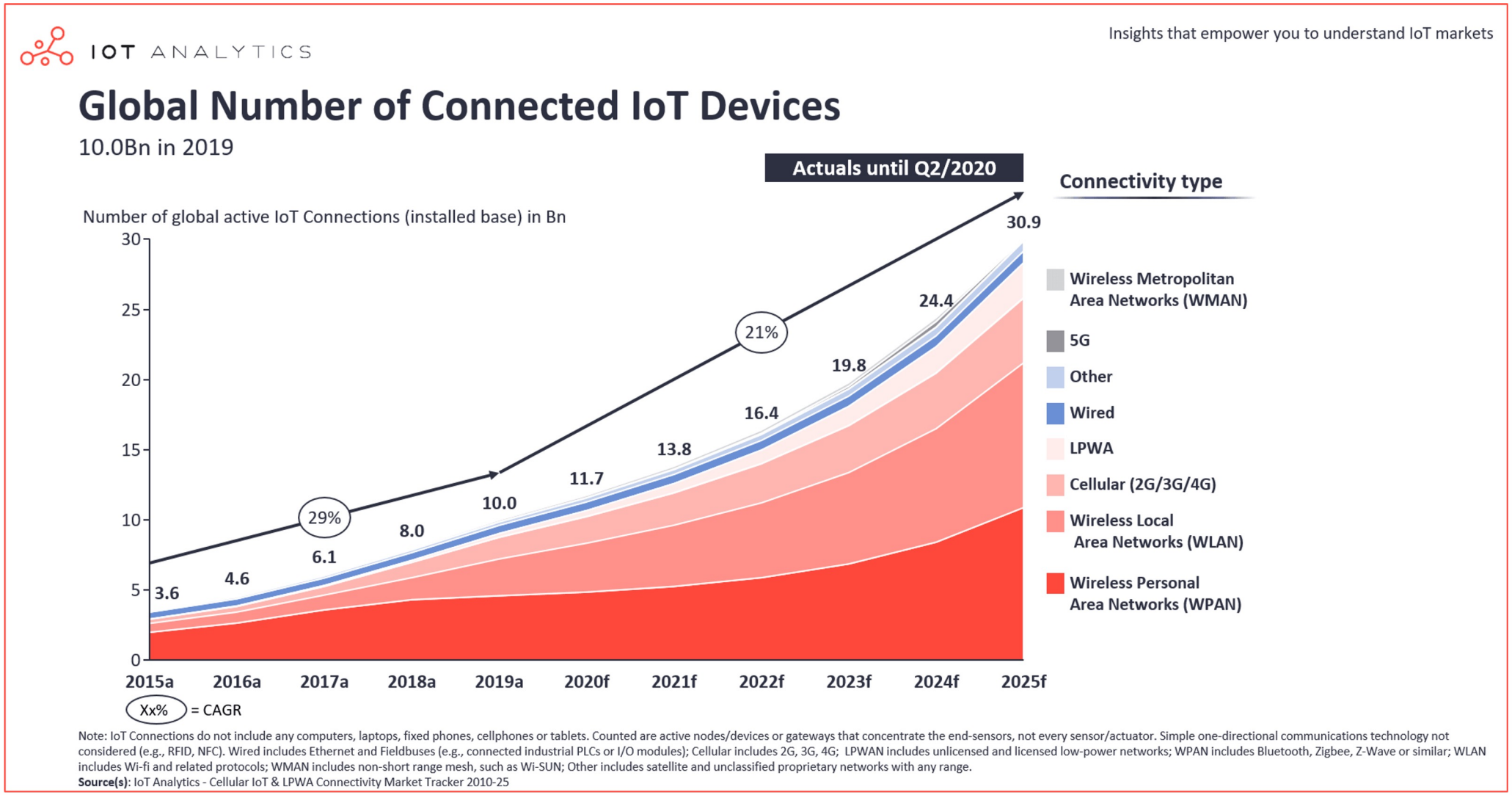
THE IOT MARKET

- As of 2022, 18 billion IoT active connections
- 31 billion expected by 2025
- The global IoT market will be worth $900 billion in revenue by 2025

- Operation adjusted due to Covid-19
  - Remote access and automation.
  - Software tools and cloud computing.

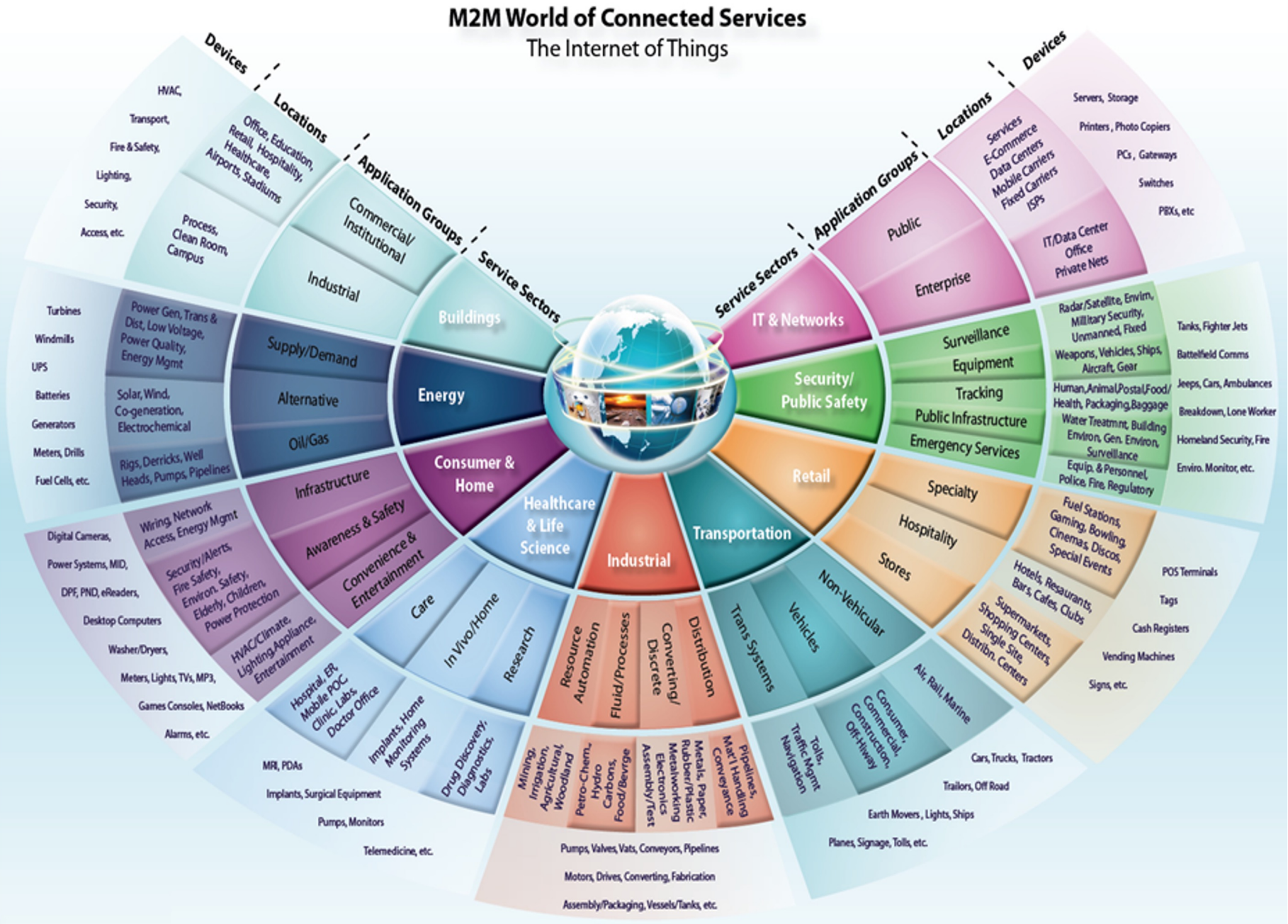


THE IOT "THING" CONNECTED TO THE INTERNET

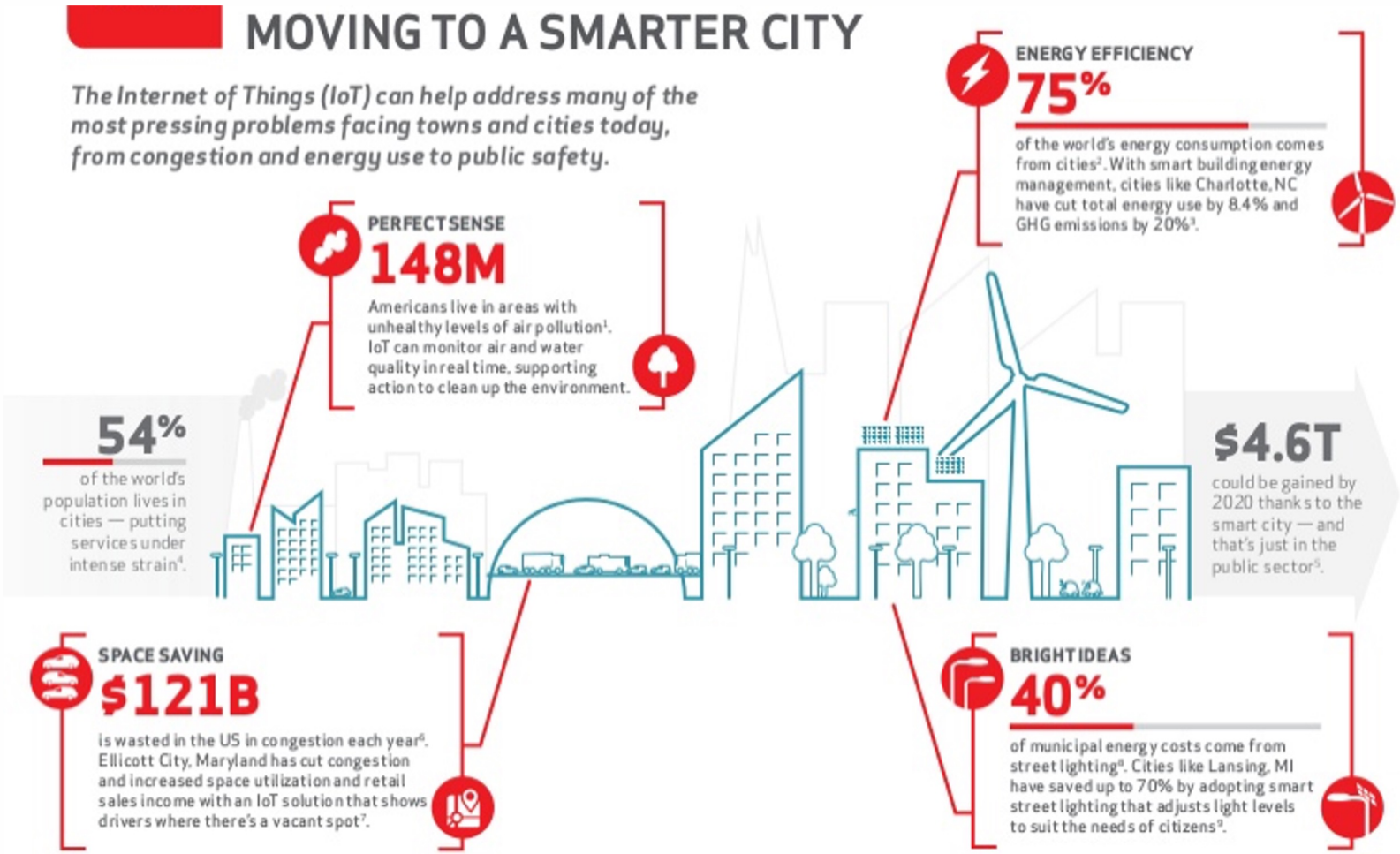


Note: IoT Connections do not include any computers, laptops, fixed phones, cellphones or tablets. Counted are active nodes/devices or gateways that concentrate the end-sensors, not every sensor/actuator. Simple one-directional communications technology not considered (e.g., RFID, NFC). Wired includes Ethernet and Fieldbuses (e.g., connected industrial PLCs or I/O modules); Cellular includes 2G, 3G, 4G; LPWAN includes unlicensed and licensed low-power networks; WPAN includes Bluetooth, Zigbee, Z-Wave or similar; WLAN includes Wi-fi and related protocols; WMAN includes non-short range mesh, such as Wi-SUN; Other includes satellite and unclassified proprietary networks with any range.

Source(s): IoT Analytics - Cellular IoT & LPWA Connectivity Market Tracker 2010-25


M2M World of Connected Services
The Internet of Things
Devices
Locations
Application Groups
Service Sectors
HVAC,
Transport,
Fire & Safety,
Lighting,
Security,
Access, etc.
Office, Education, Retail, Hospitality, Healthcare, Airports, Stadiums
Process, Clean Room, Campus
Commercial/ Institutional
Industrial
Buildings
Energy
Supply/Demand
Alternative
Oil/Gas
Turbines
Windmills
UPS
Batteries
Generators
Meters, Drills
Fuel Cells, etc.
Power Gen, Trans & Dist, Low Voltage, Power Quality, Energy Mgmt
Solar, Wind, Co-generation, Electrochemical
Rigs, Derricks, Well Heads, Pumps, Pipelines
Consumer & Home
Infrastructure
Awareness & Safety
Convenience & Entertainment
Digital Cameras,
Power Systems, MID,
DPF, PND, eReaders,
Desktop Computers
Washer/Dryers,
Meters, Lights, TVs, MP3,
Games Consoles, NetBooks
Alarms, etc.
Wiring, Network Access, Energy Mgmt
Security/Alerts, Fire Safety, Environ. Safety, Elderly, Children, Power Protection
HVAC/Climate, Lighting,Appliance, Entertainment
Healthcare & Life Science
Care
In Vivo/Home
Research
Hospital, ER, Mobile POC, Clinic, Labs, Doctor Office
Implants, Home Monitoring Systems
Drug Discovery, Diagnostics, Labs
MRI, PDAs
Implants, Surgical Equipment
Pumps, Monitors
Telemedicine, etc.
Industrial
Resource Automation
Fluid/Processes
Converting/ Discrete
Distribution
Mining, Irrigation, Agricultural, Woodland
Petro-Chem., Hydro Carbons, Food/Bevrge
Assembly/Test Electronics
Metalworking Metals, Paper, Rubber/Plastic
Pipelines, Mat'l Handling Conveyance
Pumps, Valves, Vats, Conveyors, Pipelines
Motors, Drives, Converting, Fabrication
Assembly/Packaging, Vessels/Tanks, etc.
Transportation
Trans Systems
Non-Vehicular
Vehicles
Tolls, Traffic Mgmt Navigation
Consumer, Commercial, Construction, Off-Hiway
Air, Rail, Marine
Cars, Trucks, Tractors
Trailors, Off Road
Earth Movers , Lights, Ships
Planes, Signage, Tolls, etc.
Retail
Specialty
Hospitality
Stores
Fuel Stations, Gaming, Bowling, Cinemas, Discos, Special Events
Hotels, Resaurants, Bars, Cafes, Clubs
Supermarkets, Shopping Centers, Single Site, Distribn. Centers
POS Terminals
Tags
Cash Registers
Vending Machines
Signs, etc.
Security/ Public Safety
Surveillance
Equipment
Tracking
Public Infrastructure
Emergency Services
Radar/Satellite, Envirn, Military Security, Unmanned, Fixed
Weapons, Vehicles, Ships, Aircraft, Gear
Human,Animal,Postal,Food/ Health, Packaging,Baggage
Water Treatmnt, Building Environ, Gen. Environ, Surveillance
Equip. & Personnel, Police, Fire, Regulatory
Tanks, Fighter Jets
Battelfield Comms
Jeeps, Cars, Ambulances
Breakdown, Lone Worker
Homeland Security, Fire
Enviro. Monitor, etc.
IT & Networks
Public
Enterprise
Services
E-Commerce
Data Centers
Mobile Carriers
Fixed Carriers
ISPs
IT/Data Center
Office
Private Nets
Servers, Storage
Printers , Photo Copiers
PCs , Gateways
Switches
PBXs, etc

MOST RELEVANT IOT MARKETS - SMART CITIES

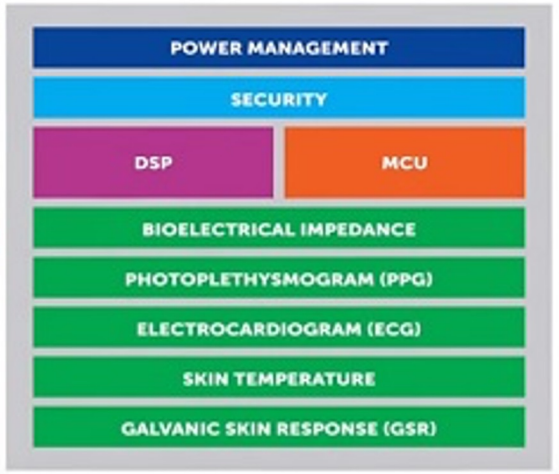


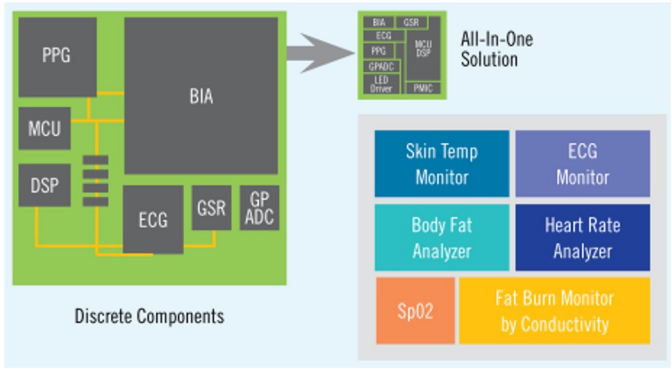
Source: Verizonenterprise.com/iot

MOST RELEVANT IOT MARKETS – HEALTHCARE/WELLNESS

Samsung

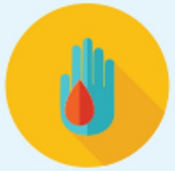
Bio-Processor





Body Fat

Body Fat Percentage
BIA sensors can measure body fat, adjusting for normal or athletic users.



PPG

Photoplethysmogram
PPG sensors can monitor heart rate and respiration.

ECG

Electrocardiogram
Electrocardiogram readings measure heart rate and heart rhythm, testing general heart health.

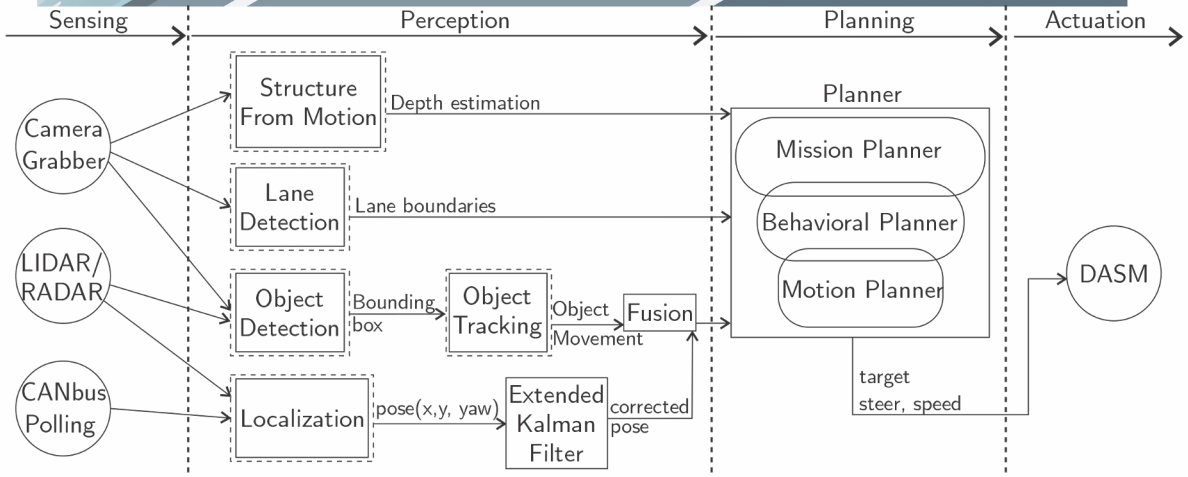
Skin Temp.

Skin Temperature
Temperature sensors measure skin temperature to obtain overall body temperature.

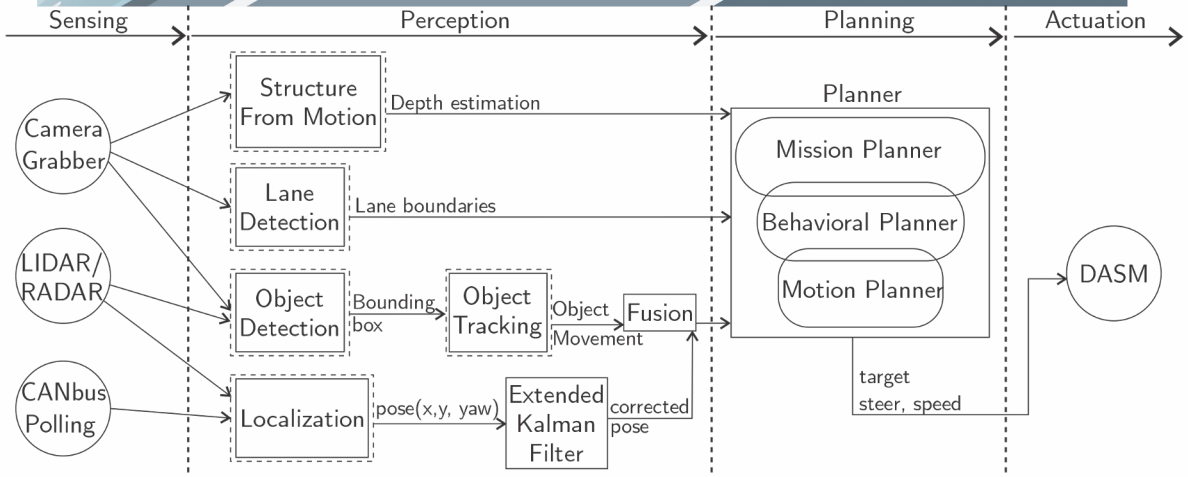
GSR (EDA)

Galvanic Skin Response
Galvanic Skin Response (also called EDA) readings measure stress levels and emotional state.

SMART TRANSPORTATION

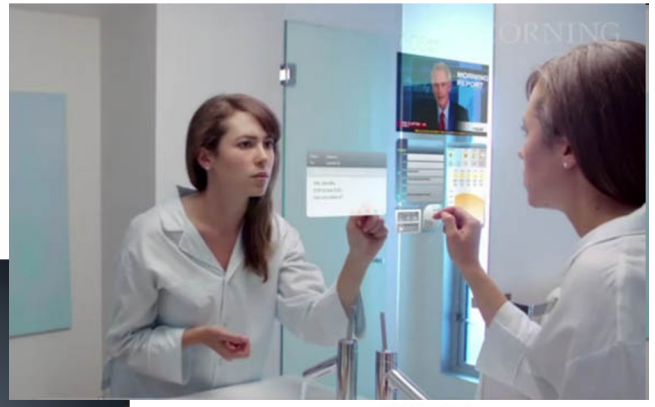


SMART TRANSPORTATION

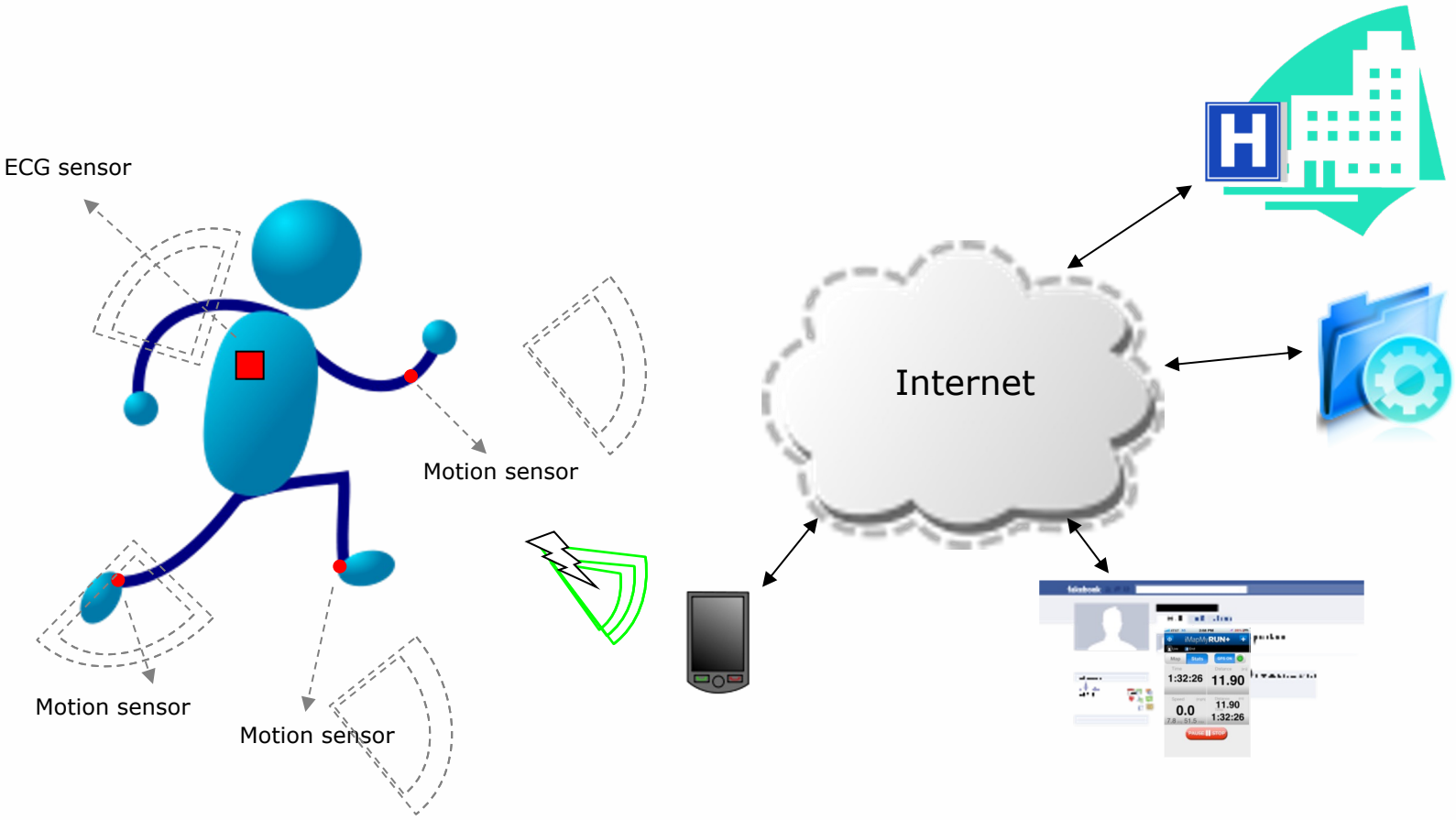


MORE "THINGS" ARE BEING CONNECTED

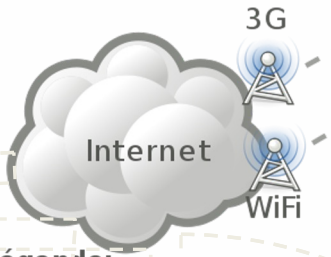
Home/daily-life devices
Business and
Public infrastructure
Health-care
…



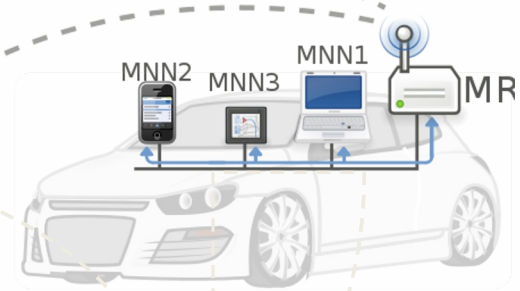
PEOPLE CONNECTING TO THINGS

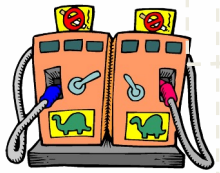


THINGS CONNECTING TO THINGS



Légende:
MR Routeur mobile
MNN Nœud Mobile
↔ Context informations

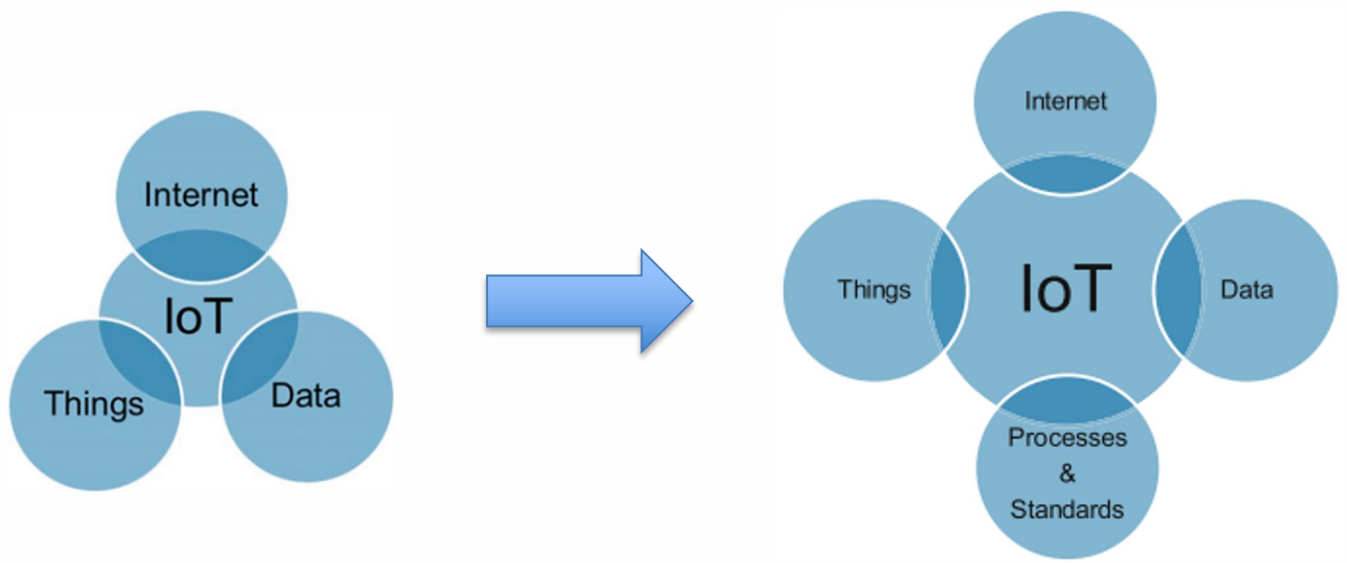




- Complex and heterogeneous resources and networks

IOT – MORE COMPLETE DEFINITION

Connecting objects together *is not an objective by itself but* ***gathering intelligence*** *from such objects to* ***enrich products and services*** *is.*



Data: Converting data into intelligence to make better decisions;
Process: Delivering the right information to the right person or machine at the right time;

IOT – MORE COMPLETE DEFINITION II

- That today's Internet is the "**Internet of People**".
  - It is mainly connecting applications that are used by people.

IoT is the network of things, with device identification, **embedded intelligence**, and sensing and **acting** capabilities, **connecting people and things** over the Internet.

IOT REFERENCE FRAMEWORK I

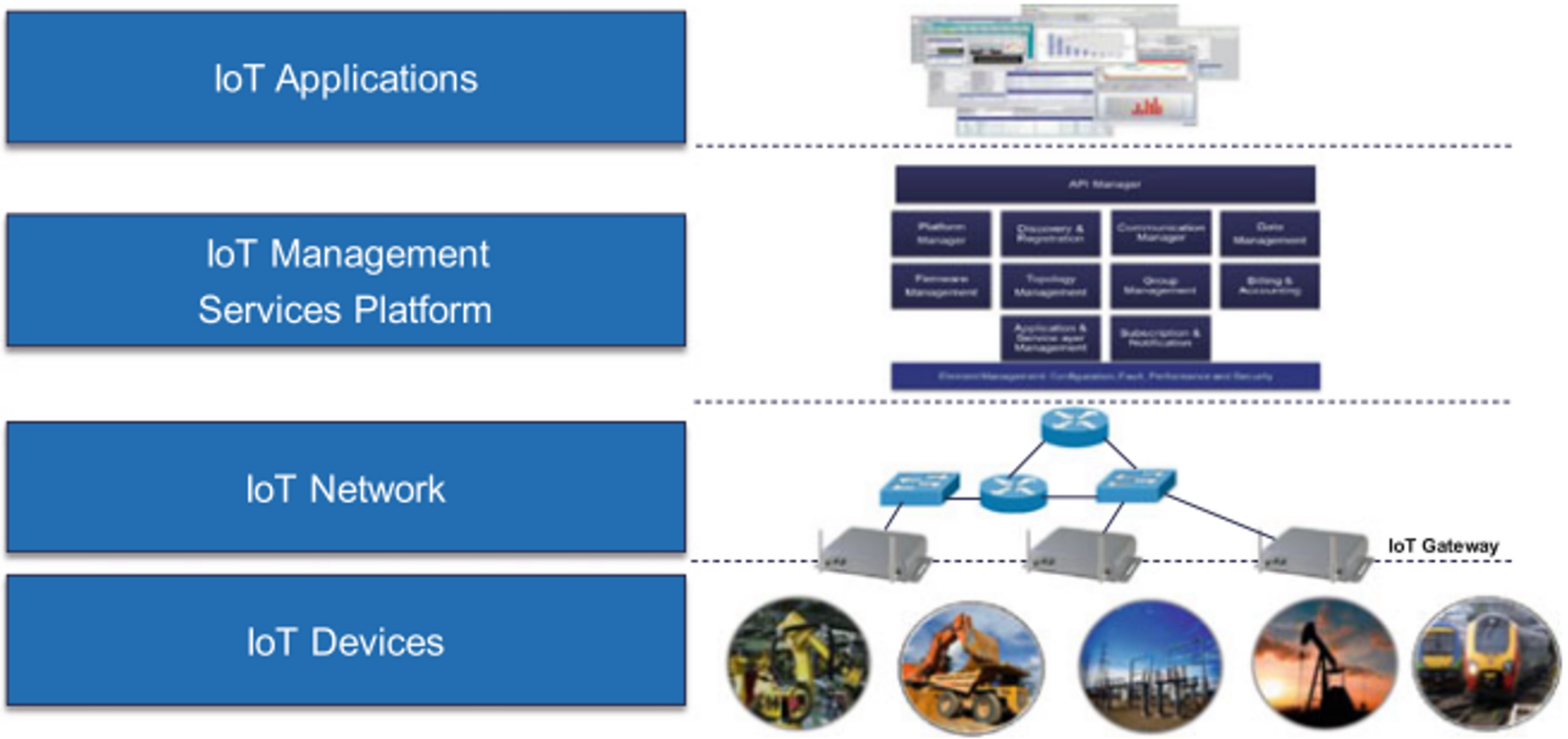
- **IoT Device Level** includes all IoT sensors and actuators
  i.e., the things in IoT

- **IoT Network Level** includes all IoT network components
  IoT gateways, routers, and switches.

- **IoT Management Services Platform Level** includes the key management software functions to enable the overall management of IoT devices and network.
  It also includes main functions connecting the device and network levels with the application layer.

- **IoT Application Level** includes all applications operating in the IoT network.

IOT REFERENCE FRAMEWORK II



MONITOR AND CONTROL

The basic promise of IoT is to **monitor** and **control** " things " from anywhere in the world.

- How to monitor and control things from anywhere in the world?
- Why do we want to do so?
- Who will perform the monitoring and control?
- How is security guaranteed?
- How is interoperability provided?
- How is reliability ensured?
- How can we enhance the efficiency?