Internet of Things (IoT)

Introduction to IoT

Definitions, Characteristics, Applications

Dr. Manas Khatua
Associate Professor
Dept. of CSE, IIT Guwahati
E-mail: manaskhatua@iitg.ac.in

What is IoT?

- ✓ Internet of Things is the **network of smart physical objects**
  - physical objects (e.g. devices, vehicles, buildings, etc.) embedded with sensors, computation unit, memory unit, power source, and network connectivity,
  - which enables the physical object to collect and exchange data,
  - analyze the collected data to extract new insight and respond accordingly.

- ✓ Goal of IoT is to "connect the unconnected"
  - "Things" or "objects" that were not supposed to be connected to the Internet

- ➢ IoT did the technology transition in traditional computer networks

Cont…

- IoT is the Unifications of technologies:
  - ✓ Embedded Systems
  - ✓ Low Power and Low Rate Network
  - ✓ Internet
  - ✓ Cloud Computing
  - ✓ Data Analytics
  - ✓ Bigdata
  - ✓ Edge Intelligence
  - ✓ Network Security and Data Security
  - ✓ Software Defined Networks
  - ✓ Etc.

- 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*

* https://www.gartner.com/en/information-technology/glossary/internet-of-things

Brief History of Initial Phase of IoT

- The term "Internet of Things" was likely coined by Kevin Ashton of Procter & Gamble, later MIT's Auto-ID Center, **in 1999.**
  - Kevin Ashton said –

  "In 20th century, computers were brains without senses – they only knew what we told them."

  "Now in 21st century, computers are sensing things for themselves!"

- **Early 1980s** at the Carnegie Melon University, a group of students created a way to get their campus Coca-Cola vending machine to report on its contents through a network in order to save them the trek if the machine was out of Coke.

Brief History of Initial Phase of IoT

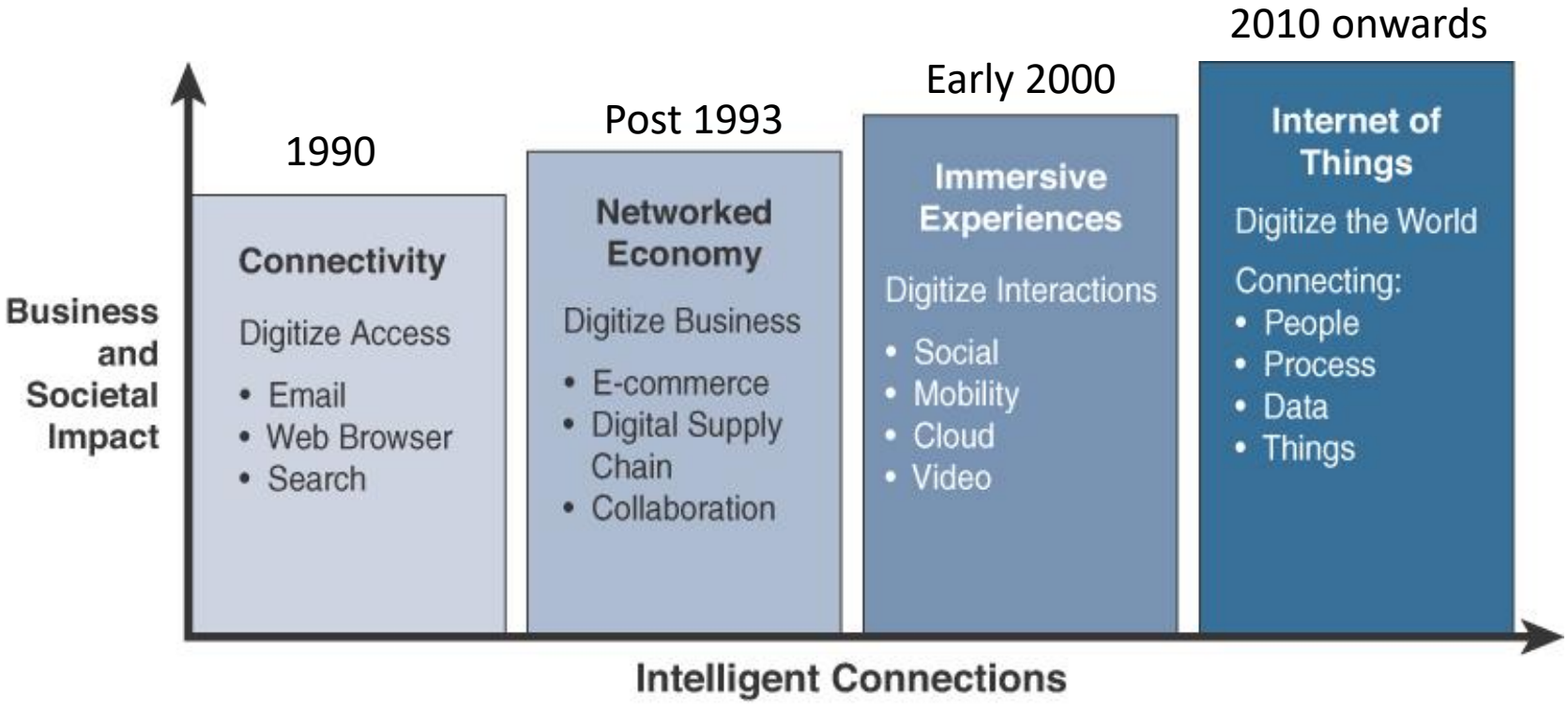
- **In 1990**, John Romkey, developer of the first TCP/IP stack for IBM PC in 1983, connected a toaster to the internet for the first time.

- **In 1991**, a group of students at the University of Cambridge used a web camera to report on coffee available in their computer labs coffee pot.

- At the **beginning of the 21st Century**, LG Electronics introduced the world's first refrigerator connected to the internet

Brief History of Initial Phase of IoT

- The popularity of IoT did not accelerate until 2010/2011 and reached mass market from 2013-14.
- Definition of the IoT has also evolved over time.



Evolutionary Phases of the Internet

Benefits of IoT

- Real-Time Monitoring
  - IoT sensors can monitor equipment and processes in real-time, providing valuable sensed data that can be used to streamline operations, reduce waste, and increase output.

- Automation of Processes
  - Machines can assemble parts with more precision and speed, resulting in fewer errors during assembly
  - Robots can very rapidly detect faults that may not be detected by the human eye

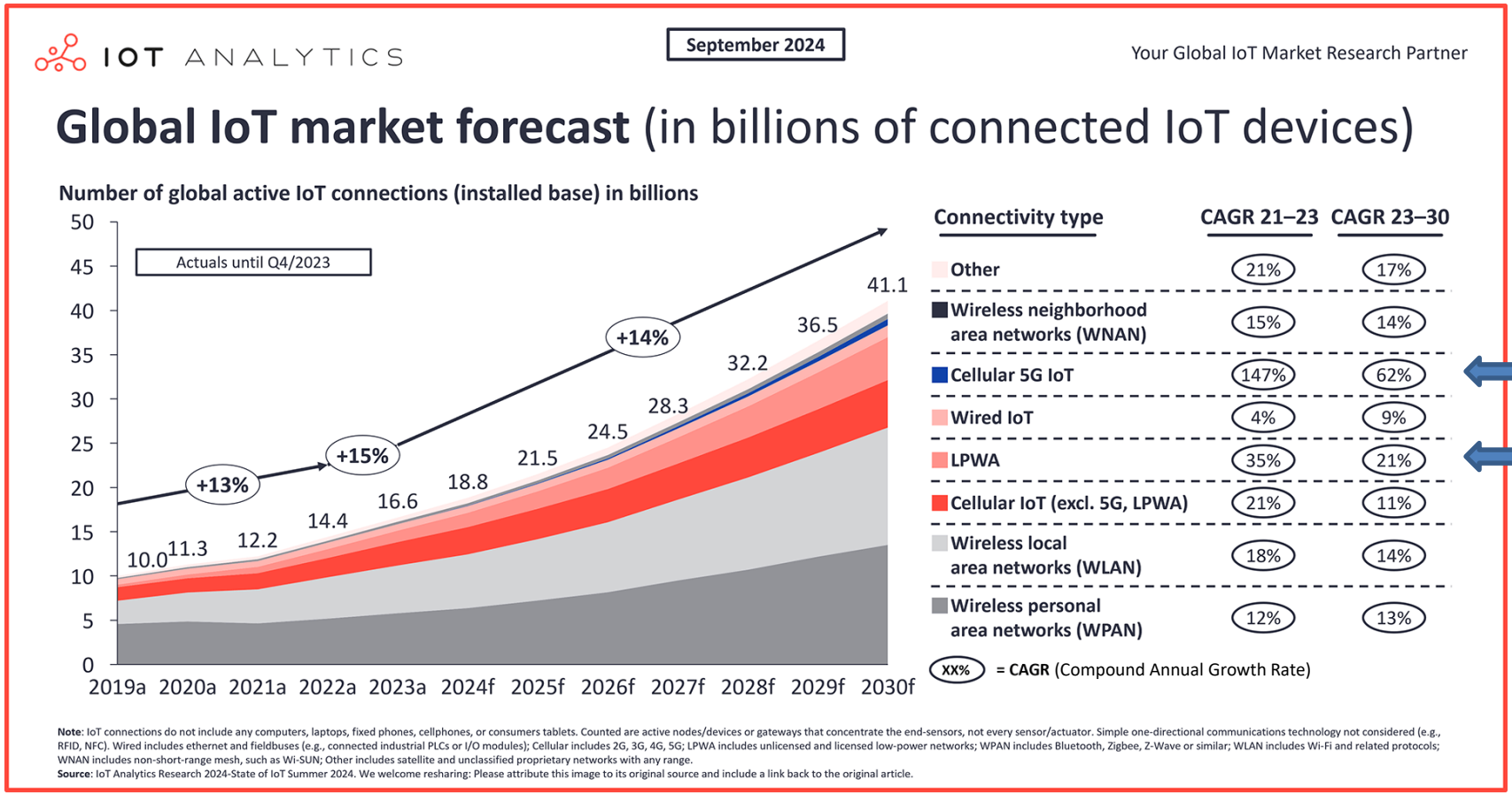
- Improved Efficiency or Productivity
  - IoT helps to enhance productivity by streamlining processes, automating tasks, and providing real-time data insights.

- Predictive Maintenance
  - Continuous monitoring of systems and processes to identify key indicators of problems before they result in downtime or system failure

Benefits of IoT

- Improved or New Insights
  - IoT generates vast amounts of data that can be analyzed to identify trends, inefficiencies, and areas for improvement. Organizations can leverage these insights to enhance productivity and operational effectiveness.
- Cost Reduction
  - When an organization can improve system uptime, automate processes, reduce the risk of failure and gain insights that support better decision making, and reduce resource usage, the result is efficiency and cost savings
- Optimized Work Environments
  - IoT technology can help create more comfortable and efficient workspaces
- Adaptability
  - The ability to adapt to new business requirements, customer needs, and changing conditions, or scale the deployment in response to business growth or customer requirements

Growth of IoT Devices



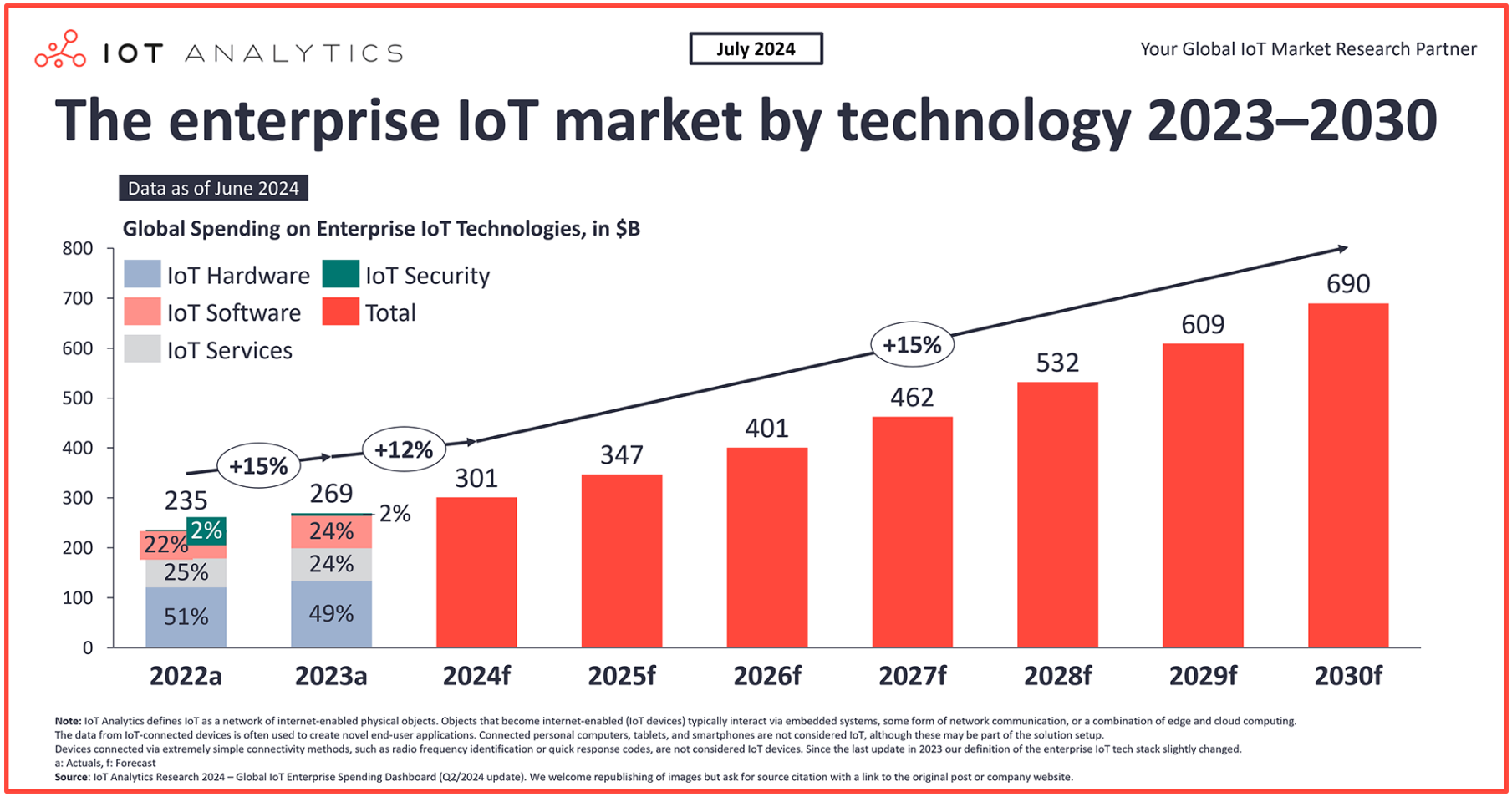
IoT Analytics' prediction

IoT devices excluding PC, Laptop, Smartphone, Tablet, and one directional technology like RFID, NFC

Image Source: https://iot-analytics.com/number-connected-iot-devices/

Wired: Eth, SCADA network (Modbus, Fieldbus, etc.)
Cellular: 2G, 3G, 4G, 5G; LPWA: LoRa, HaLow
WPAN: BLE, ZigBee, Z-Wave, etc.; WLAN: WiFi
WNAN: Non-short-range mesh e.g. Wi-SUN

Global Spending on IoT



IoT Analytics' Report on Global IoT Market as on July 2024

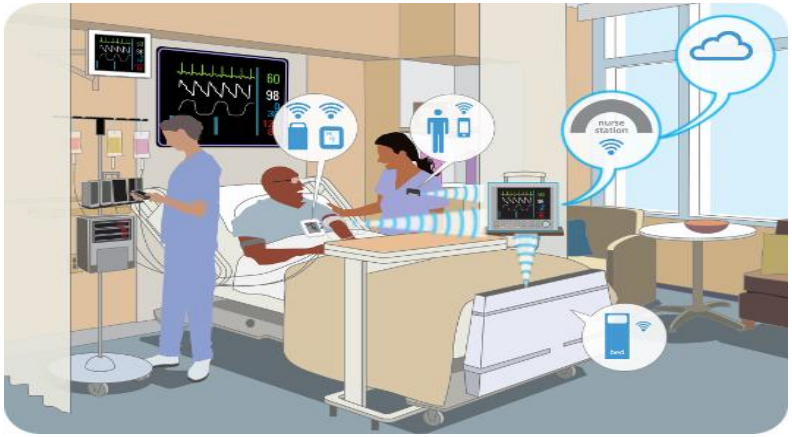
Image source: https://iotbusinessnews.com/2024/07/10/06205-enterprise-iot-market-size-reached-269-billion-in-2023-with-growth-deceleration-in-2024/

Where is IoT?

Wearable
Tech Devices

Smart Appliances

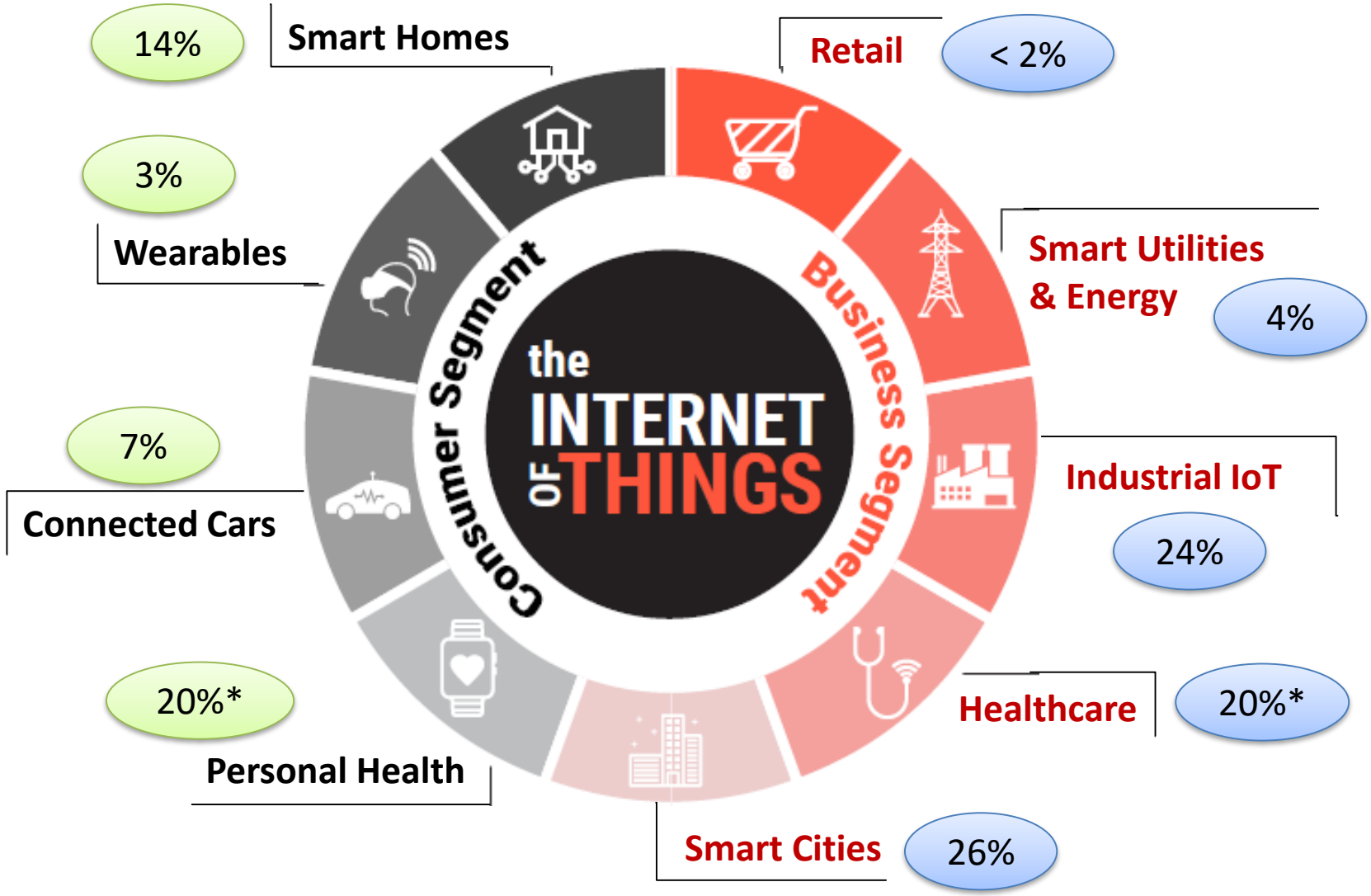
It's everywhere!



Healthcare

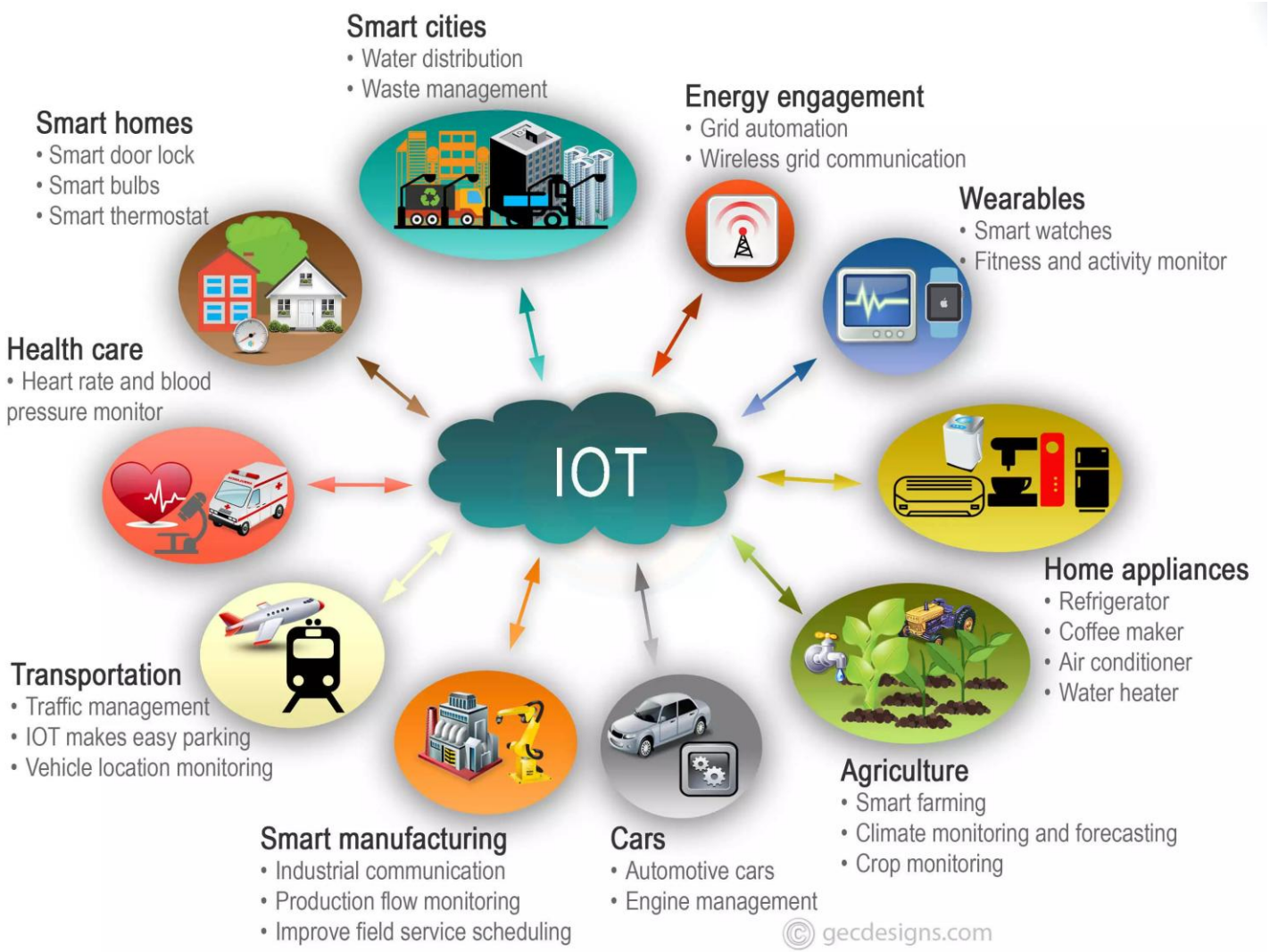
Industry Automation
and Monitoring

Global IoT Market Share



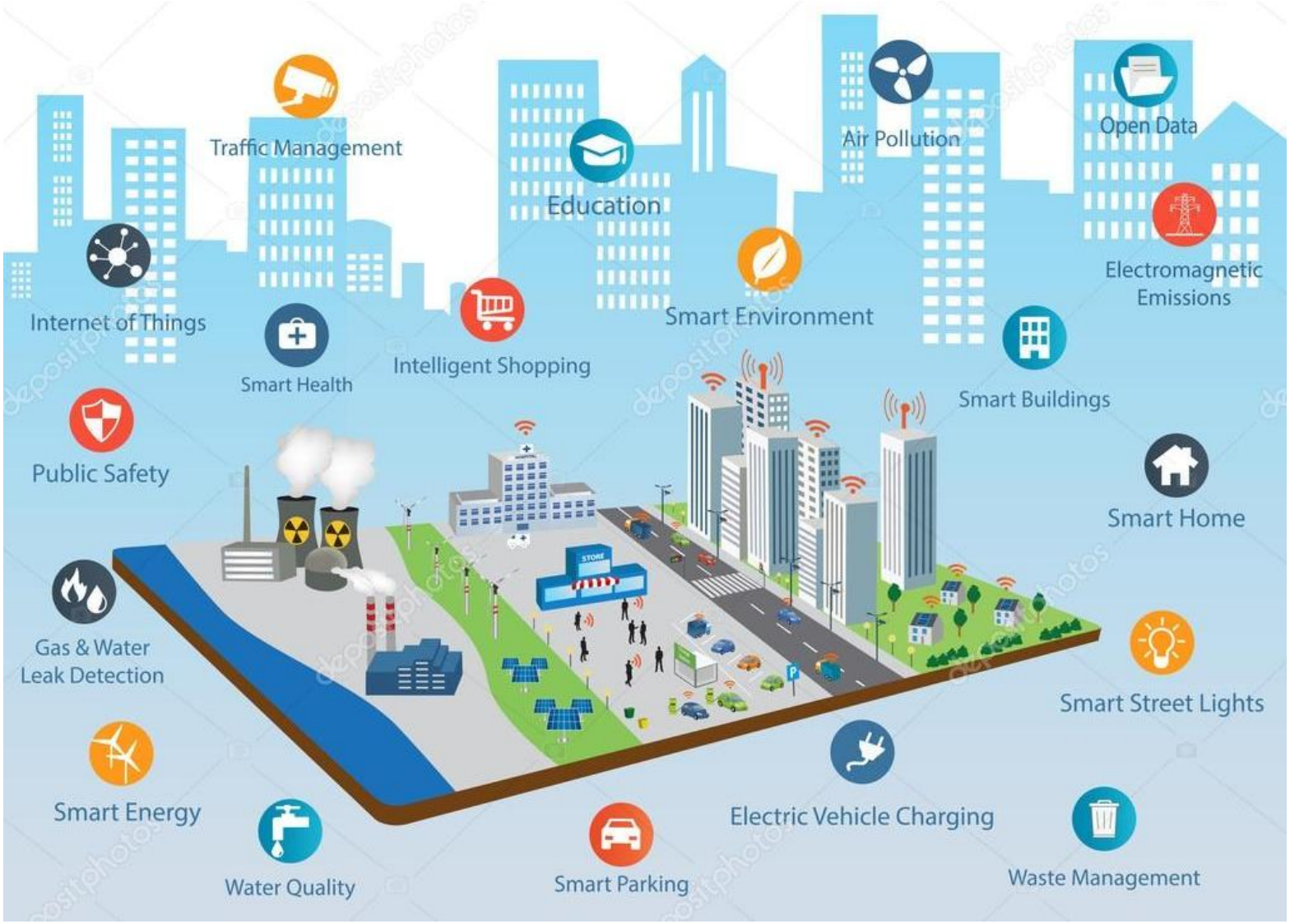
Source: https://growthenabler.com/flipbook/pdf/IOT%20Report.pdf

Applications of IoT



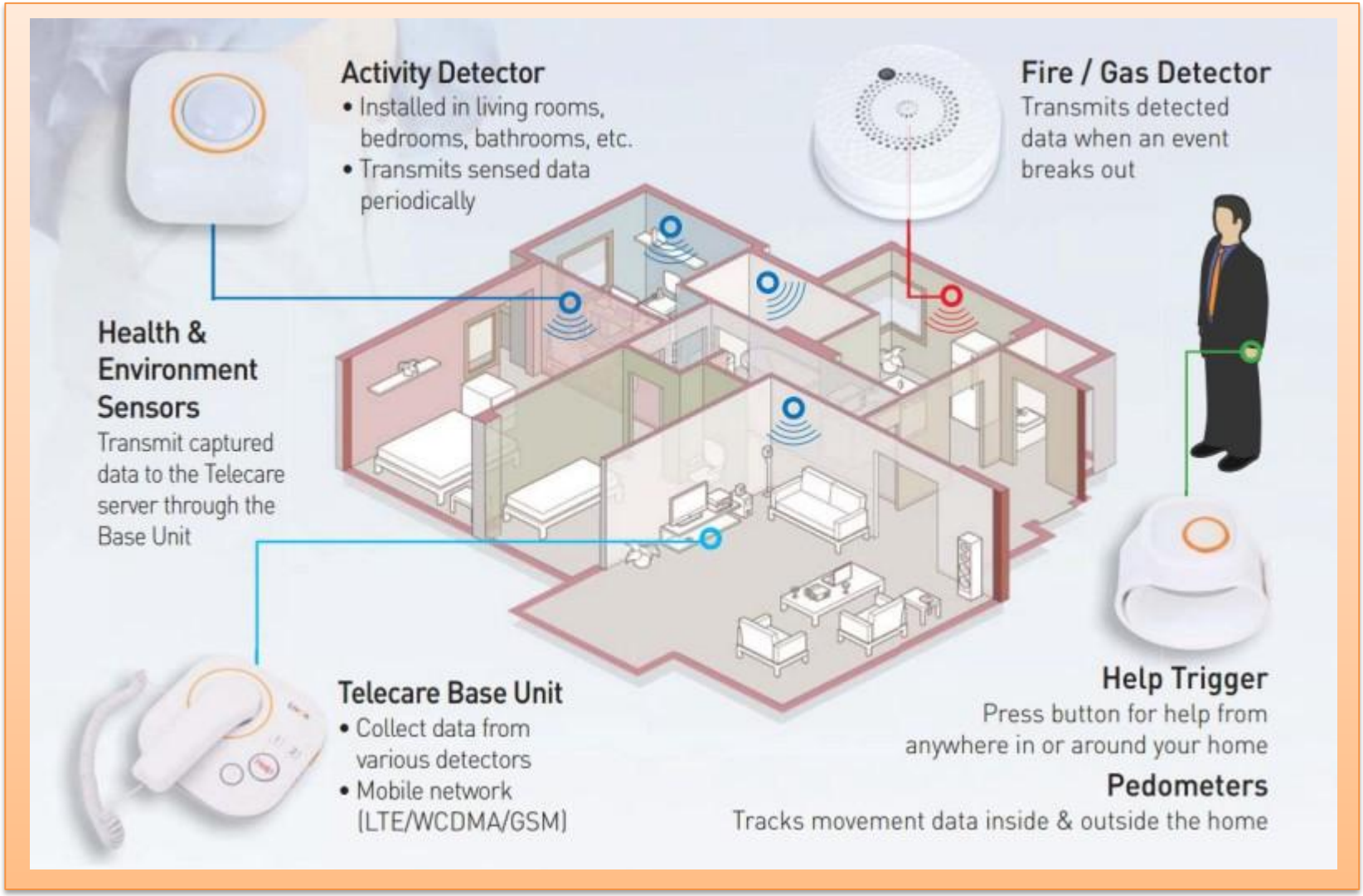
Source: https://sl.bing.net/jncHHWgAj36

Smart City



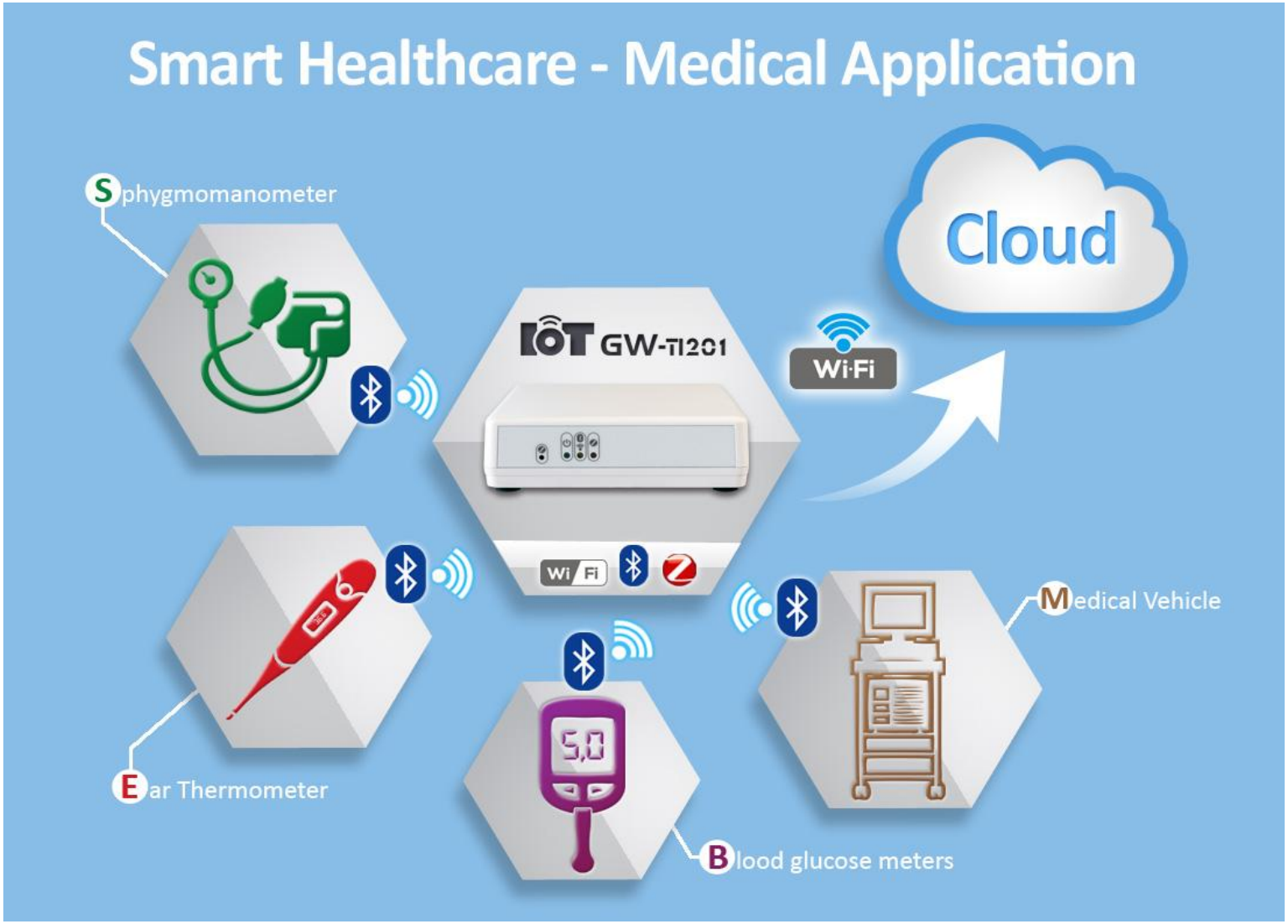
Source: https://depositphotos.com/126025652/stock-illustration-smart-city-concept-and-internet.html

Smart Home



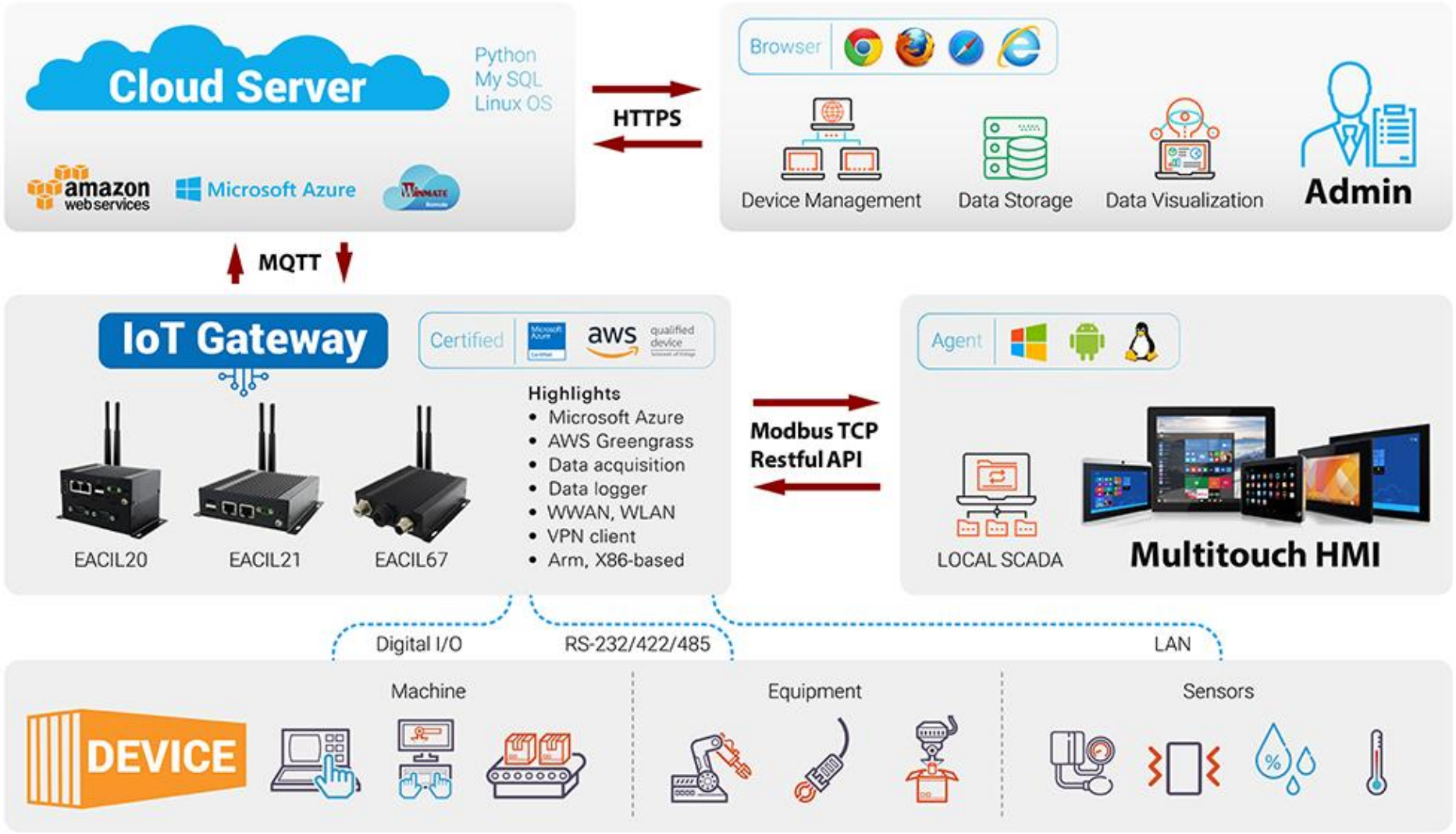
Source: https://medium.com/@globalindnews/north-america-accounted-for-major-share-in-the-global-smart-home-healthcare-market-in-2015-cc9cc1974ac5

Smart Healthcare



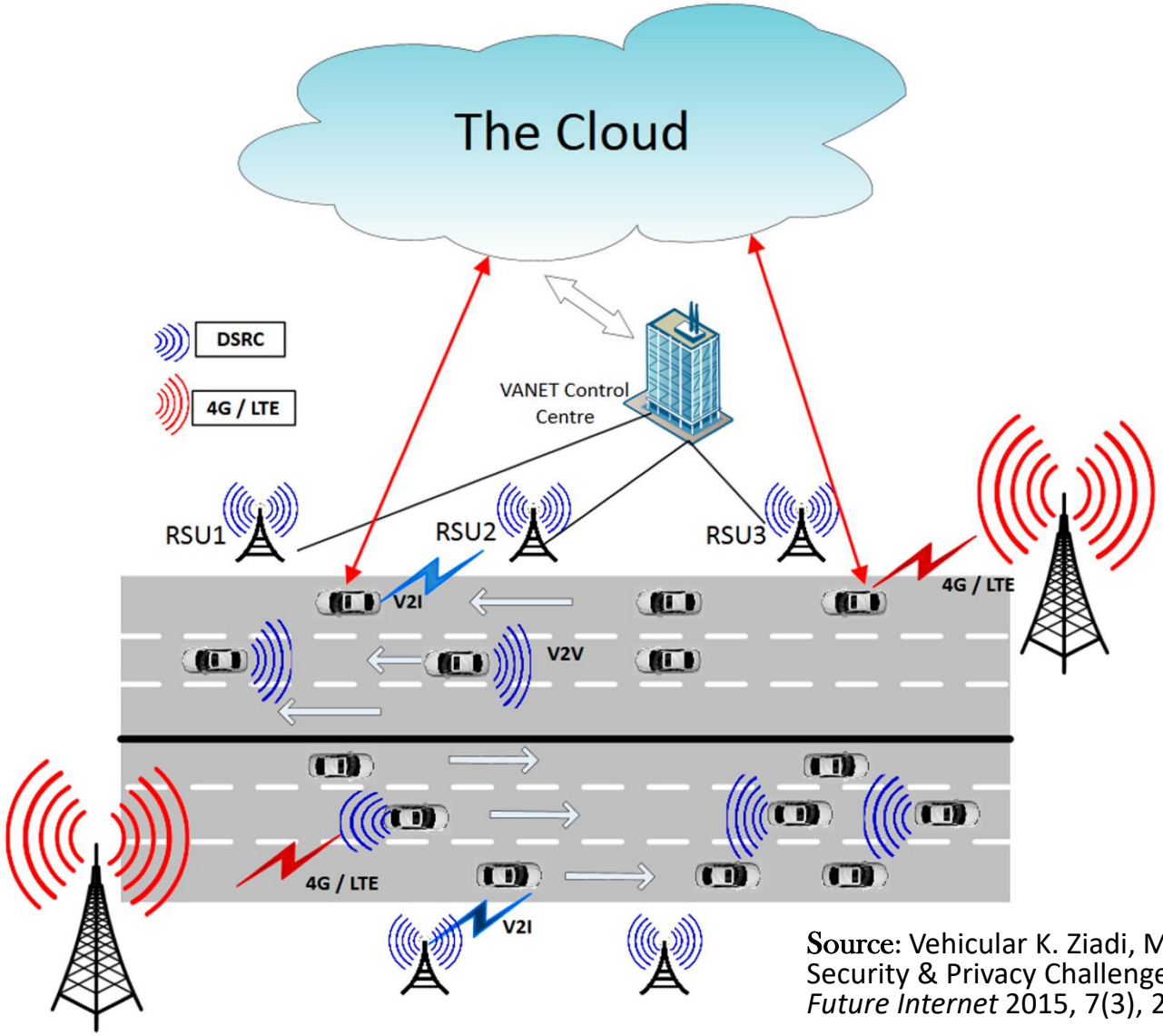
Source: http://iot.fit-foxconn.com/

Industrial IoT



Source: https://www.winmate.com/Solutions/Solutions_IoT.asp

Connected Cars



Source: Vehicular K. Ziadi, M. Rajarajan, "Internet: Security & Privacy Challenges and Opportunities", *Future Internet* 2015, 7(3), 257-275.

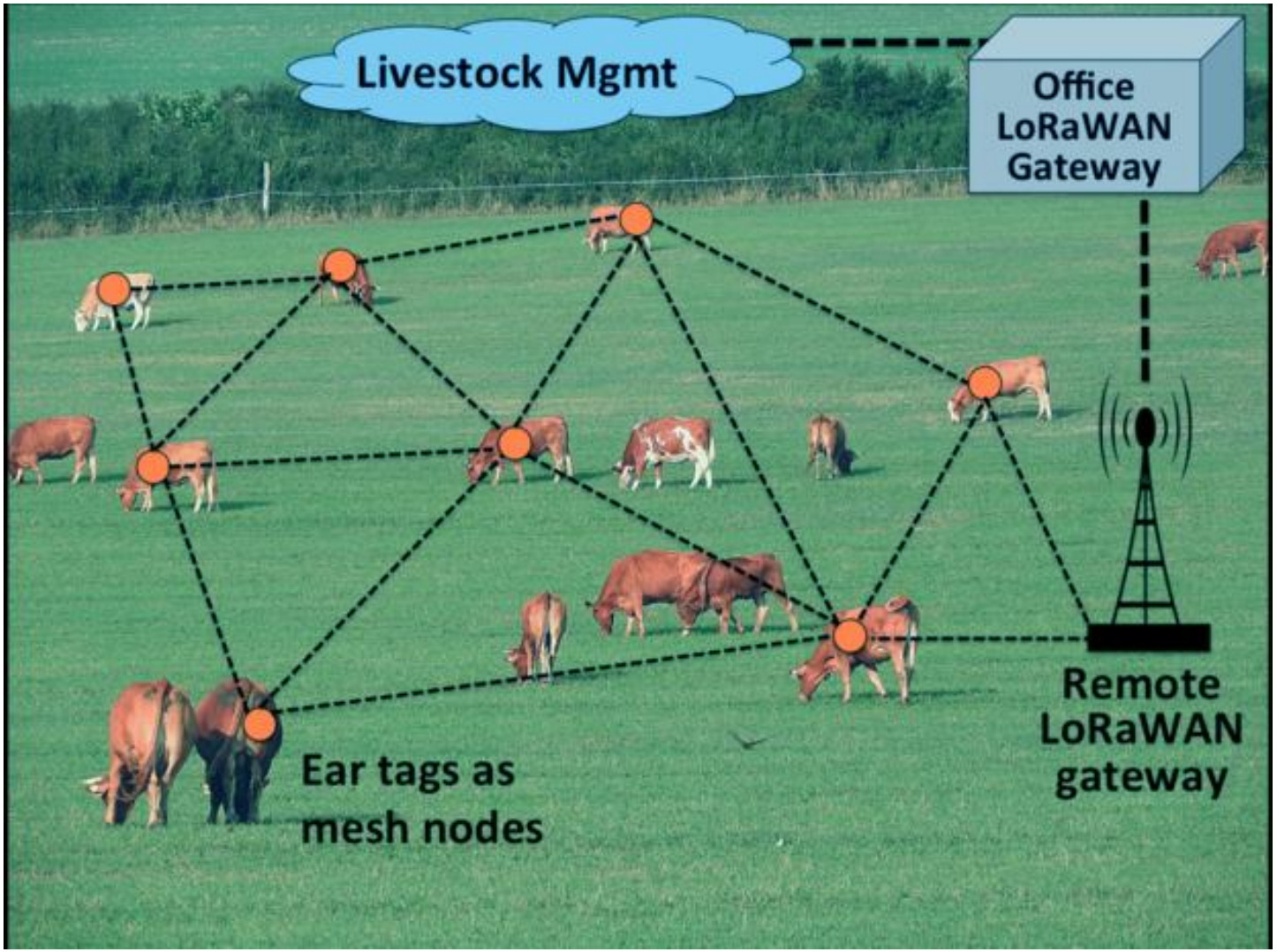
Google's Self-Driving Car

Source: https://www.google.com/

Smart Agriculture

Source: https://in.pinterest.com/pin/515380751093603767/?lp=true

Livestock Management



Source: https://data-flair.training/blogs/iot-applications-in-agriculture/

Main Challenges in IoT Implementation

Sensors

- limited resources
- limited types of sensors

Scale

- millions of devices are connected to form IoT

Low Power Network

- devices should remain connected to the network for years
- high network latency
- can't use traditional communication protocols

Interoperability

- various protocol, various architecture
- unavailability of standardized platform
- different technology leads to interoperability issue

Bigdata & Data analytics

- massive amount of sensor data
- different sources and various forms
- extract intelligence form the heaps of data

Privacy

- which personal data to share with whom
- how to control

Security

- "things" becomes connected, so security becomes complex

Lessons Learned

- ✓ Learned about what is IoT
- ✓ Learned the genesis of IoT
- ✓ Understand the benefits of IoT
- ✓ Learned about the market share of IoT
- ✓ Understand the real world applications of IoT
- ✓ Understand various challenges in IoT implementation

Thanks!

Figures and slide materials are taken from the following Books:

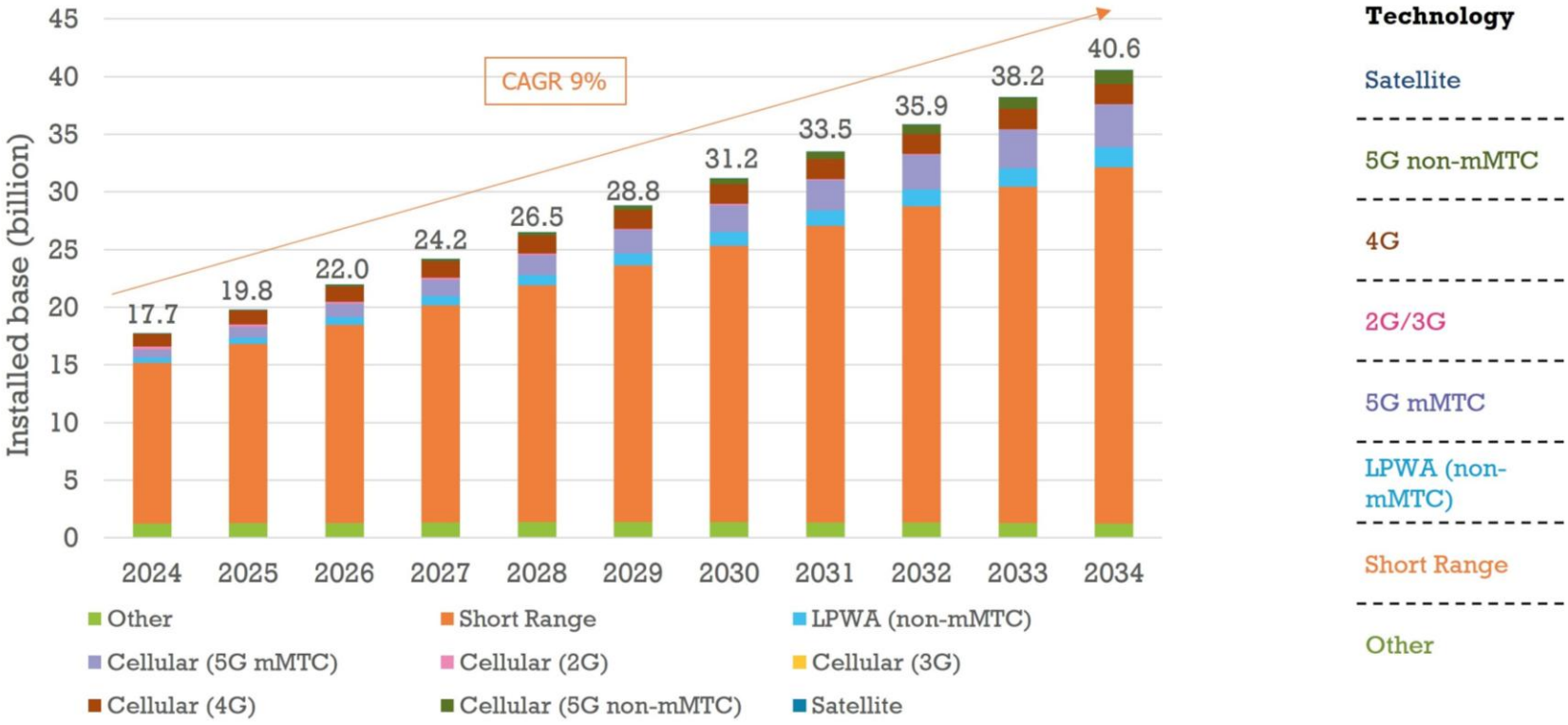
1. David Hanes *et al.*, "**IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things**", 1st Edition, 2018, Pearson India.

2. Mayur Ramgir, "**Internet of Things: Architecture, Implementation and Security**", 1st Edition, 2020, Pearson India.

Growth of IoT Devices

Global IoT connections forecast, 2024-34

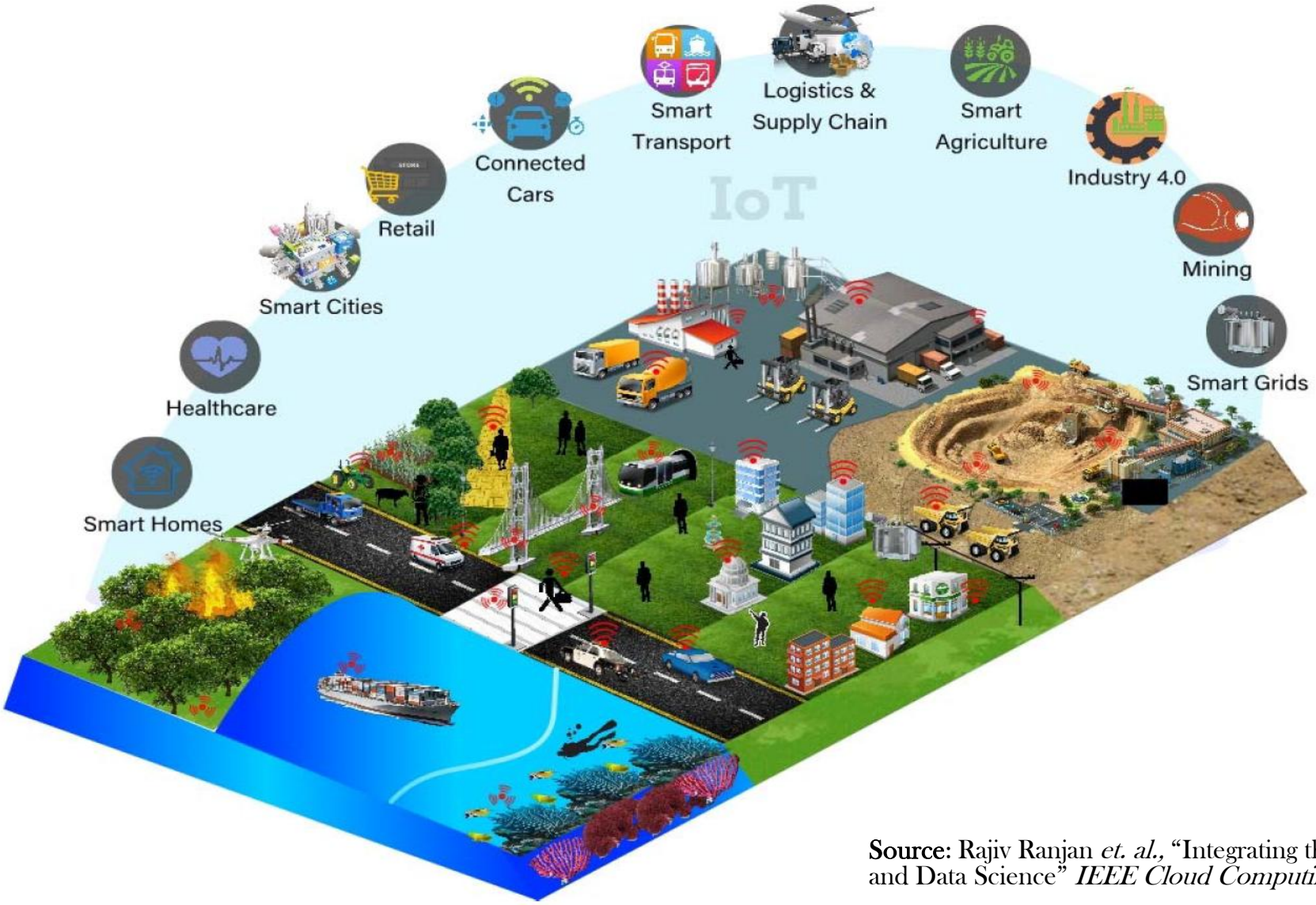
[Source: Transforma Insights IoT Forecast Database, 2025]



Transforma Insights's Prediction

Image Source: https://transformainsights.com/research/reports/global-iot-forecast-report-2024-2034

Many More ….



Source: Rajiv Ranjan *et. al.,* "Integrating the IoT and Data Science" *IEEE Cloud Computing*, 2018