

Introduction to Internet of Things

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General Information

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- Course Grading

Component	Marks
Quiz 1	7.5 (MCQ's)
Quiz 2	7.5(MCQ's)
Mid-Sem	15 (short answers)
End-sem	30 (short & long)
Lab	20 (every lab is graded for 2 marks– 10 labs)
Project	20 (team of 2)

Reference Material

- Lea, P., 2018. Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. Packt Publishing Ltd.

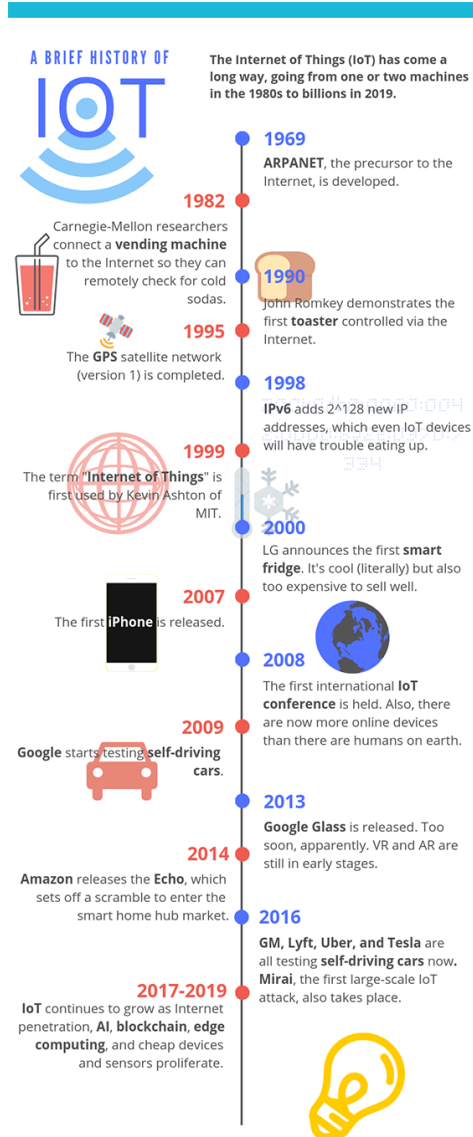
Outline

- History of IoT
- What is IoT?
- IoT Applications
- M2M vs IoT
- Importance of IoT
- Challenges/Impediments
- Case Study



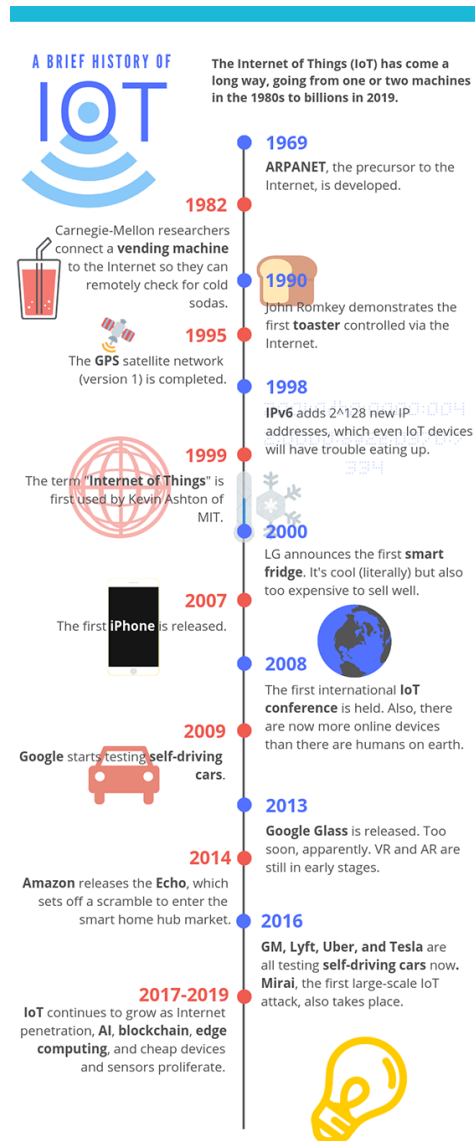
Source: <https://www.groundreport.com/>

History of IoT



- 1969 – ARPANET was put into service by DARPA, which paved way for the “Internet”
- 1982 – A Coca-Cola vending machine is connected to the Internet by researchers at CMU to check availability of cold sodas. Often cited as one of the first IoT devices.
- 1990 – John Romkey, an Internet pioneer connected a smart toaster to the Internet and controlled it. The birth of communication protocol.
- 1995 – The first GPS satellite program of US government is completed making it possible to get location information required for many IoT devices
- 1998 – 128-bit IPv6 becomes a draft standard allowing more devices to be addressed than IPv4 could (32-bit).
- 1999 – A big year for IoT as the term was used for the first time by Kevin Ashton, a cofounder of Auto-ID center at MIT

History of IoT (continued)



- 2000 – LG introduced the Internet refrigerator with screens and trackers to keep track of the food that was there in the fridge. It was expensive.
- 2007 – The first iPhone is released allowing people to interact with the world and internet connected devices in a whole new way.
- 2008 – The first international IoT conference was held in Zurich and also the number of Internet connected devices surpassed the number of humans.
- 2009 – Google starts self-driving car tests
- 2014 – Amazon Echo is released which paves way for the Smart Home Hub market
- 2016 – GM, Lyft, Tesla and Uber all start testing self-driving cars
- -
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- -
- 2023: TomTom and Microsoft unveil generative AI for connected vehicles
- Virgin Media develops 5G drone for search and rescue missions
- **Cybersecurity threats facing medical devices**
- **P2PInfect malware variant targets IoT devices**

What is IoT?

Source: <https://www.gartner.com/en/information-technology/glossary/internet-of-things>

- 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. – By Gartner Research



7 IoT trends for businesses in 2022: MobiDev

Read more at:

<https://ciosea.economictimes.indiatimes.com/news/internet-of-things/7-iot-trends-for-businesses-in-2022-mobidev/90623252>

What is IoT?

- Alternate definitions

- A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

Source: <https://www.itu.int/rec/T-REC-Y.2060-201206-I>

- The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Source: <https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT>

What is IoT?

- Alternate Definition (From Wikipedia)
 - The Internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data.

What is IoT?

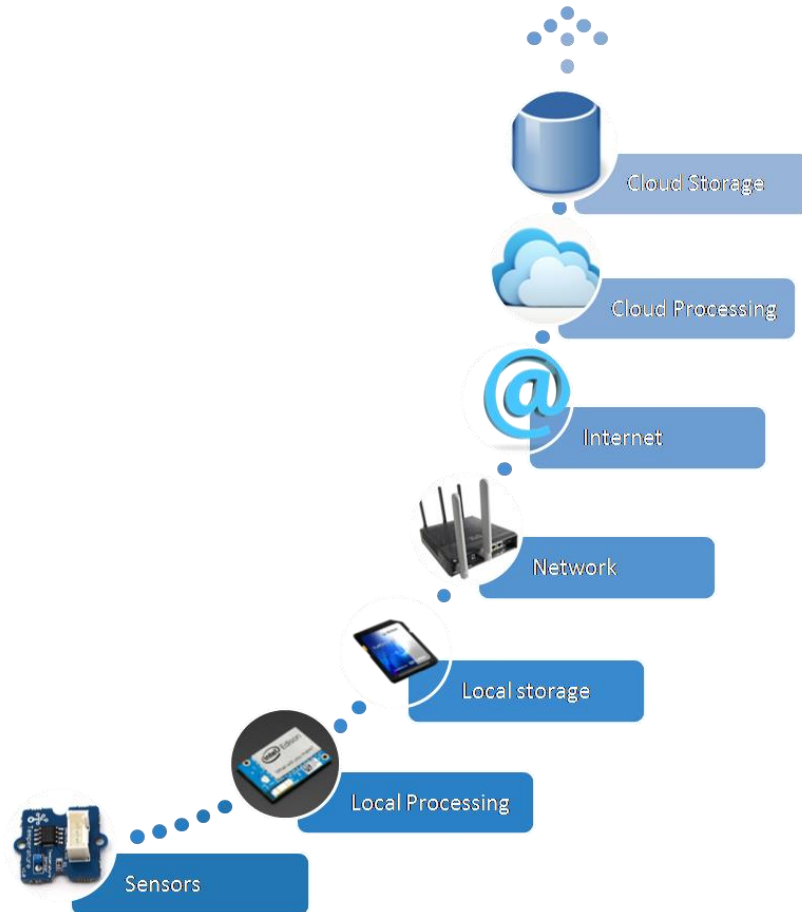
- Simple Definition

Internet of Things (IoT) is a simple concept which means taking all the things in the world and connecting them to the internet.

But is connecting everything to Internet enough for IoT?

The true potential of IoT is realized when the connected things can sense the environment and send data or receive data and trigger some action or do both.

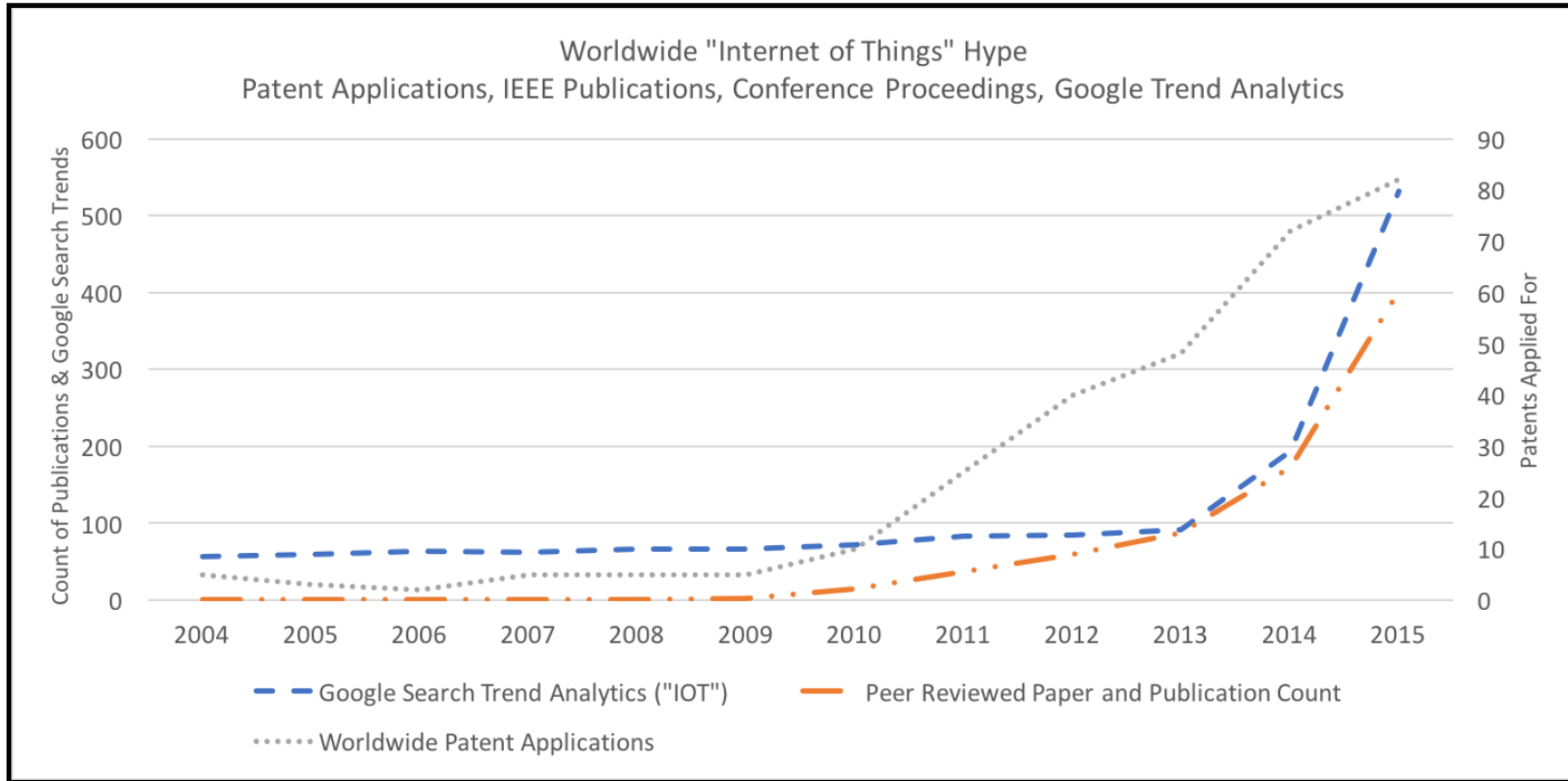
Upstream Information Flow in IoT



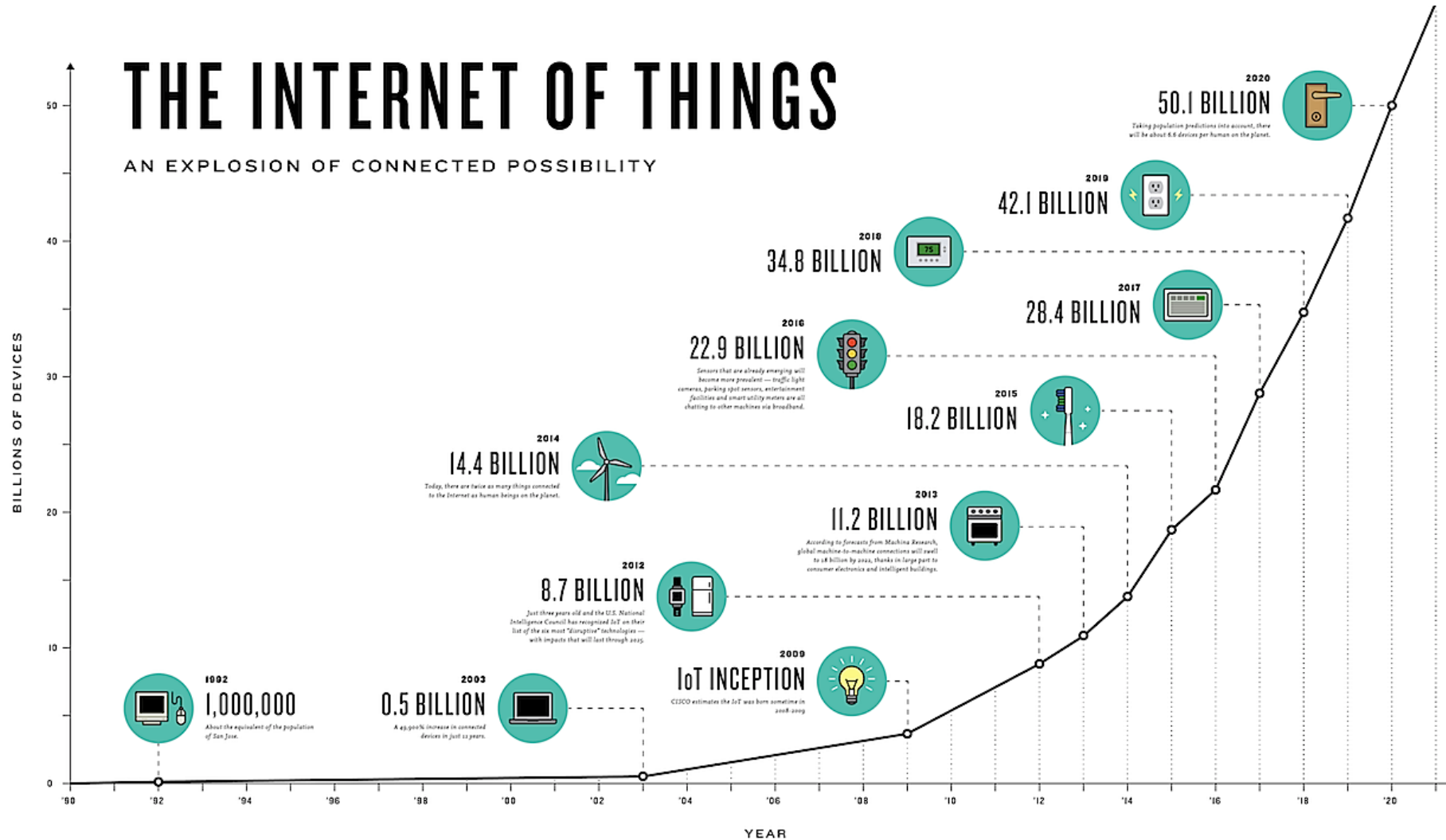
- The initial information flow did not encompass the local storage and the local processing – Purely cloud based processing
- Currently *edge computing* is a concept that is gaining prominence whereby there is availability of some local processing and storage

Source: http://ocw.cs.pub.ro/courses/_media/iot2015/courses/picture11.png?w=450&tok=584430

Rise of IoT

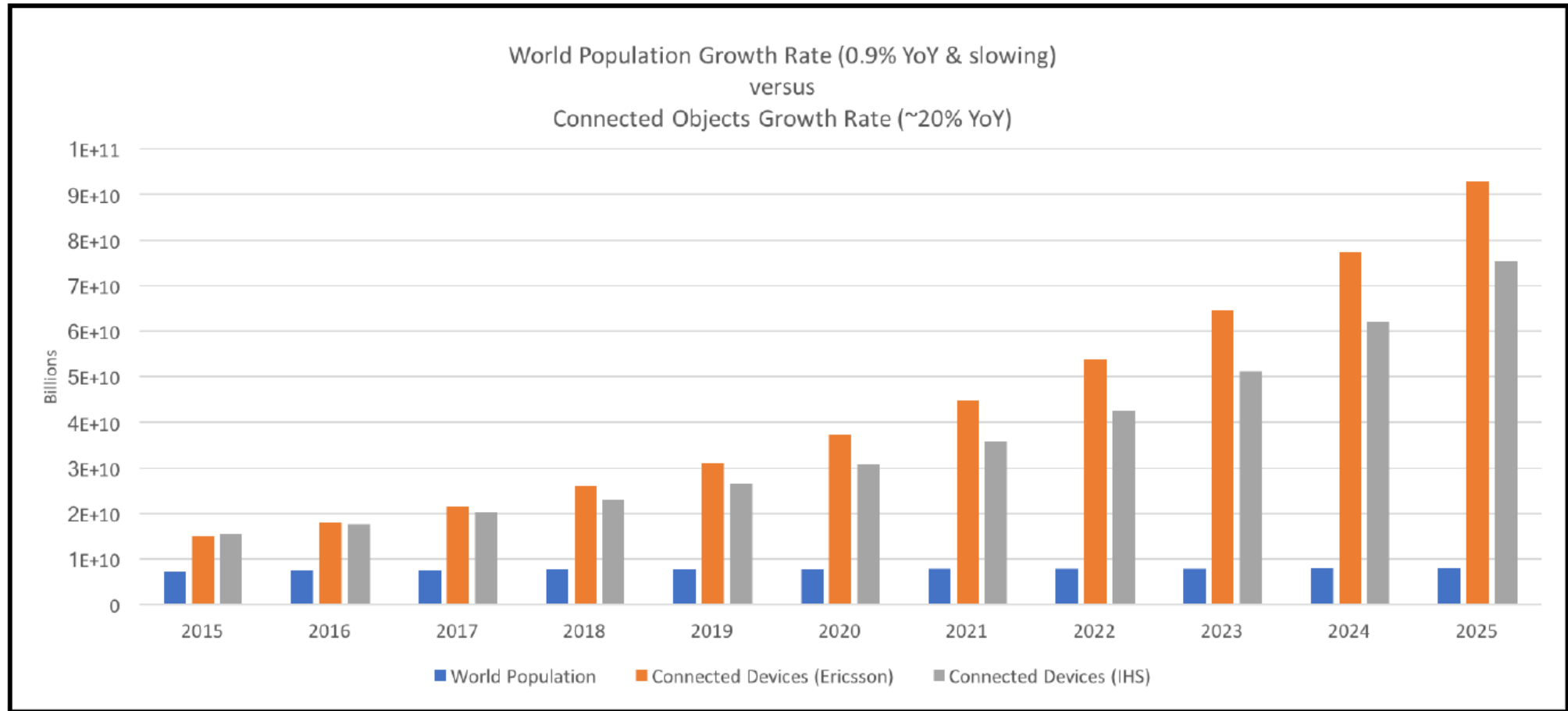


Rise of IoT



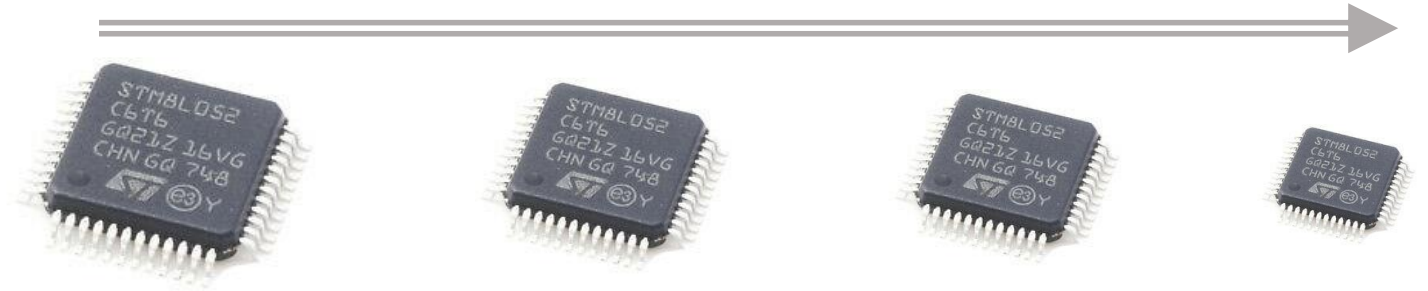
Source:
<https://www.weforum.org/agenda/2017/06/internet-of-things-will-power-the-fourth-industrial-revolution/>

Rise of IoT

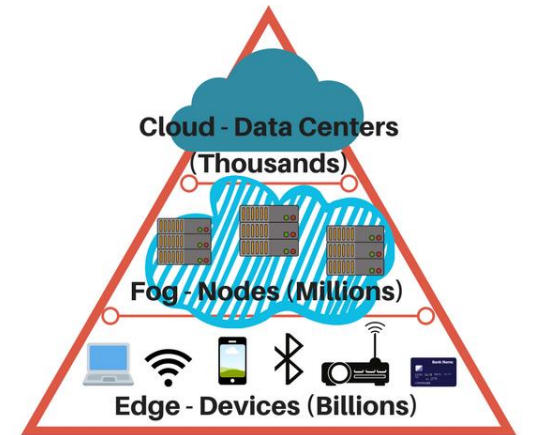


Why is IoT buzz word now?

- Embedded chips are becoming cheaper, smaller and low power devices
- Emergence of faster communication technologies
- Flexibility of IPv6 to address more IoT devices
- Emergence of fog/edge computing
- Advances in Big Data, Deep Learning and AI understanding

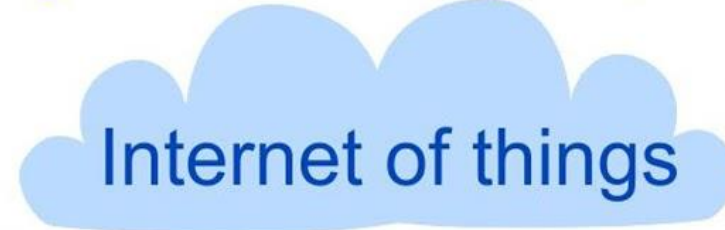


Source: <https://timestech.in/gartner-say-worldwide-5g-network-infrastructure-revenue-will-reach-4-billion-in-2020/>

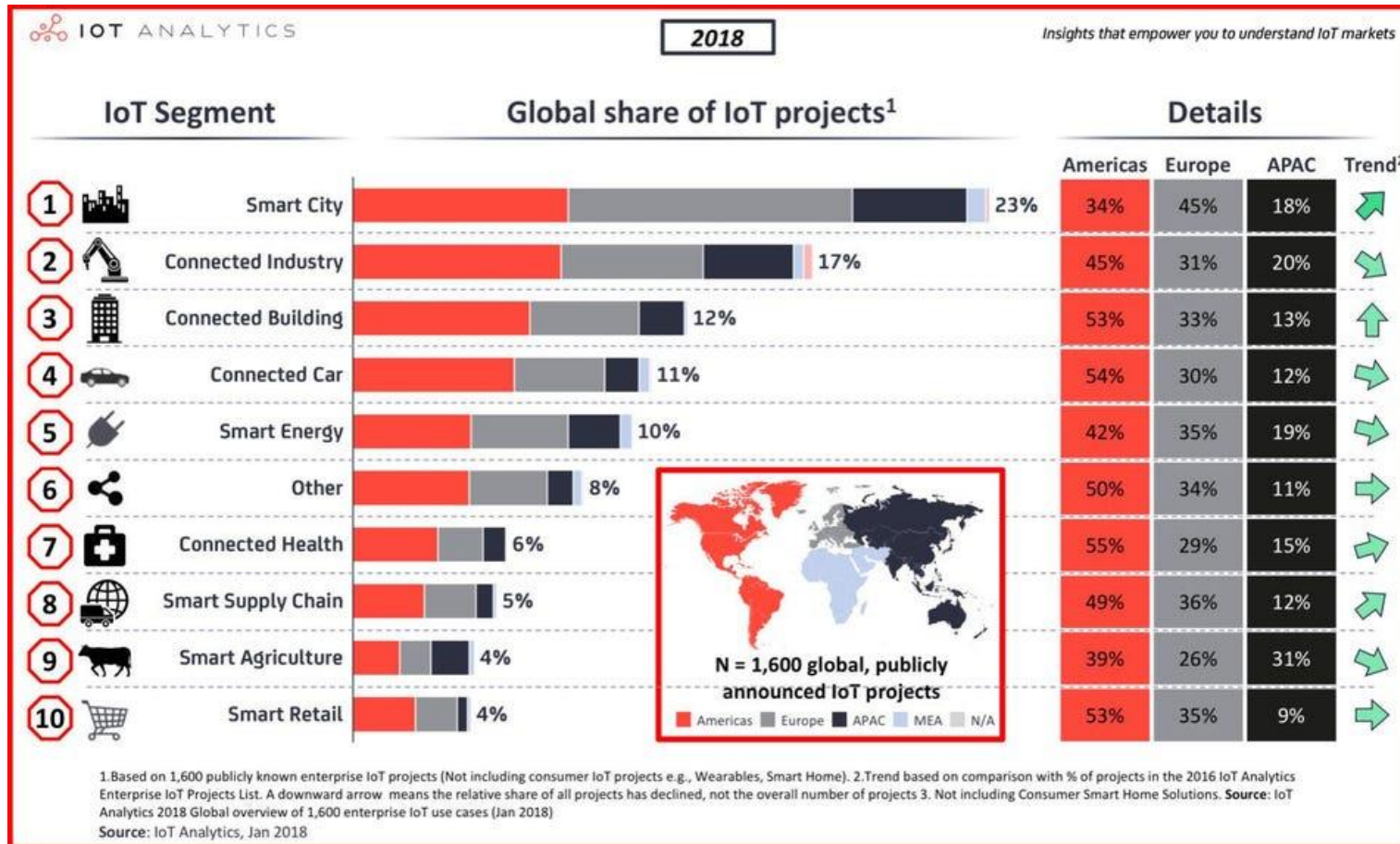


Source: <https://www.power-solutions.com/industry-trends-best-practices/industry-trends/fog-computing-and-edge-computing-what-you-need-to-know>

IoT Applications



Source: <https://iotworm.com/internet-of-things-applications-area/>



Source: <https://www.forbes.com/sites/louiscolombus/2018/06/06/10-charts-that-will-challenge-your-perspective-of-iots-growth/?sh=42f59eed3ecc>

IoT vs M2M, CPS

- M2M – An autonomous device communicating directly with another autonomous device
- IoT – Incorporates M2M nodes but aggregates data at an edge router or gateway
- CPS – Involves sensing, control, actuation and feedback as a closed loop system
- IoT – Does not compulsorily need feedback

Importance of IoT

- **Gathers useful data:** Significant information gathered helps in making the right decision. If something malfunctions in the system, it can be maintained because the information is gathered.
- **Focuses on Automation and Control:** Connectivity of physical objects and their control using wireless support enables significant control and automation without the need of human intervention, which makes execution faster leading to timely output.
- **Useful in Monitoring:** Helps knowing things in advance, i.e., collects information on quantity of supplies, water distribution and consumption, intelligent energy management, which also allows taking necessary actions.
- **Increases efficiency and saves time**
- **Improves quality of life**

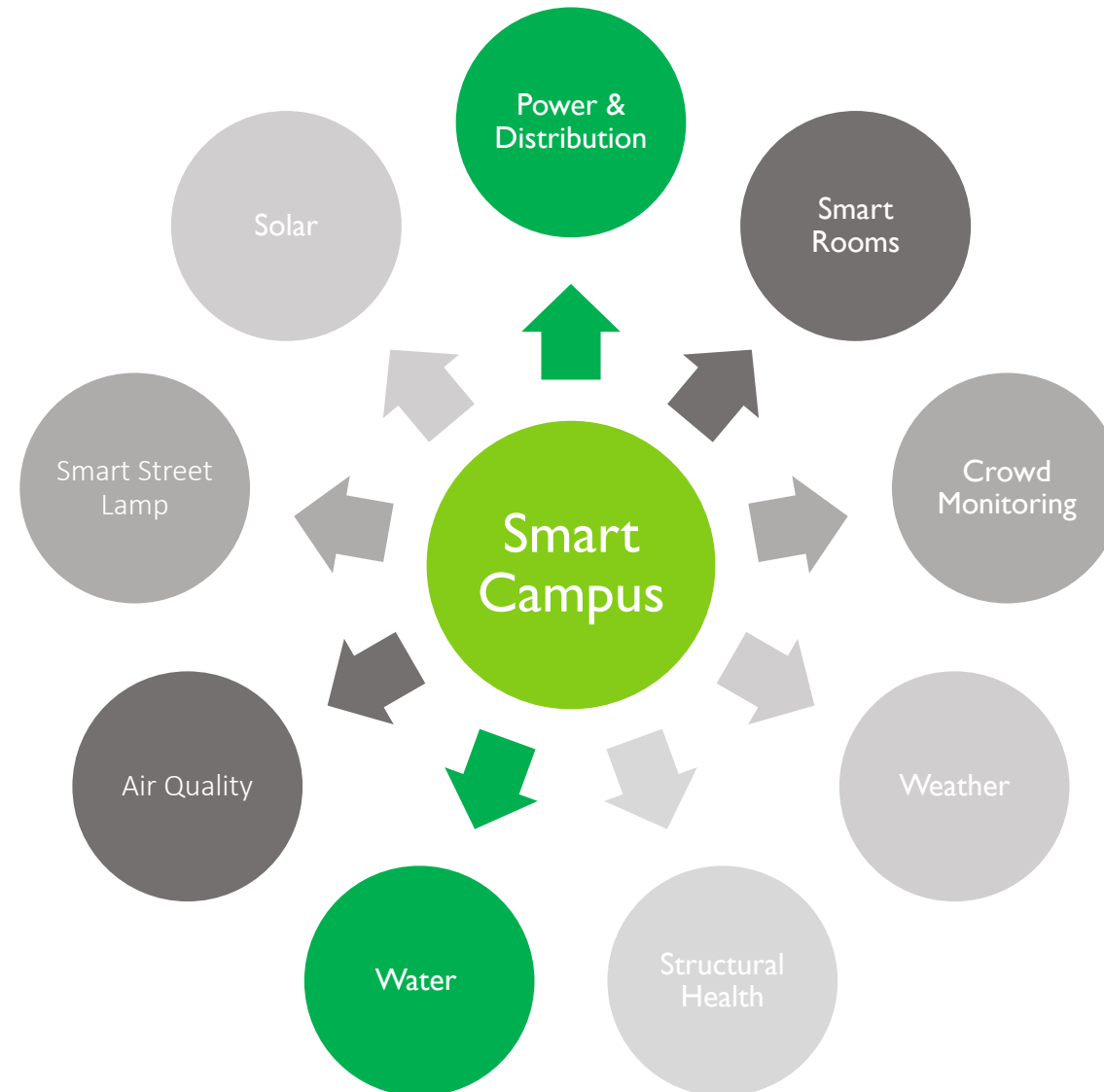
Challenges/Impediments

- **Privacy and Security:** Connectivity brings vulnerability to leakage of user identity and confidential data
- **Huge Volume of Data:** With increasing number of connected devices, the amount of data generated will be huge, which will need advancements in storage technology and processing infrastructure
- **Complexity:** The increasing complexity of IoT systems with increasing number of connected devices makes it difficult to verify such a system for safety and correctness
- **Intermittent Connectivity:** A mobile node may experience lack of connectivity on its path which reduces the quality of user experience

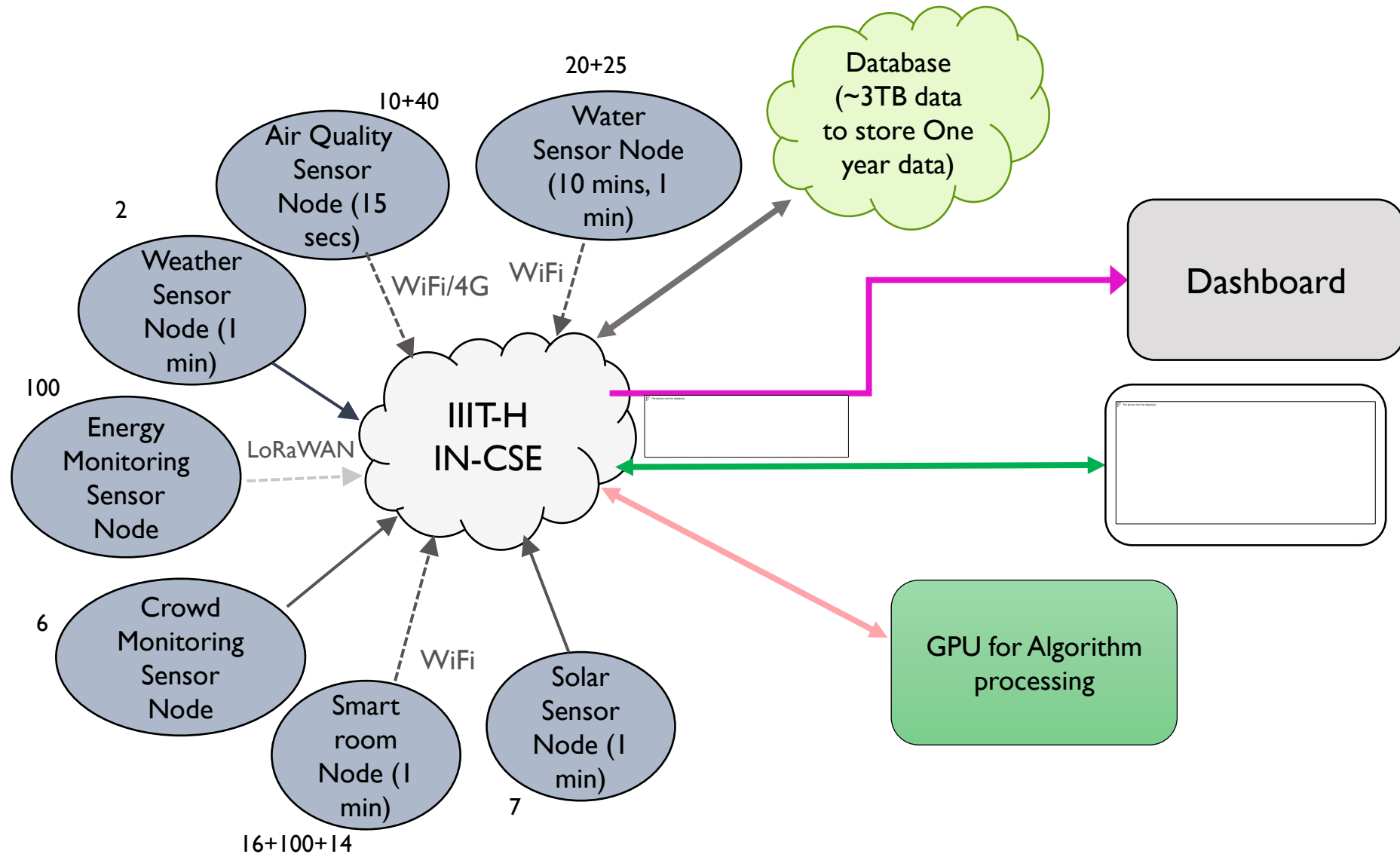
IoT Use Cases

- Industrial and Manufacturing
- Consumer
- Retail
- Healthcare
- Transportation and Logistics
- Agriculture
- Energy
- Smart City

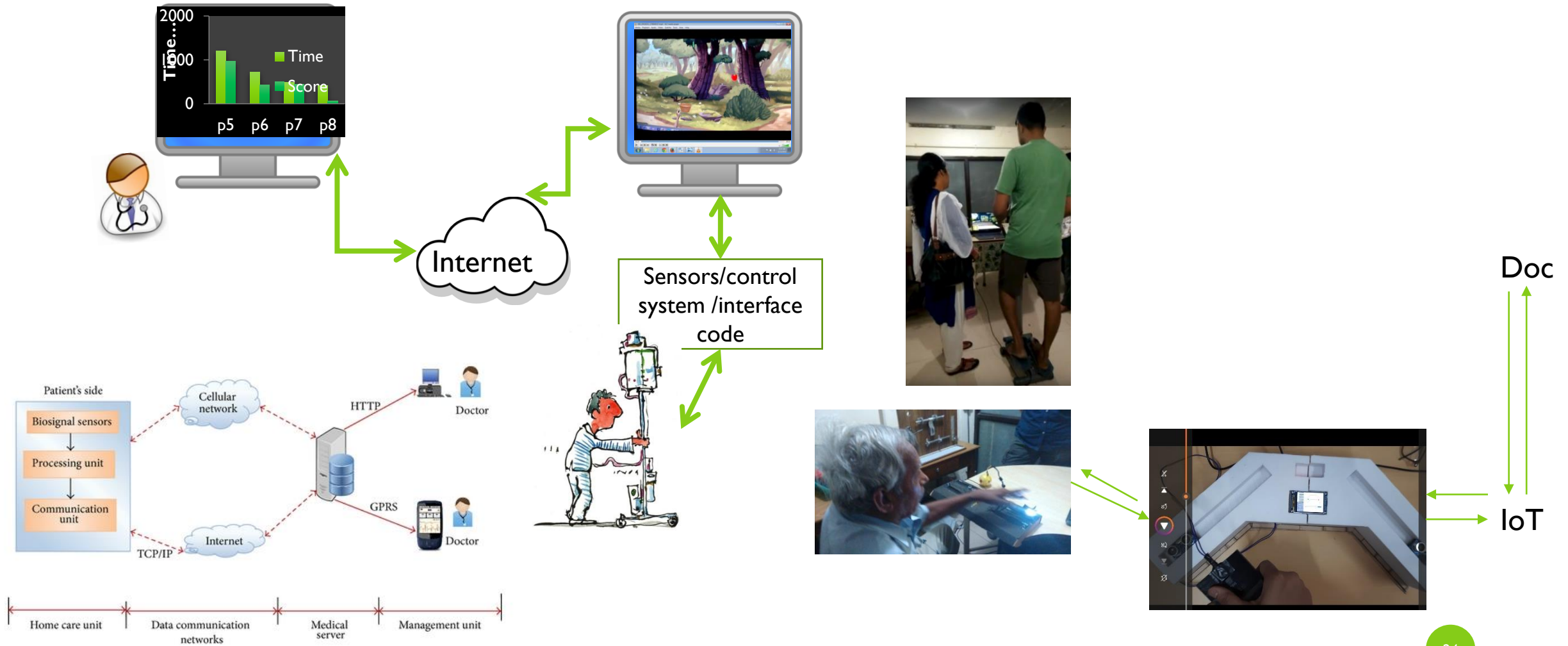
Smart City Living Lab



Smart City Living Lab – General Architecture



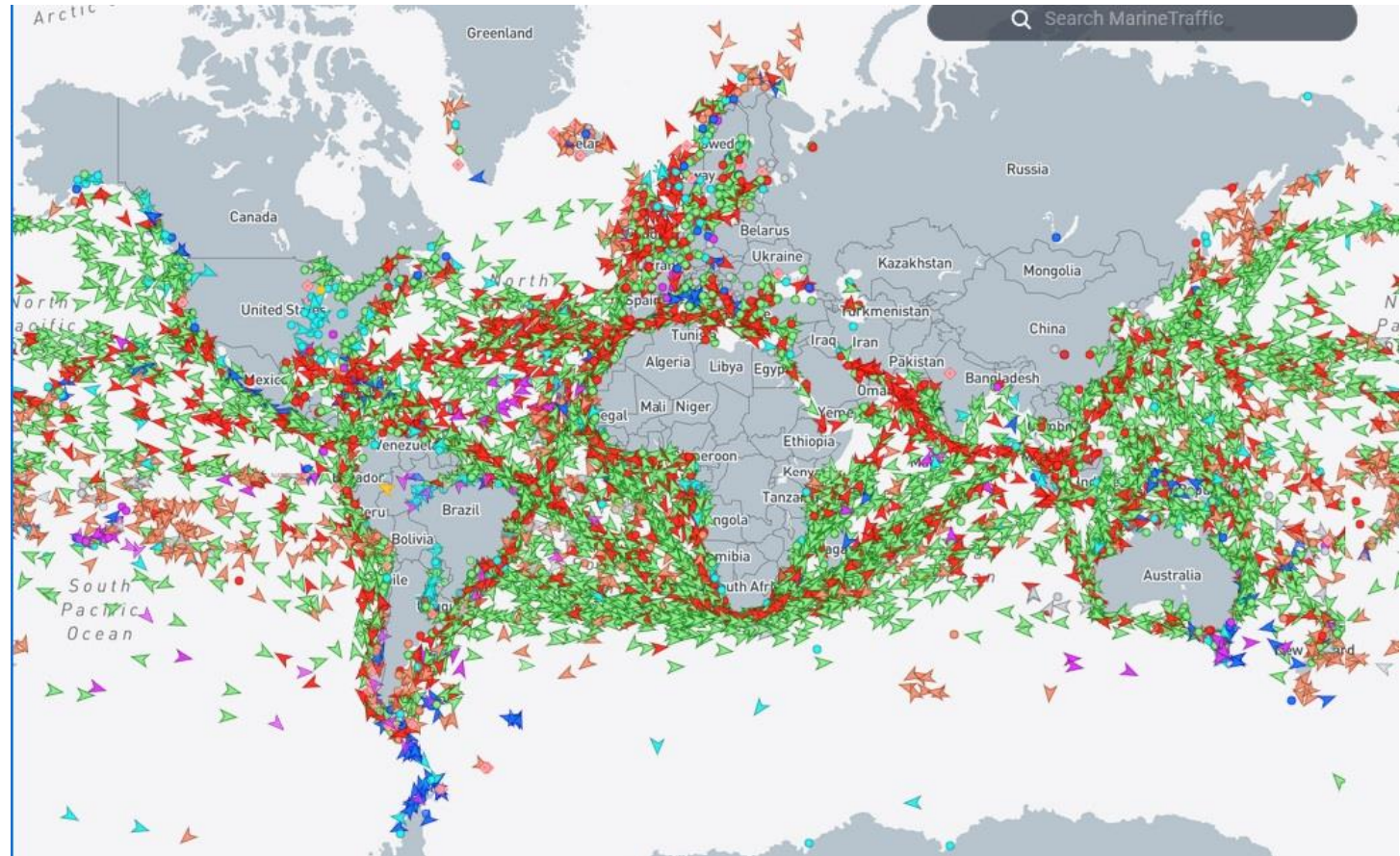
IoT and healthcare



IoT Case Study



IoT in connected vehicles



<https://www.marinetraffic.com/en/ais/home/centerx:126.9/centerx:-9.8/zoom:2>

Thank you