UFV.ES

New trends

MODULE 2 / UNIT 8.2 / 0.5

MOISES M. MARTINEZ

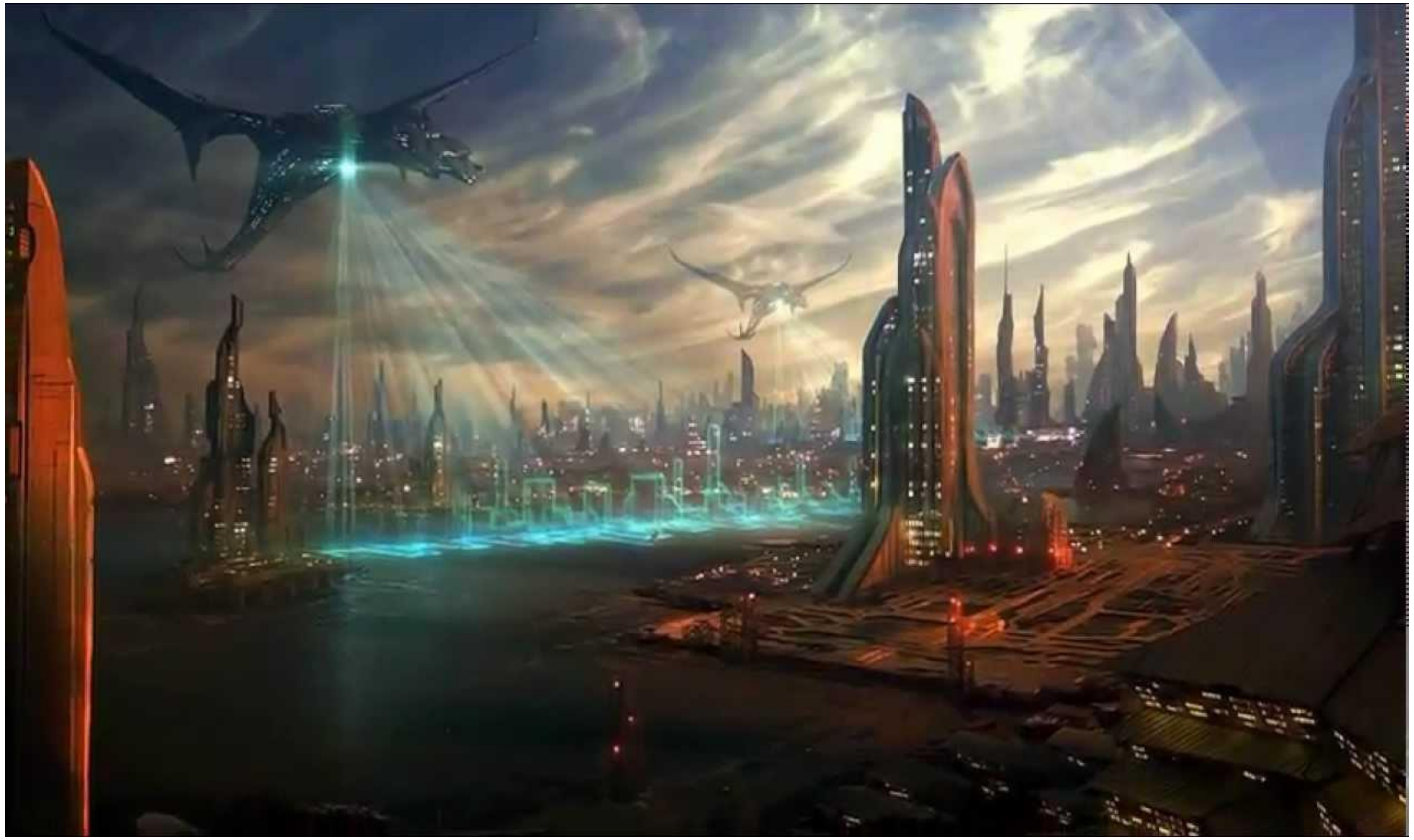
FUNDAMENTALS OF COMPUTER ENGINEERING

2024/25

Trend technologies

A trend represents a shift or movement towards something new or different, suggesting that emerging technologies will play a pivotal role in shaping our future.

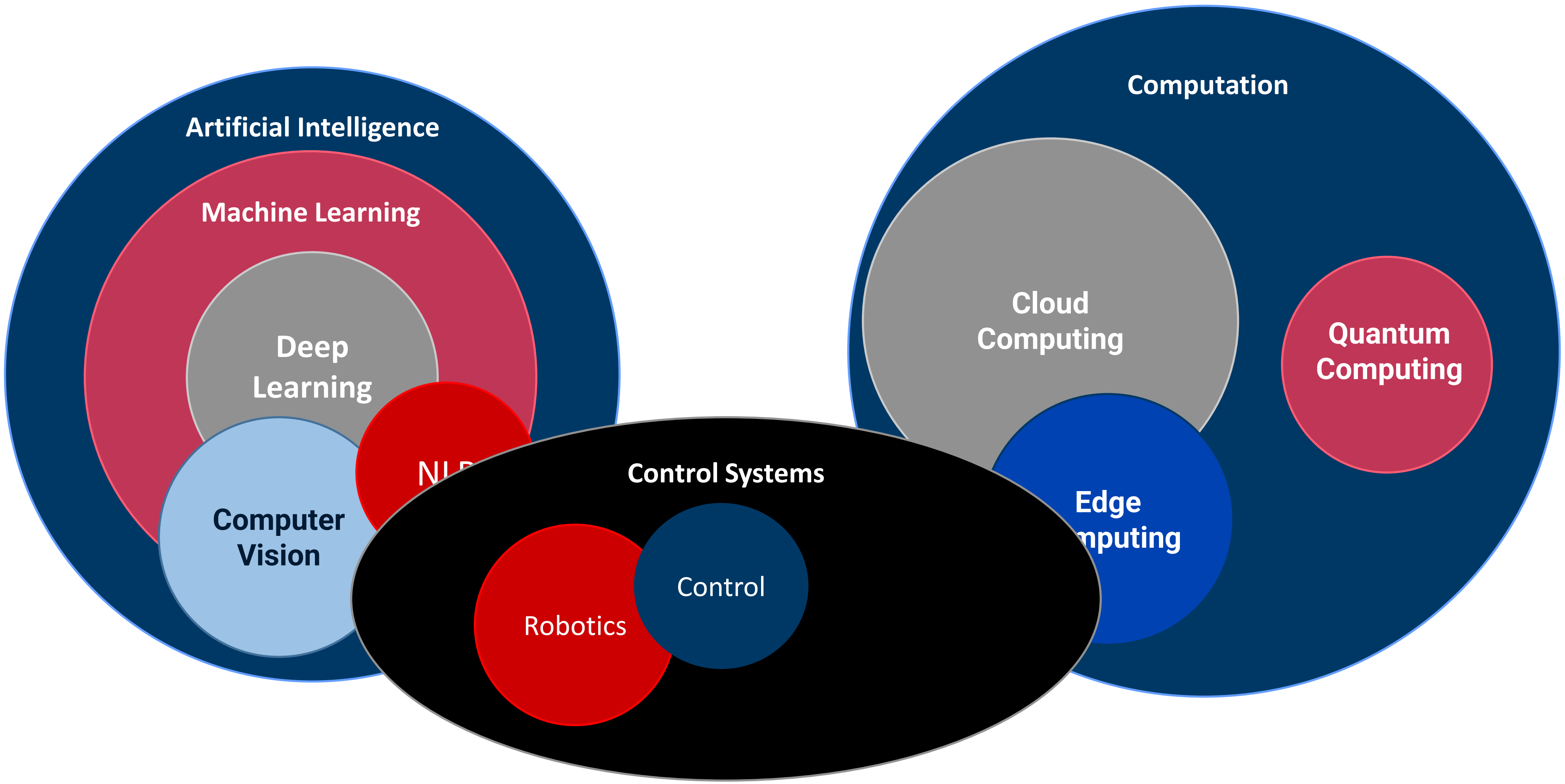
- Artificial Intelligence (AI).
- Machine Learning (ML).
- Computer Vision.
- Natural Language Processing (NLP)
- Computation.
- **Control systems.**
- **Internet of Things (IoT).**
- **Blockchain.**
- **5G.**



Control Systems Robotics

01

Control Systems



Control Systems

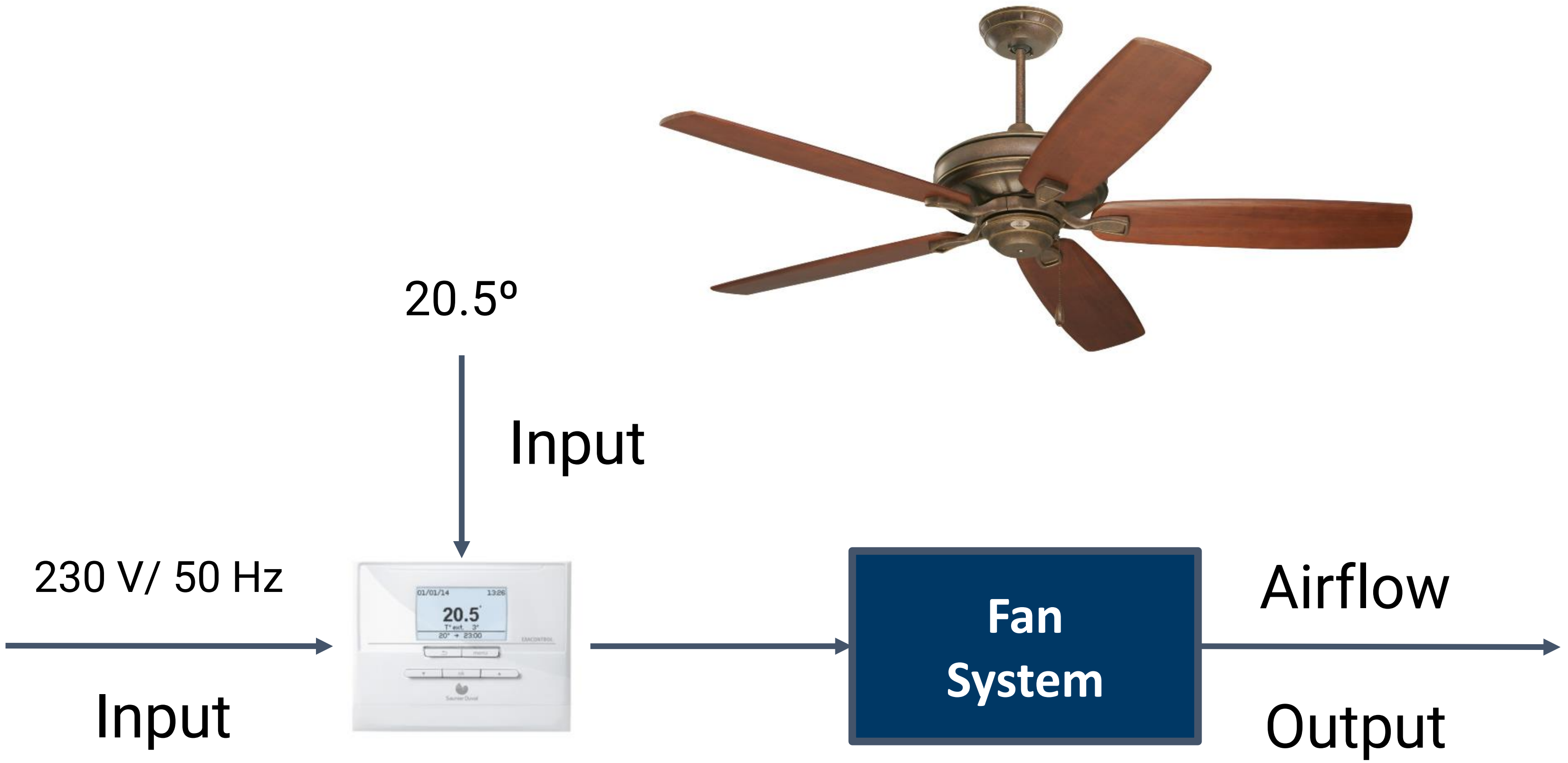
In technical terms, control refers to the systematic manipulation or regulation of a system to achieve a specific, predefined goal or objective.

The control panel of the Kozloduy Nuclear Power Plant.

Citroën C3 production line


230 V/ 50 Hz
Input
Fan System
Airflow
Output

Control Systems



Control Systems

A control system is a system or subsystem made up of various components, such as sensors, actuators, and signal conditioners. These components work together to regulate the behavior of a system — or, in some instances, their own behavior — with the goal of achieving a predefined objective.

Control Systems

A sensor is a device that uses a transducer to collect data from its surrounding environment.

- Proprioceptive sensors: These sensors measure internal states or values within the system itself. Examples include motor speed, wheel load, robot arm joint angles, and battery voltage.
- Exteroceptive sensors: These sensors gather information from the external environment. Examples include distance (GPS), proximity (sonar, laser, etc.), tactile (bumpers, pressure sensors, etc.), visual (cameras), and acoustic (microphones).



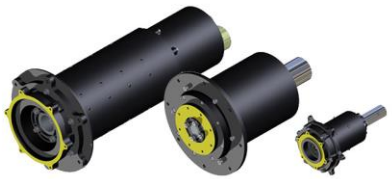





Control Systems

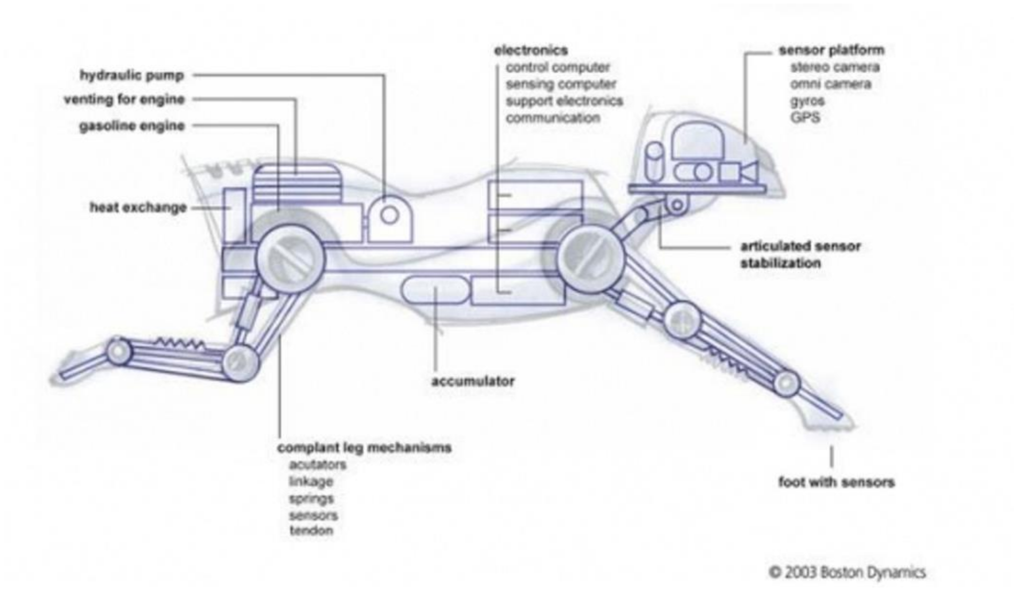
An actuator is a device that uses a transducer to convert one form of energy into another, with the purpose of causing changes or modifications in the surrounding environment or within a system. Actuators are employed to implement these changes effectively.

- Locomotion: Engines used for movement.
- Servomotor: Precision motors for controlled motion.
- Visual: Devices like screens or LEDs that create visual outputs.
- Acoustic: Devices like speakers that produce sound.



Robotics

A robot is a programmable machine designed to perform tasks autonomously or semi-autonomously by interacting with its environment. It typically consists of mechanical components, sensors, and a control system that governs its behavior. The control system processes input data from the environment and directs the robot's actions to achieve specific tasks or objectives, ensuring that the robot operates accurately and efficiently in various conditions.



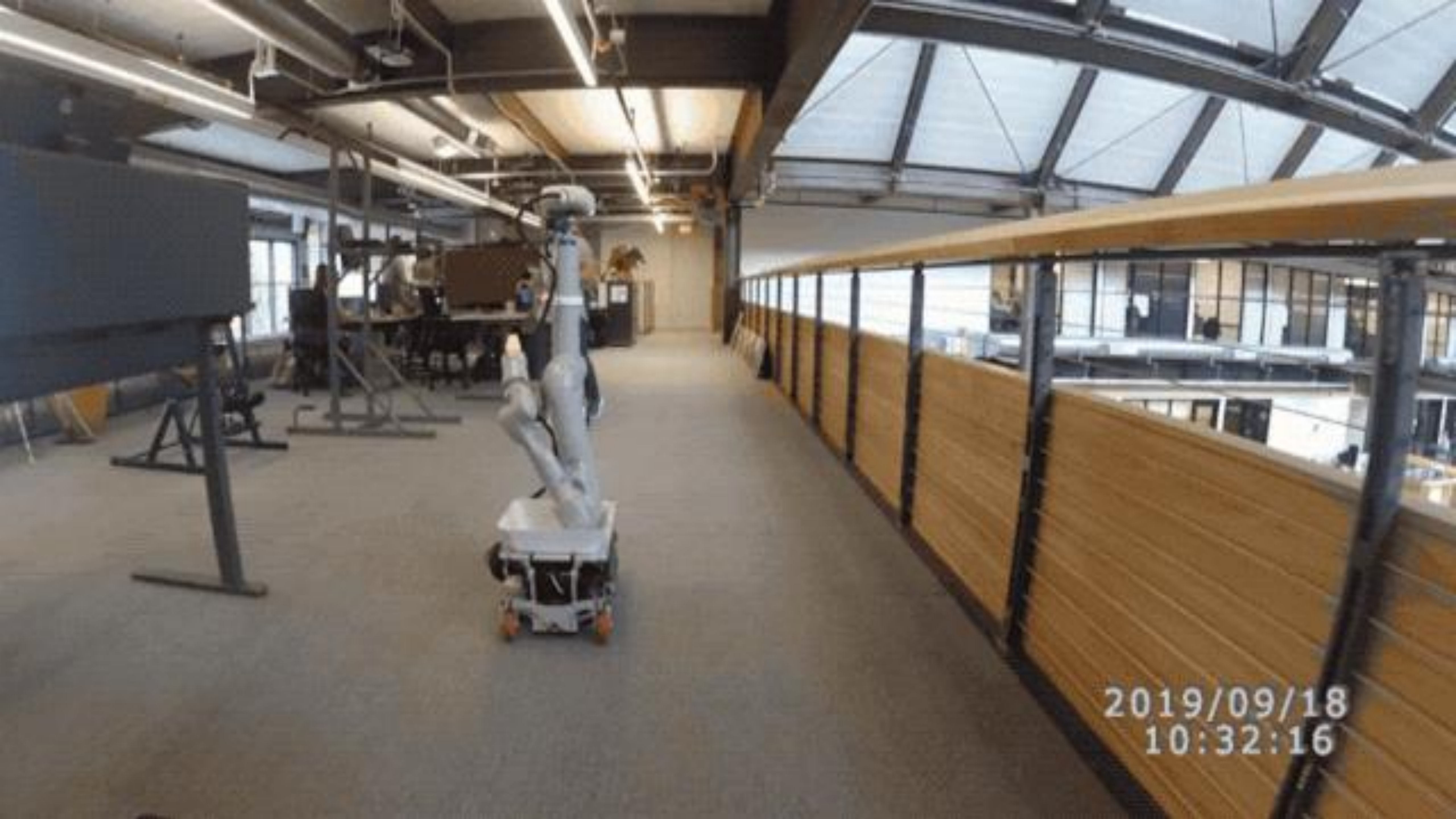
Robotics

A humanoid robot is a robot designed to closely mimic the human body in both form and function. It typically features a head, torso, arms, and legs, allowing it to perform tasks and interact with the environment in ways similar to a human.


NASA’s R5 robot

Spot and Atlas
(Boston Dynamics)

Optimus Gen2
(Tesla)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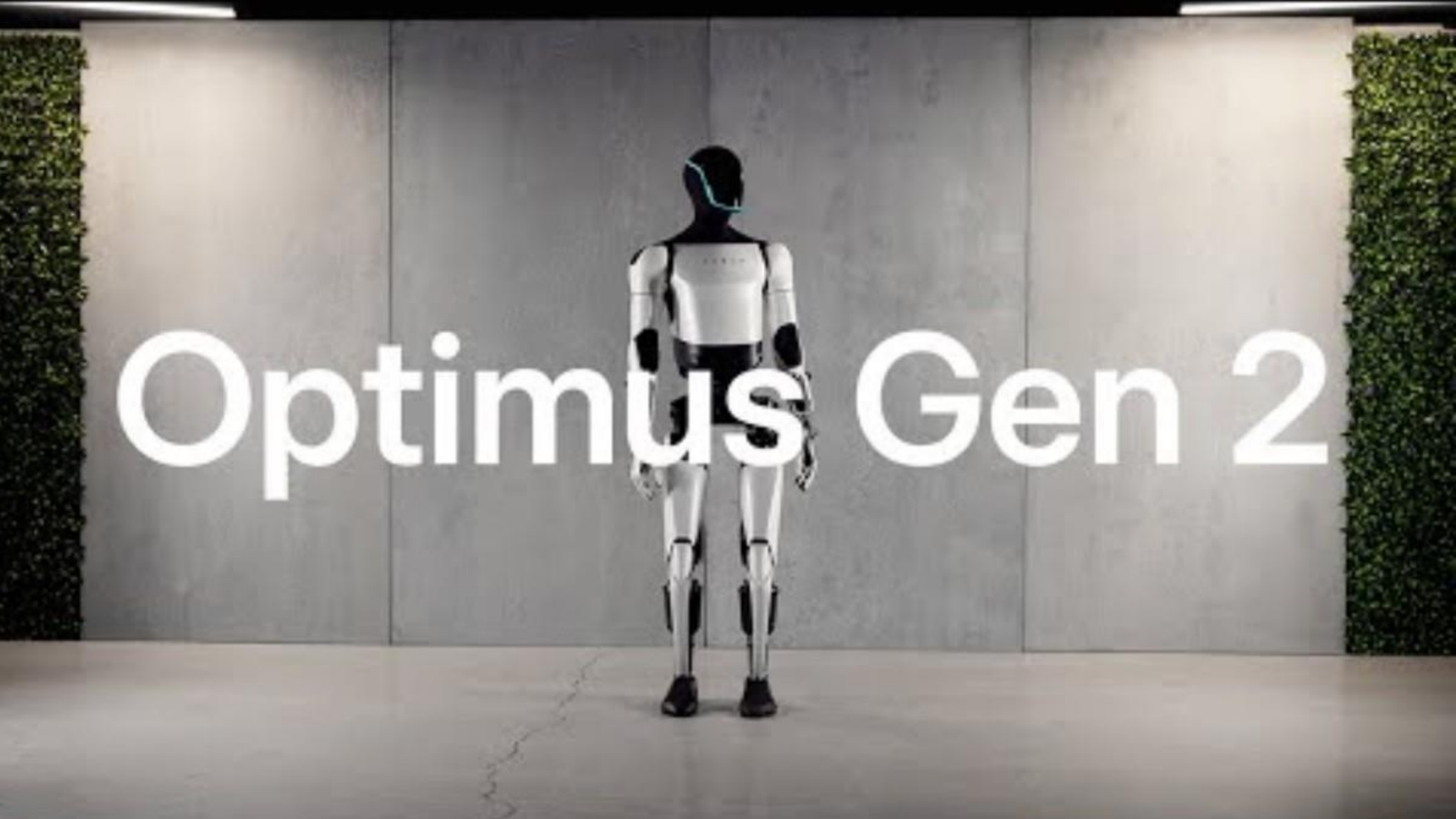
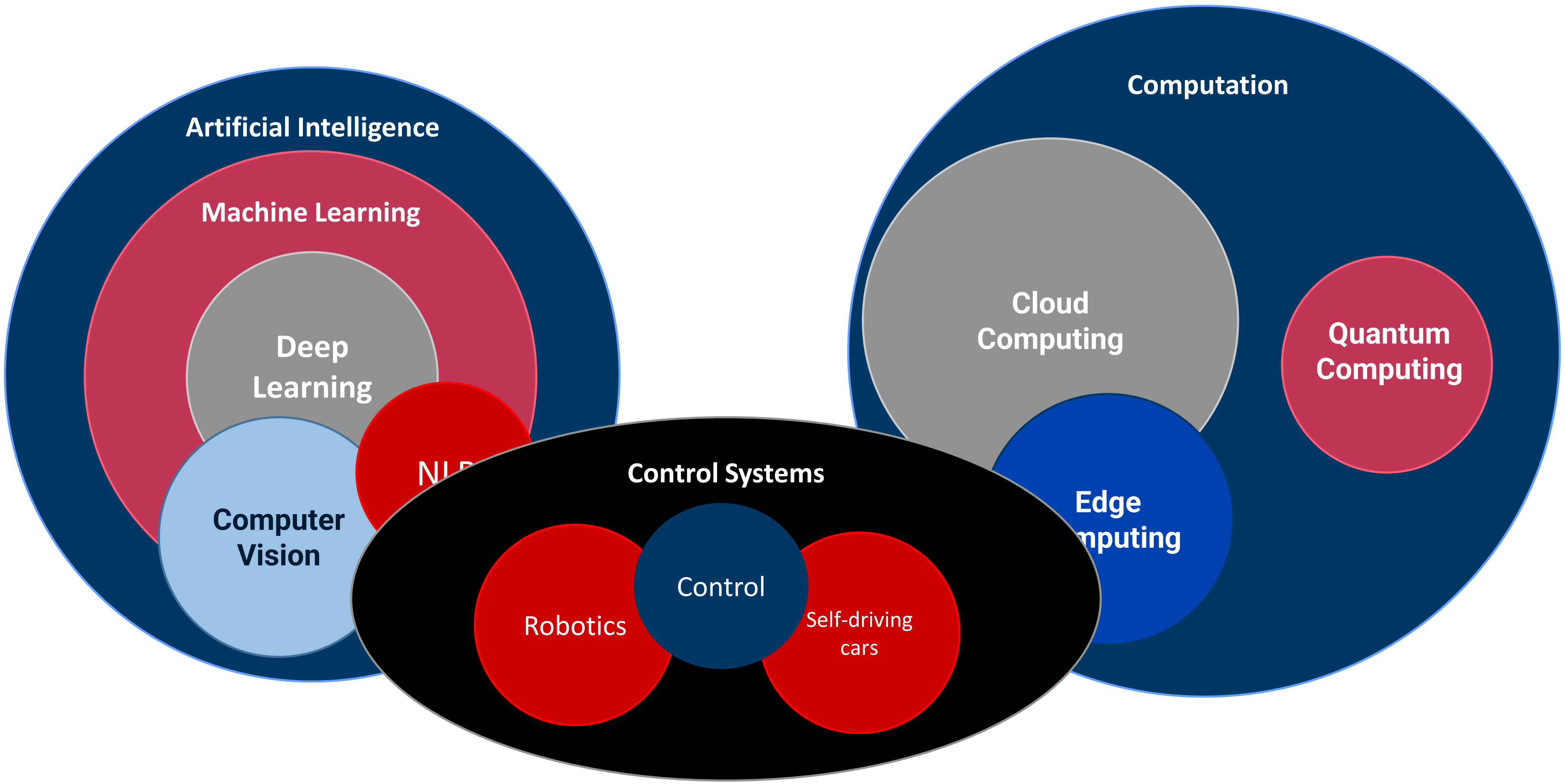

Optimus Gen 2

Control Systems
Self-driving cars

02

Control Systems



Control systems

Is this a self-driving car system?

Self-driving cars

Control systems in self-driving cars are generally categorized into two groups:

- Driver-in-Control where the **vehicle is equipped with advanced semi-automated functions designed to assist the driver**, such as adaptive cruise control, lane-keeping assistance, and automated parking. However, **the driver remains ultimately responsible** for the vehicle's operation and must be ready to take control at any moment.
- Vehicle-in-Control where the **vehicle is fully autonomous**, capable of operating independently without any human intervention. These vehicles utilize a complex network of sensors, artificial intelligence, and control systems to navigate, make decisions, and drive safely. They are typically limited to specific environments or conditions, such as designated urban areas or highways, where the infrastructure and regulations support autonomous operation.

Self-driving cars

The concept of **driving mode** defines the entity responsible for governing the behaviour of the control system.

Levels of driving automation SAE (Society of Automotive Engineers)

Self-driving cars

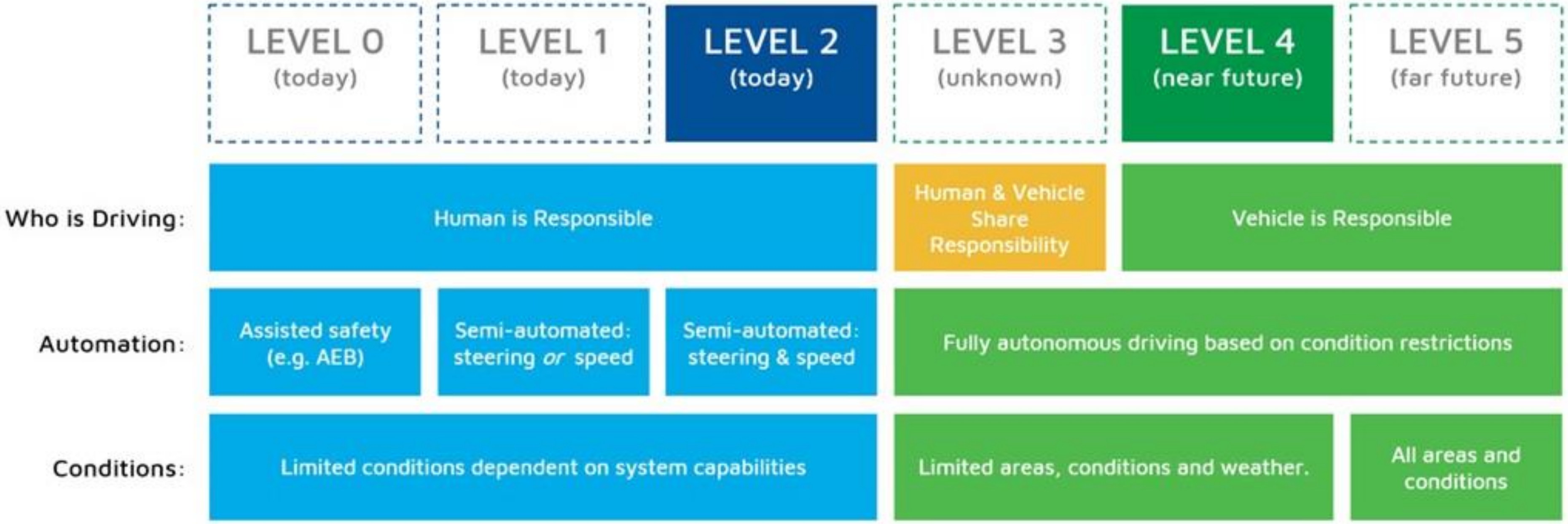
The concept of **automation** defines the characteristics and functionalities of the control system, outlining how tasks are performed with minimal or no human intervention.

Levels of driving automation SAE (Society of Automotive Engineers)

Self-driving cars

The term **conditions** refers to the specific environmental configurations and parameters within which the autonomous control system is designed to operate effectively.

Levels of driving automation SAE (Society of Automotive Engineers)



Self-driving cars

Self-driving cars – which levles are available now?

Levels of driving automation SAE (Society of Automotive Engineers)

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
(today)	(today)	(today)	(unknown)	(near future)	(far future)

BMW serie 3

Ford 150

Tesla Model S

Google Waymo

Renault Symbioz

Self driving cars or autonomous vehicles?

Self-driving cars

Both self-driving cars and autonomous cars are commonly used terms, but they have slightly different connotations:

- **Self-driving cars** typically refer to **vehicles that have varying levels of automation**, from basic driver assistance systems to fully autonomous driving. This term is often used in a broader, more general sense and can include vehicles that still require some level of human intervention or supervision.

- **Autonomous cars** generally refer to **vehicles capable of operating entirely without human input**, relying on advanced sensors, algorithms, and control systems to navigate and make decisions. This term is more specific and is often used to describe fully automated systems that don't require a driver.

Self-driving cars

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Level 2+ and Level 3 are considered self-driving cars.

- **Autonomous cars** generally refer to **vehicles capable of operating entirely without human input**, relying on advanced sensors, algorithms, and control systems to navigate and make decisions. This term is more specific and is often used to describe fully automated systems that don't require a driver.

Level 4 and Level 5 are considered autonomous cars.

Self-driving cars

The e-stop button: This is a panic stop device and it allows to stop the self-driving system.

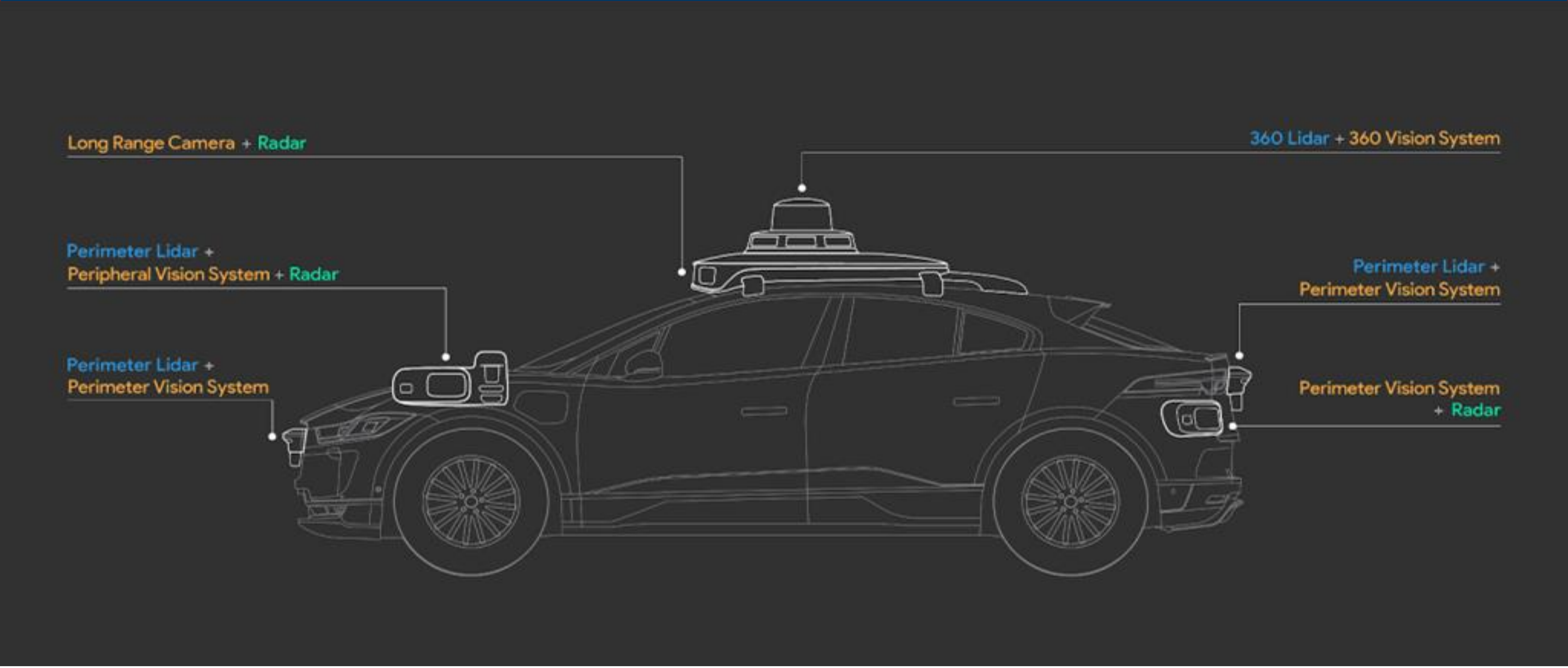
Self-driving cars

Otto was a San Francisco-based startup that developed software and hardware kits to enable self-driving capabilities in vehicles. **The company focused on retrofitting existing trucks with autonomous driving technology**.

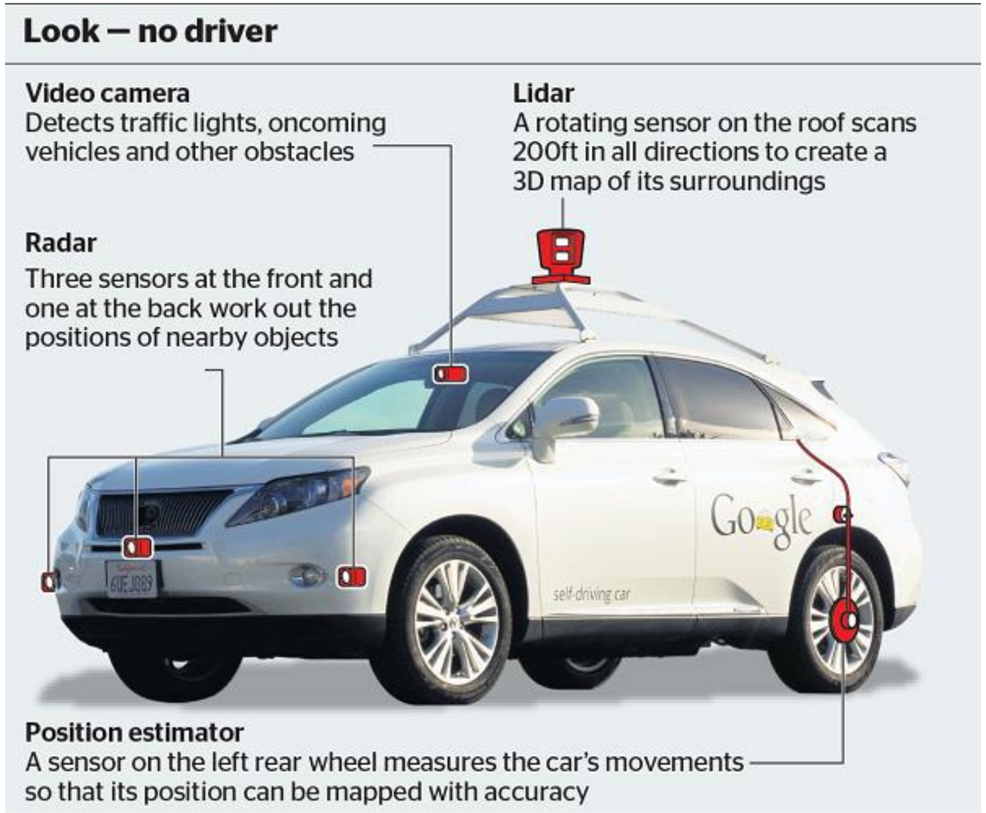
In 2016, Otto was acquired by Uber, which integrated its technology and expertise into Uber's own autonomous car.

The Google self-driving car

Control Systems



Self-driving cars



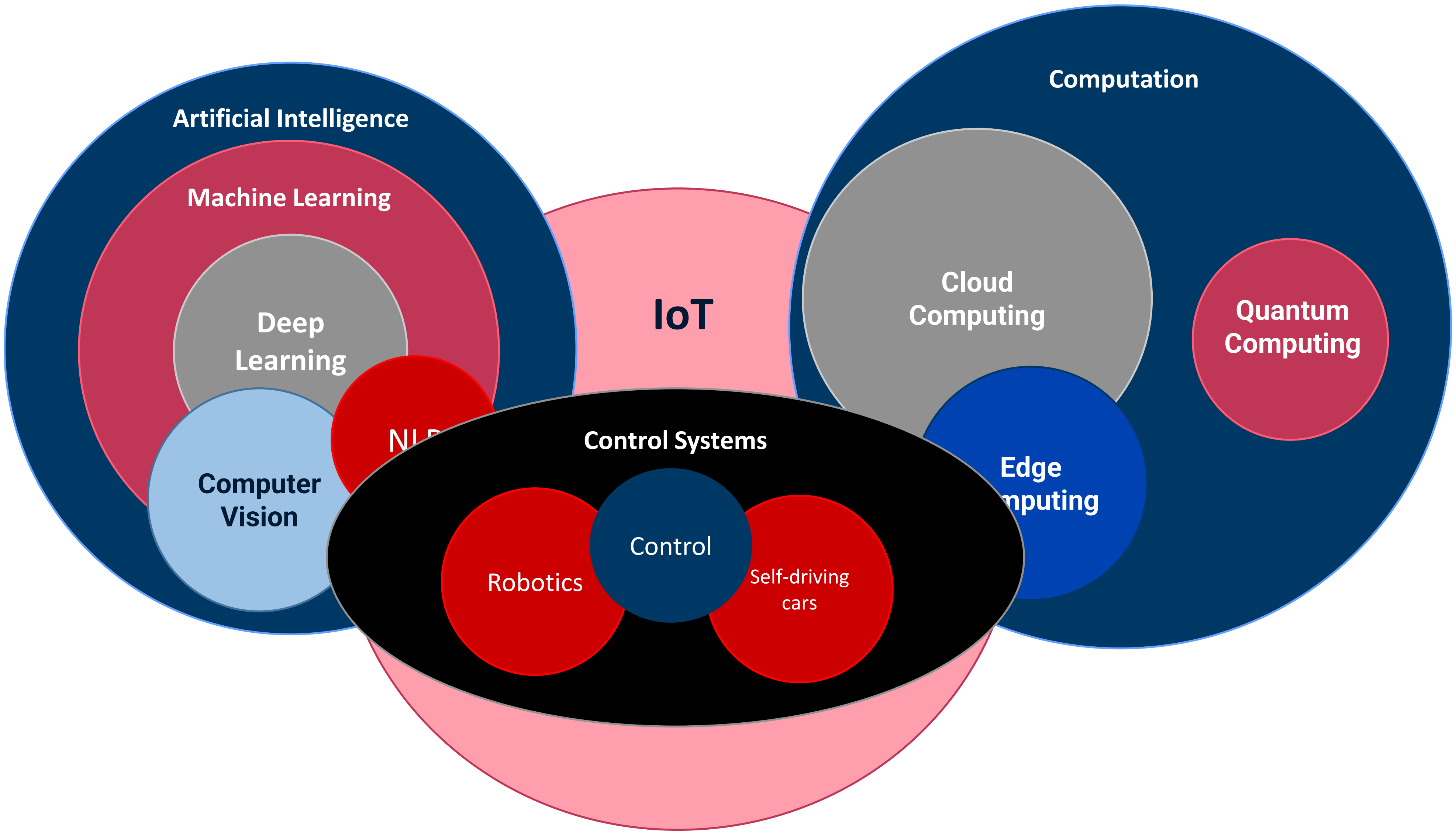
- The lidar system sits atop the car, always spinning like R2D2, catching objects and helping the AI to figure out where things are.
- Radar sensors around the car detect objects so that the car can avoid them.
- Video camera on the human level to detect traffic lights, signals or objects.
- Position estimators to measure car movements.

Control Systems

The internet of things

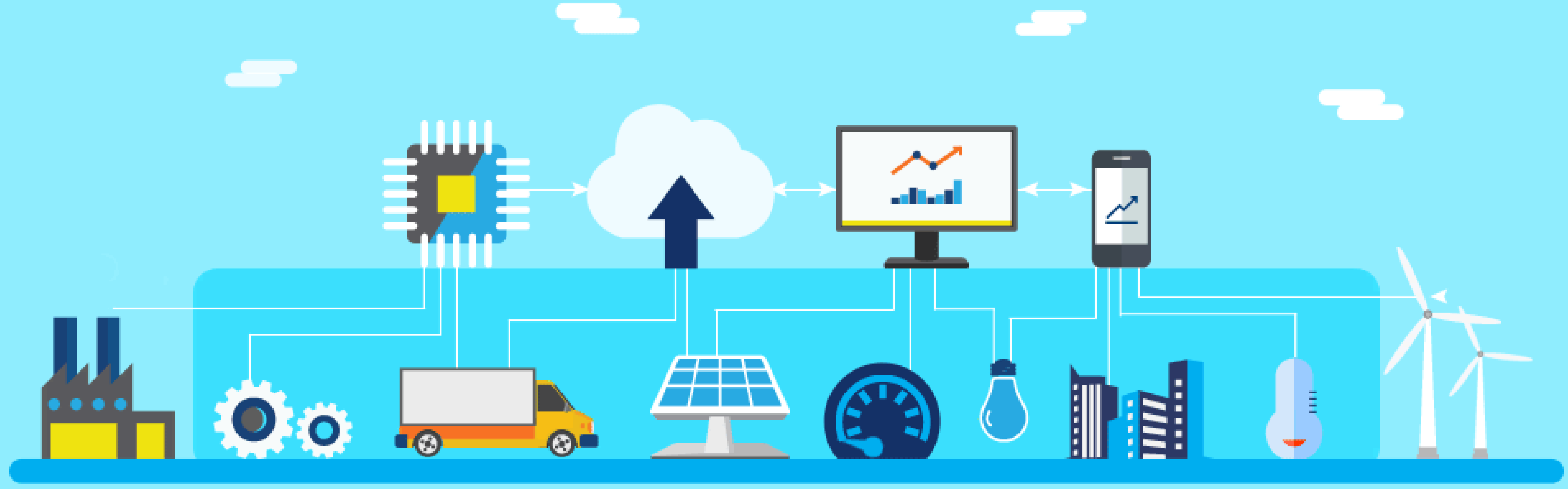
03

The internet of things



The internet of things

The Internet of Things (IoT) refers to a network of interconnected physical objects, often called things, that are embedded with sensors, software, and other technologies. These objects can communicate and share data with other devices and systems over the internet, enabling a wide range of applications, from smart homes and cities to industrial automation and healthcare.



The internet of things

IoT technologies can be categorized into two primary types:

- Consumer IoT (CIoT): This category is focused on enhancing convenience and improving daily life experiences for individual consumers. It includes user-friendly IoT solutions such as smart home devices, wearable technology, and connected appliances, all designed to make everyday tasks easier and more efficient.
- Industrial IoT (IIoT): This category is centered around improving efficiency, security, and operations within industrial and organizational settings. IIoT serves sectors like manufacturing, logistics, and energy, where it is used to optimize processes, reduce energy consumption, and integrate AI into devices for smarter automation. Applications include smart factories, predictive maintenance, and interconnected supply chains.

IIoT is the most established and mature form of IoT, with widespread adoption across various industries due to its significant impact on operational efficiency and cost savings.

The internet of things

Consumer IoT (CIoT) is utilized in the development of applications with the following characteristics:

- Consumer Devices: CIoT applications are designed for consumer-oriented devices, including smartphones, smart refrigerators, smart glasses, wearable fitness trackers, and other everyday gadgets that enhance convenience and lifestyle.
- Data Volumes and Speed: These applications typically manage lower volumes of data and operate at moderate data transfer rates compared to industrial counterparts. The data exchanged is often related to user preferences, device status, or basic sensor readings.
- Non-Critical Applications: CIoT applications are generally non-critical, meaning that failures or malfunctions do not pose significant risks or harm to users.





CIoT applications are considered consumer-centric

Industrial IoT (IIoT) is leveraged for the development of applications with the following attributes:

- Industrial Devices: IIoT applications are specifically designed for devices that operate in industrial, transportation, energy, healthcare, and other critical sectors.
- Data Volume and Speed: IIoT applications manage a wide range of data volumes, often requiring sustained and sometimes very high data transfer rates. The data collected and processed is crucial for real-time monitoring, control, and decision-making in industrial environments.
- Safety-Critical Applications: Many IIoT applications are safety-critical, meaning their proper functioning is essential for ensuring safety and reliability.

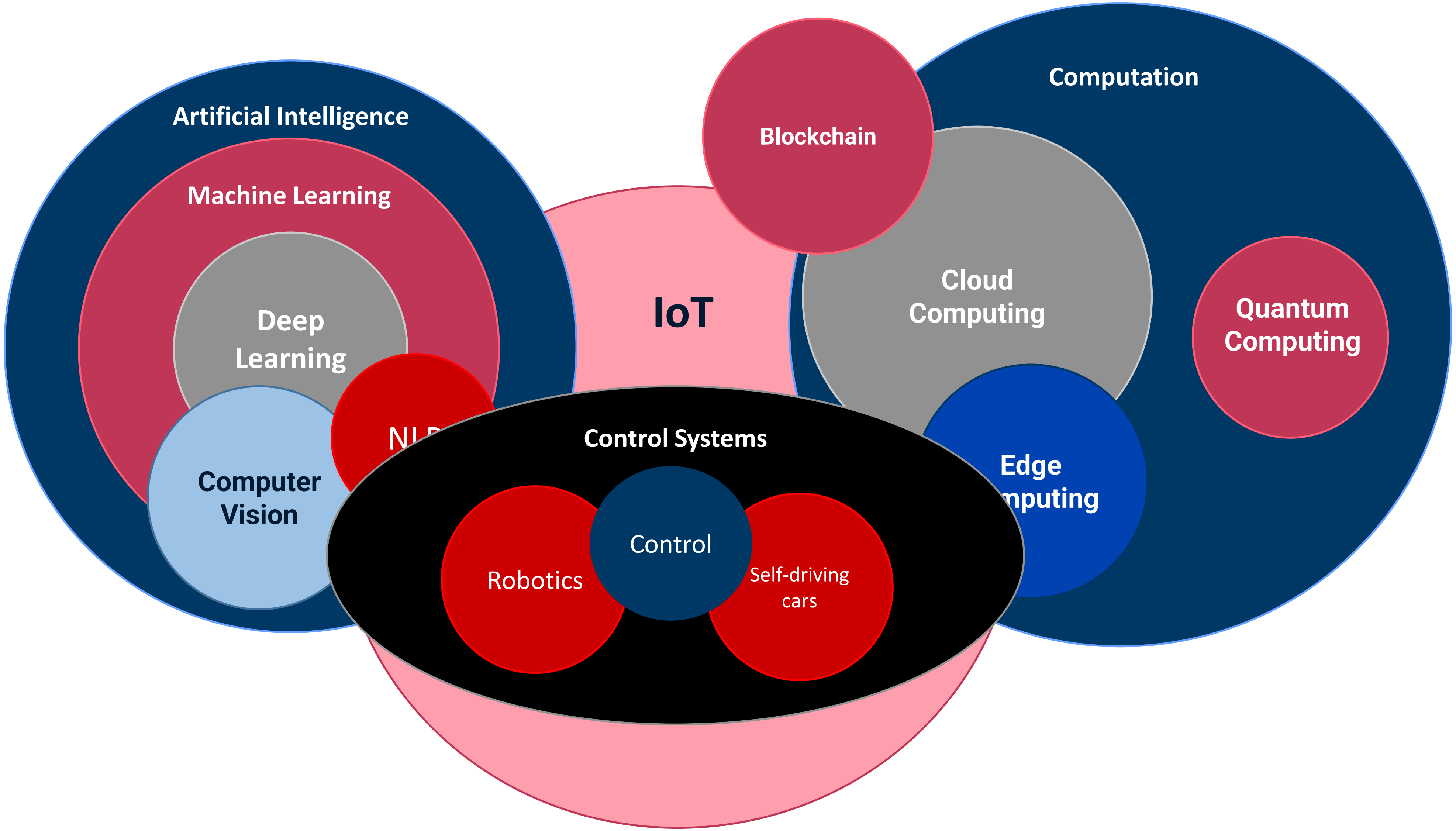



IIoT applications are considered system-centric

Blockchain

04

Blockchain


Artificial Intelligence
Machine Learning
Deep Learning
Computer Vision
NLP
IoT
Blockchain
Computation
Cloud Computing
Quantum Computing
Edge Computing
Control Systems
Robotics
Control
Self-driving cars

Blockchain

Blockchain is an open, distributed ledger that records transactions between two parties with efficiency, verifiability, and permanence.

Open: It is accessible to all participants, ensuring transparency and inclusivity in the network.

Distributed: It is decentralized across multiple nodes, eliminating the need for a central authority and enhancing reliability.

Ledger: It is a digital record that immutably logs all transactions, providing a clear and unalterable history.

P2P (Peer-to-Peer): It operates directly between participants, facilitating direct transactions without intermediaries.

Secure: It employs advanced cryptography to protect data integrity and ensure trust in the system.

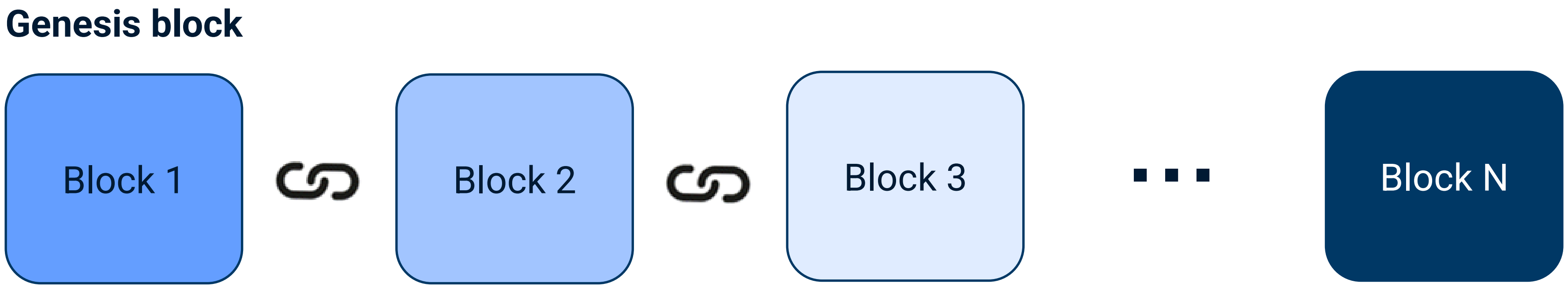
Blockchain

A really important thing: Bitcoin ≠ BlockChain

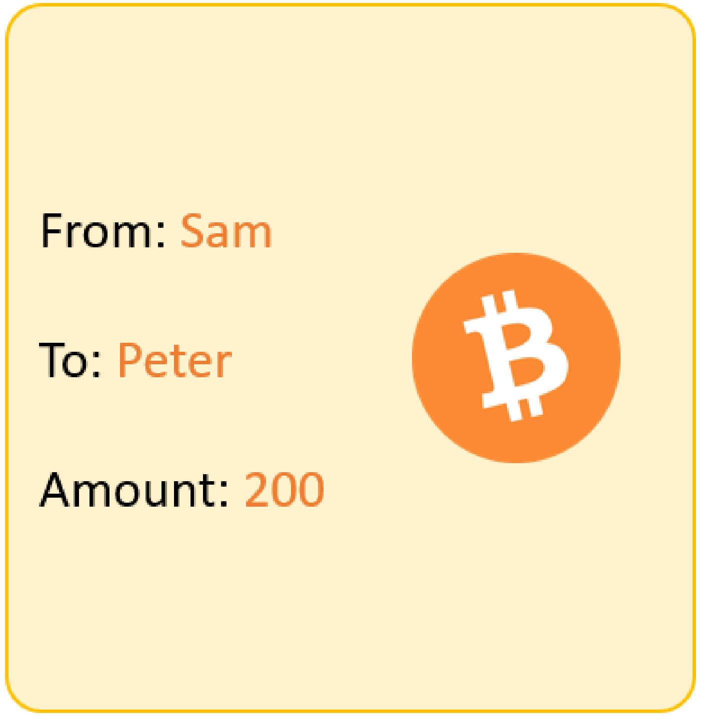
- Blockchain is not the same as Bitcoin, but it is the foundational technology that powers Bitcoin.
- Bitcoin is a digital token, while blockchain serves as the ledger that tracks ownership of these tokens.
- Bitcoin relies on blockchain to function, but blockchain technology itself can exist independently of Bitcoin and be applied to various other use cases beyond cryptocurrencies.

Blockchain

Blockchain is a chain of blocks, each containing specific information. The type of data stored within a block varies depending on the purpose and type of blockchain being used.



- The first block in a blockchain is known as the **Genesis block**.
- Each subsequent block in the chain is cryptographically linked to the previous block, forming a continuous and secure chain of data.



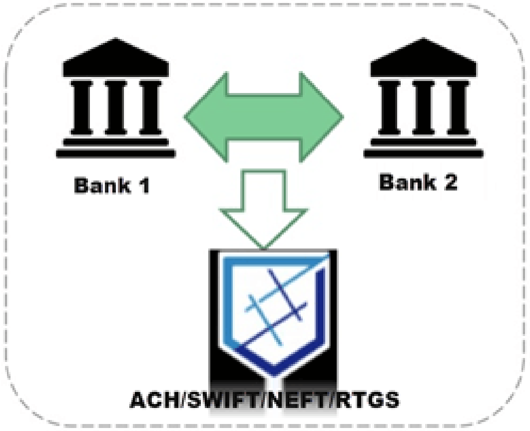
Bitcoin Block Example

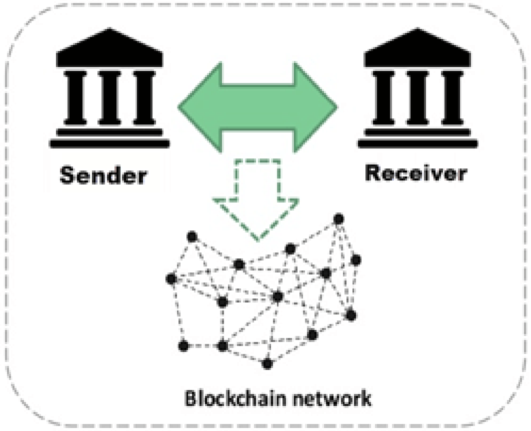
For example, a Bitcoin block contains the following information:

- Sender (From): The address of the party sending the bitcoins.
- Receiver (To): The address of the party receiving the bitcoins.
- Amount: The number of bitcoins being transferred.

Blockchain

A cryptocurrency is a digital medium of exchange, similar to traditional currencies like the Euro, but it is specifically designed to facilitate the exchange of digital information using principles of cryptography.





Ethereum

Bitcoin

Ripple

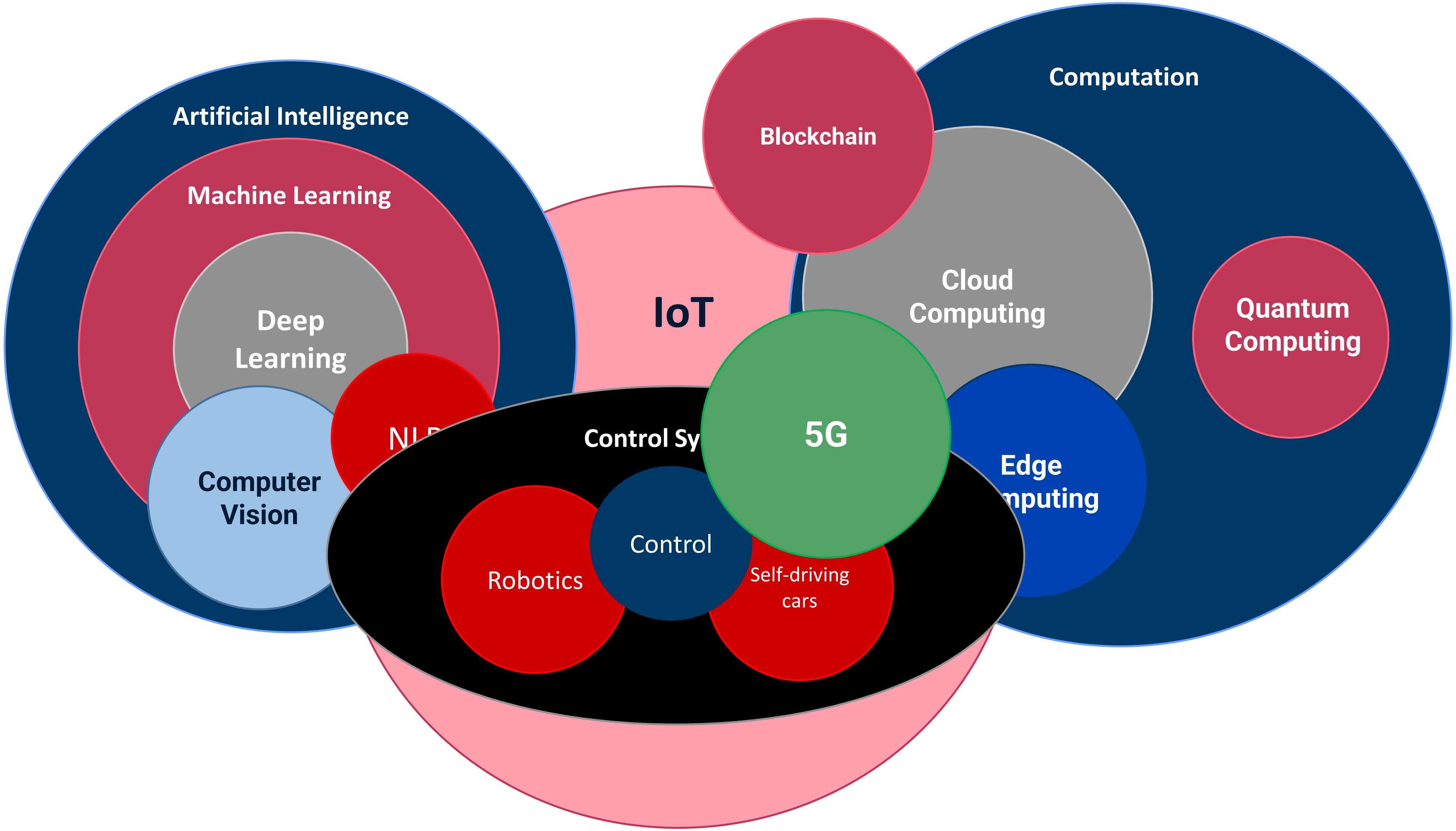
Litecoin

As a digital currency, cryptocurrency is categorized as a subset of both alternative currencies and virtual currencies.

5G and more …

05

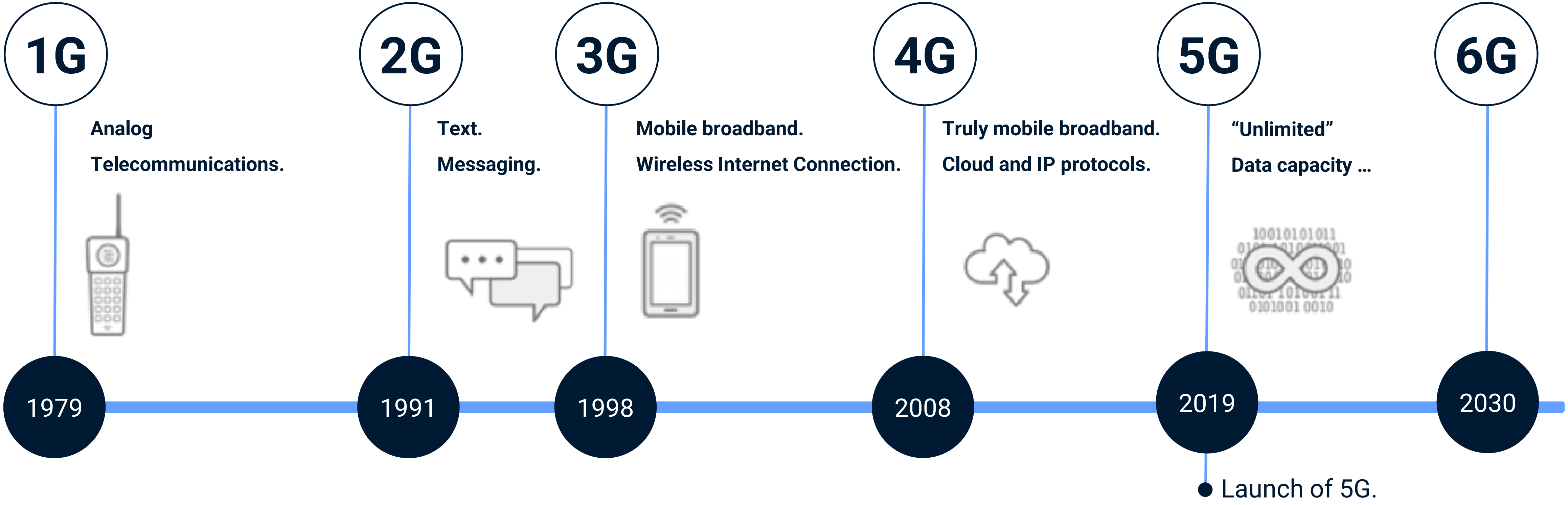
5G and more …



Computation
Artificial Intelligence
Blockchain
Machine Learning
Cloud Computing
IoT
Deep Learning
Quantum Computing
5G
Control Sy
Edge
mputing
Computer Vision
Control
Robotics
Self-driving cars

5G and more …

5G is the fifth generation of mobile networks, offering speeds up to 100 times faster than 4G. With download speeds that can reach up to 10 gigabits per second, 5G is set to revolutionize connectivity.



5G and more …

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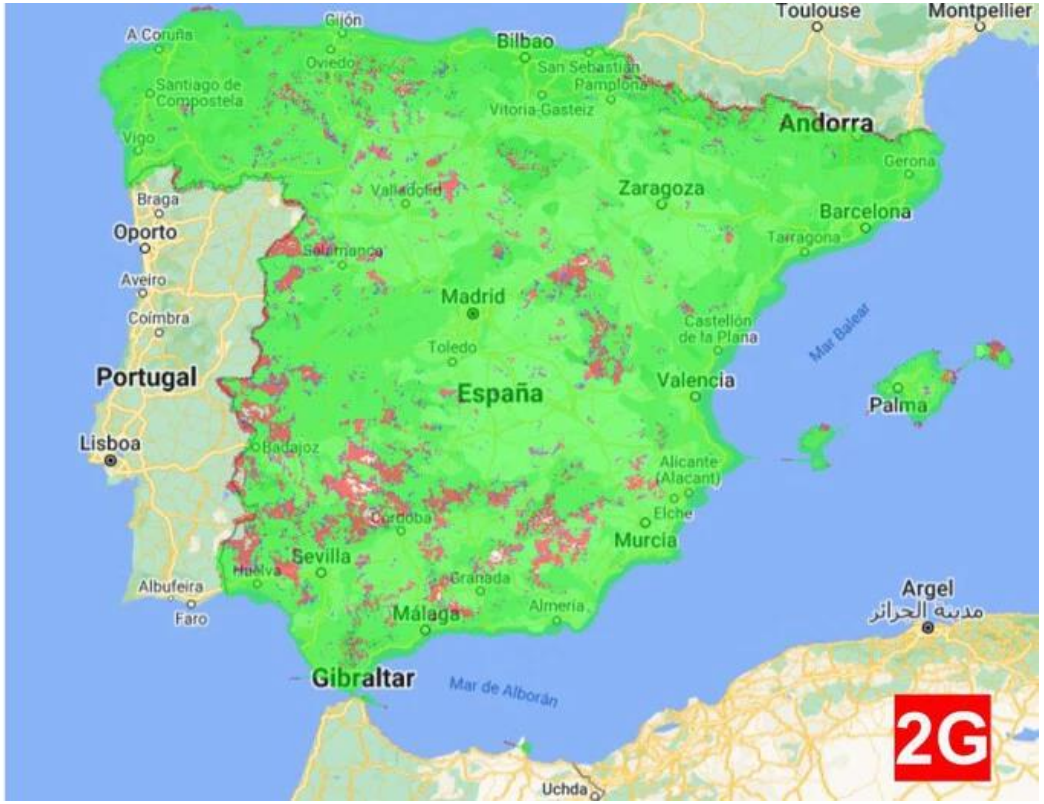
Spain coverage map 5G



Spain coverage map 2G

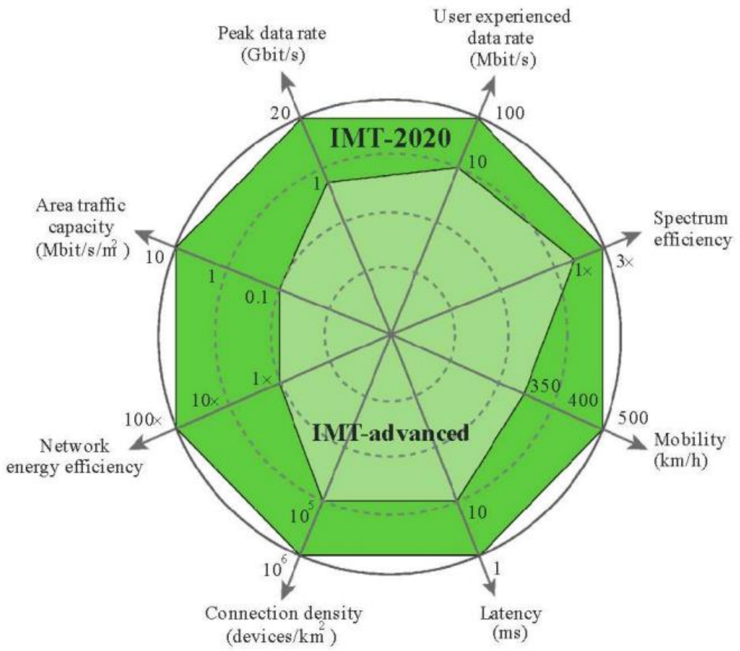
UFV

Which are the advantages of 5G over 4G?

- 5G can deliver download speeds of up to 10 gigabits per second, which is up to 100 times faster than 4G.
- 5G networks can achieve **latency as low as 1 millisecond**, compared to 20-30 milliseconds for 4G. This near-instantaneous response time is crucial for applications that require real-time interaction like autonomous vehicles.
- 5G can support a **much larger number of connected devices per square kilometer** compared to 4G. This is essential for the growing number of Internet of Things (IoT) devices, allowing more devices to operate simultaneously without network congestion.
- 5G networks offer **enhanced reliability**, which is critical for mission-critical applications like remote surgery, autonomous driving, and industrial automation, where consistent and stable connections are necessary.
- 5G technology is designed to be **more energy-efficient**, which can lead to longer battery life for mobile devices and lower operational costs for network providers.
- 5G allows for the creation of **virtual networks** (**network slices**), that can be tailored to meet the specific needs of different applications, whether it’s low latency for autonomous vehicles or high bandwidth for streaming services.
- 5G networks are better equipped to **handle high data traffic in densely populated areas**, such as stadiums, urban centers, and large events..
- 5G is designed to integrate and support **advanced technologies** such as Artificial Intelligence (AI), enabling new applications and services that were not feasible with 4G.

5G - Performance Goals International Telecommunication Union

The International Telecommunication Union is a specialized agency of the United Nations responsible for many matters related to information and communication technologies.



5G: IMT-2020 **4G: IMT-advanced**

- Peak Data Rate (Gbit/s): 20 Gbit/s.
- User Experienced Data Rate (Mbit/s): 100 Mbit/s.
- Mobility (km/h): It is up to 500 km/h (suitable for high-speed trains).
- Latency (ms): The latency as low as 1 millisecond.
- Connection Density (devices/km²): 10^6 devices/km².
- Network Energy Efficiency: 100 times more energy efficient than4G.
- Area Traffic Capacity (Mbit/s/m²): The total traffic can handle is around 10 Mbit/s/m².

and much more …