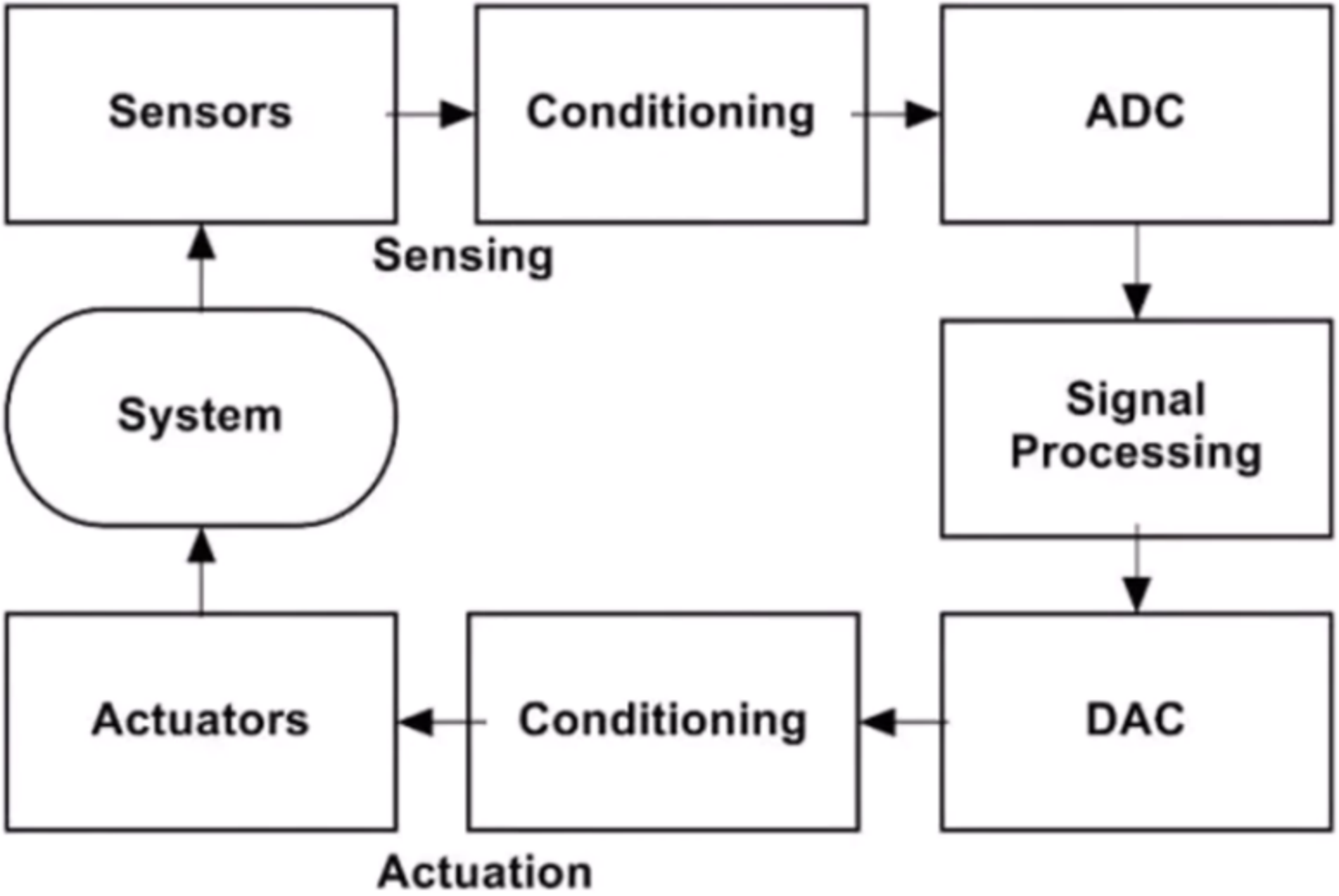
- Sensing is a technique used to gather information, a physical object or process including the occurence of events (i.e,changes in states such as drop in temperature or pressure).
- An object performing such a sensing task is called a sensor .
- Phenomena in the physical world are observed by a sensor device .
- The resulting electrical signals are often not ready for immediate processing therefore they pass through a signal conditioning state.

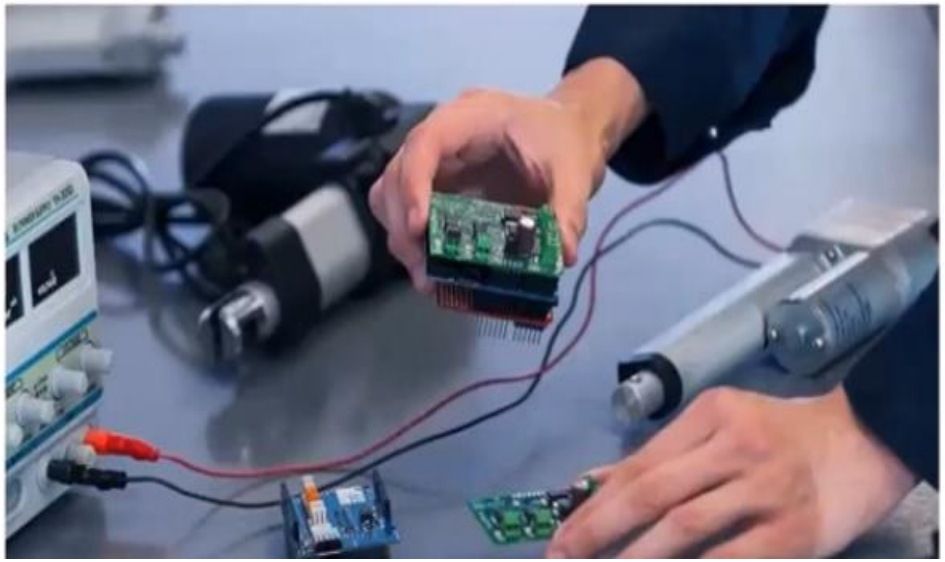
Sensing & Actuation



- The signals require amplification for further conversion of analog to digital conversion .
- After conditioning the analog signal is transformed into a digital signal using an analog to digital converter (ADC).
- The signal is now available in a digital form and ready for further processing, storing or visualization .
- Many wireless sensor networks also include actuators which allow them to directly control the physical world .
- For example an actuator can be a value controlling the flow of hot water .
- Motor that opens or closes a door or window .

A pump that controls the amount of fuel injected into an engine .

Such a wireless sensor and actuator network(WSAN) takes command from the processing device(controller) and transform these commands into input signals for the actuator which then interacts with the physical process thereby forming a closed control loop.

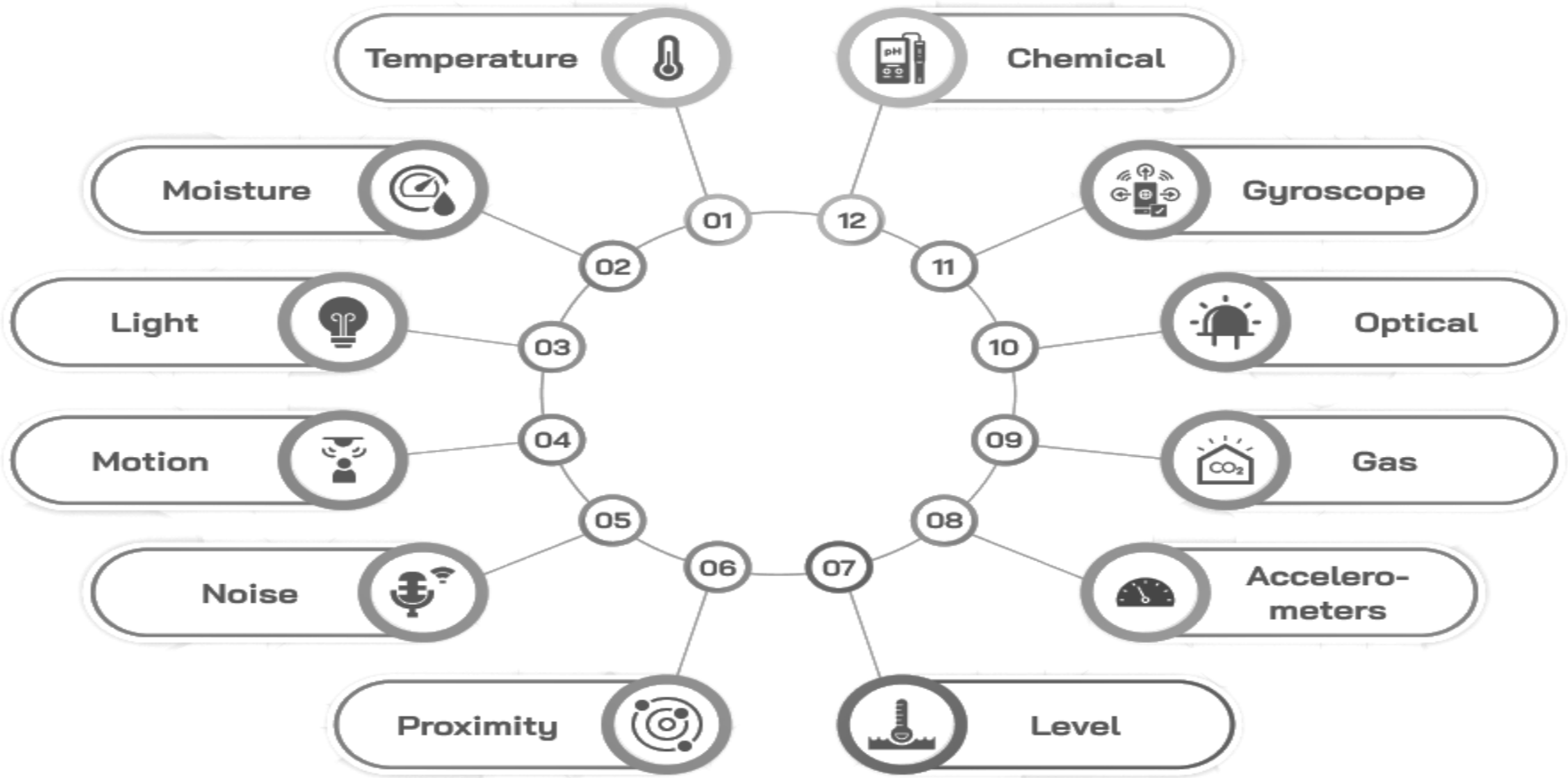


Sensor Networks

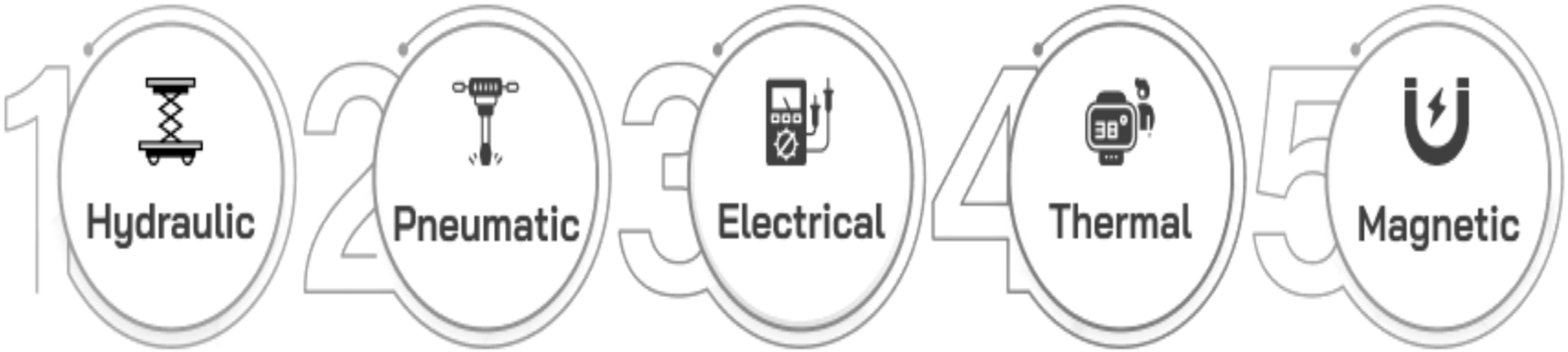
- A **sensor network** is a group of sensors where each sensor monitors data in a different location and sends that data to a central location for storage, viewing, and analysis.
- **For eg. Home security system**, in which all the sensors sends data to the owner.
- All of the sensors send their data to a central system, which gives the homeowners a way to view it. More sophisticated system can analyse the data and send an alert to the homeowners when it sees enough evidence of an intrusion.

- **Municipal surveillance,** a network of surveillance cameras throughout the city, all linked together and sending video back to the police station.

Types of Sensors



Types of Actuators



1. Hydraulic: These actuators harness hydraulic power to perform mechanical functions and operations. Generally, these types of actuators are powered by a cylinder or a fluid motor. According to the requirements and recommendations, the mechanical motion is converted into oscillatory, linear, or rotary.

2. Pneumatic: Pneumatic actuators create two types of motions, rotary or linear. They are powered by a vacuum or compressed air at high pressure to implement the required type of motion. Compared to other types of actuators, pneumatic actuators are low-cost and low-maintenance actuators.

3. Electrical: In these actuators, a motor converts electrical energy into mechanical motion. These actuators are powered by electricity and provide precision control. These actuators are heavily used in industrial settings to automate mechanical operations.

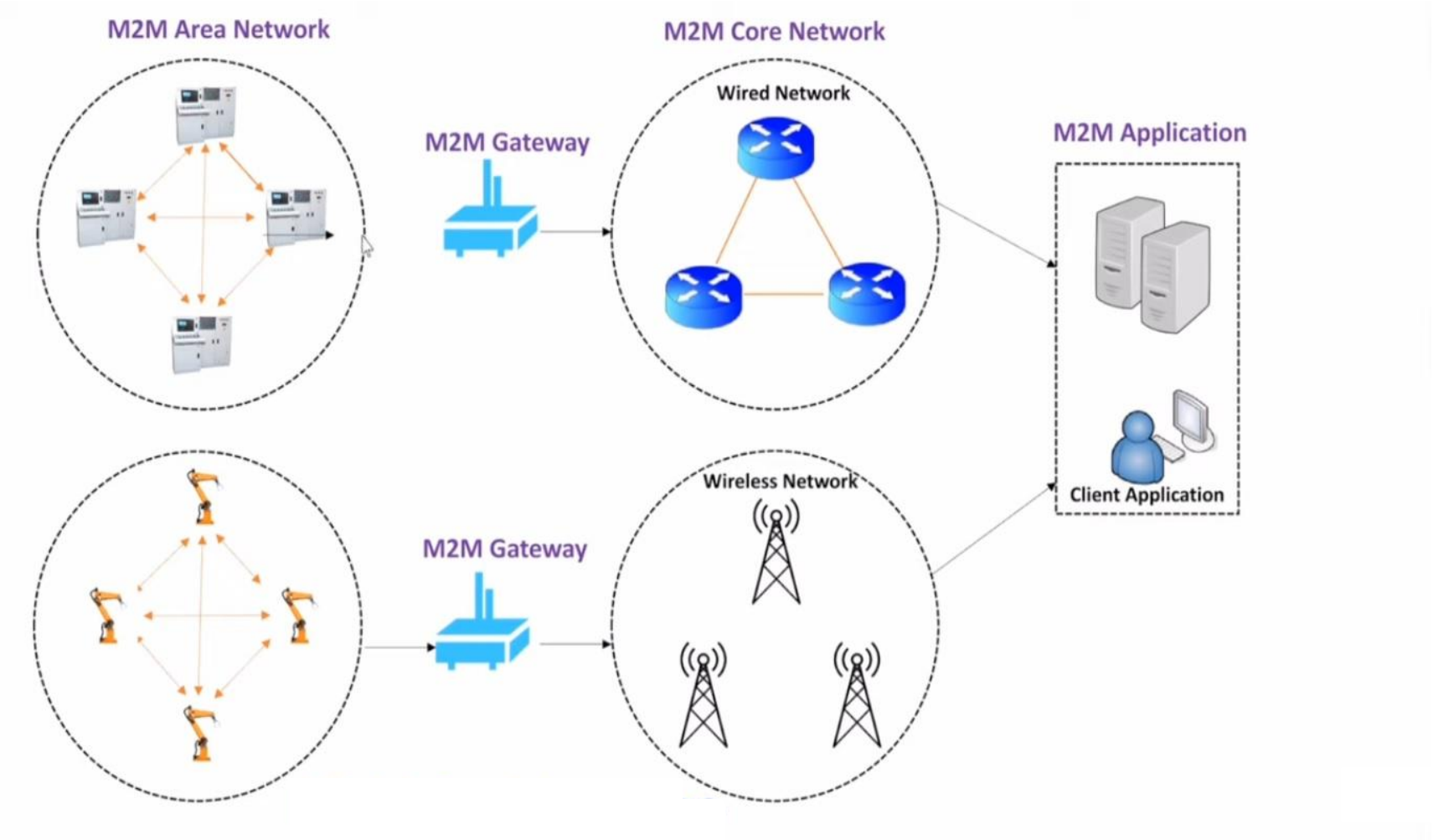
4. Thermal: The thermal actuators have thermal-sensitive material fitted inside, which is used to produce linear motion. The word thermal implies that these actuators are used in response to temperature changes. The most popular use case includes shutting off valves and operating latches or switches.

5. Magnetic: These types of actuators convert electromagnetic energy into mechanical output and operate in a linear or rotary direction. Magnetic actuators can provide continuous mechanical operation and are popularly used in the automotive and aerospace industries.

M2M Communication

- It is a direct communication of devices including wireless or wired.
- In M2M communication objects can talk to each other (can exchange data) without any human intervention.
- Each machine in M2M communication is Embedded with a smart device. The device senses the data or status of the machine and performs the communication and computations function.

M2M Architecture



What is IoT and M2M

- **Provide Remote access –** IoT and M2M provide access to information without human intervention.
- **M2M –** M2M provides direct communication between individual machines or devices. It is designed to communicate between devices (Machines) for a specific purpose.
- **IoT –** IoT is a broader concept for internet communication between devices. It involves a wide range of devices, sensors, actuators, and applications that communicate with the internet.
- M2M uses non-IP-based proprietary networks and IoT uses broad networks protocol based on IP.

M2M gateway

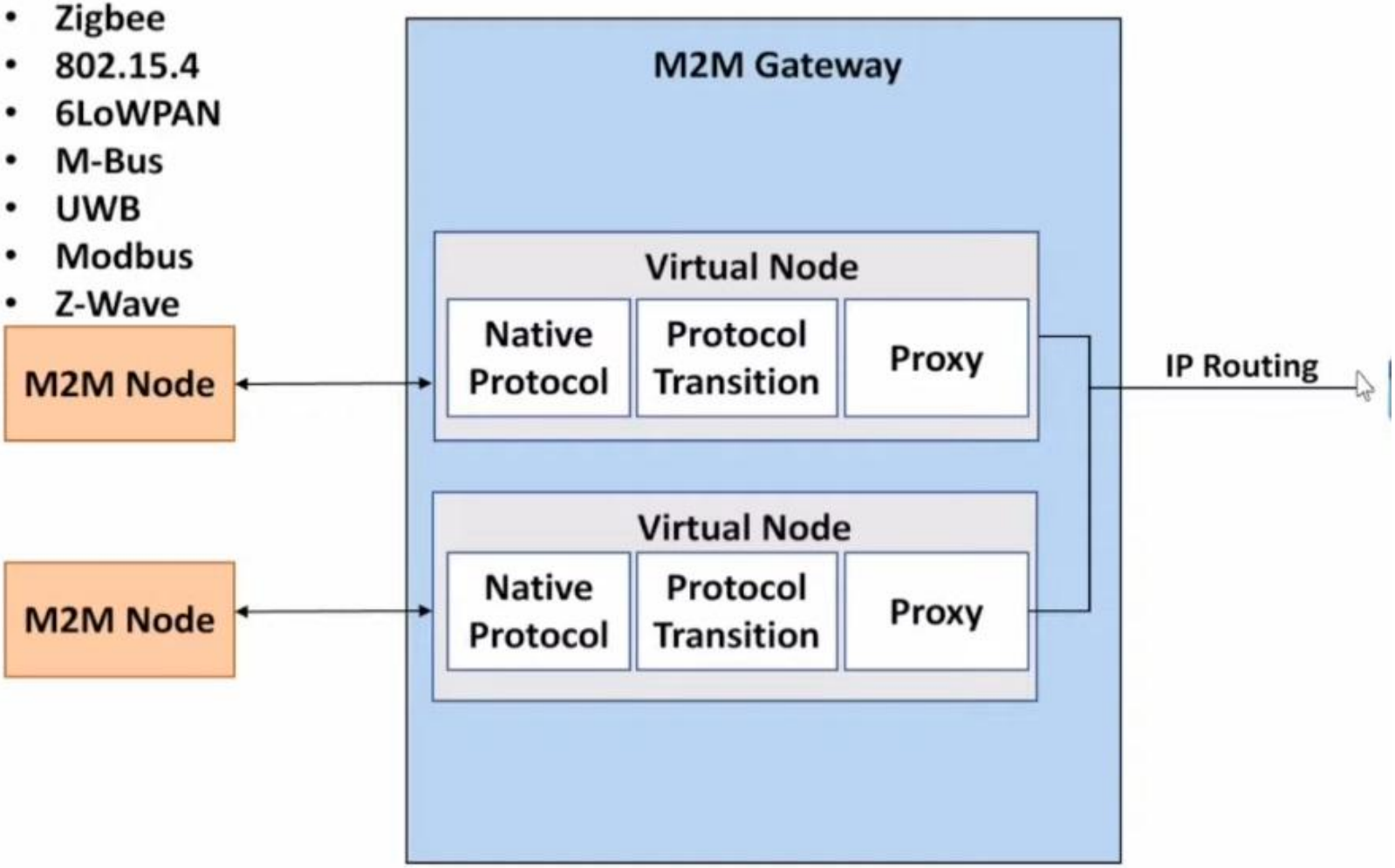
- **What is M2M gateway?**
- M2M gateway acts as an intermediatory between various devices and systems in a machine-to-machine setup.
- It provides the following functionalities:
  - Connectivity between machines.
  - Data exchange between machines.
  - Compatibilities between different networks.

- **What is the purpose or necessity of an M2M gateway?**
- Within the network nodes communicate with each other.
- To communicate with remote M2M area network, M2M gateway is required.

M2M gateway

M2M Networks:

- Bluetooth
- Zigbee
- 802.15.4
- 6LoWPAN
- M-Bus
- UWB
- Modbus
- Z-Wave



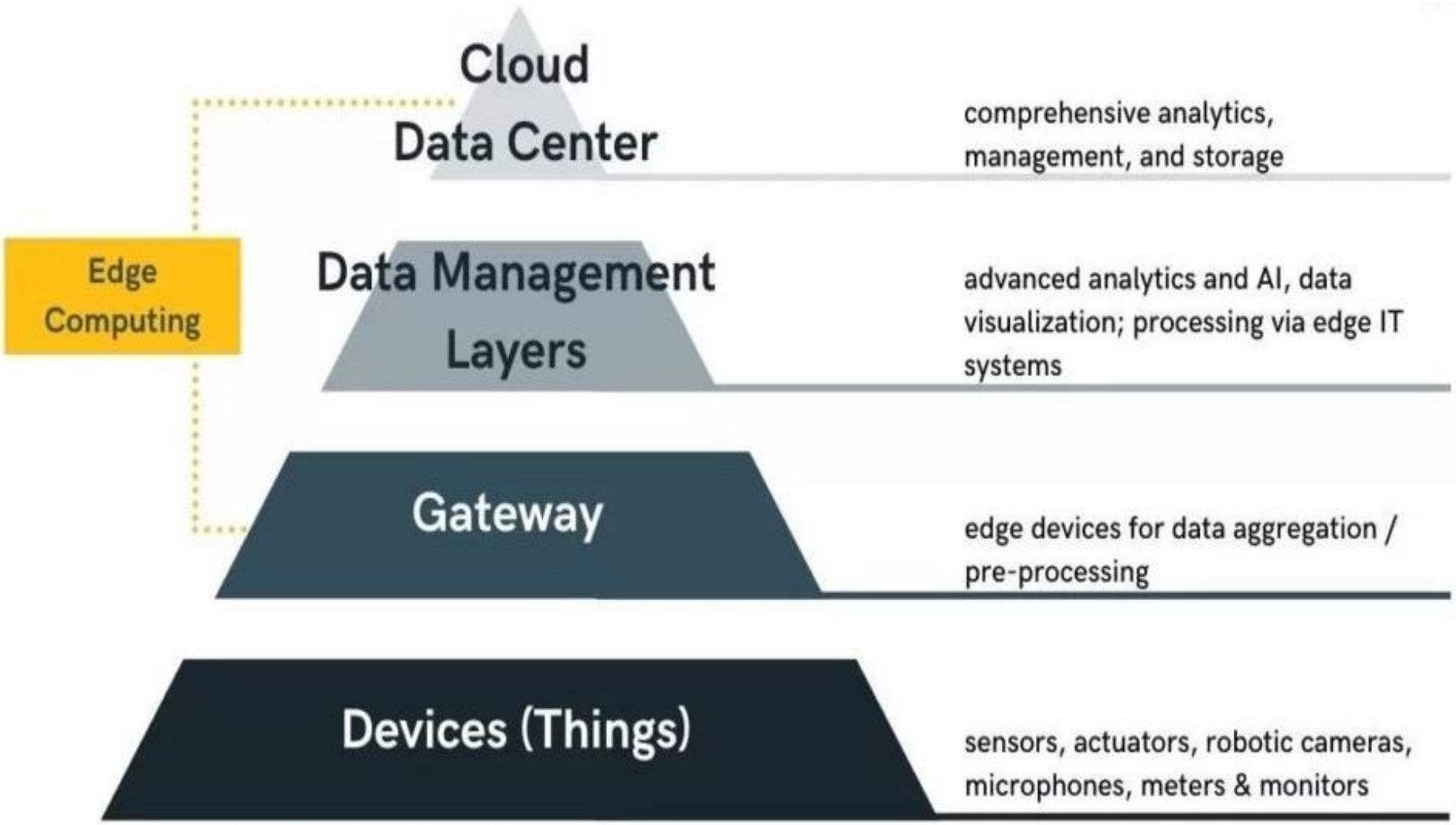
M2M Summery

- M2M is Fundamental component of IoT. {IoT is a broader concept for device communication}
- M2M is the Backbone of IoT applications.

Industrial structure of IoT (IIoT)

- Connecting edge to core in the industry.
- IoT is used in smaller applications like home automation o google alexa whereas IIoT connects the whole factory.
- IIoT is a subclass of IoT.
- It is a big pillar of industry 4.0

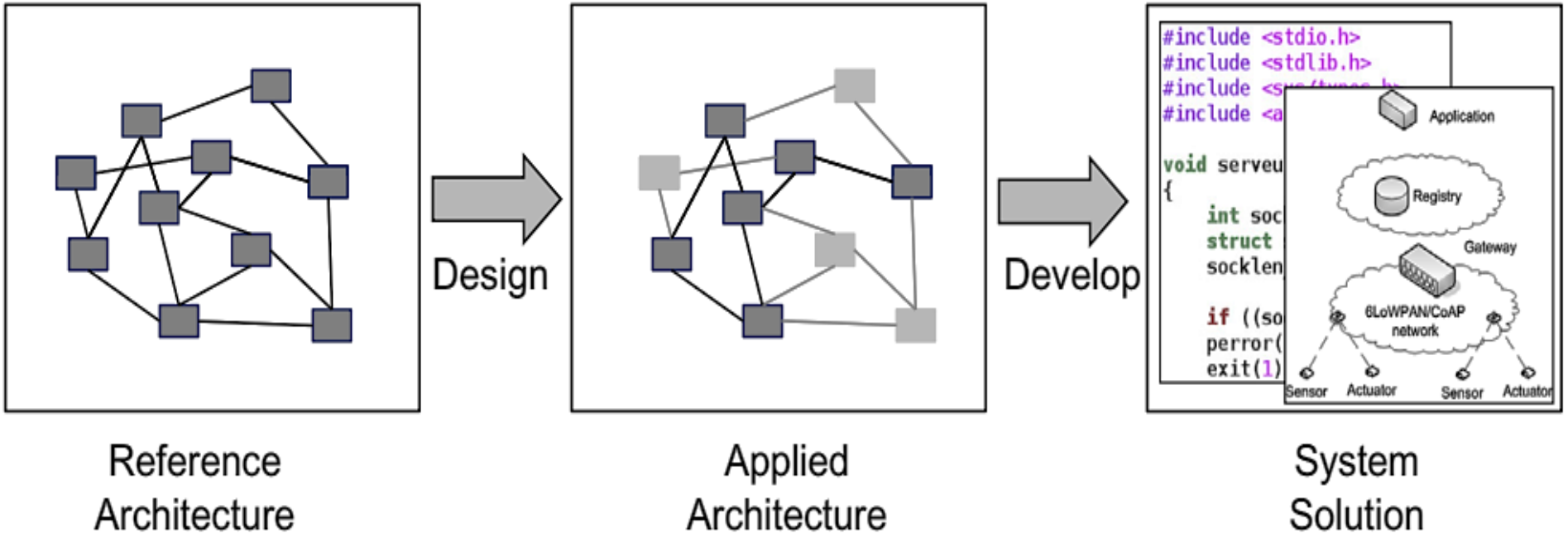
IIoT Architecture layers



Components of IIoT Architecture

- IoT enabled devices at the edge of the network.
- Edge data management and initial processing.
- Cloud for advanced processing.
- Internet gateways
- Connectivity protocols
- IIoT platforms.

IoT Reference Architecture

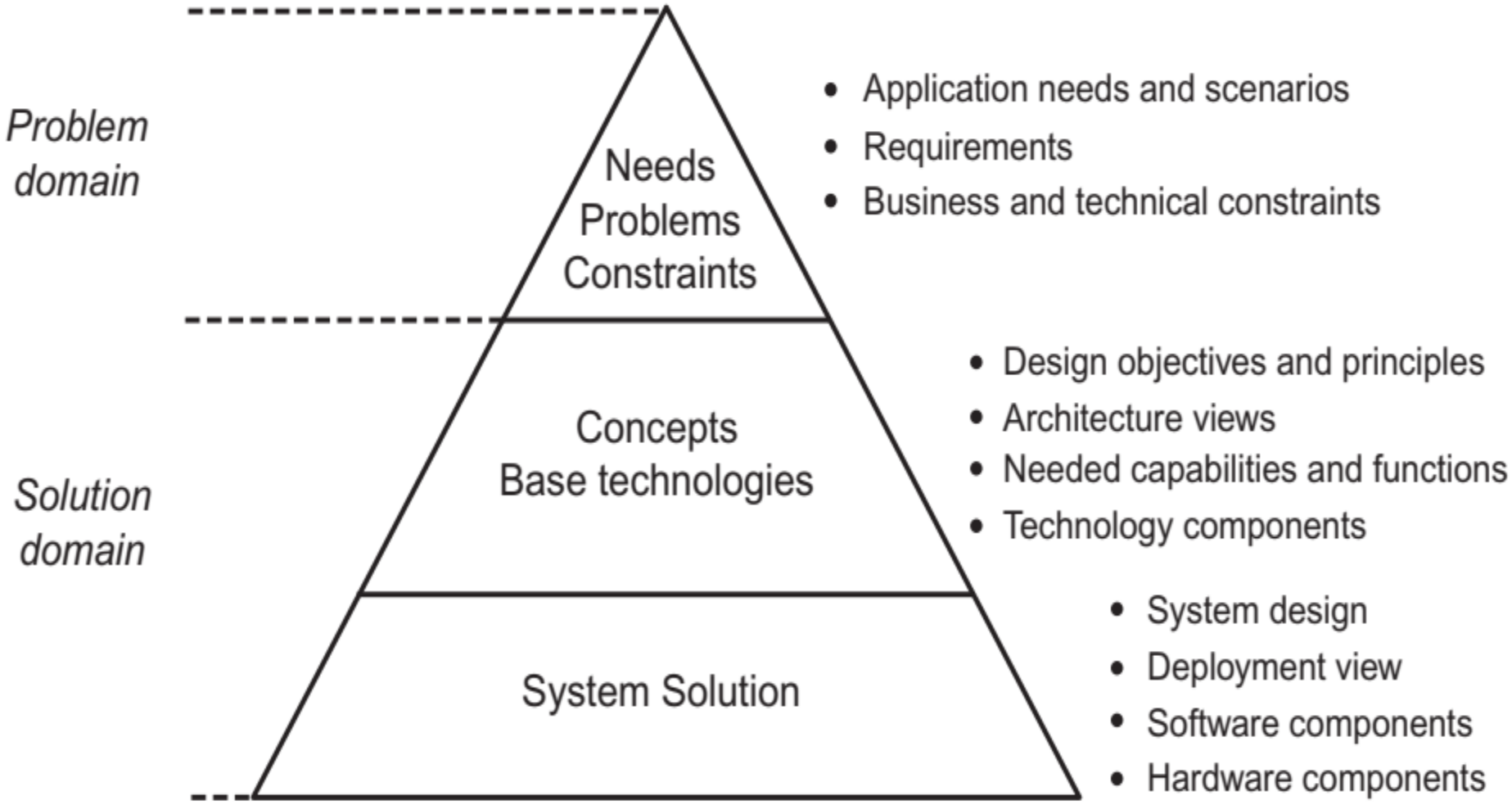


Reference Architecture

Applied Architecture

System Solution

Problem and solution domain partitioning of IoT Architecture reference model



The term “reference architecture” relates to a generalized model that contains the richest set of elements and relations that are of relevance to the domain “Internet of Things.

When looking at solving a particular problem or designing a target application, the reference architecture is to be used as an aid to design an applied architecture, i.e. an instance created out of a subset of the reference architecture.

The top level of the triangle is referred to here as the “problem domain” (“domain model” in software engineering). The problem domain is about understanding the applications of interest, for example, developed through scenario building and use case analysis in order to derive requirements. In addition, constraints are typically identified as well. These constraints can be technical, like limited power availability in wireless sensor nodes, or non-technical, like constraints coming from legislation or business.

The next section outlines the design objectives and principles for IoT, the main capabilities, and then an architecture outline. The section also introduces two proposed state-of-the-art examples of architectures fromEuropean Telecommunications Standards Institute (ETSI) and IoT-A.

The lower level is referred to as the solution domain. This is where design objectives and principles are established, conceptual views are refined, required functions are identified, and where logical partitions of functionality and information are described. Often this is where a logical architecture is defined, or network architecture in the form of a network topology diagram is produced. It is also common to identify suitable technology components such as operating systems and protocols or protocol stacks at this level. The actual system solution is finally captured by a system design that typically results in actual software and hardware components, as well as information on how these are to beconfigured, deployed, and provisioned.