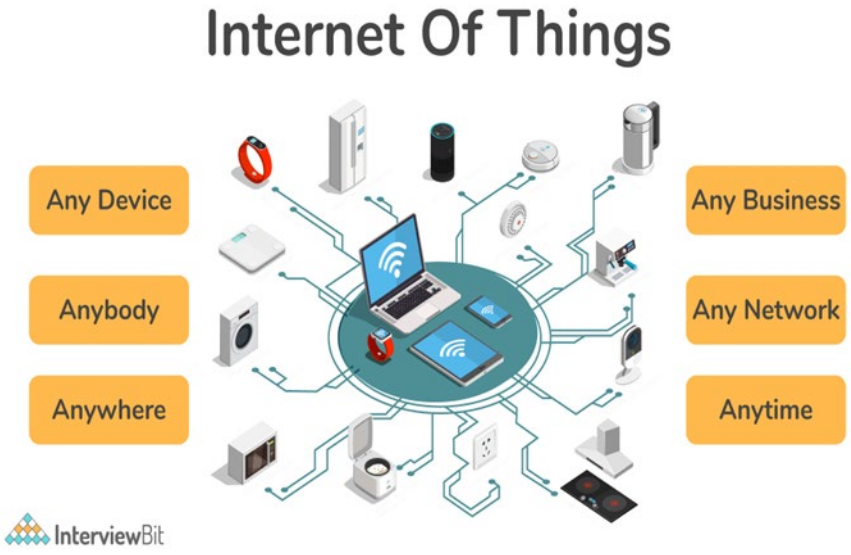
Ubiquitous Computing
Week 5

Faculty of Computing
UTM

- ✓ WHAT is Ubiquitous Computing?
- ✓ Evolution of Ubiquitous Computing
- ✓ The application of Ubiquitous Computing
- ✓ Computing Comparison
- ✓ Mobile Computing
- ✓ Architecture
- ✓ Ubiquitous vs IoT
- ✓ WHAT is IoT?
- ✓ IoT Components
- ✓ Sensor and Actuator
- ✓ Network Protocols
- ✓ Controller
- ✓ Trend and Application
- ✓ Issue & Challenges



普偏 Ubiquitous computing, also known as **pervasive computing or ambient intelligence**, refers to the concept of embedding computing devices into everyday objects and environments, making them effectively invisible to users.

The goal is to create environments where computing capabilities are **seamlessly integrated into our surroundings**, allowing for constant, unobtrusive interaction.

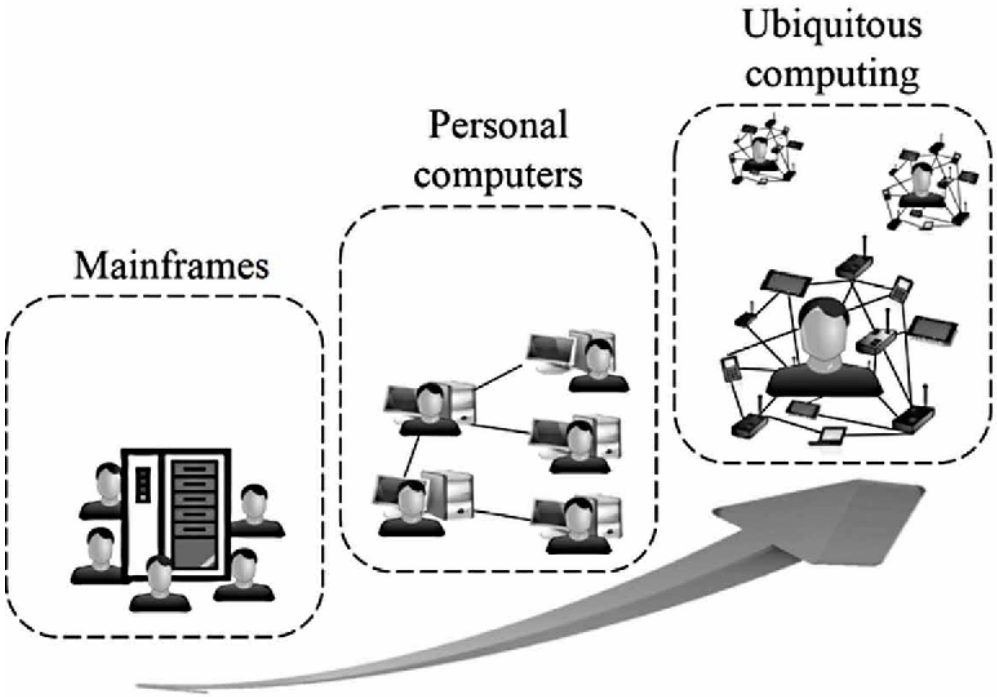
devices is everywhere

A vision for computing to:
Enable computer-based services to be made available **everywhere**, support intuitive human usage yet, appear to be **invisible** to the user

The 1st era of computing known as Mainframe era –
Many Person to One Computer many people shared one pc

The 2nd era of computing known as PC era –
One Person to One Computer

The 3rd era of computing known as Ubiquitous computing –
One Person using Many Computers (computing devices)

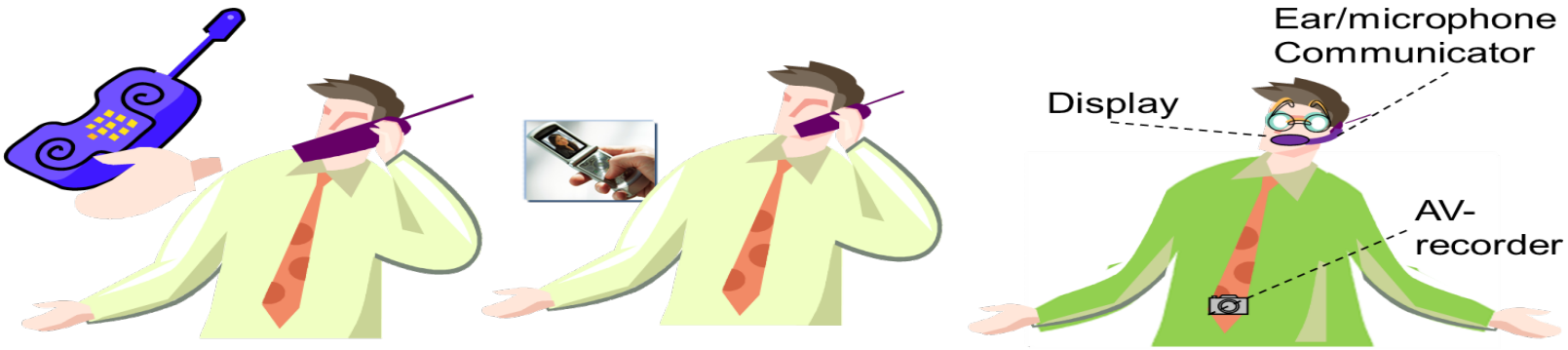


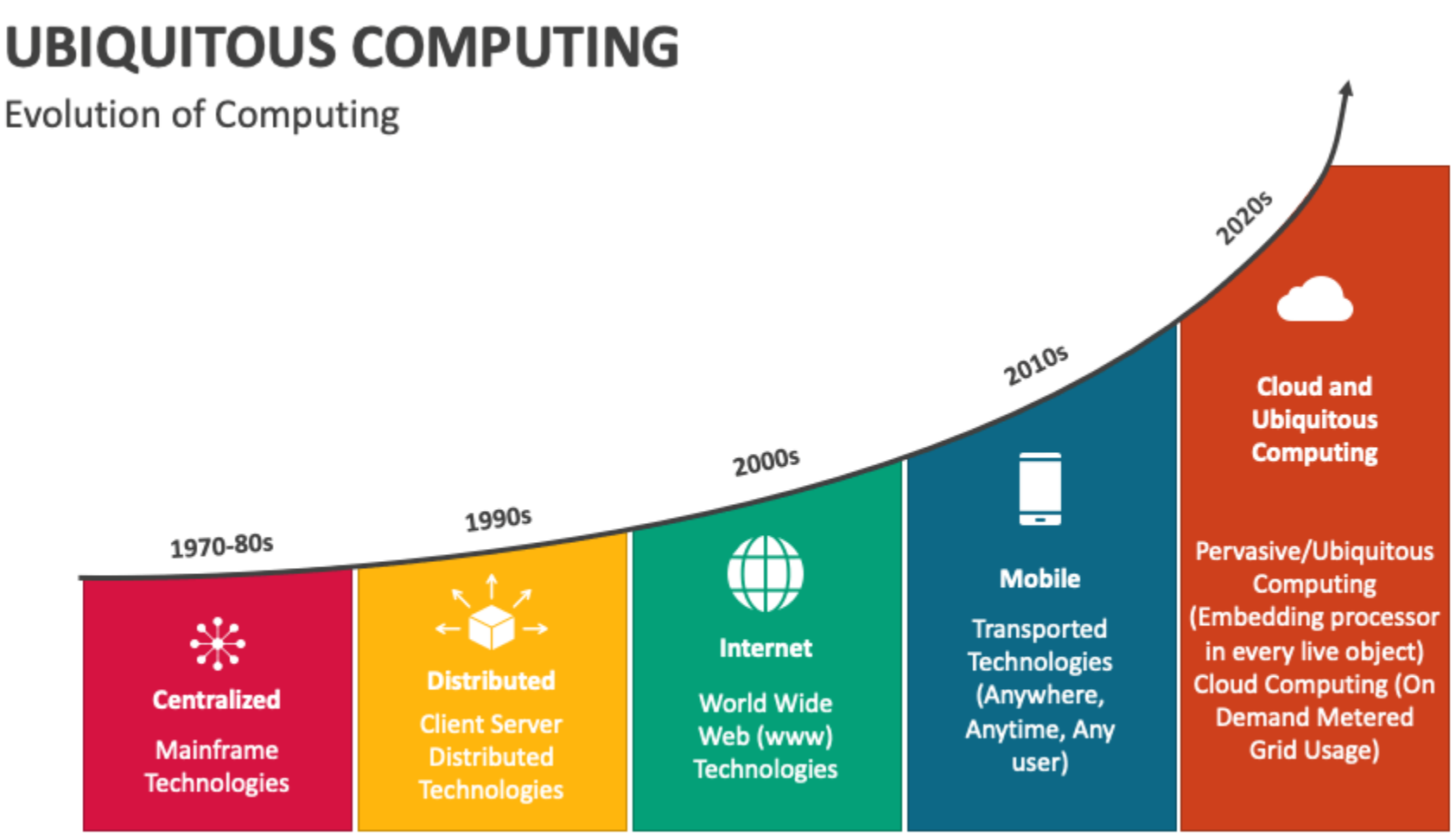
3 main properties for Ubiquitous Computing Systems were proposed by Weiser (1991)

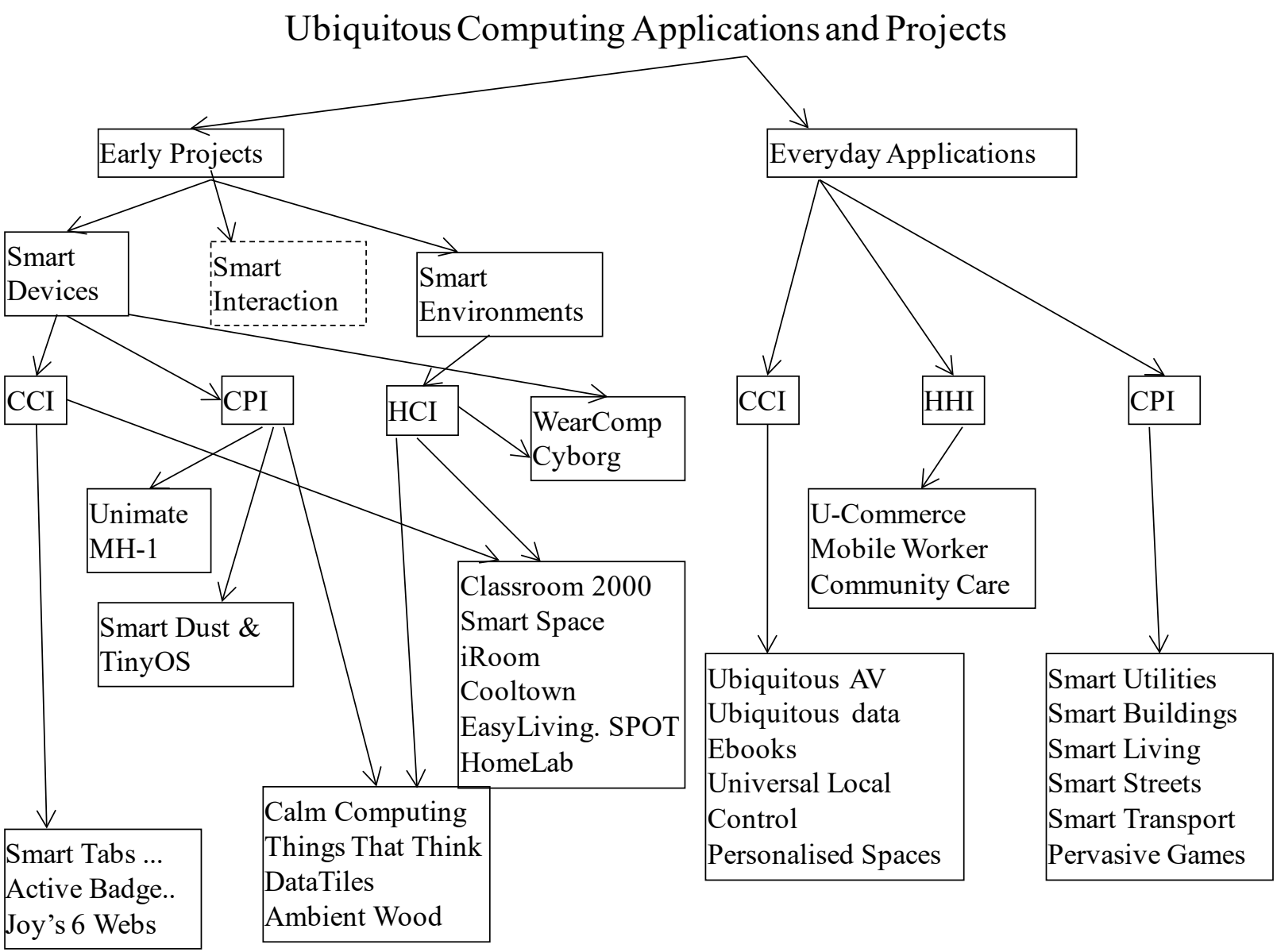
1. Computers need to be networked, distributed and transparently accessible

2. Computer Interaction with Humans needs to be more hidden

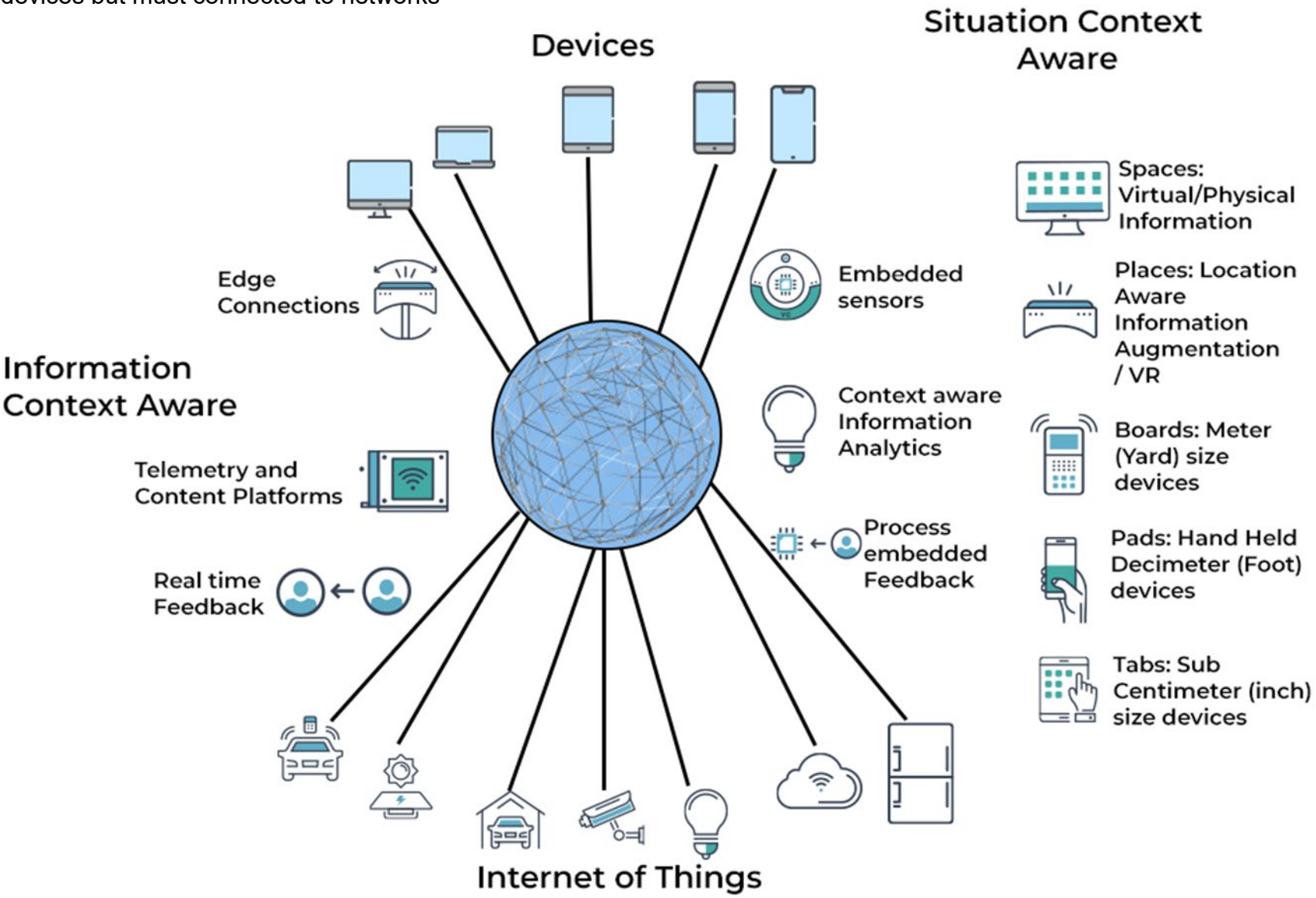
3. Computers need to be aware of environment context
   To optimize their operation in their physical & human environment.




UBIQUITOUS COMPUTING
Evolution of Computing
1970-80s
1990s
2000s
2010s
2020s
Centralized
Mainframe Technologies
Distributed
Client Server Distributed Technologies
Internet
World Wide Web (www) Technologies
Mobile
Transported Technologies (Anywhere, Anytime, Any user)
Cloud and Ubiquitous Computing
Pervasive/Ubiquitous Computing (Embedding processor in every live object) Cloud Computing (On Demand Metered Grid Usage)

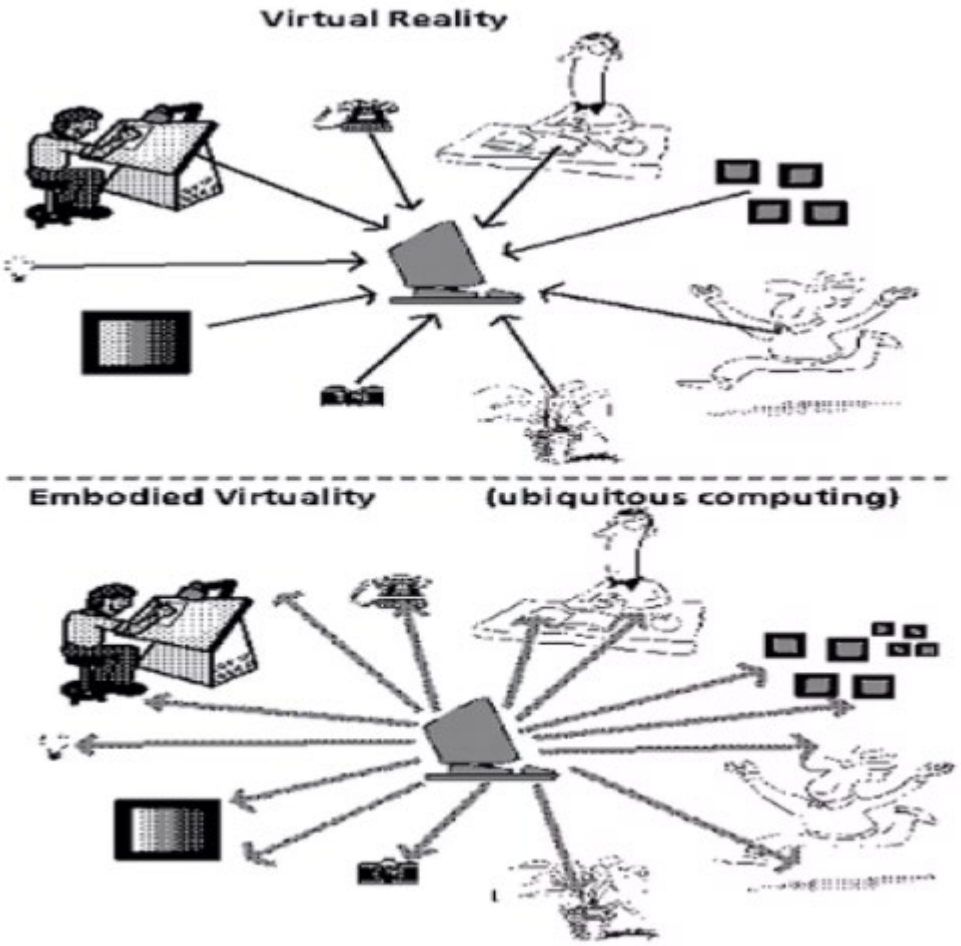

Ubiquitous Computing Applications and Projects
Early Projects
Everyday Applications
Smart Devices
Smart Interaction
Smart Environments
CCI
CPI
HCI
WearComp
Cyborg
Unimate
MH-1
Smart Dust &
TinyOS
Classroom 2000
Smart Space
iRoom
Cooltown
EasyLiving. SPOT
HomeLab
Smart Tabs ...
Active Badge..
Joy's 6 Webs
Calm Computing
Things That Think
DataTiles
Ambient Wood
CCI
HHI
CPI
U-Commerce
Mobile Worker
Community Care
Ubiquitous AV
Ubiquitous data
Ebooks
Universal Local
Control
Personalised Spaces
Smart Utilities
Smart Buildings
Smart Living
Smart Streets
Smart Transport
Pervasive Games

got devices but must connected to networks



Ubiquitous Computing	Non – Ubiquitous Computing
Force computer (computing power) to live out in the world with people	Put people inside a computer “world”
Very difficult integration of a lot of factor such as human factors, computer science, social science and engineering	Primarily depends on computing power only

less training to human



put data in cloud

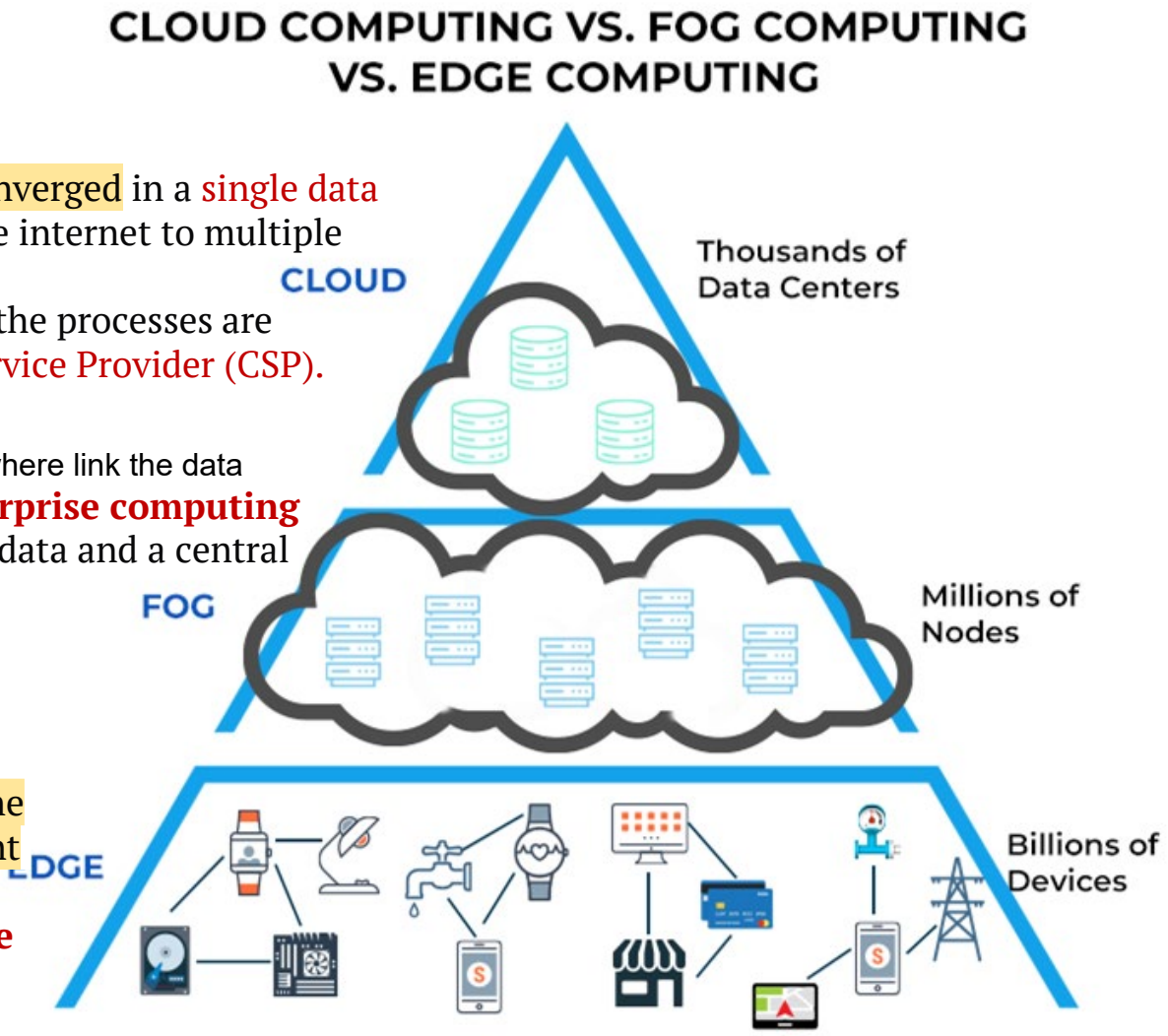
- data and applications are converged in a single data center and delivered over the internet to multiple end point devices.
- All the resources to execute the processes are contributed by the Cloud Service Provider (CSP).

data and centre cloud platform where link the data

- places a **decentralized enterprise computing layer** between the source of data and a central cloud platform

very close and related to devices

- brings processing and storage systems as **close** as possible to the application, device, or component that generates and collects data.
- helps **minimize processing time** by removing the need for transferring data to a central processing system and back to the endpoint



anything need to be proceed very fast must be stored in edge

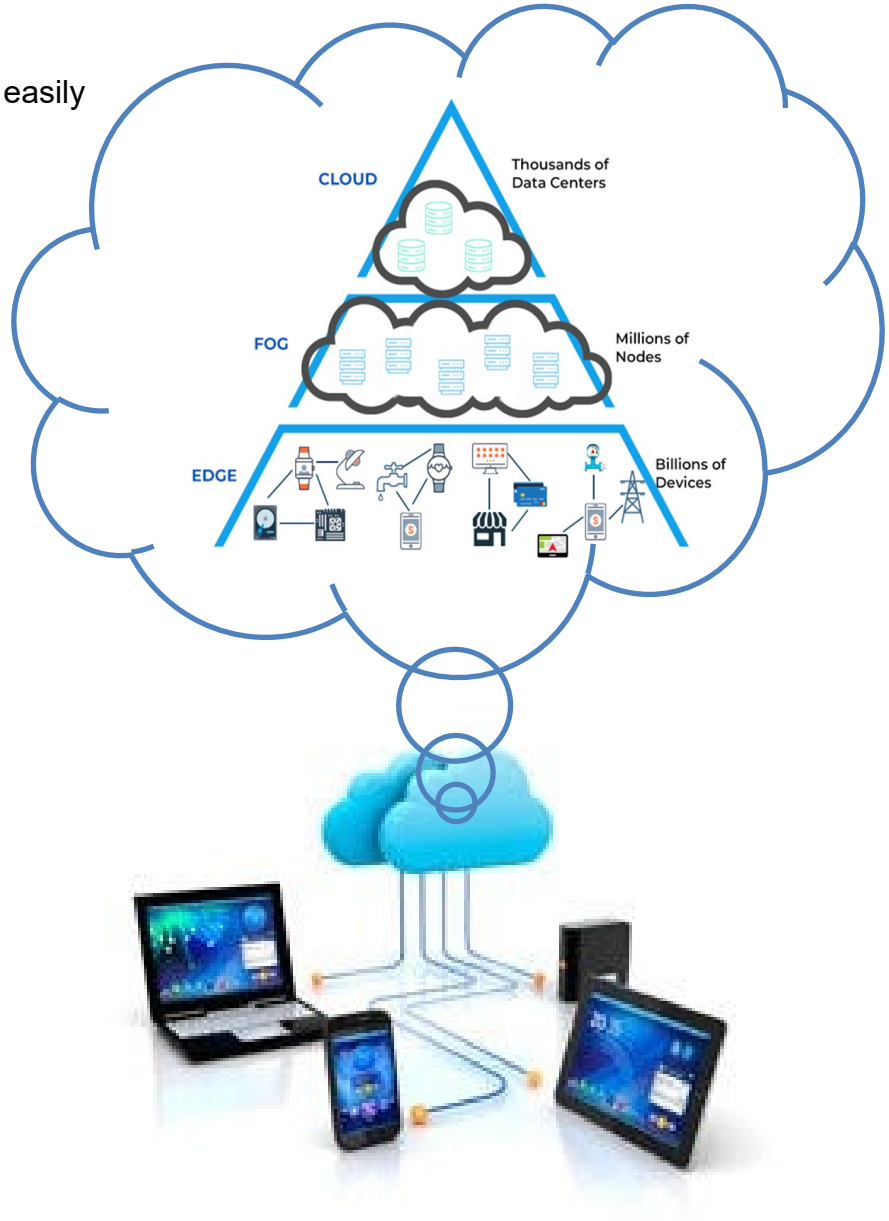
Compare	Cloud	Fog	Edge
Latency	Highest	Medium	Lowest
Scalability	High, easy to scale	Scalable within network	Hard to scale
Distance	Far from the edge	Network close to the edge	At the edge
Data analysis	Less time-sensitive data processing, permanent storage	Real-time, decides to process locally or send to cloud	Real-time, instant decision making
Computing power	High	Limited	Limited
Interoperability	High	High	Low

While not strictly a layer in the hierarchy, mobile computing refers to the use of portable devices, such as smartphones, tablets, and laptops, to access computing resources and services while being mobile or on the move.

can be remove easily

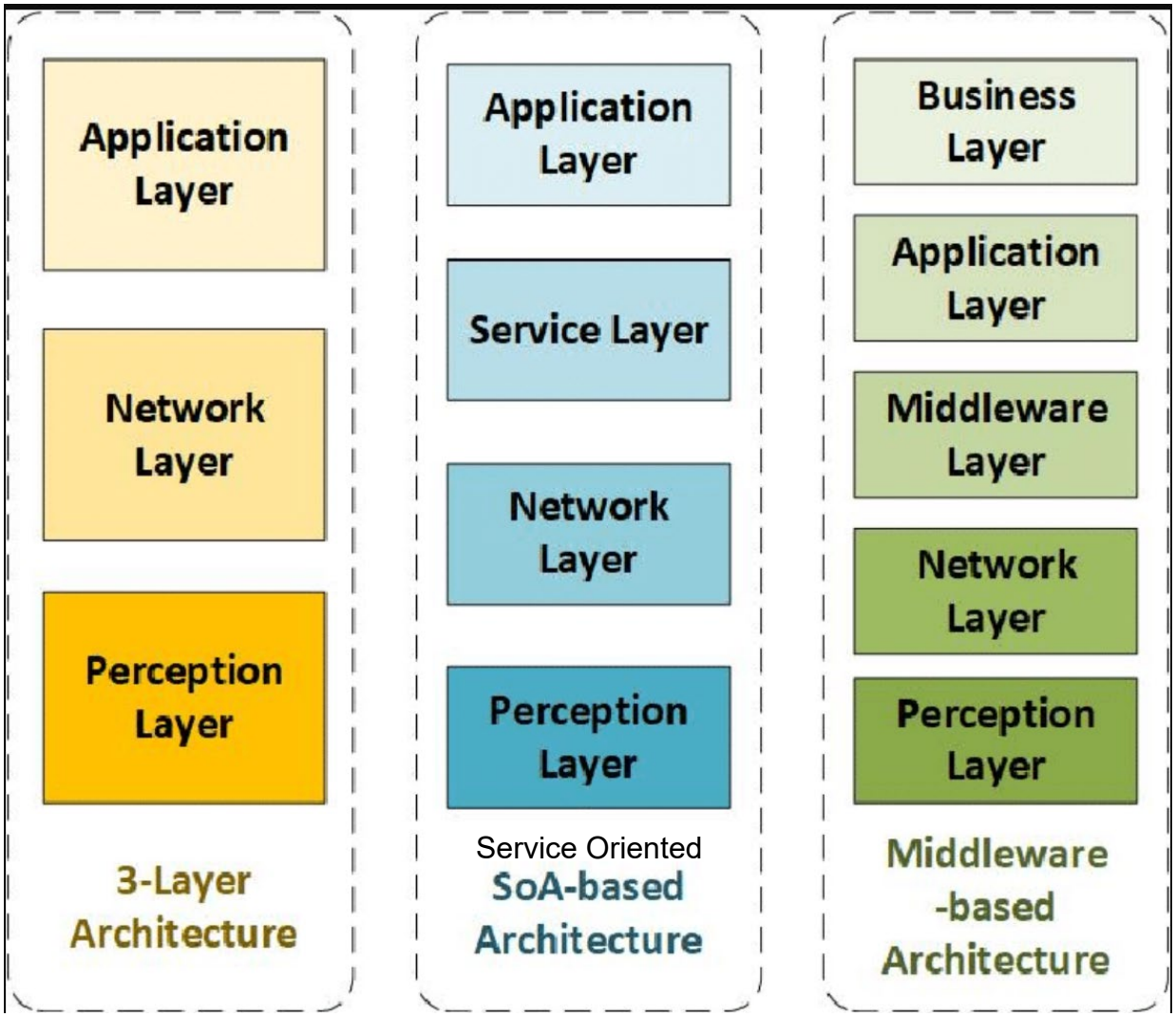
Mobile computing devices are equipped with wireless connectivity and can run applications and access data from remote servers.

Mobile computing complements cloud, fog, and edge computing by enabling users to interact with distributed computing resources and services from anywhere, at any time

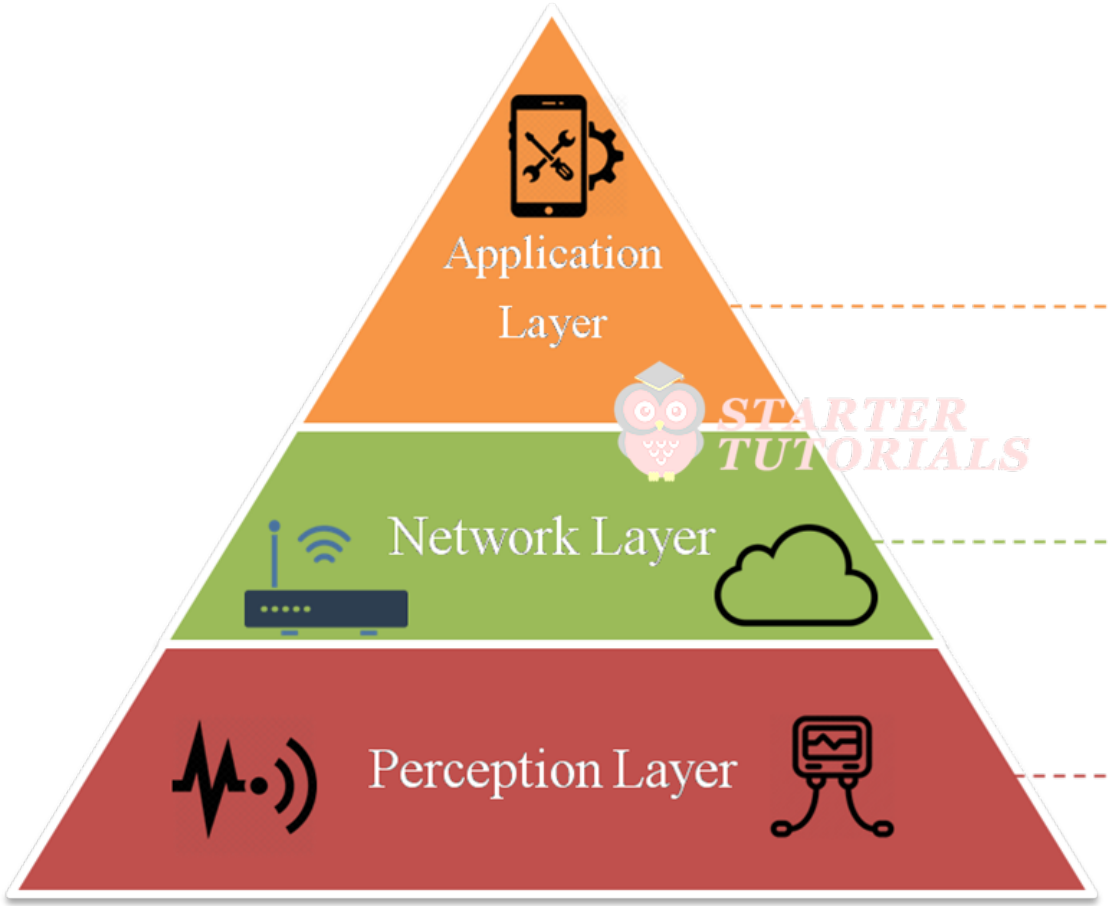


Most Common Architecture

most easier



3 Layer Architecture

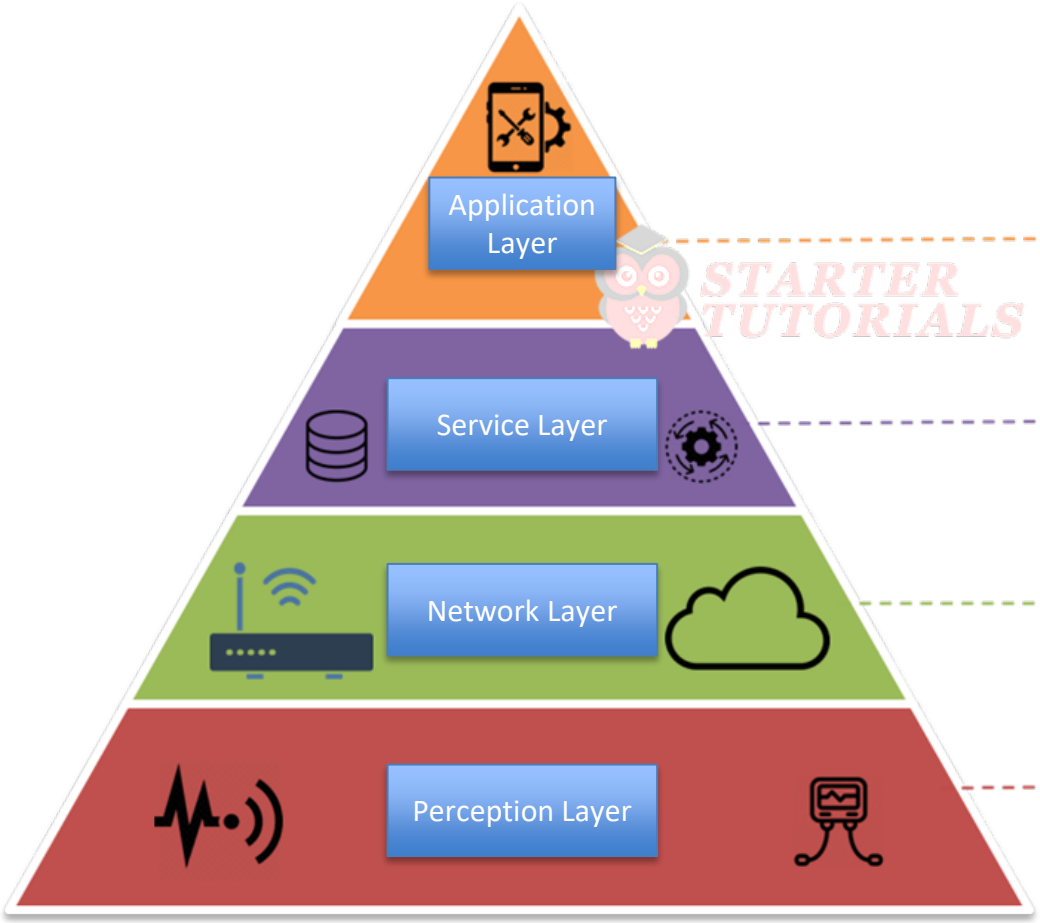


Responsible for delivering application services to the users via user interfaces.

Responsible for connecting to other devices or servers. Also includes transmitting and processing the data from sensors.

Is the physical layer which contains sensors to gather data.

SOA-based Architecture



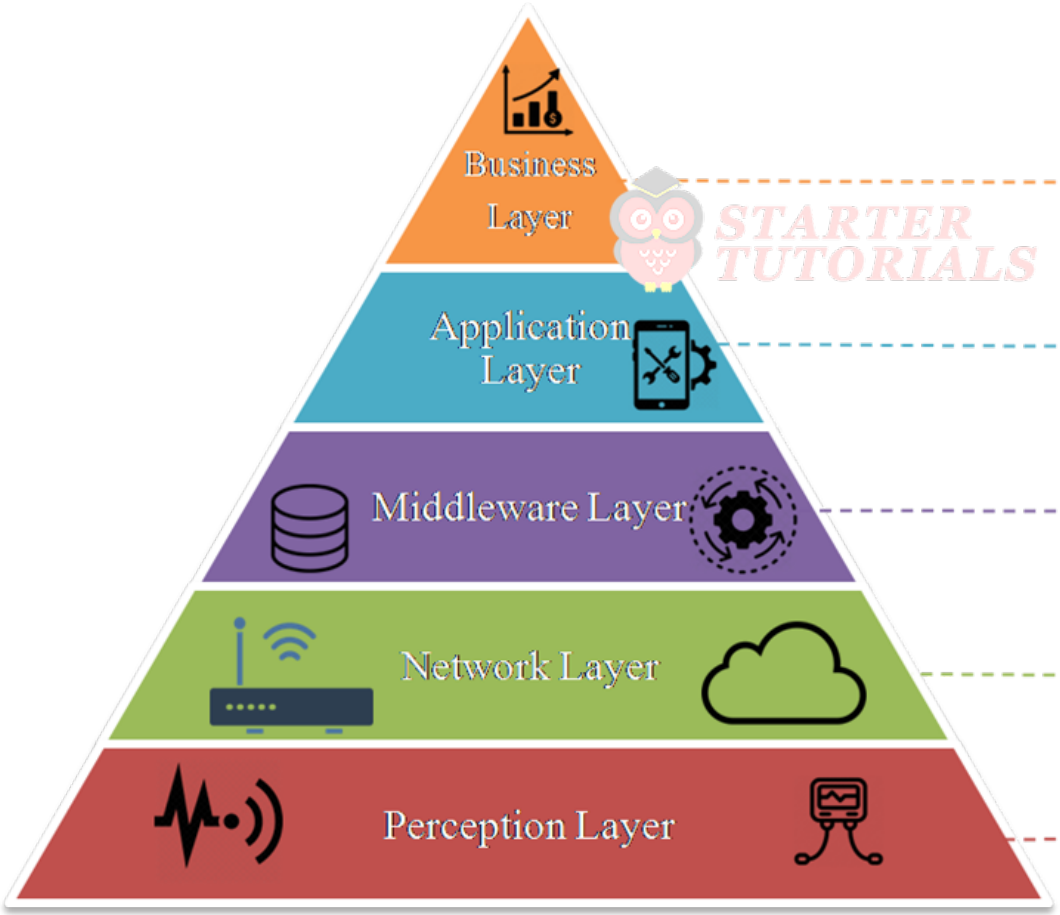
Provides interfaces to interact with the services provided by the service layer

Creates and manages services required by users and applications

Transfers the data from sensing layer to service layer.

Is the physical layer which contains sensors to gather data.

Middleware-based Architecture



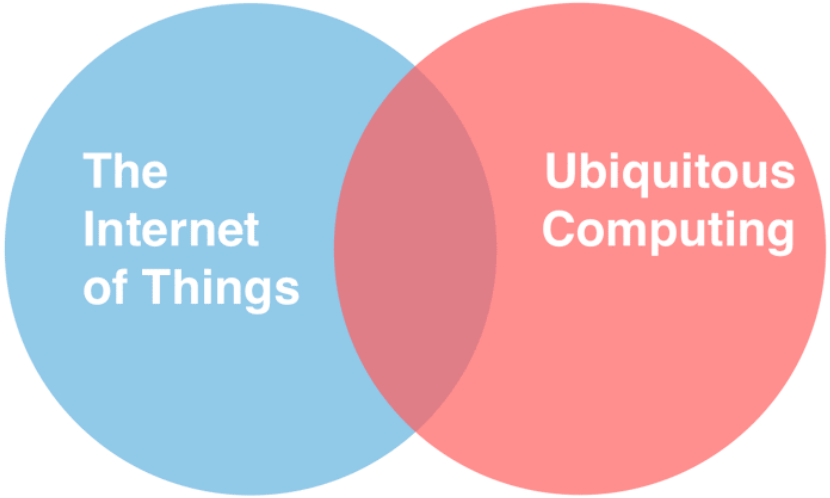
Manages the whole IoT system, including applications, profit models, etc

Responsible for delivering application services to the users via user interfaces.

Stores, analyzes, and processes data coming from the network layer.

Transfers the data from perception layer to middleware layer.

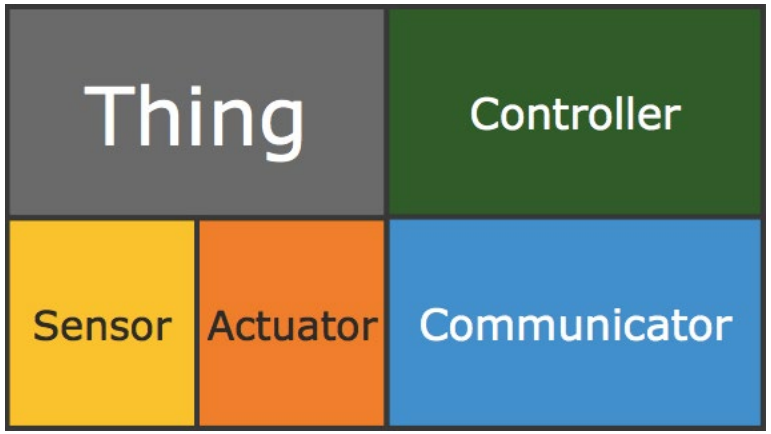
Is the physical layer which contains sensors to gather data.



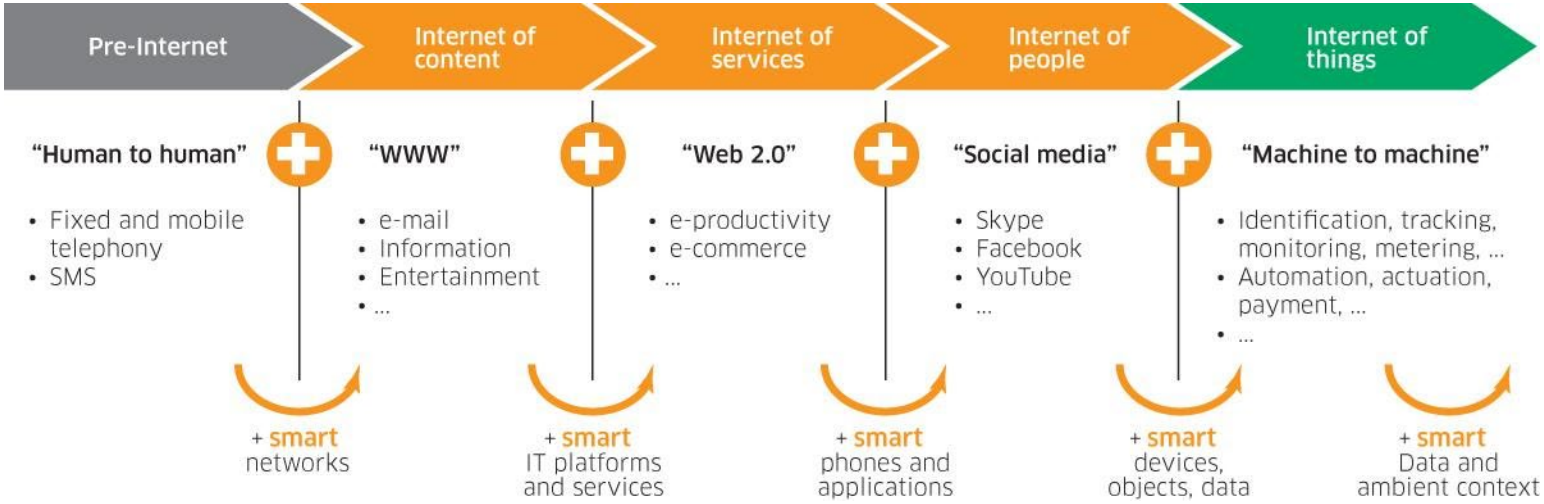
Ubiquitous Computing Vs IoT

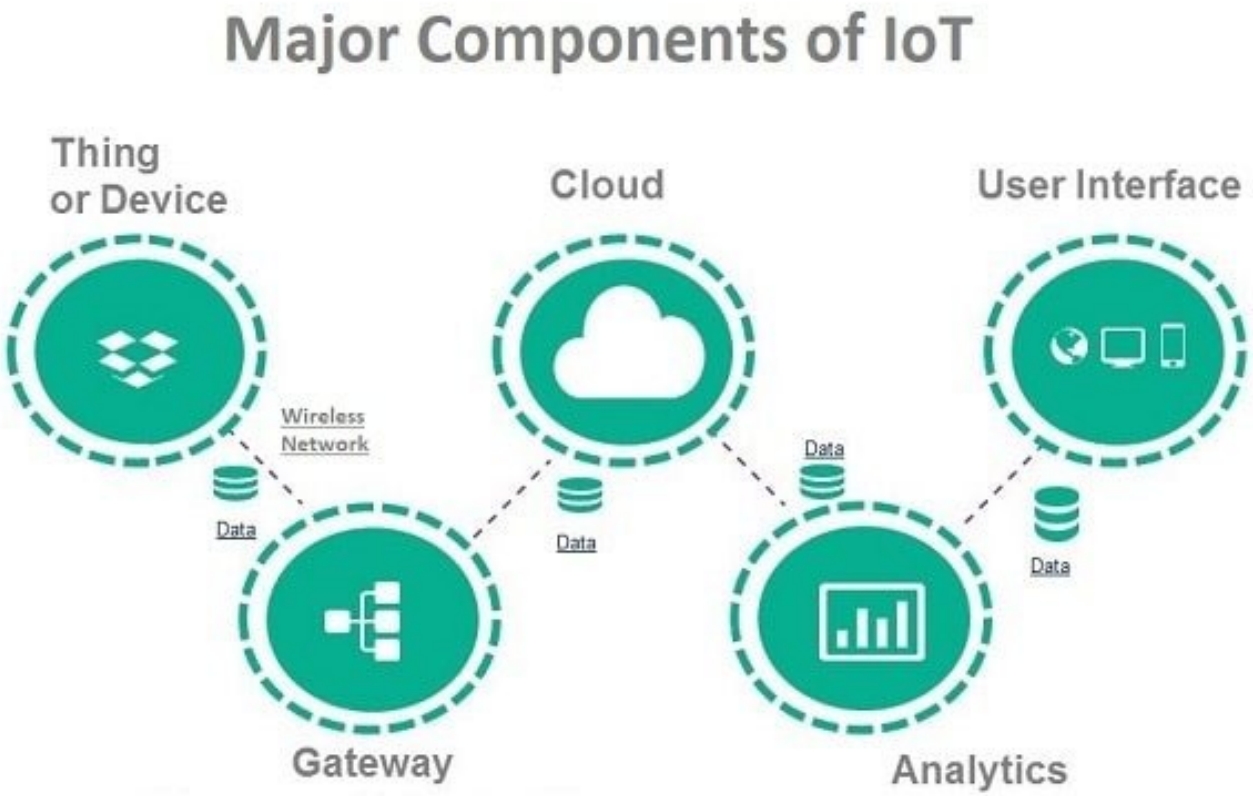
Ubiquitous Computing	IoT
Ubiquitous computing is all about having computational capability in many different objects in our environment. Things like Fridges, TV, Cars etc all having some computational power.	The Internet of Things (IoT) is about having these objects in our environment all connected to an internet.
Computing is made to appear anytime, everywhere.	Computing is Made to only Devices connected to internet. IoT can be made to appear as UbiComp
Ubiquitous computing fall into Human to Machine interaction .	IoT fall into Machine to Machine interaction .

"IoT or Internet of Things, refers to physical objects (or groups of such objects) with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks."



Physical object ("thing")
+
Controller ("brain")
+
Sensors
+
Actuators
+
Networks (Internet)

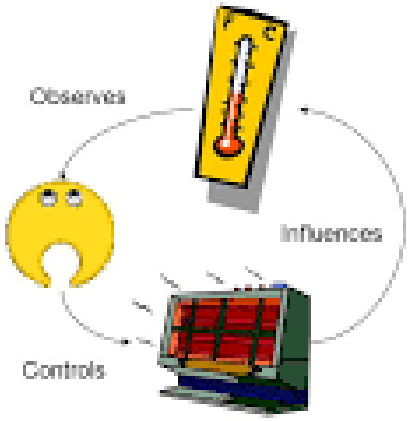

Pre-Internet
Internet of content
Internet of services
Internet of people
Internet of things
"Human to human"
• Fixed and mobile telephony
• SMS
+ smart networks
"WWW"
• e-mail
• Information
• Entertainment
• ...
+ smart IT platforms and services
"Web 2.0"
• e-productivity
• e-commerce
• ...
+ smart phones and applications
"Social media"
• Skype
• Facebook
• YouTube
• ...
+ smart devices, objects, data
"Machine to machine"
• Identification, tracking, monitoring, metering, ...
• Automation, actuation, payment, ...
• ...
+ smart Data and ambient context

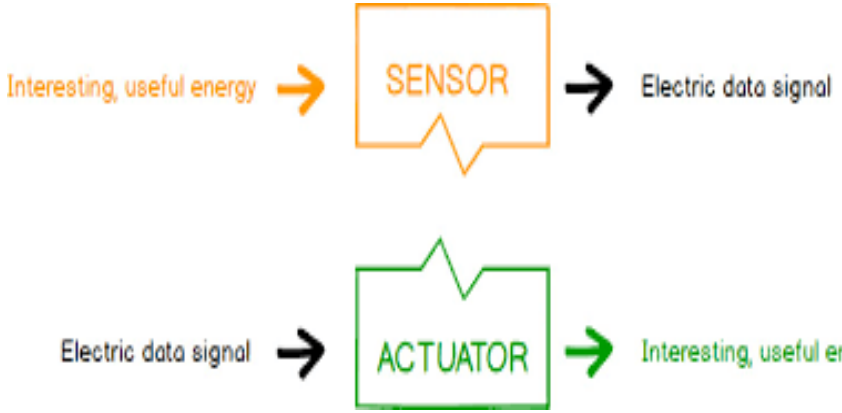

Major Components of IoT
Thing or Device
Cloud
User Interface
Wireless Network
Data
Data
Data
Data
Gateway
Analytics

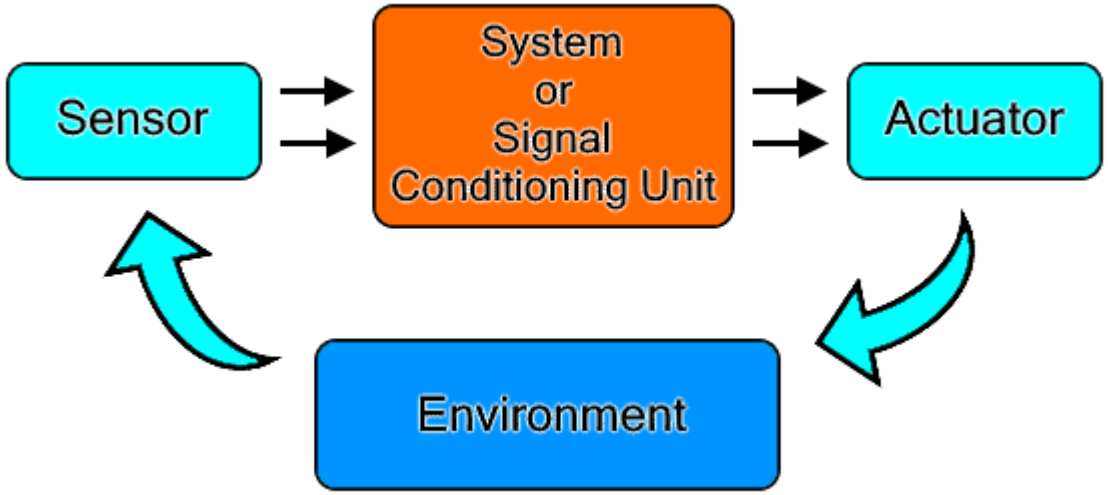
Actuators and Sensors

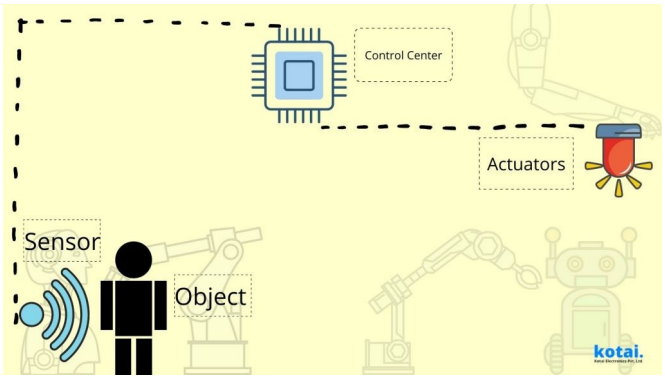
An agent observes the state of the world and can act by controlling actuators.

Actuators are (weakly) related to sensors.



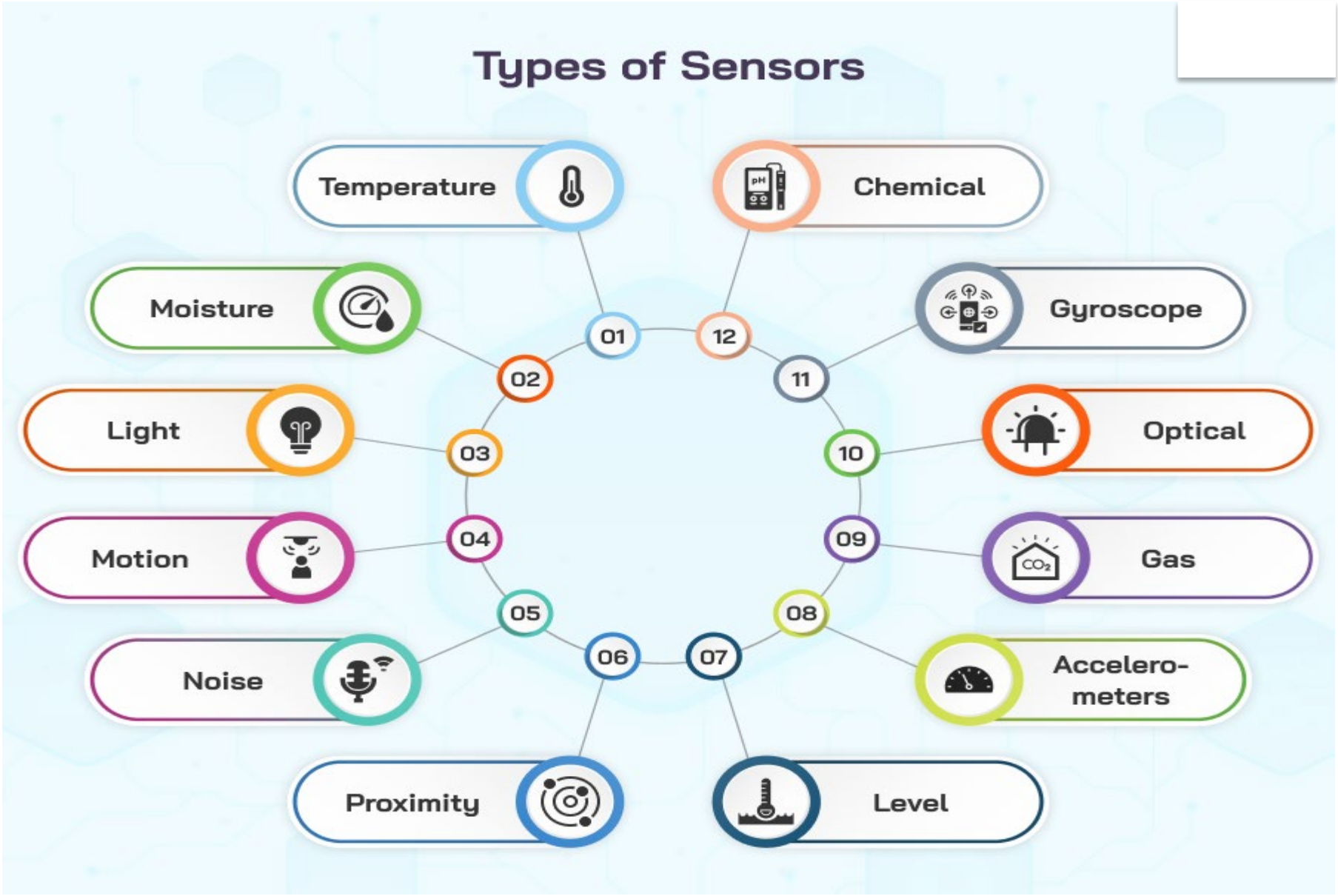






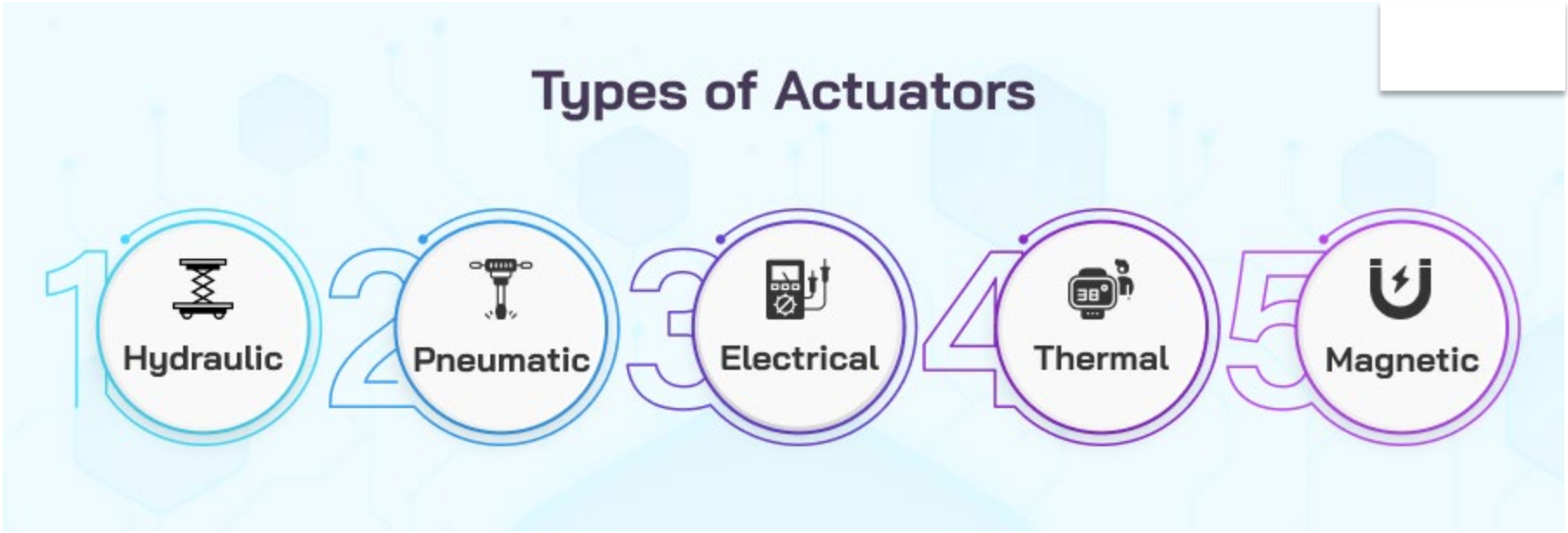
What is sensor?

- Sensors or transducers represent physical devices that convert one form of energy into another.
- Sensors convert a physical device into an electrical impulse to take the desired action. For instance, sensors in an ambient light system will measure the brightness of the light by turning it into an electrical signal.
- These sensors have a wide array of applications in the IoT network.

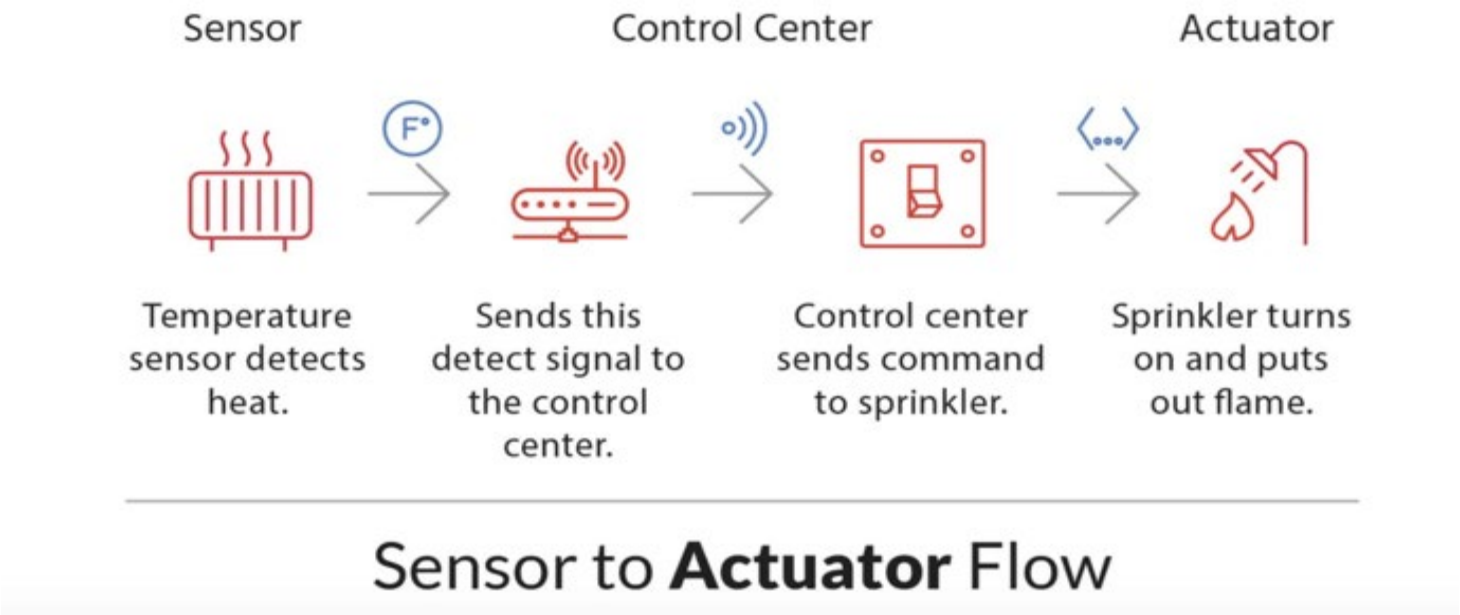

Types of Sensors
Temperature
Chemical
Moisture
Gyroscope
Light
Optical
Motion
Gas
Noise
Accelero-meters
Proximity
Level
01
02
03
04
05
06
07
08
09
10
11
12

What is actuator?

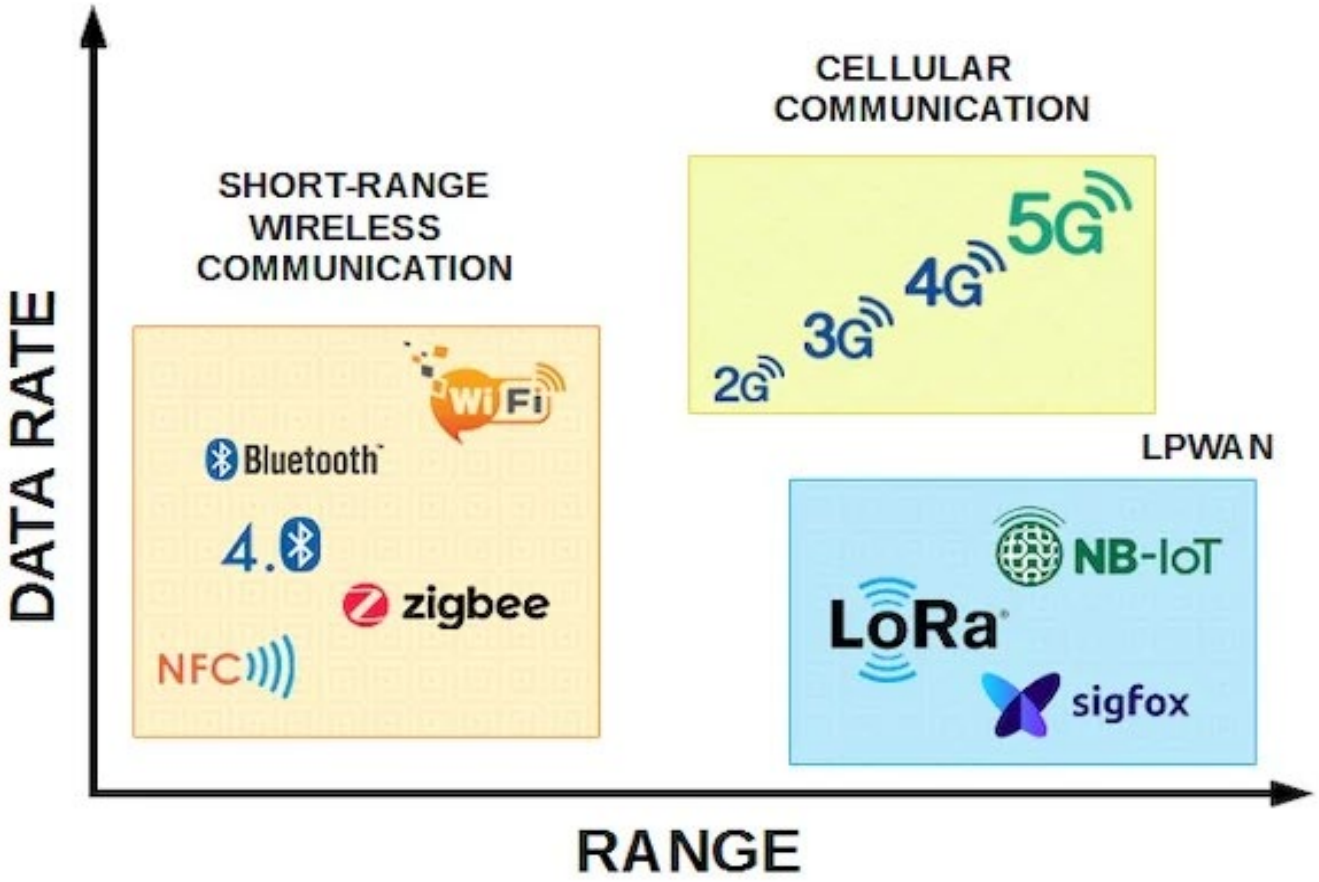
- Actuators convert electrical impulses into physical actions or objects.
- In the light example, as the sensor is reading the brightness of the light by converting it into an electrical signal, an actuator takes action according to the desired setting. It will decrease or increase the light brightness according to the set parameters.
- We can leverage actuators to control and manage our devices in the IoT network according to the information sent by the sensors.


Types of Actuators
1
Hydraulic
2
Pneumatic
3
Electrical
4
Thermal
5
Magnetic

Example of Sensor and Actuator

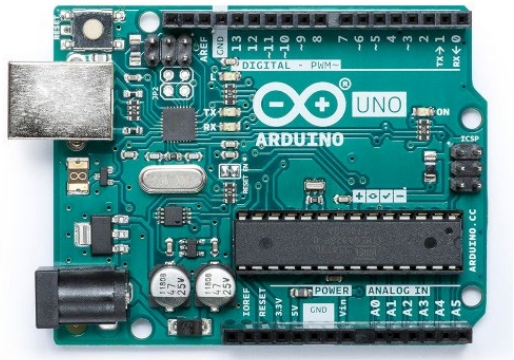


Network Protocols



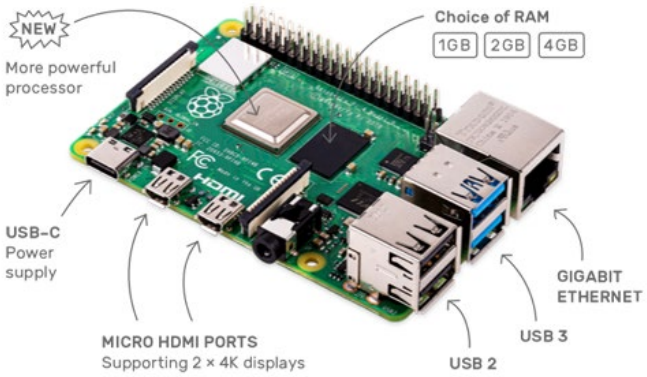
Network Protocol Characteristics

Protocol	Frequency	Range	Data Rates
Bluetooth	2.4 GHz	100 m	125 Kbps–Mbps
Wi-Fi	2.4 GHz, 5 GHz	50 m	150–600 Mbps
NFC	13.56 MHz	4 cm	100–420 Kbps
LoraWAN	867–869 MHz (Europe) 902–928 MHz (North America)	15 Km	0.3–50 Kbps
Cellular	900/1800/1900/2100 MHz	30 m (Between node and base station)	21 Mbps (3G+) 600 Mbps (4G)
Z-wave	865–926 MHz (ISM)	100 m	100 Kbps
Zigbee	2.4 GHz (ISM)	100 m	20 Kbps–250 Kbps
Sigfox	900 MHz	3–50 Km	10–1000 bps

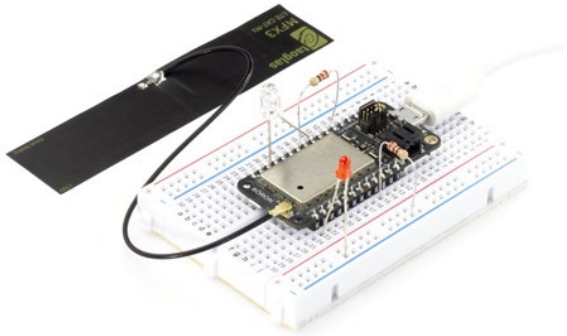


Arduino Uno

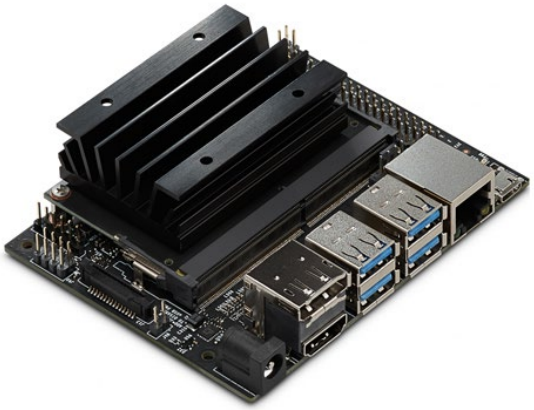
Examples



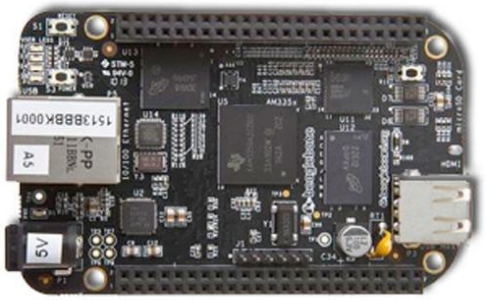
Raspberry Pi 4



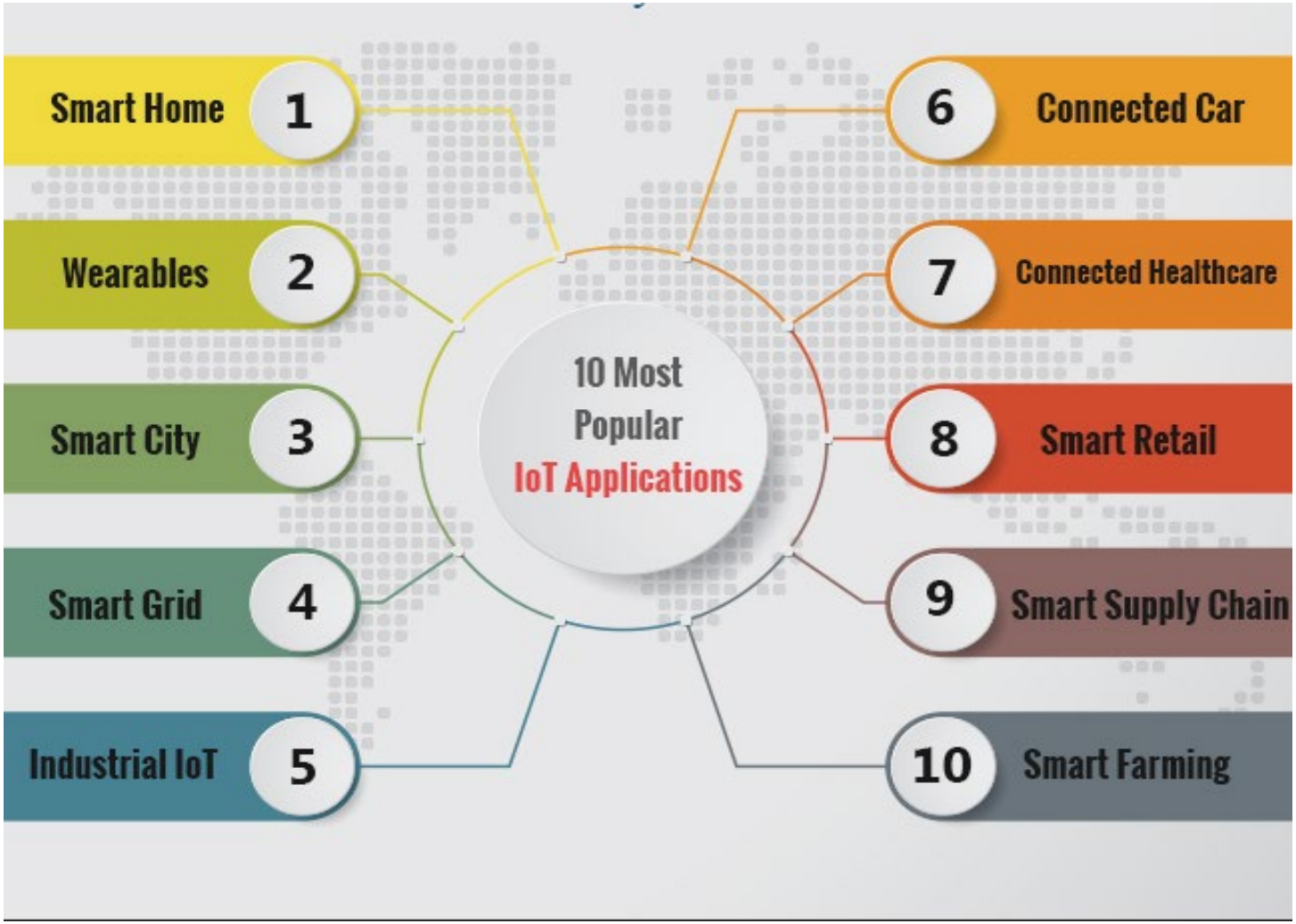
Particle Boron

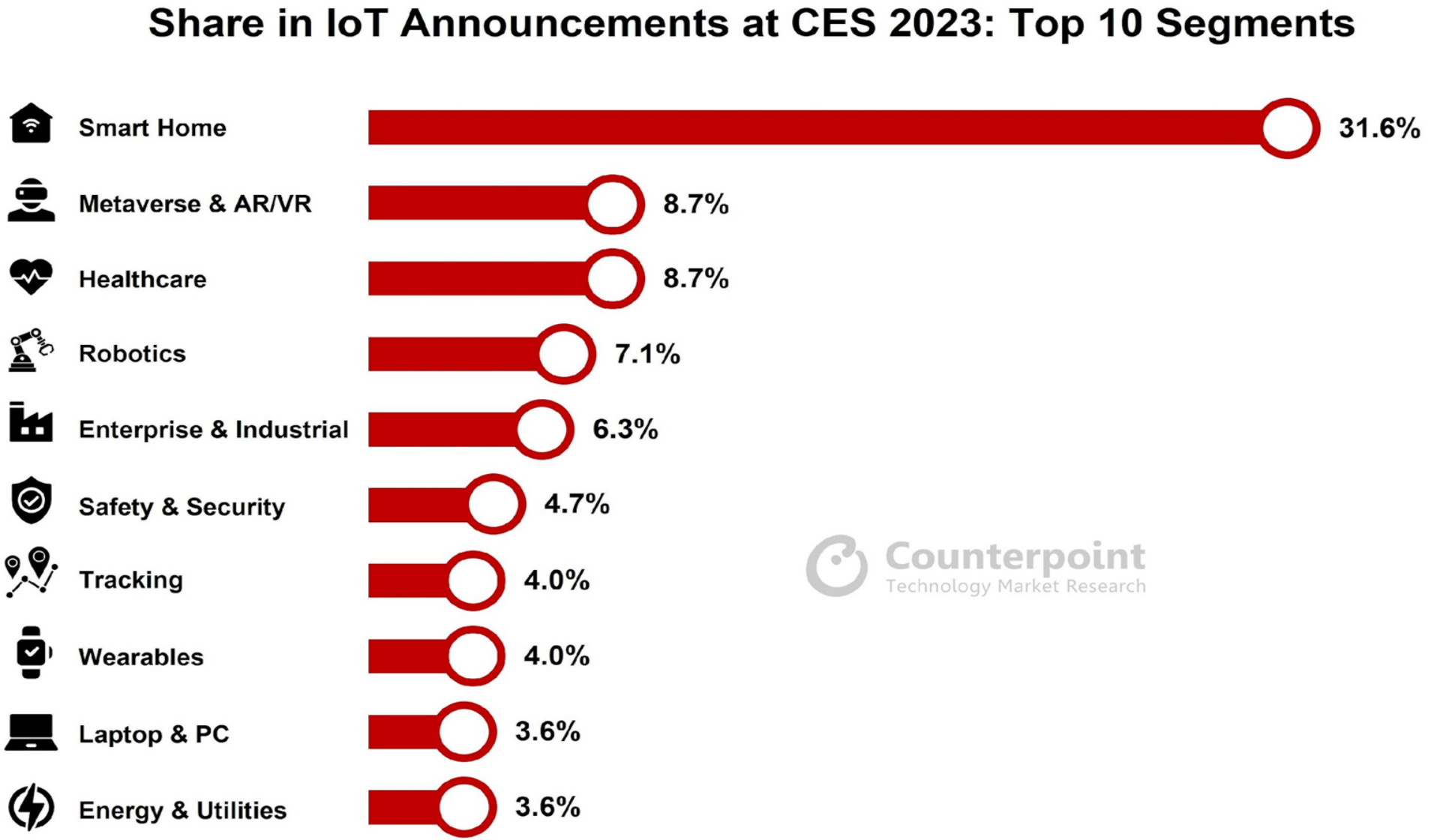


NVIDIA Jetson Nano



BeagleBoard


10 Most
Popular
IoT Applications
1 Smart Home
2 Wearables
3 Smart City
4 Smart Grid
5 Industrial IoT
6 Connected Car
7 Connected Healthcare
8 Smart Retail
9 Smart Supply Chain
10 Smart Farming


Share in IoT Announcements at CES 2023: Top 10 Segments
Smart Home
31.6%
Metaverse & AR/VR
8.7%
Healthcare
8.7%
Robotics
7.1%
Enterprise & Industrial
6.3%
Safety & Security
4.7%
Tracking
4.0%
Wearables
4.0%
Laptop & PC
3.6%
Energy & Utilities
3.6%
Counterpoint
Technology Market Research
Source: CES 2023 and Counterpoint Analysis

Issue and Challenges

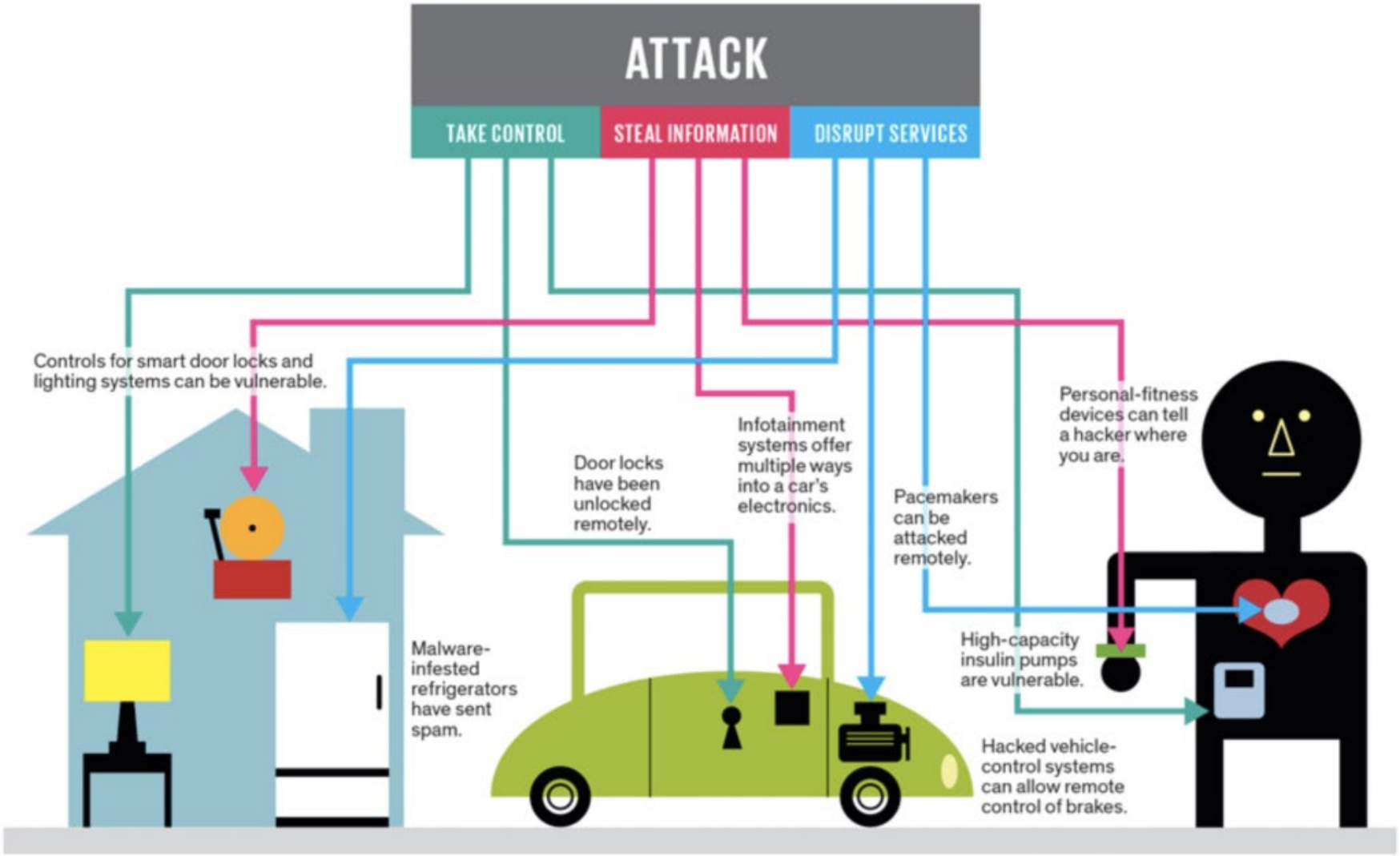


Illustration: J. D. King