INTERNET OF THINGS

Introduction and Basic Concepts

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Amirkabir University of Technology

Fall 2020

CONTENTS

- Introduction
- Physical and Link Layers Protocols (IoT Access Technologies)
- Application Layer Protocols
- IoT Open problem and challenge
- LoRaWAN Assignment

Mostly adopted from Chapters 4, 5, and 6 of IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

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- Introduction
  - Basic Concepts
  - Ecosystem
    - Things
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    - Platform
    - Applications and Verticals
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WHAT IS IOT?

- "IoT" term was first introduced by Kevin Ashton in 1999.
- **Kevin Ashton:**
  - If we had computers that knew everything there was to know about things—using data they gathered without any help from us—we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves.

* Internet of Things Challenges, Advances, and Applications, CRC Press, 2018

WHAT IS IOT?

- Cisco defines the Internet of Everything (IoE) as the networked connection of people, process, data, and things. The benefit of IoE is derived from the compound impact of connecting people, process, data, and things, and the value this increased connectedness creates as "everything" comes online.

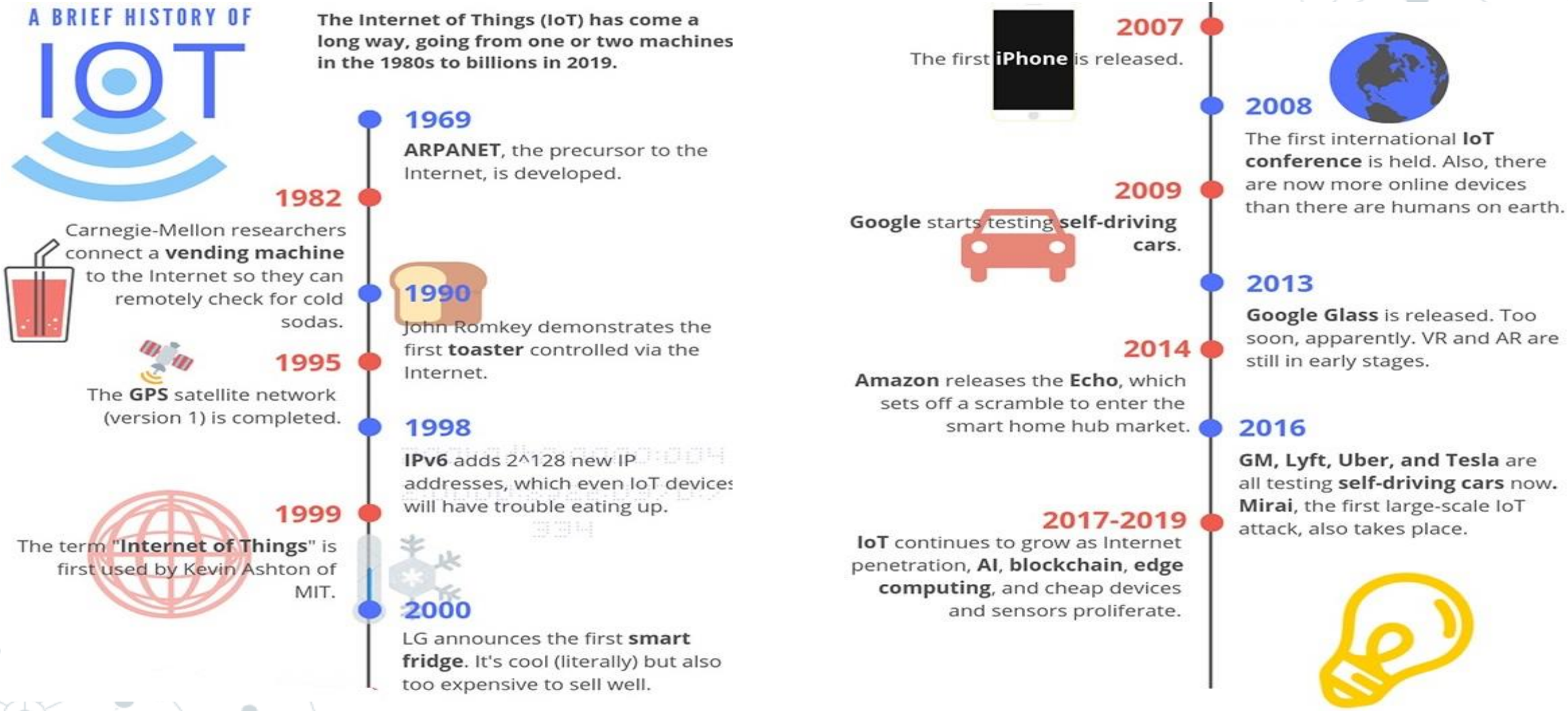
https://www.cisco.com/c/dam/en_us/about/business-insights/docs/ioe-value-at-stake-public-sector-analysis-faq.pdf

WHAT IS IOT?

- IoT is a world of interconnected things which are capable of sensing, actuating, and communicating among themselves and with the environment (i.e.,smart things or smart objects) while providing the ability to share information and act in parts autonomously to real/physical world events and by triggering processes and creating services with or without direct human intervention.

* Internet of Things A to Z : Technologies and Applications, IEEE Press, 2018

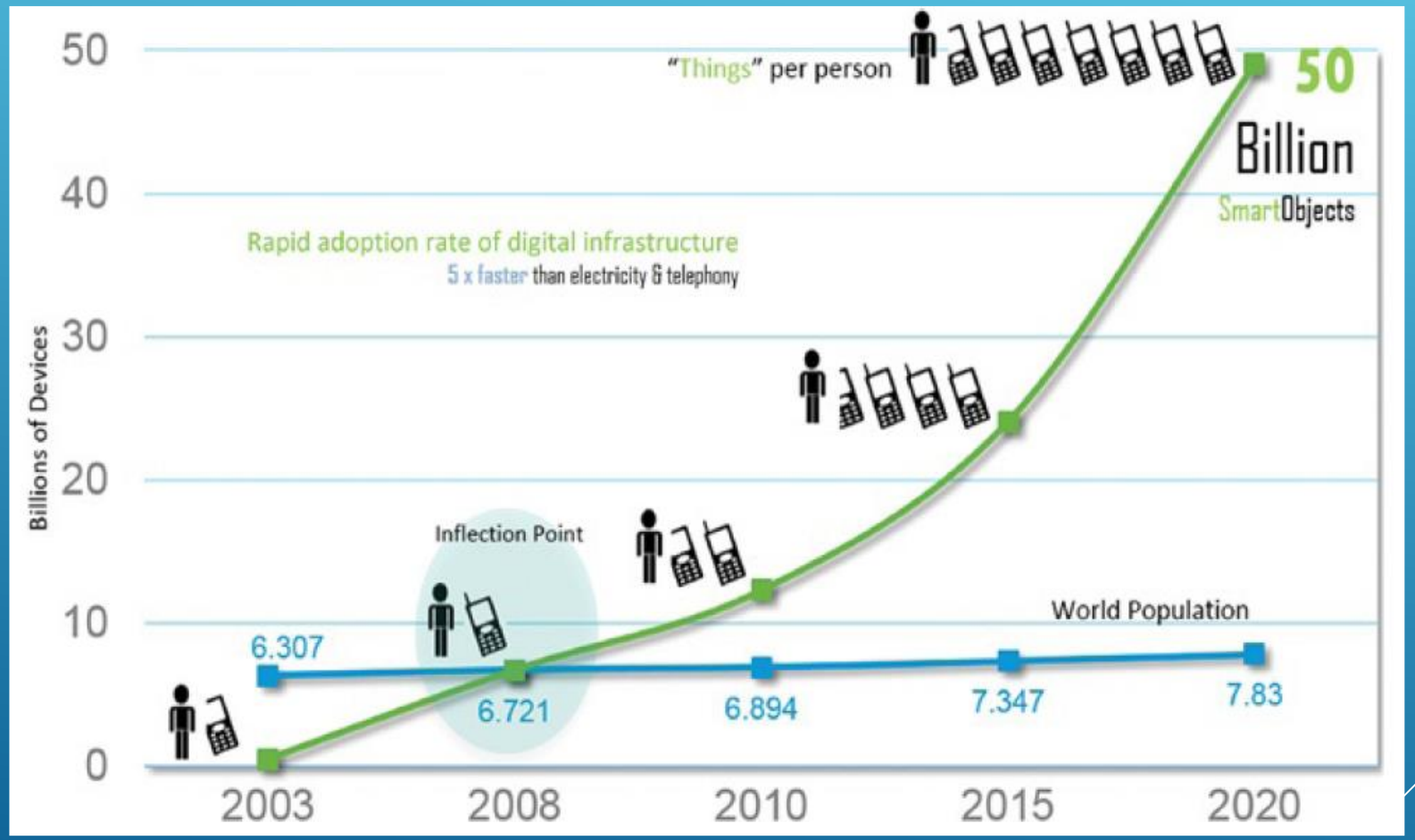
History of IoT



* https://www.iottechtrends.com/history-of-iot/

THE GROWING NUMBER OF CONNECTED DEVICES)

- Growing the number of connected devices to 50 billion in 2020.



* IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

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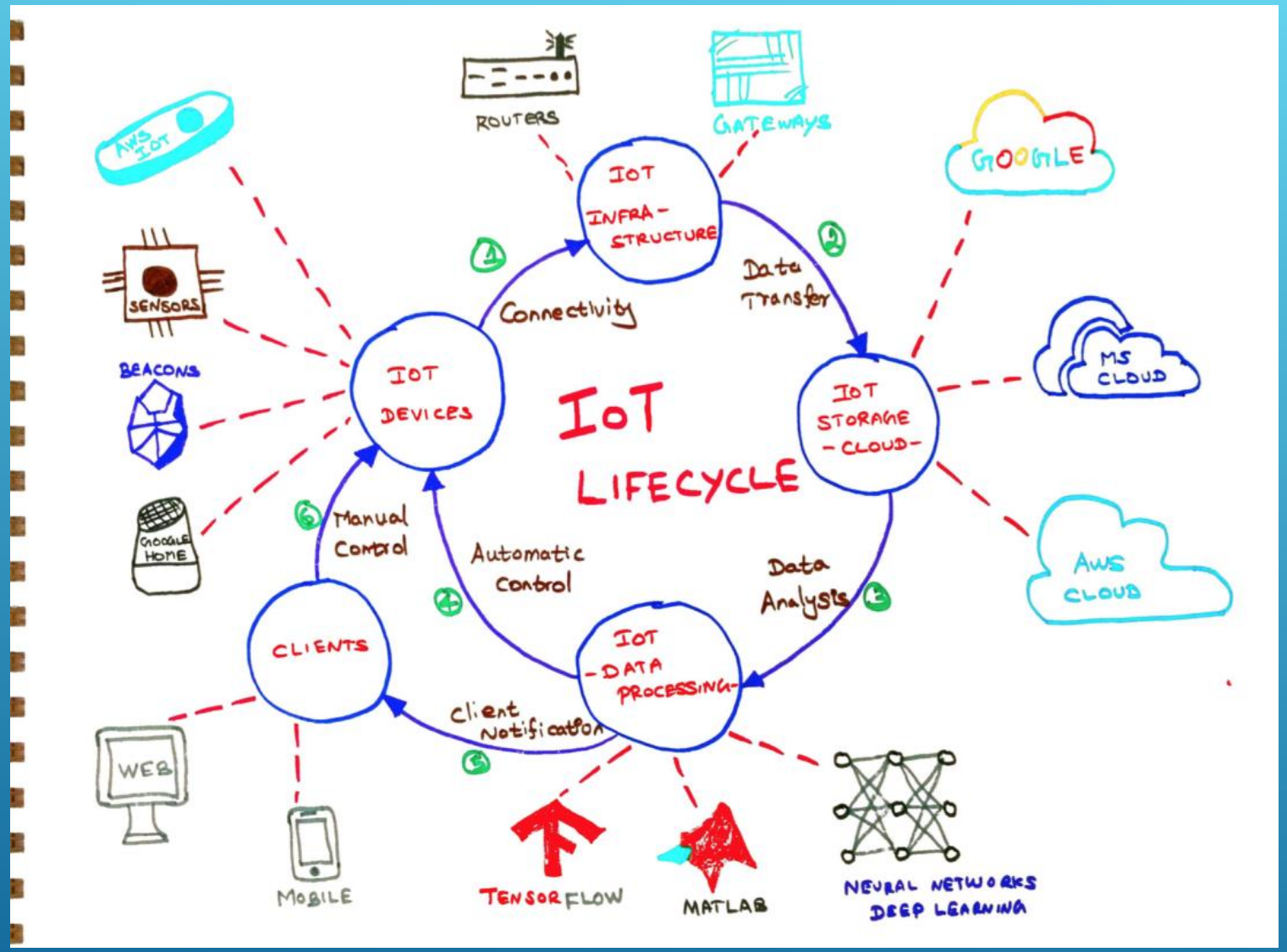


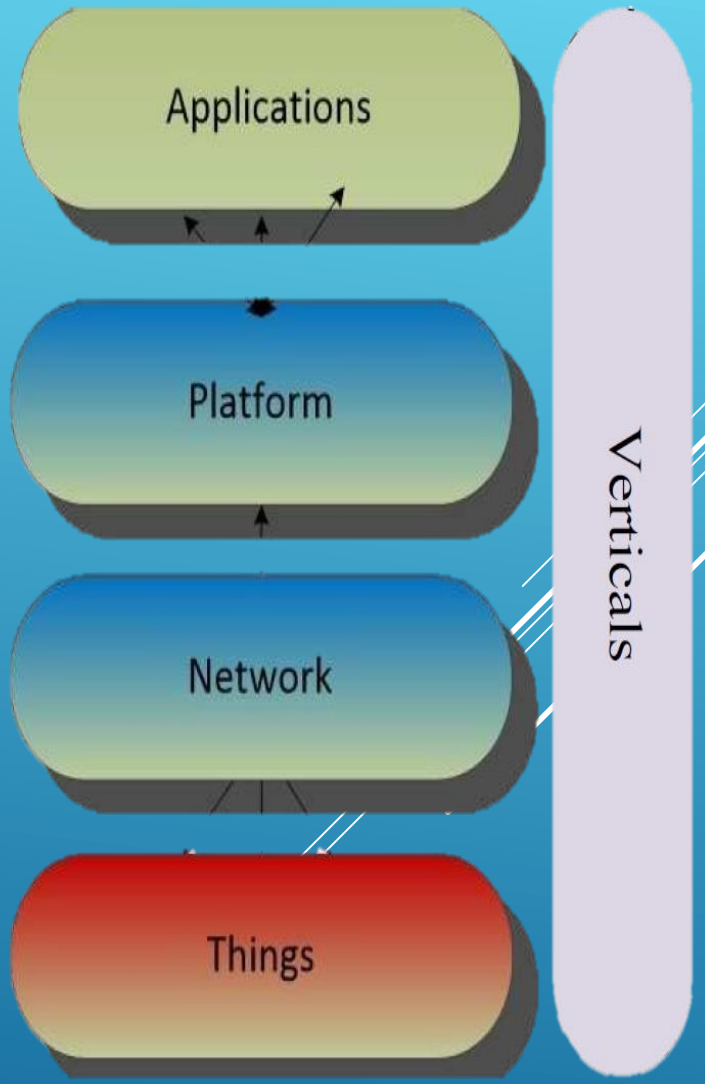
IoT Ecosystem

*https://shankarkumarasamy.blog/2017/06/19/iot-ecosystem/

IOT ECOSYSTEM

- Things:
  - sensors and actuators → IoT Devices, Electronic boards
- Network:
  - communication technologies → IoT Network Infrastructure
- Platform:
  - - definition: A **platform** is a group of **technologies** that are used as a base upon which other applications, processes or **technologies** are developed.

    security, process modeling and device management, data stream and information management, integration of information access mechanisms, data analysis and visualization → IoT Clouds and Data processing
- Applications:
  - making decisions, different services and verticals, message passing protocols → Websites, Mobile applications



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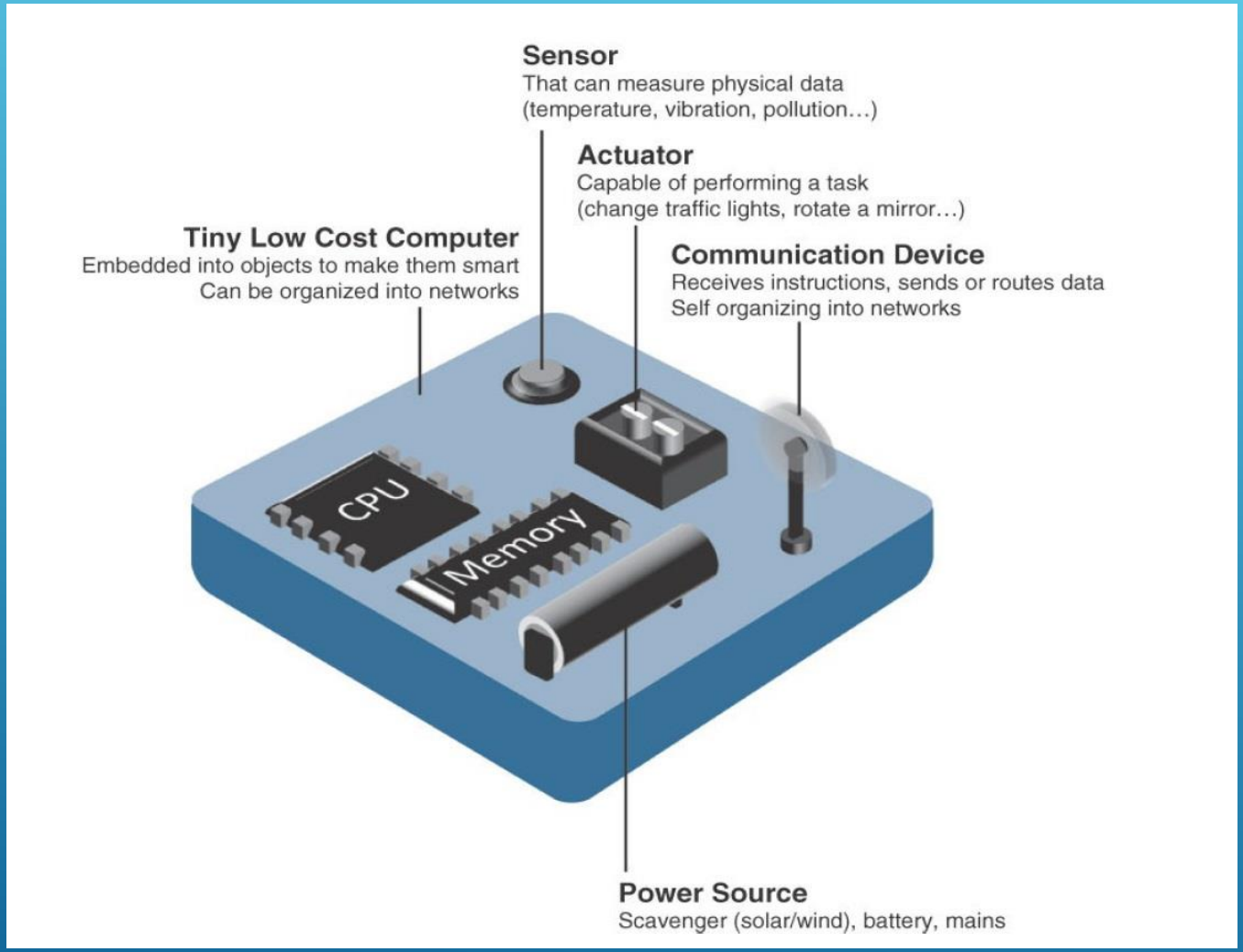
WHAT ARE THINGS?

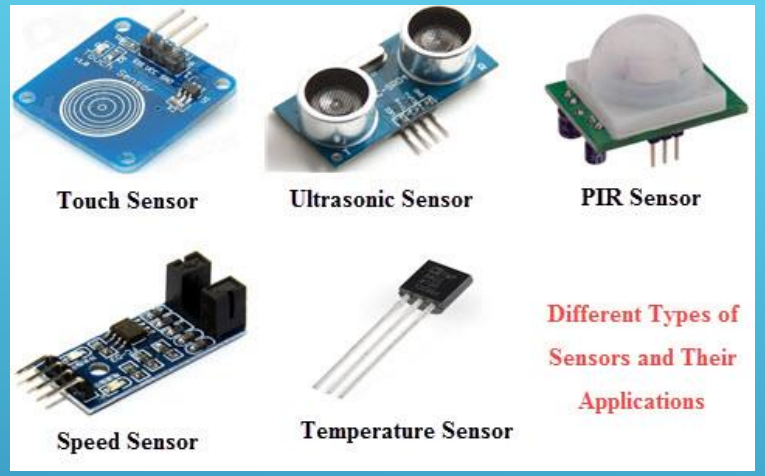
- Smart objects or Things are any physical objects that contain embedded technology to sense and/or interact with their environment in a meaningful way by being interconnected and enabling communication among themselves or an external agent.
- Things are
  - Sensors
  - Actuators

* IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

WHAT ARE THINGS?



Sensors

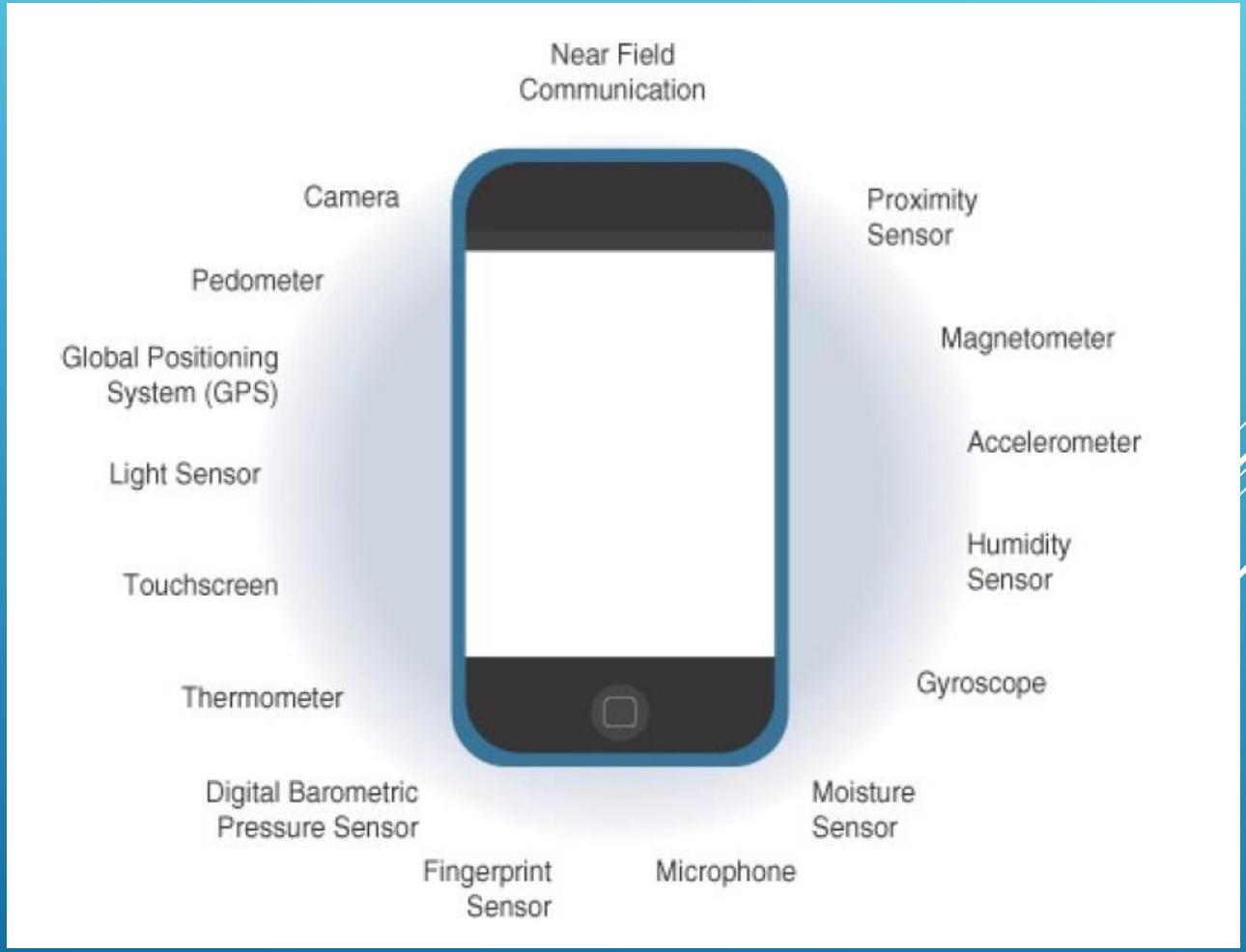


Actuators

* IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

WHAT ARE THINGS?

- Sensors in smart phones



* IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

SENSORS

- Measures some physical quantity and converts it into a digital representation.
- That digital representation is typically passed to another device for transformation into useful data that can be consumed by intelligent devices or humans.
- Sensors can be readily embedded in any physical objects that are easily connected to the Internet by wired or wireless networks.
- Because these connected host physical objects with multidimensional sensing capabilities communicate with each other and external systems, they can interpret their environment and make intelligent decisions.

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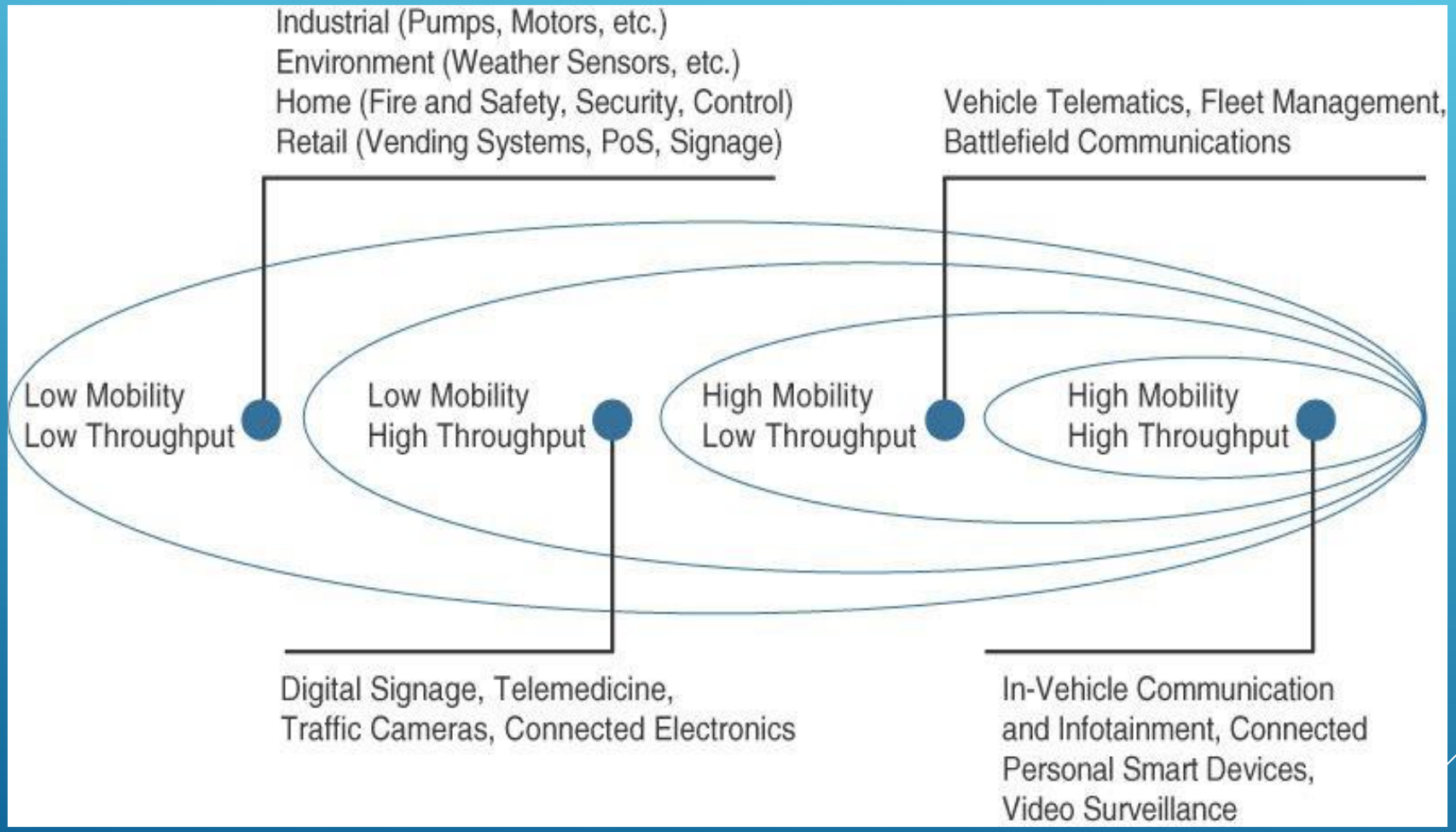
SENSORS

Example of Sensor Applications Based on Mobility and Throughput



* IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

ACTUATORS

- Actuators receive some type of control signal (commonly an electric signal or digital command) that triggers a physical effect, usually some type of motion, force, and so on.

* IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

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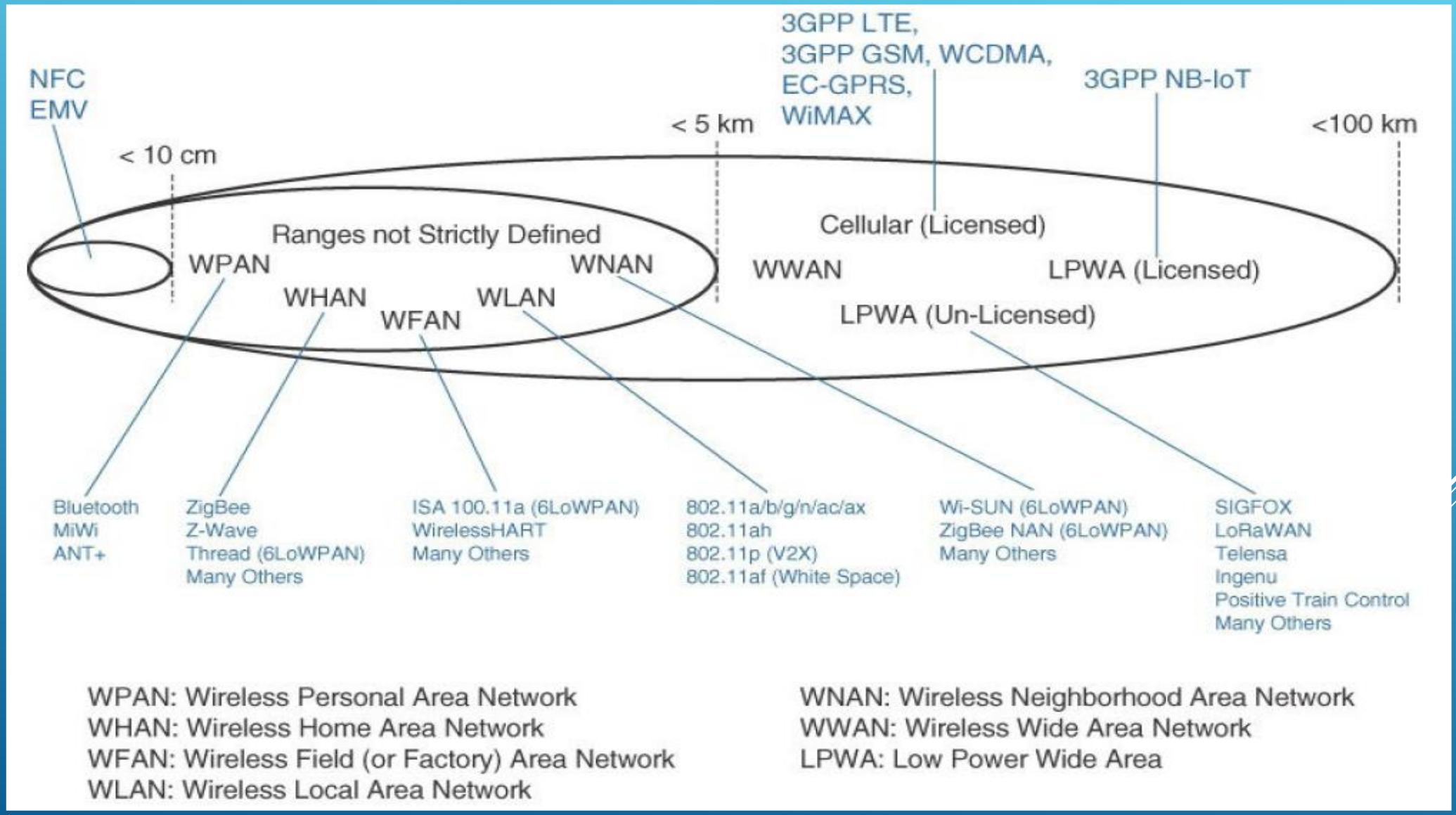
IOT NETWORKS

- Having determined the smart object and its required transmission capabilities (transmission range, data volume and frequency, sensor density and mobility), you are ready to connect the object and communicate.
- A first step in designing an IoT network is to examine the requirements in terms of mobility and data transmission (how much data, how often, how long, how much power).
- IoT Network is the communication domain for the IoT devices and endpoints.
- It includes the devices themselves and the communications network that links them.

* IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017

ACCESS TECHNOLOGIES AND DISTANCES



WPAN: Wireless Personal Area Network
WHAN: Wireless Home Area Network
WFAN: Wireless Field (or Factory) Area Network
WLAN: Wireless Local Area Network

WNAN: Wireless Neighborhood Area Network
WWAN: Wireless Wide Area Network
LPWA: Low Power Wide Area

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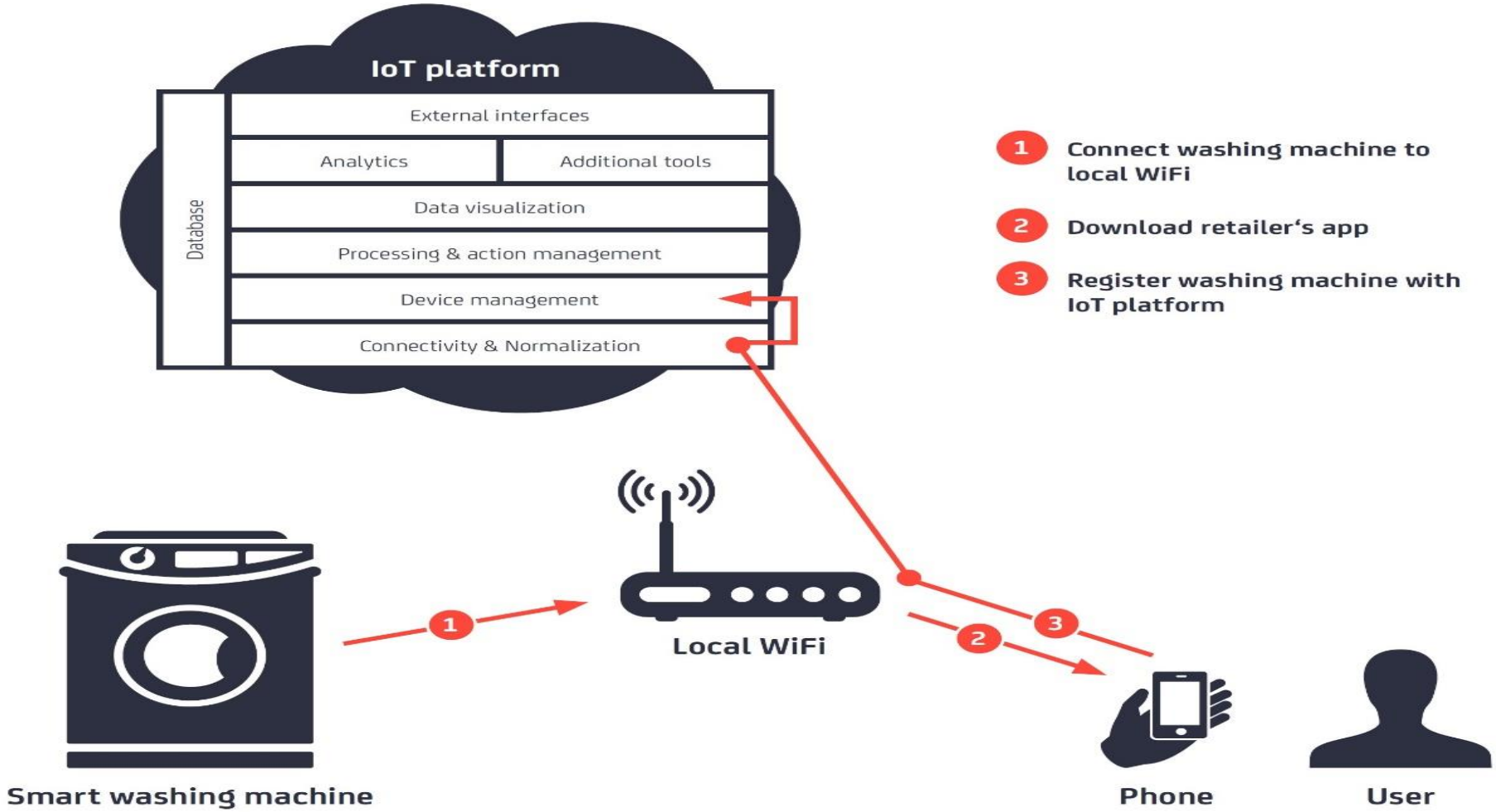
IOT PLATFORMS

- IoT platforms are the central piece in the Internet of Things architecture that connect the real and the virtual worlds and enable communication between objects.
- In its most simple form, an IoT platform is just about enabling connectivity between objects.
- In a more sophisticated form, the platform consists of a variety of important building blocks:
  - device management,
  - database,
  - processing and action management,
  - analytics,
  - visualization,
  - additional tools, and
  - external interfaces

- IoT Platforms, IoT Analytics, 2015
- https://medium.com/schaffen-softwares/part-4-iot-platforms-b8f2c4e4639b

IOT PLATFORMS



* IoT Platforms, IoT Analytics, 2015, https://www.educba.com/iot-platform/

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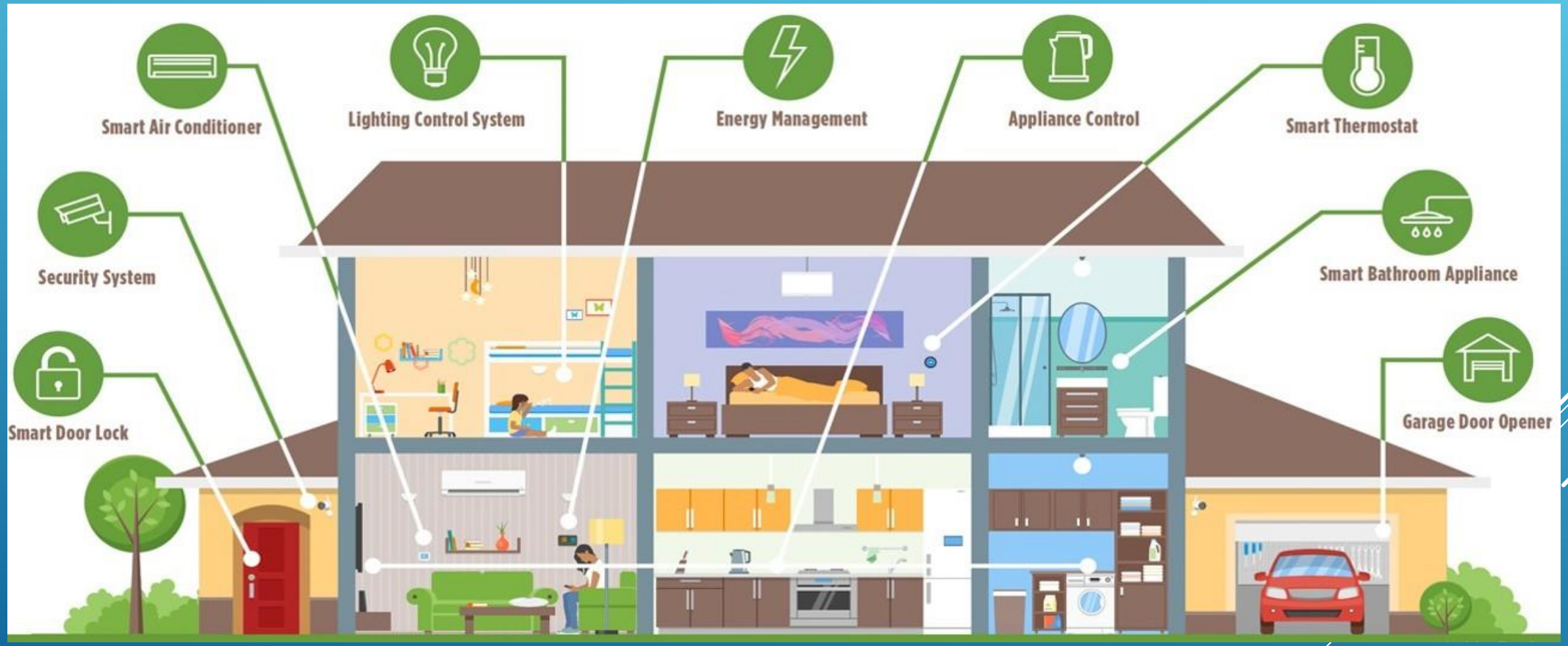
IOT APPLICATIONS AND VERTICALS

* https://www.meee-services.com/category/artificial-intelligence/

IOT APPLICATIONS AND VERTICALS- SMART HOME

Smart Home



* https://www.bluebonnetelectric.coop/Community/News/articles/2016/Magazine-Stories/HOME,-SMART-HOME-Trends-in-residential-technology

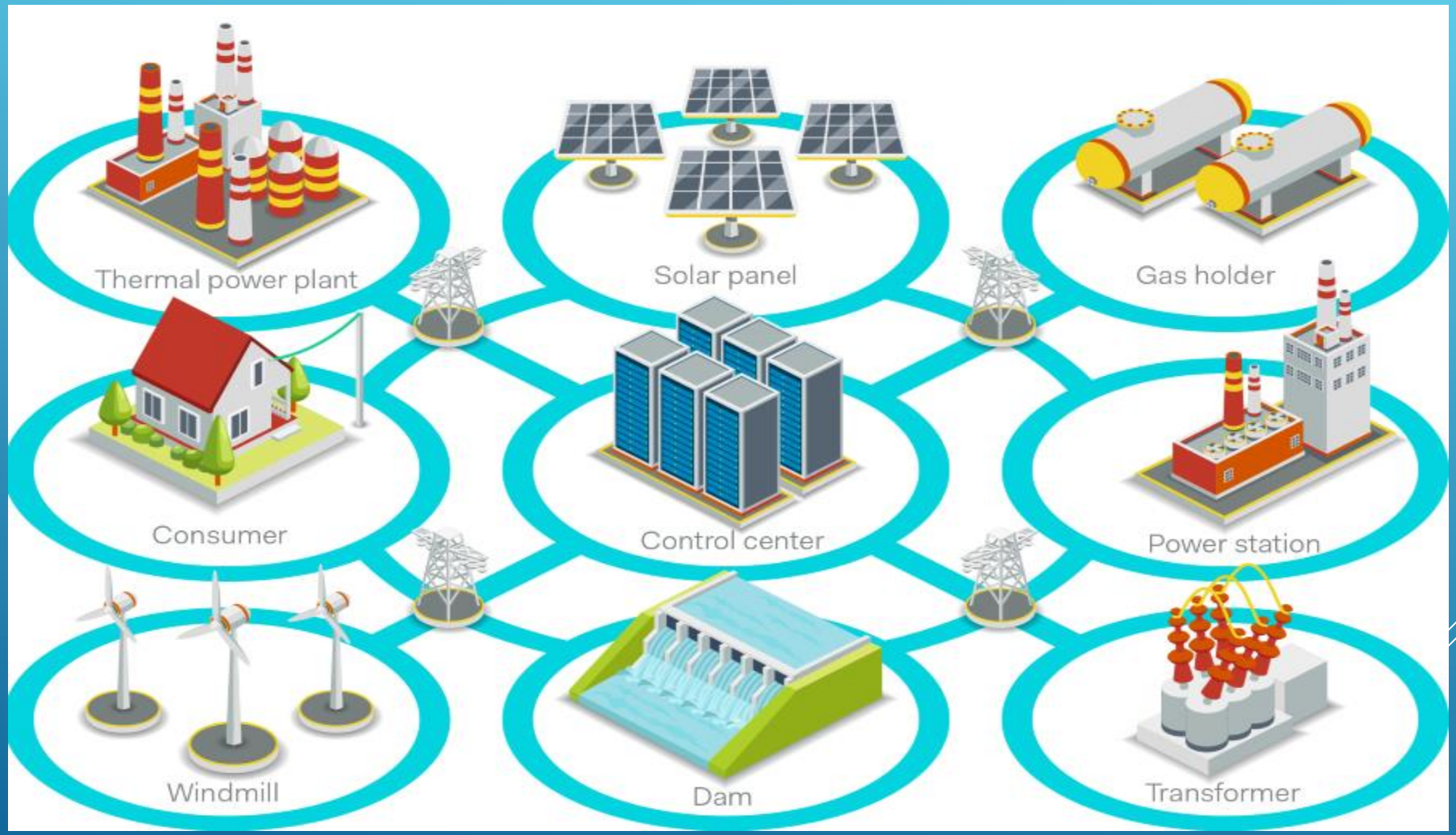
IOT APPLICATIONS AND VERTICALS- SMART WEARABLES

* https://www.quora.com/Why-the-boom-of-wearable-devices

IOT APPLICATIONS AND VERTICALS- SMART CITY

* https://www.ifpenergiesnouvelles.com/article/smart-city-energy-challenges-facing-sustainable-cities

IOT APPLICATIONS AND VERTICALS- SMART GRID

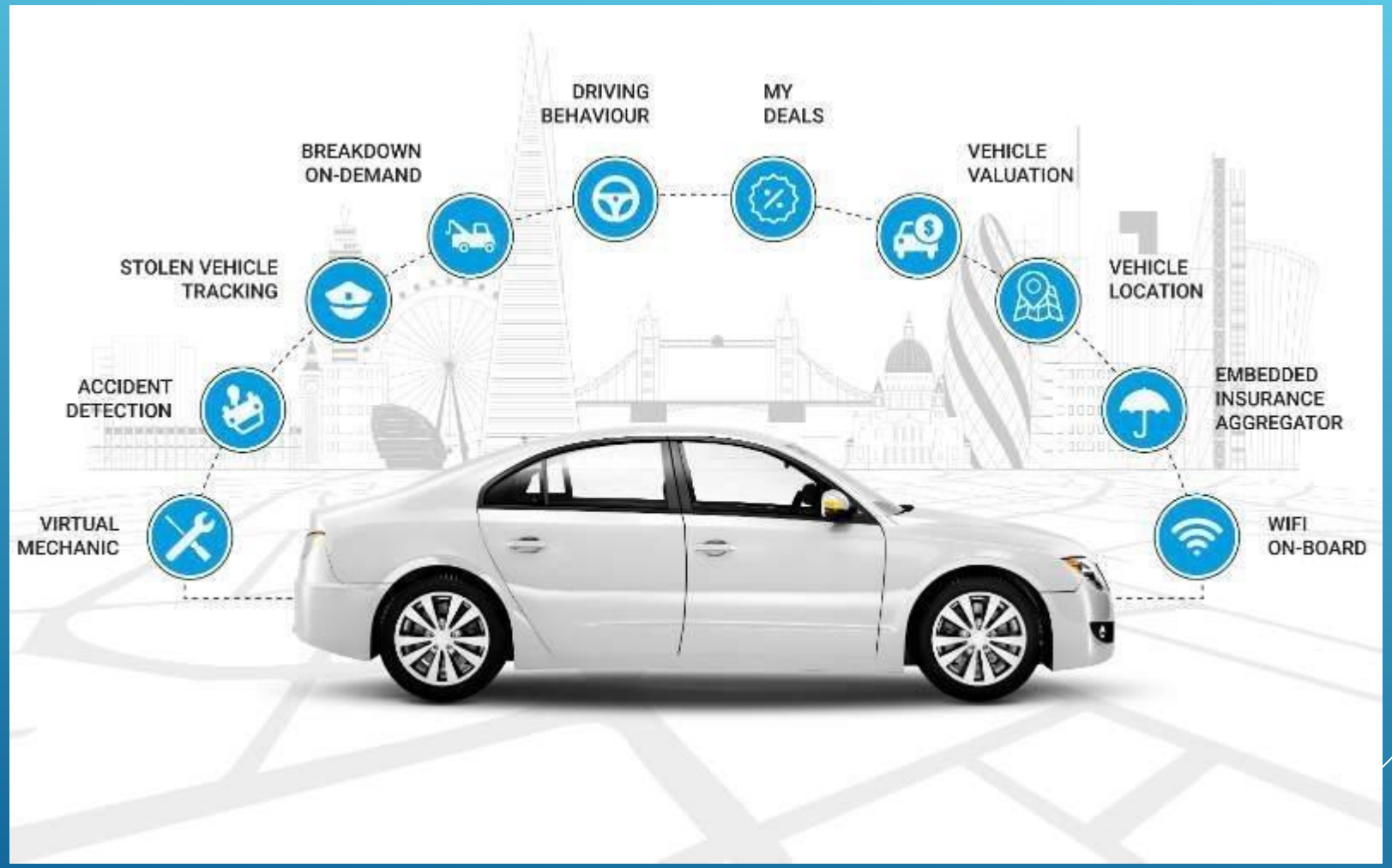


* https://www.powerelectronicsnews.com/technology/is-your-smart-grid-secured

IOT APPLICATIONS AND VERTICALS- SMART TRANSPORTATION

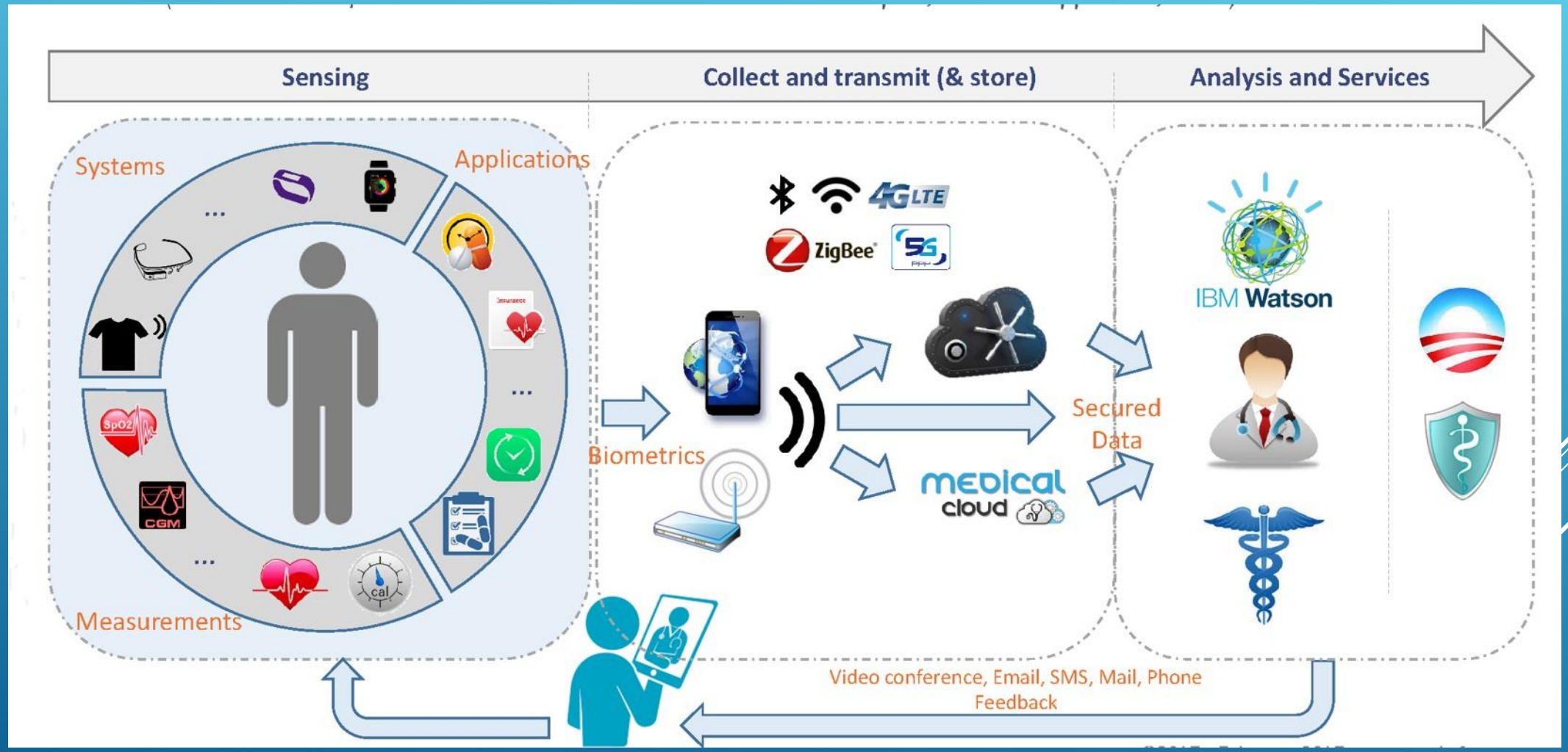
* https://www.sentinelassam.com/editorial/intelligent-transportation-system-and-smart-city-4/

IOT APPLICATIONS AND VERTICALS- CONNECTED CAR



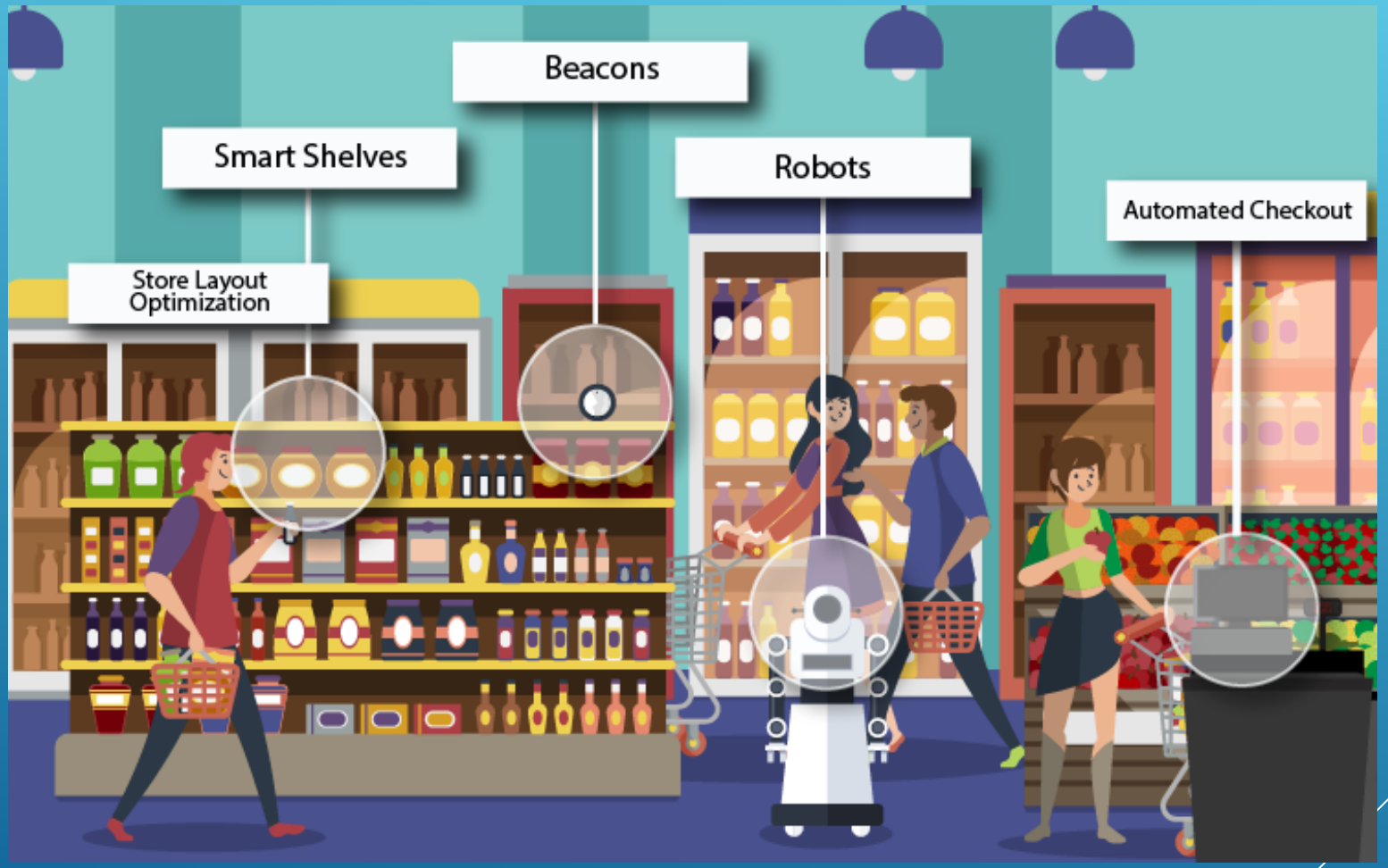
* https://www.researchgate.net/figure/Function-of-connected-car_fig1_323258412

IOT APPLICATIONS AND VERTICALS- CONNECTED HEALTH



* http://www.yole.fr/IoT_Seminar_Yole_FraunhoferEMFT.aspx

IOT APPLICATIONS AND VERTICALS- SMART RETAIL



* https://www.42gears.com/blog/how-iot-is-changing-retail-industry/

IOT APPLICATIONS AND VERTICALS- SMART FARMING

* https://volansys.com/modular-iot-gateway/

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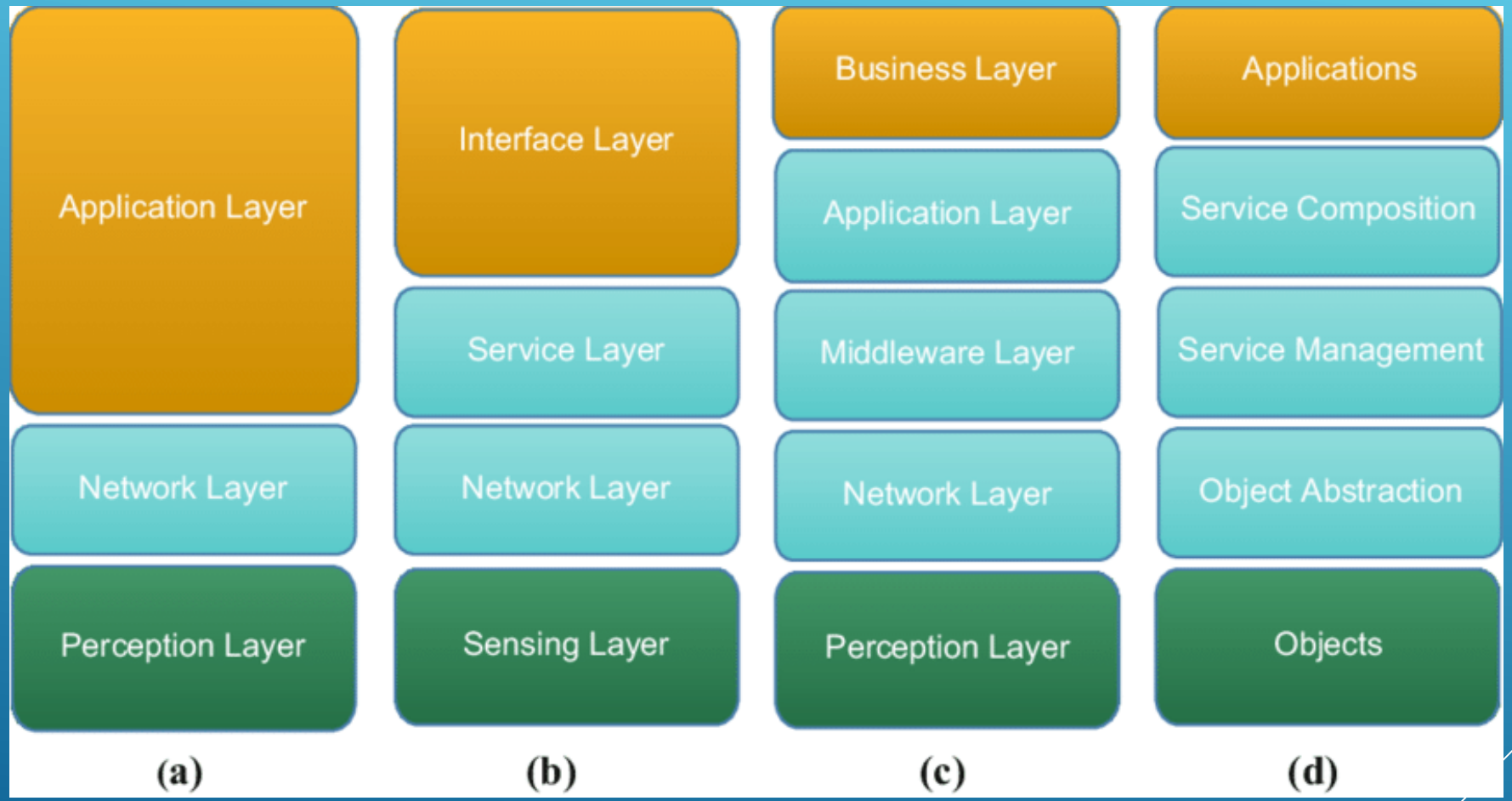
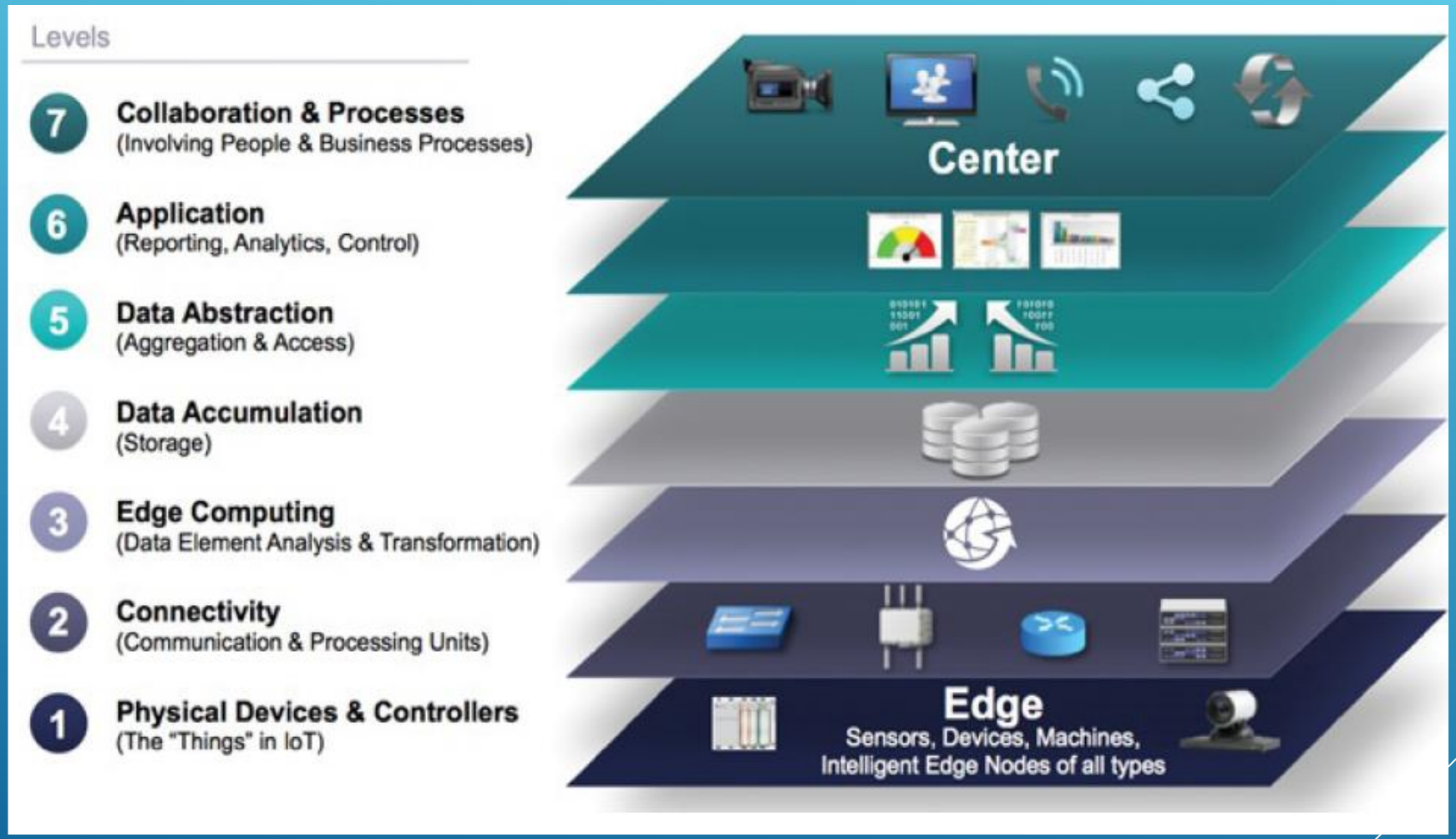
IOT ARCHITECTURES

a: 3 layer architecture, b: 3 layer architecture, c: 4 layer architecture1 d: 4 layer architecture2



IOT 7 LAYER ARCHITECTURE BY CISCO



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IOT CHALLENGES

- Scalability
- Security
- Privacy
- Big Data and Data Analytics
- Interoperability

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IOT CHALLENGES

- Scalability
  - The IPv4 address space has reached exhaustion and is unable to meet IoT's scalability requirements.
  - For IoT scale can be met only by IPv6.
- Security
- Privacy
- Big Data and Data Analytics
- Interoperability

	Internet Protocol version 4 (IPv4)	Internet Protocol version 6 (IPv6)
Deployed	1981	1999
Address Size	32-bit number	128-bit number
Address Format	Dotted Decimal Notation: 192.149.252.76	Hexadecimal Notation: 3FFE:F200:0234:AB00: 0123:4567:8901:ABCD
Prefix Notation	192.149.0.0/24	3FFE:F200:0234::/48
Number of Addresses	2^{32} = ~4,294,967,296	2^{128} = ~340,282,366, 920,938,463,463,374, 607,431,768,211,456

- IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017
- https://rezwanlink.wordpress.com/tag/ipv4-vs-ipv6/

IOT CHALLENGES

- Scalability
- Security
  - With more "things" connected with other "things" and people security is an increasingly complex issue for IoT.
  - Threat surface is greatly expanded and if device gets hacked, its connectivity is a major concern.
  - A Compromised device can serve as a launching point to attack other devices and systems.
- Privacy
- Big Data and Data Analytics
- Interoperability

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IOT CHALLENGES

- Scalability
- Security
- Privacy
  - A sensor become more prolific in every day lives, the data what they gather will be specific to individuals and their activities.
  - For Businesses, the data has monetary value.
  - Organization discusses about who owns the data and how individuals can control whether it is shared and with whom.
- Big Data and Data Analytics
- Interoperability

- IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017
- https://internetofbusiness.com/consumers-demand-more-data-privacy-from-the-iot-economist-report/

IOT CHALLENGES

- Scalability
- Security
- Privacy
- Big Data and Data Analytics
  - IoT and large number of sensors are going to trigger deluge of data that must be handled.
  - This data will provide critical information and insights if it can be processed in an efficient manner.
  - Challenge is evaluating massive amounts of data arriving from different sources in various forms and doing so in a timely manner.
- Interoperability

- IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing, Cisco press, 2017
- https://www.karmelsoft.com/big-data-and-the-internet-of-things/

IOT CHALLENGES

- Scalability
- Security
- Privacy
- Big Data and Data Analytics
- Interoperability
  - As with nascent technology, various protocols and architectures are jockeying for market share and standardizations within IoT.
  - Some of these protocols and architectures are based on proprietary elements and others are open.
  - Recently IoT Standards are helping minimize this problem, but there are often various protocols and implementations available for IoT networks.

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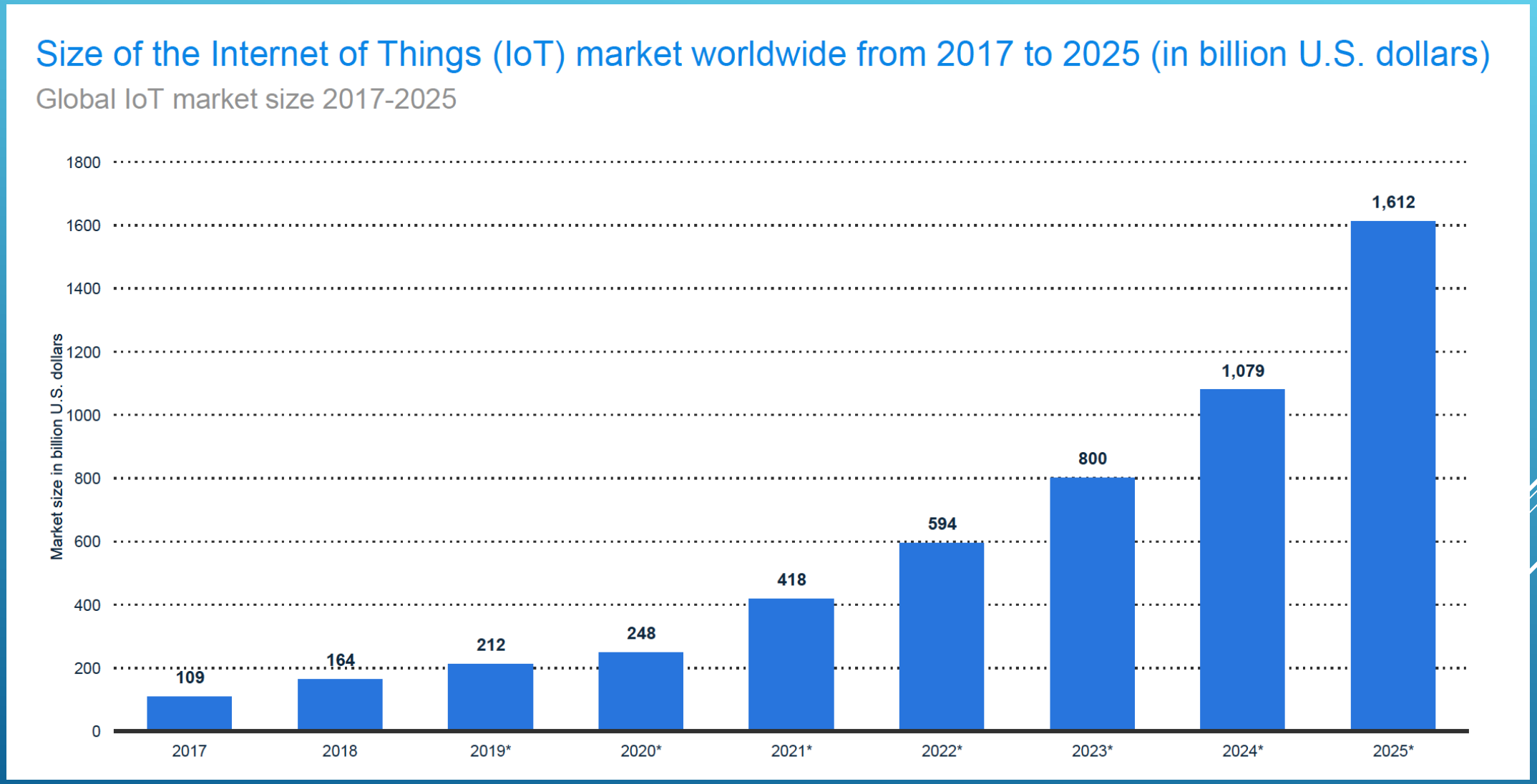
IOT GLOBAL MARKET SIZE 2017-2025

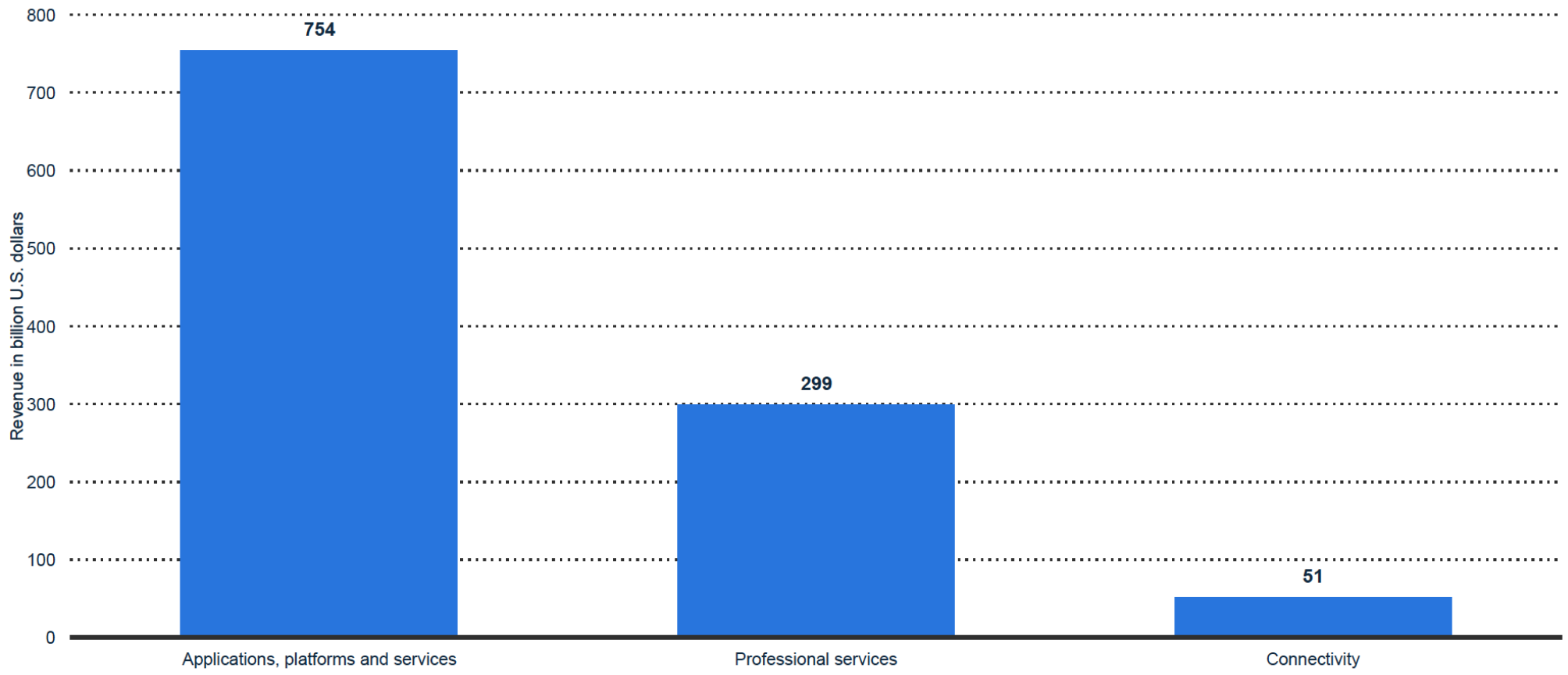


https://www.statista.com/

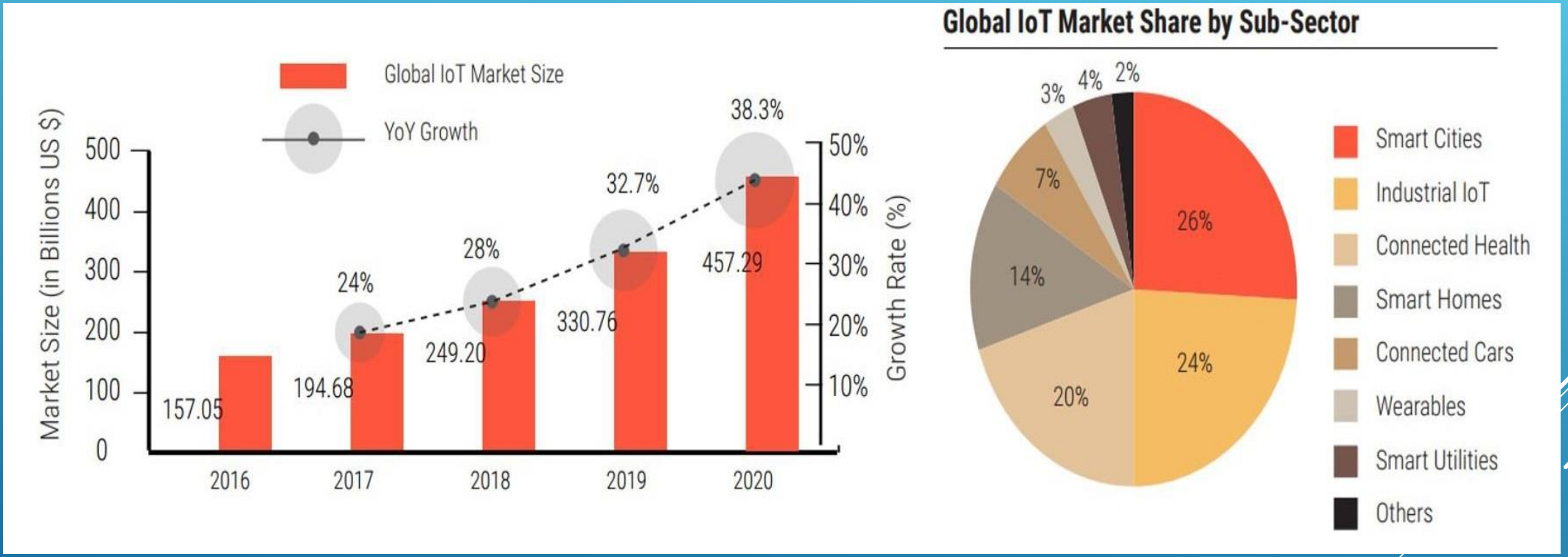
IOT REVENUE FORECAST BY SEGMENT

IoT revenue forecast by segment worldwide in 2025 (in billion U.S. dollars)

Global IoT revenue forecast 2025, by segment



IOT BUSINESS AND MARKET OPPORTUNITIES



* https://dreamziot.com/the-upcoming-iot-market/

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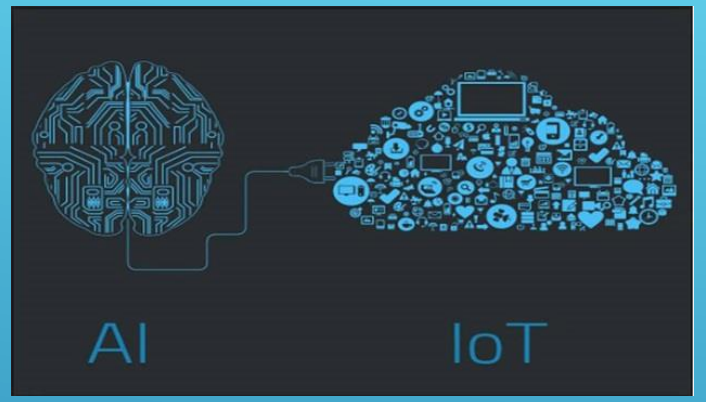
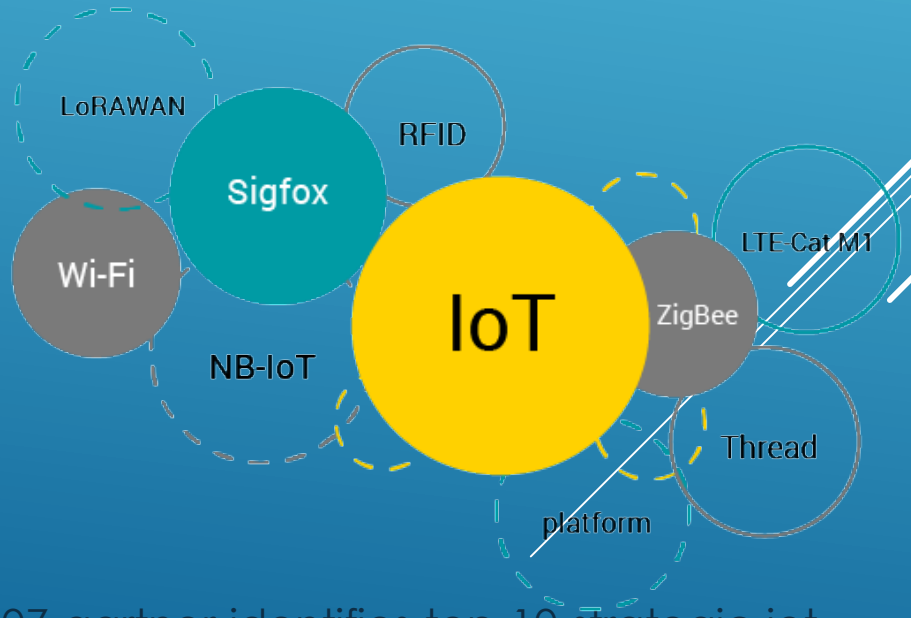
IOT TRENDS

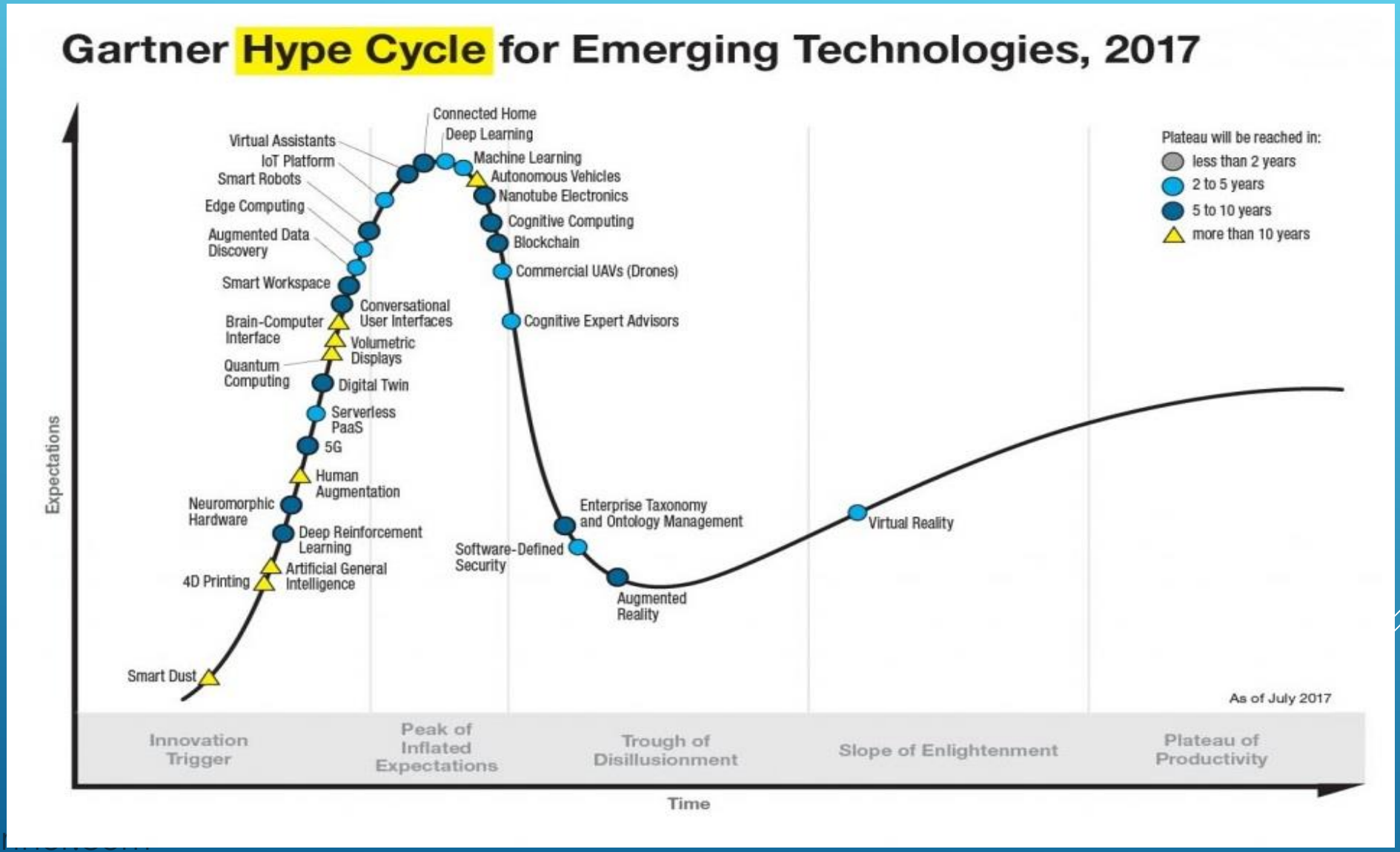
1. Artificial Intelligence
2. Social, Legal, and Ethical IoT
3. IoT Governance
4. Sensor Innovation
5. Trusted Hardware and Operating System
6. IoT User Experiences
7. New Wireless Networking Technologies for IoT





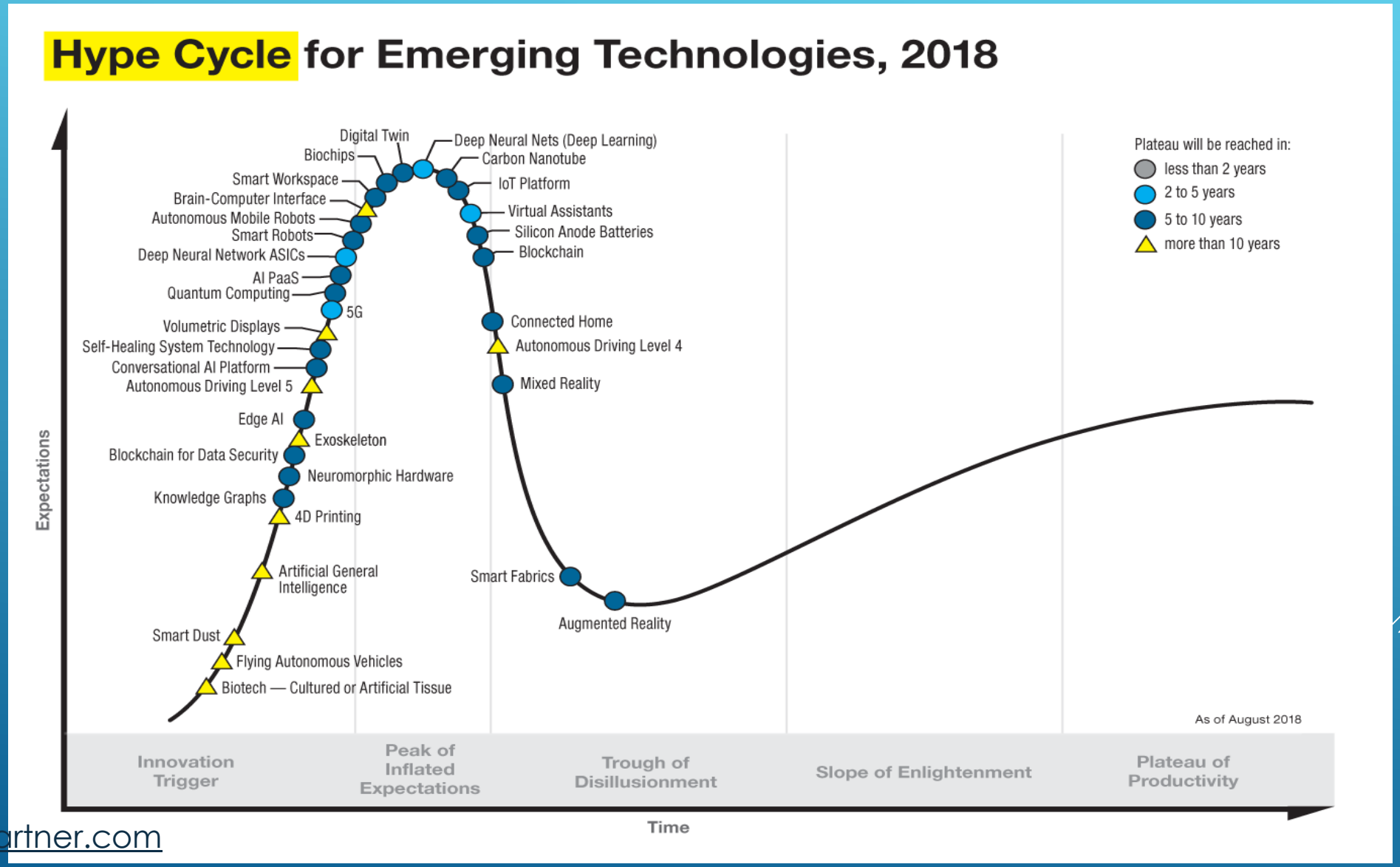
* https://www.gartner.com/en/newsroom/press-releases/2018-11-07-gartner-identifies-top-10-strategic-iot-technologies-and-trends

IOT TRENDS



* https://gartner.com

IOT TRENDS



* https://gartner.com

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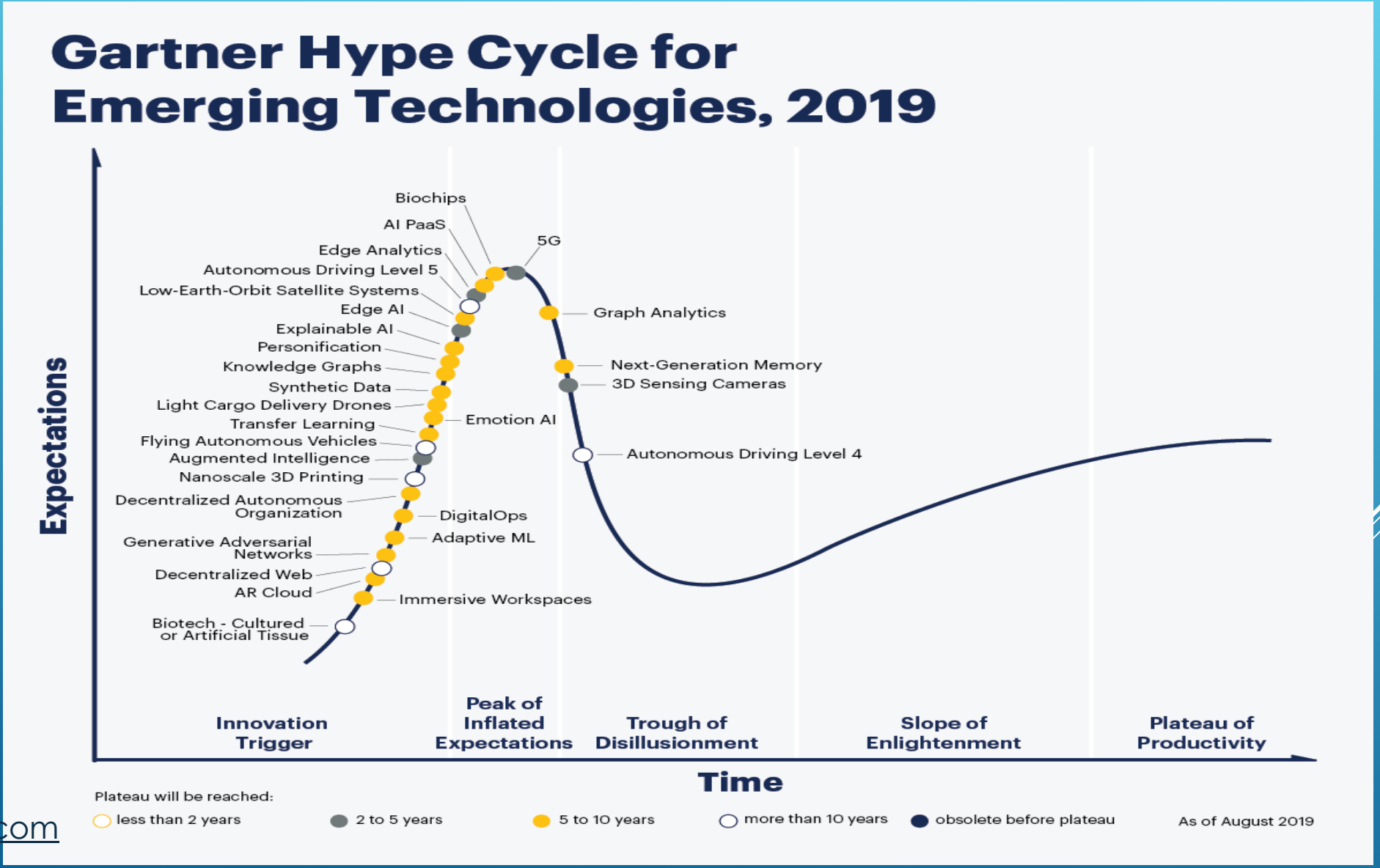

* https://gartner.com

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چیزهای عالی هرگز در راحتی بدست نمی آیند.