Introduction to Internet of Things

Week 1

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Introduction

Internet technology connecting devices, machines and tools to the internet by means of wireless technologies.

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.

Characteristics

- ✓ Efficient, scalable and associated architecture
- ✓ Unambiguous naming and addressing
- ✓ Abundance of sleeping nodes, mobile and non-IP devices
- ✓ Intermittent connectivity

Applications

- Smart Parking
- Structural health
- Noise Urban Maps
- Smartphone Detection
- Traffic Congestion
- Smart Lighting
- Waste Management
- Smart Roads
- Supply Chain Control
- Smart Grid
- Tank level
- Photovoltaic Installations
- Water Flow
- Silos Stock Calculation
- Perimeter Access Control
- Liquid Presence
- River Floods
- NFC Payment
- Forest Fire Detection
- Air Pollution
- Snow Level Monitoring
- Landslide and Avalanche Prevention
- Earthquake Early Detection
- Water Leakages
- Radiation Levels
- Explosive and Hazardous Gases
- Intelligent Shopping Applications

IoT Enablers

Some areas identified as IoT enablers:

- RFID,
- Nanotechnology,
- Sensors,
- Smart Networks.

IoT vs M2M

✓ M2M refers to communications and interactions between machines and devices.

✓ Such interactions can occur via a cloud computing infrastructure (e.g., devices exchanging information through a cloud infrastructure).

✓M2M offers the means for managing devices and devices interaction, while also collecting machine and/or sensor data.

✓ M2M is a term introduced by telecommunication services providers and, pays emphasis on machines interactions via one or more telcom/communication networks (e.g., 3G, 4G, 5G, satellite, public networks).

IoT vs M2M

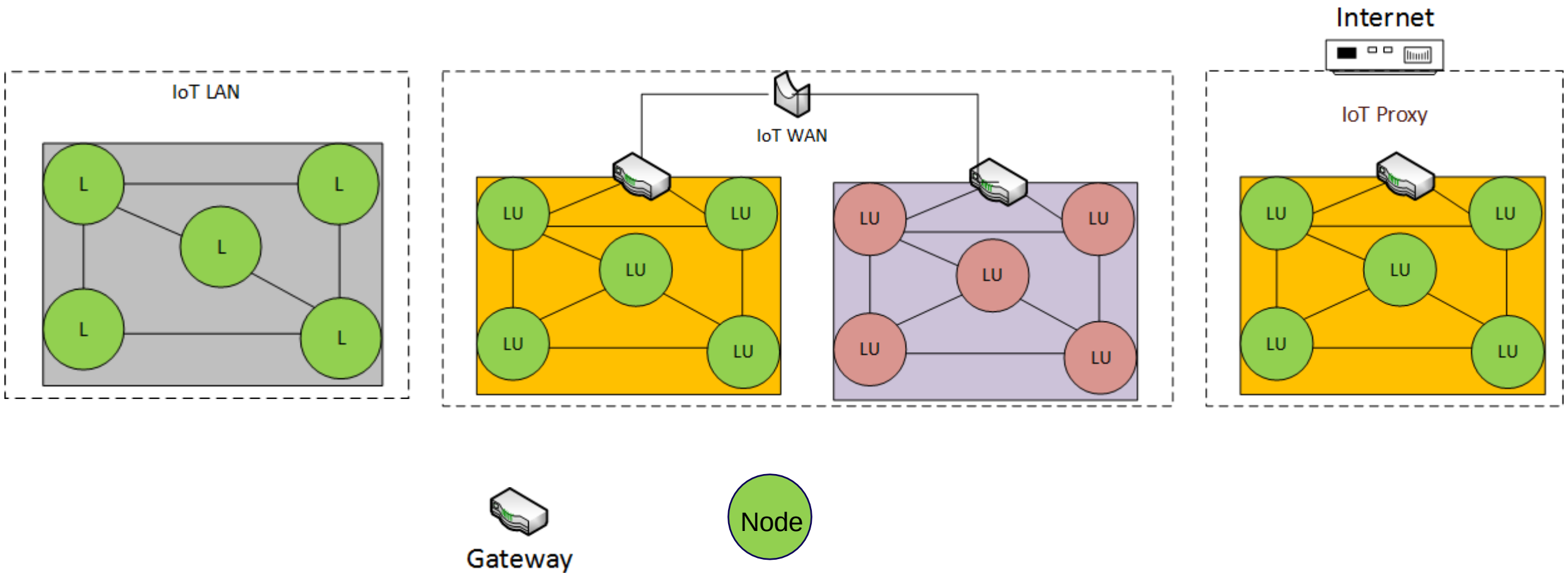
✓ **M2M is part of the IoT, while M2M standards have a prominent place in the IoT standards landscape.**

✓ However, IoT has a broader scope than M2M, since it comprises a broader range of interactions, including interactions between devices/things, things and people, things with applications and people with applications.

✓ It also enables the composition of workflows comprising all of the above interactions.

✓ IoT includes the notion of internet connectivity (which is provided in most of the networks outlined above), but is not necessarily focused on the use of telecom networks.

IoT Network Configuration



Sensing

A sensor detects (senses) changes in the ambient conditions or in the state of another device or a system, and forwards or processes this information in a certain manner.

✓ They perform some input functions by sensing or feeling the physical changes in characteristics of a system in response to a stimuli.

✓For example heat is converted to electrical signals in a temperature sensor, or atmospheric pressure is converted to electrical signals in a barometer.

Transducing

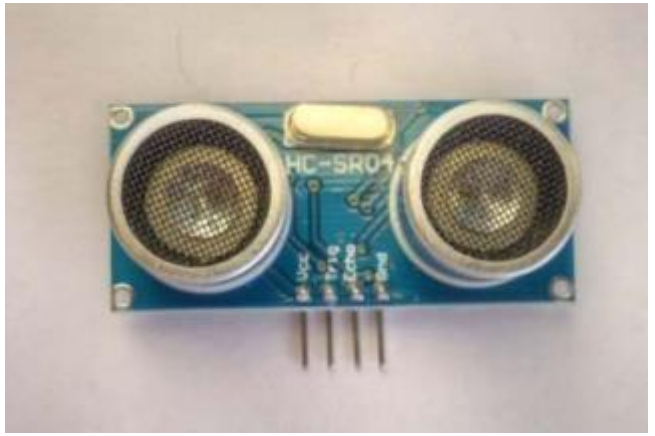
Transducers convert or transduce energy of one kind into another.

For example, in a sound system, a microphone (input device) converts sound waves into electrical signals for an amplifier to amplify (a process), and a loudspeaker (output device) converts these electrical signals back into sound waves.

The word “Transducer” is the collective term used for both **Sensors** which can be used to sense a wide range of different energy forms such as movement, electrical signals, radiant energy, thermal or magnetic energy etc., and **Actuators** which can be used to switch voltages or currents

Different Types of Sensors

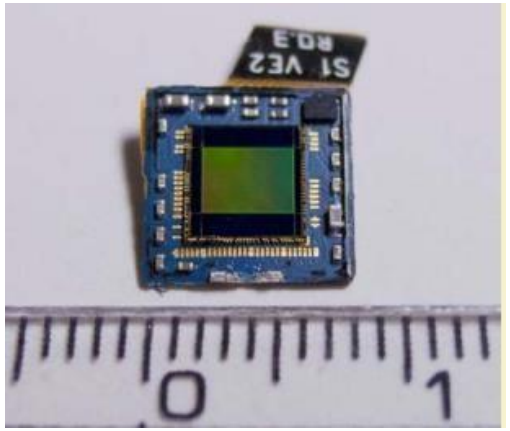
Pressure Sensor



Ultrasonic Distance Sensor

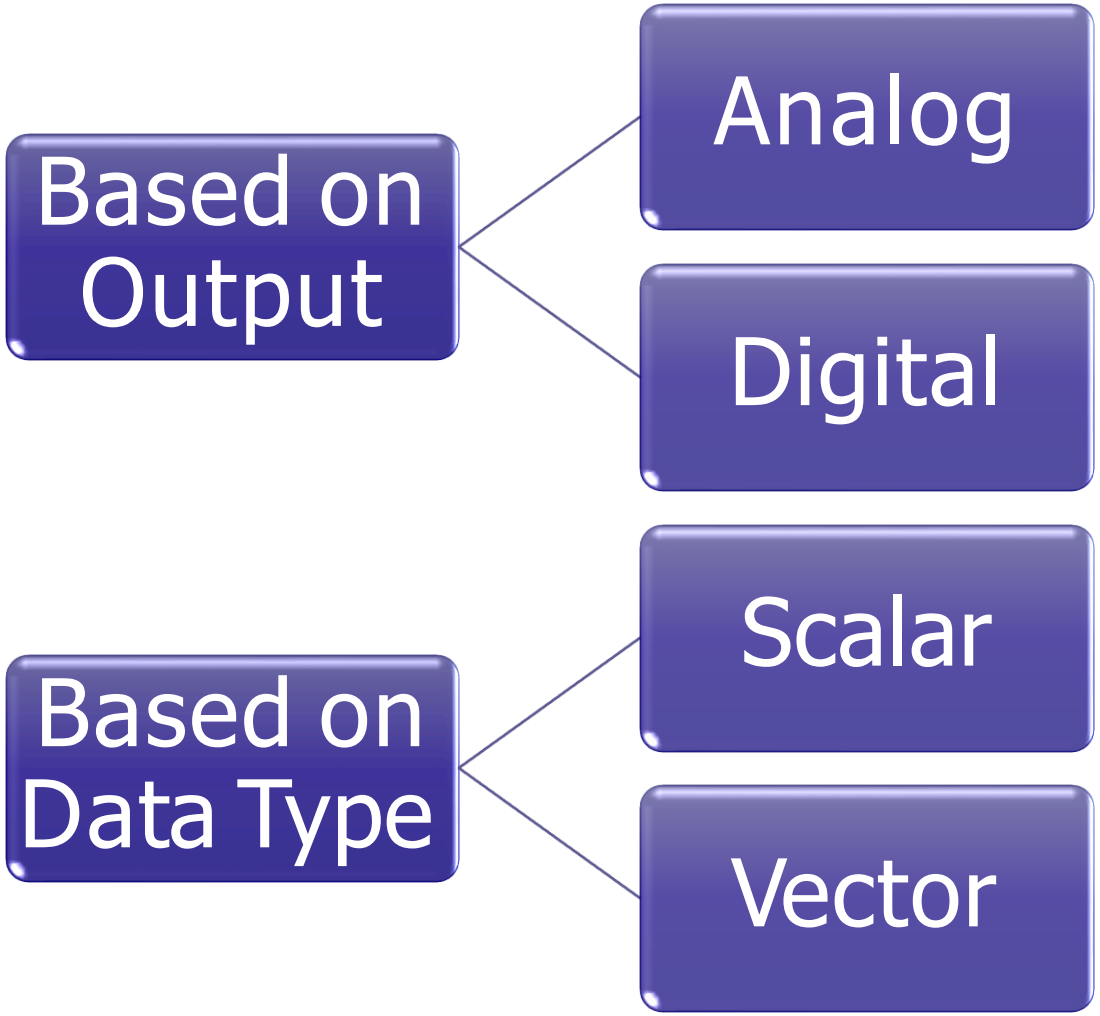
Analog Temperature Sensor

Infrared Motion Sensor



Camera Sensor

Sensor Classes



Analog Sensors

✓ **Analog Sensors** produce a continuous output signal or voltage which is generally proportional to the quantity being measured.

✓Physical quantities such as Temperature, Speed, Pressure, Displacement, Strain etc. are all analog quantities as they tend to be continuous in nature.

✓ For example, the temperature of a liquid can be measured using a thermometer or thermocouple (e.g. in geysers) which continuously responds to temperature changes as the liquid is heated up or cooled down.

Digital Sensors

✓ **Digital Sensors** produce discrete digital output signals or voltages that are a digital representation of the quantity being measured.

✓ Digital sensors produce a binary output signal in the form of a logic “1” or a logic “0”, (“ON” or “OFF”).

✓ Digital signal only produces discrete (non-continuous) values, which may be output as a single “bit” (serial transmission), or by combining the bits to produce a single “byte” output (parallel transmission).

Scalar Sensors

✓**Scalar Sensors** produce output signal or voltage which is generally proportional to the magnitude of the quantity being measured.

✓ Physical quantities such as temperature, color, pressure, strain, etc. are all scalar quantities as only their magnitude is sufficient to convey an information.

✓For example, the temperature of a room can be measured using a thermometer or thermocouple, which responds to temperature changes irrespective of the orientation of the sensor or its direction.

Vector Sensors

✓**Vector Sensors** produce output signal or voltage which is generally proportional to the magnitude, direction, as well as the orientation of the quantity being measured.

✓ Physical quantities such as sound, image, velocity, acceleration, orientation, etc. are all vector quantities, as only their magnitude is not sufficient to convey the complete information.

✓For example, the acceleration of a body can be measured using an accelerometer, which gives the components of acceleration of the body with respect to the x,y,z coordinate axes.

Sensorial Deviation

- If the output signal differs from the correct value by a constant, the sensor has an **offset error** or **bias**.
- Nonlinearity is deviation of a sensor's transfer function (TF) from a straight line transfer function.
- If the output signal slowly changes independent of the measured property, this is defined as **drift**. Long term drift over months or years is caused by physical changes in the sensor.
- **Noise** is a random deviation of the signal that varies in time.
- A hysteresis error causes the sensor output value to vary depending on the sensor’s previous input values

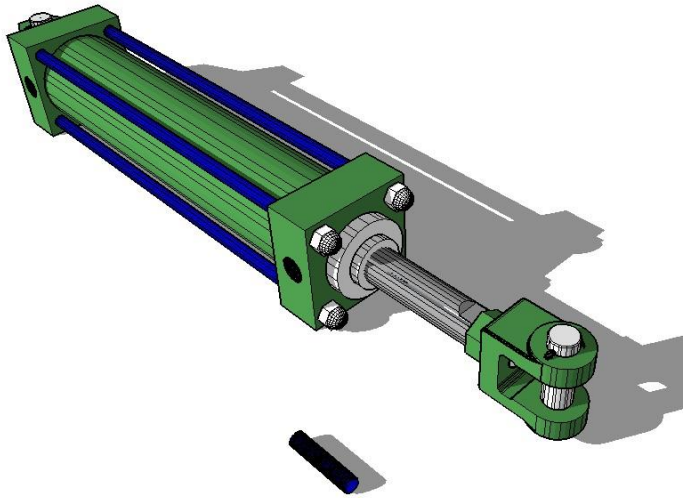
Actuation

- An actuator is a component of a machine or system that moves or controls the mechanism or the system.
- An actuator is the mechanism by which a control system acts upon an environment
- An actuator requires a control signal and a source of energy.
- Upon receiving a control signal is received, the actuator responds by converting the energy into mechanical motion.

Types of Actuators

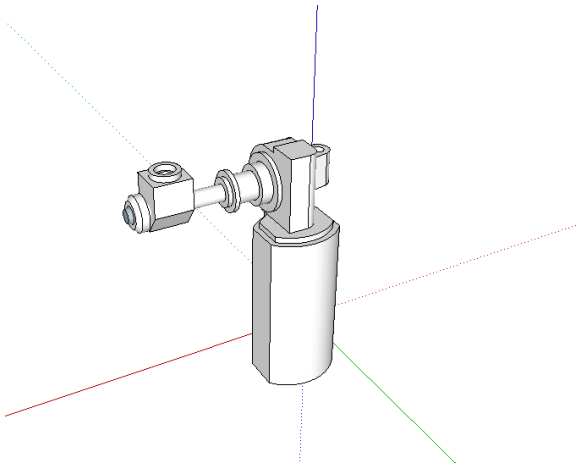
- Hydraulic
- Pneumatic
- Electrical
- Thermal/ Magnetic
- Mechanical

Types of Actuators

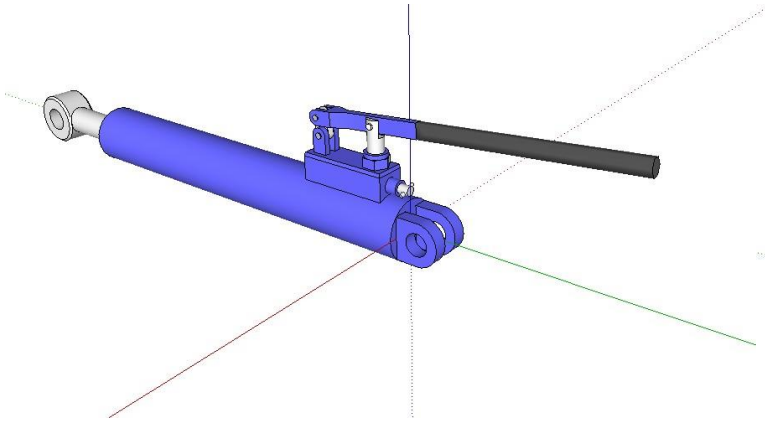


An oil based hydraulic actuator

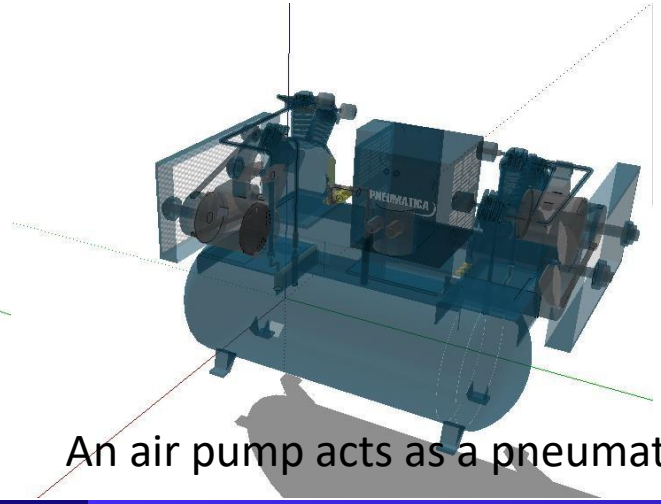
A radial engine acts as a hydraulic actuator



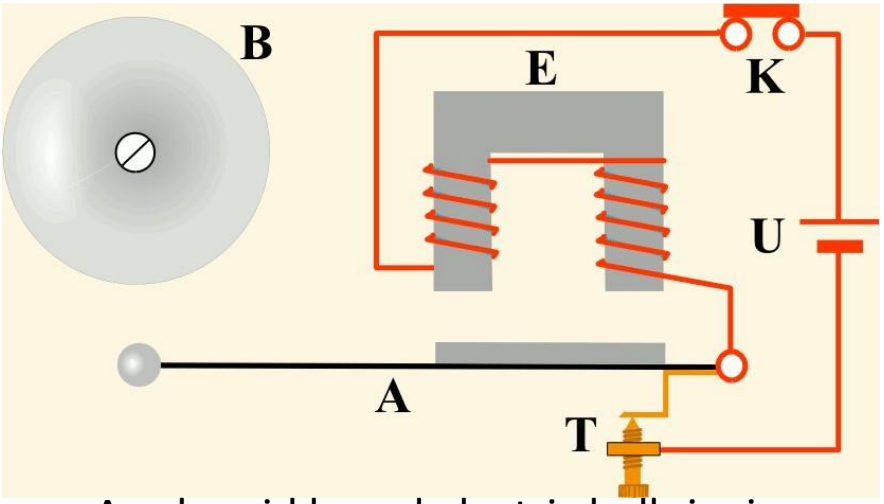
A motor drive-based rotary actuator



A manual linear pneumatic actuator

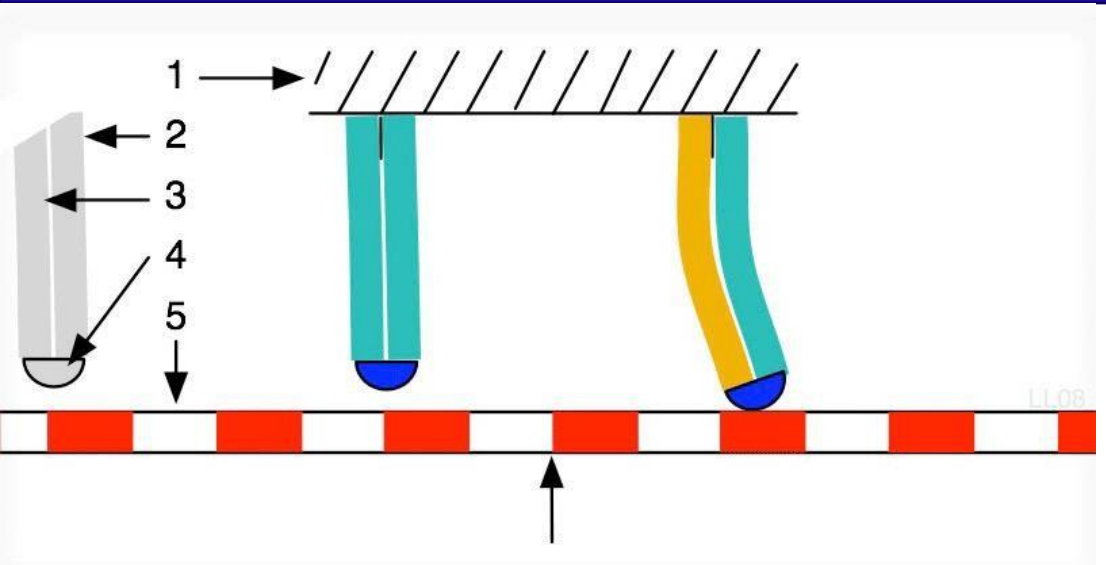


An air pump acts as a pneumatic actuator

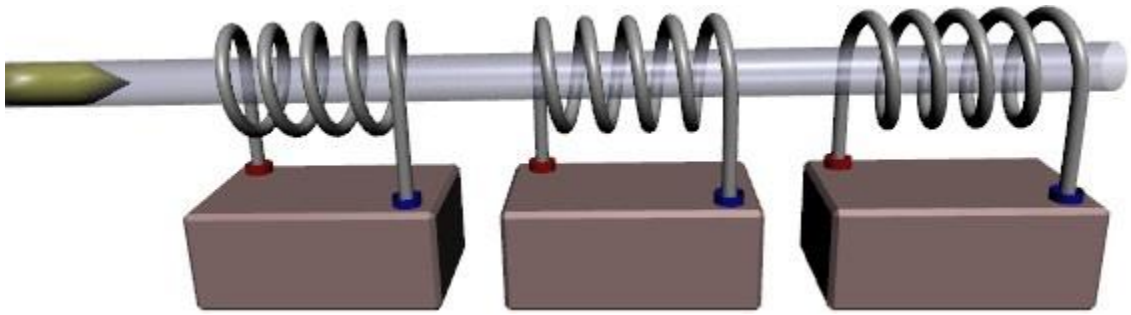


A solenoid based electric bell ringing mechanism

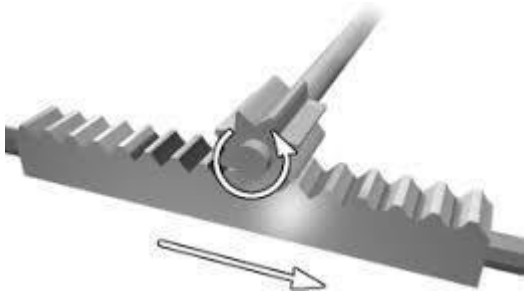
Types of Actuators



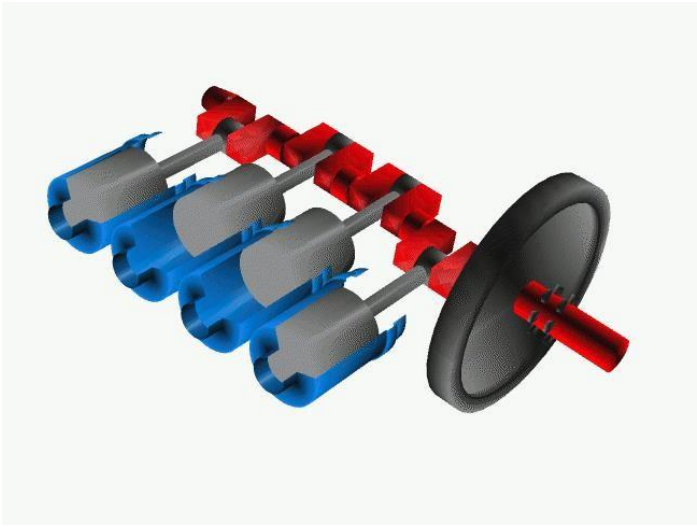
A piezo motor using SMA



A coil gun works on the principle of magnetic actuation

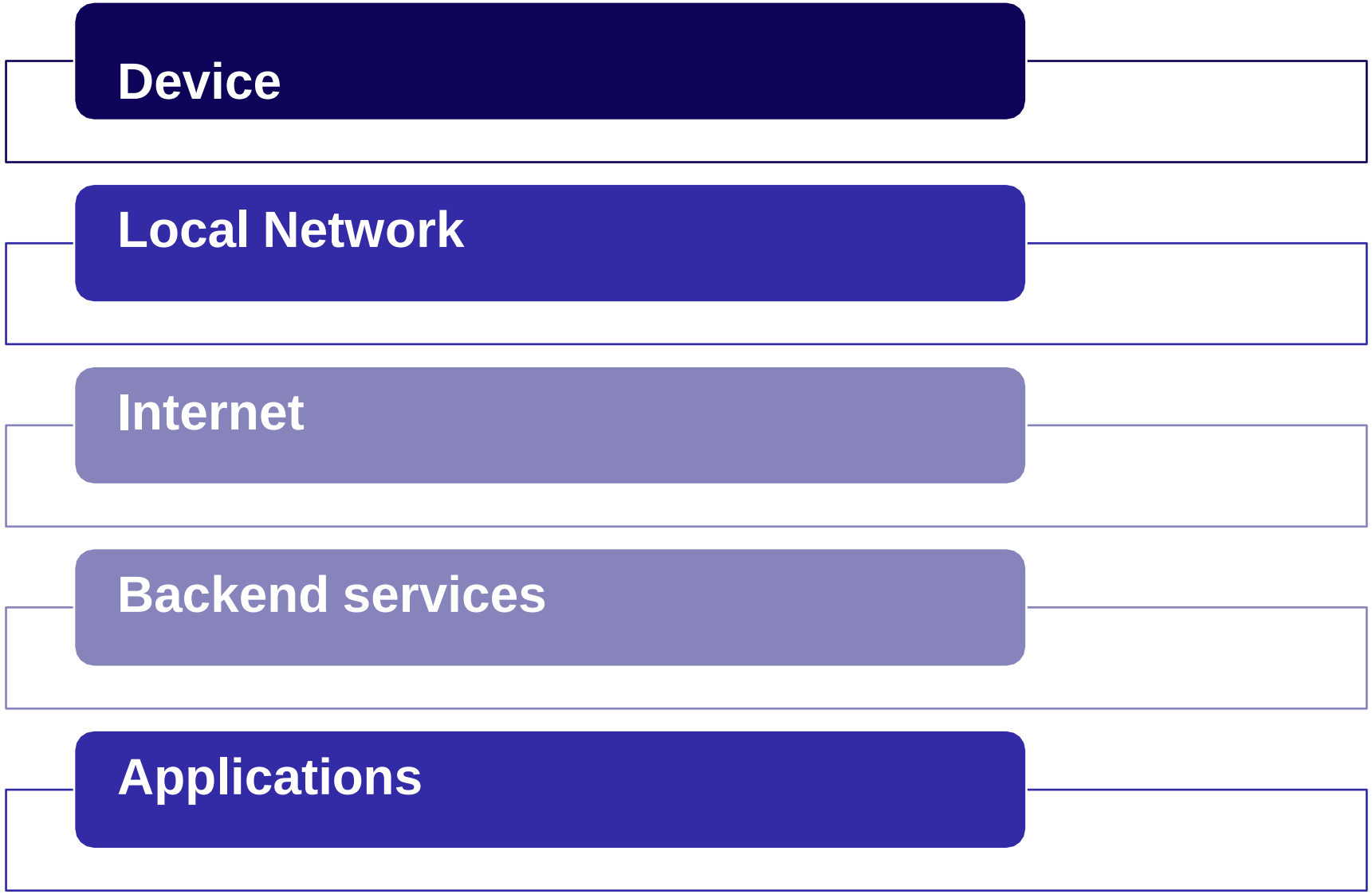


A rack and pinion mechanism

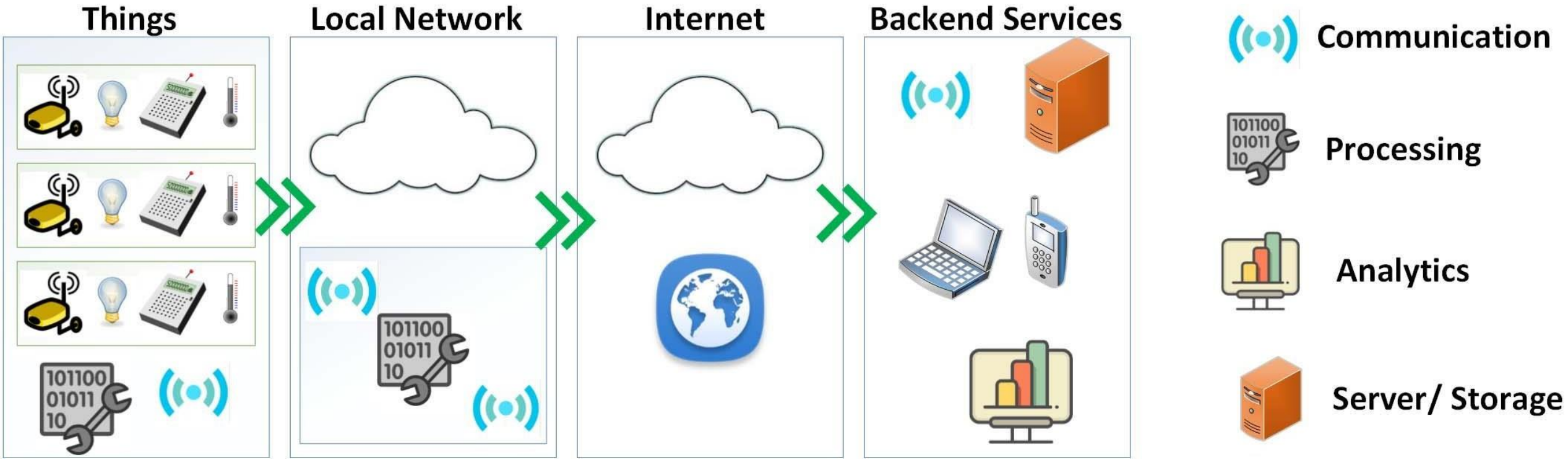


A crank shaft acting as a mechanical actuator

IoT Components



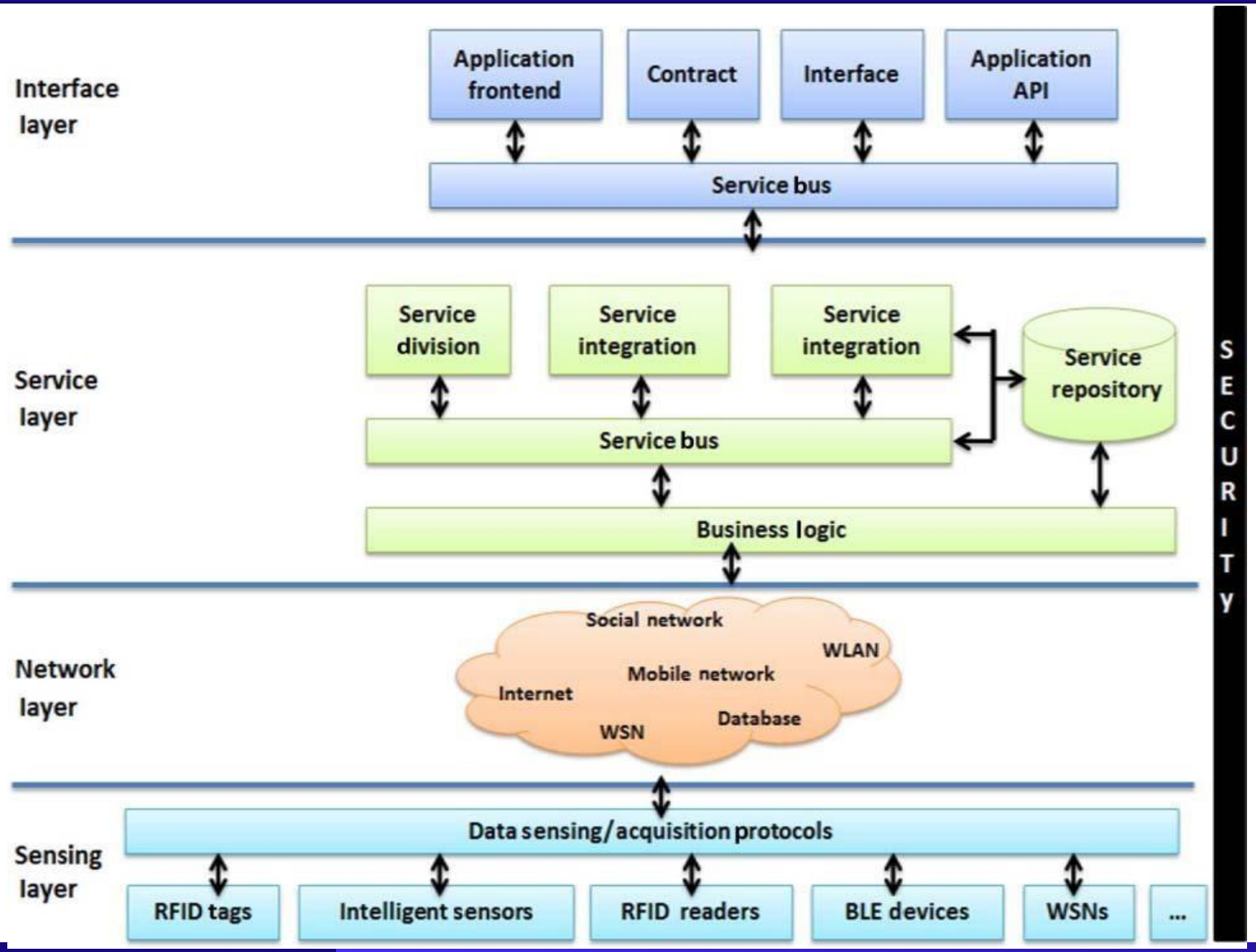
IoT Components



IoT Components

- ✓ Component for interaction and communication with other IoT devices
- ✓ Component for processing and analysis of operations
- ✓ Component for Internet interaction
- ✓ Components for handling Web services of applications
- ✓ Component to integrate application services
- ✓ User interface to access IoT

Service Oriented Architecture of IoT



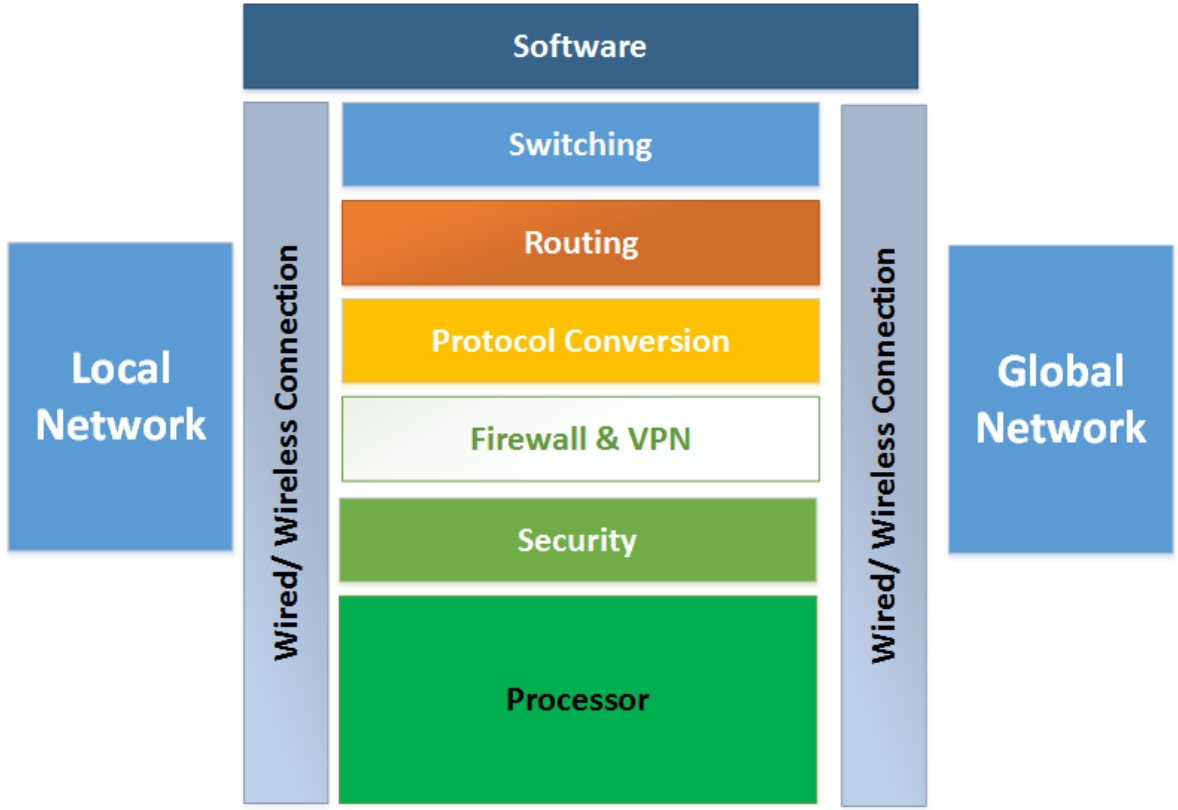
IoT Gateways

✓ IoT gateways with or without proxies responsible mainly for:

- Internet connectivity
- IoT LAN intra-connectivity

✓Upstream address prefixes are obtained using mechanisms like DHCPv6 and delegated to the nodes using SLAAC (stateless addressing).

✓LU addresses are maintained independently of globally routable addresses, in cases were internal address stability is of prime concern.



Question No: 1

Which of the following is a static mechanism for address allocation of IoT nodes?

a. Configuration over a management interface

b. IPv6 address based on a hardware identifier

c. Both configuration over a management interface & based on a hardware identifier

d. IoT nodes can’t be configured statically

Question No: 1

Which of the following is a static mechanism for address allocation of IoT nodes?

a. Configuration over a management interface

b. IPv6 address based on a hardware identifier

c. Both configuration over a management interface & based on a hardware identifier

d. IoT nodes can’t be configured statically

IoT nodes can be statically configured in different ways, such as an address can be configured over a management interface, or a node may use IPv6 address based on a hardware identifier.

Question No: 2

Which of the following error is commonly found in heating of metal strips?

a. quantization error
b. aliasing error
c. hysteresis error
d. None of these

Question No: 2

Which of the following error is commonly found in heating of metal strips?

a. quantization error
b. aliasing error
c. hysteresis error
d. None of these

A hysteresis error causes the sensor output value to vary depending on the sensor's previous input values. It is typically found in analog sensors, magnetic sensors, heating of metal strips.

Question No: 3

Identify the component shown below.

a. Gas sensor
b. PIR sensor
c. Light sensor
d. Speaker

Question No: 3

Identify the component shown below.

a. Gas sensor
b. PIR sensor
c. Light sensor
d. Speaker

Passive infrared (PIR) sensors use a pair of pyroelectric sensors to detect infrared energy radiating from objects within their field of vision.

Question No: 4

"X" performs active application layer functions between IoT nodes and other entities. What is X?

a. IoT node
b. IoT proxy
c. IoT gateway
d. IoT Network

Question No: 4

"X" performs active application layer functions between IoT nodes and other entities. What is X?

a. IoT node
b. IoT proxy
c. IoT gateway
d. IoT Network

IoT proxy is an entity that performs an active application layer function between IoT nodes, and other entities. The IoT proxy can be collocated with the IoT gateway.

Question No: 5

Which of the following field in IPv4 header format indicates that it is concerned with reliable transmission?

a. Traffic class
b. Hop limit
c. Fragment offset
d. Destination address

Question No: 5

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b. Hop limit
c. Fragment offset
d. Destination address

The IPv4 emphasizes more on reliable transmission, as is evident by fields, such as type of service, total length, id, offset, TTL, checksum fields.

Question No: 6

Which of the following is a function of IoT Gateway?

a. Data forwarding

b. Device management

c. Protocol conversion

d. All of these

Question No: 6

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Question No: 7

Which of the following actuator converts pressure into force?

a. Mechanical actuators

b. Pneumatic actuators

c. Electric actuators

d. Magnetic actuators

Question No: 7

Which of the following actuator converts pressure into force?

a. Mechanical actuators

b. Pneumatic actuators

c. Electric actuators

d. Magnetic actuators

Pneumatic actuators enable large forces to be produced from relatively small pressure changes (e.g., Pneumatic brakes are very responsive to small changes in pressure applied by the driver)

Question No: 8

Which of the following mechanism for address autoconfiguration provide more control on the allocated addresses?

a. DHCPv6
b. SLAAC
c. Both DHCPv6 and SLAAC
d. None of these

Question No: 8

Which of the following mechanism for address autoconfiguration provide more control on the allocated addresses?

a. DHCPv6
b. SLAAC
c. Both DHCPv6 and SLAAC
d. None of these

DHCPv6 can be used to explicitly configure IPv6 addresses to nodes, thereby providing network administrators with added control over the nodes on their networks.

Question No: 9

Which of the following can measure position?

Potentiometer

Encoder

Both potentiometer & encoder

None of these

Question No: 9

Which of the following can measure position?

Potentiometer

Encoder

Both potentiometer & encoder

None of these

A potentiometer sensor measures the distance or displacement of an object in a linear or rotary motion and converts it into an electrical signal. An encoder is an electromechanical device that can measure motion or position.

Question No: 10

In a scenario when the IoT proxy has uplink connectivity, does the IoT LAN need global addressing mandatorily?

a. Yes

b. No

c. Not applicable

Question No: 10

In a scenario when the IoT proxy has uplink connectivity, does the IoT LAN need global addressing mandatorily?

a. Yes

b. No

c. Not applicable

When the IoT proxy has uplink connectivity, it proxies communication between the local IoT nodes and nodes in the external network. In this scenario, where all communications go through a proxy, the IoT LAN does not need global addressing, but can manage with link-local or ULA addresses, depending on the type of proxy.

Question No: 11

Which of the following is TRUE?

a. M2M is not a subset of IoT

b. WoT and IoT are same

c. IoT and M2M are same

d. None of these

Question No: 11

Which of the following is TRUE?

a. M2M is not a subset of IoT

b. WoT and IoT are same

c.IoT and M2M are same

d. None of these

M2M is a part of the IoT, where IoT has a broader scope than M2M. Both are different since M2M uses point-to-point communication. IoT and WoT aren’t same.

Question No: 12

Statement I: Aliasing error occurs if the input variable or added noise changes periodically at a frequency proportional to the multiple of the sampling rate.

Statement II: If the signal is monitored digitally, the sampling frequency can cause a dynamic error triggering aliasing error.

a. Both Statement I and II are false

b. Both Statement I and II are true

c. Statement I is false but Statement II is true

d. Statement I is true but Statement II is false

Question No: 12

Statement I: Aliasing error occurs if the input variable or added noise changes periodically at a frequency proportional to the multiple of the sampling rate.

Statement II: If the signal is monitored digitally, the sampling frequency can cause a dynamic error triggering aliasing error.

a. Both Statement I and II are false

b. Both Statement I and II are true

c. Statement I is false but Statement II is true

d. Statement I is true but Statement II is false

If the signal is monitored digitally, the sampling frequency can cause a dynamic error, or if the input variable or added noise changes periodically at a frequency proportional to the multiple of the sampling rate, aliasing errors may occur.

Question No: 13

Does polymer-based actuator find application in manufacturing artificial muscles?

a. Yes

b. No

Question No: 13

Does polymer-based actuator find application in manufacturing artificial muscles?

a. Yes

b. No

Shape memory polymer (SMP) actuators function similar to our muscles, even providing a response to a range of stimuli such as light, electrical, magnetic, heat, pH, and moisture changes.

Question No: 14

Unique Local Addresses are intended to allow routing over a network that expands over multiple links and routing hops, and even can expand over multiple networks. Can these addresses prevent address collision?

a. Yes

b. No

c. Not Applicable

Question No: 14

Unique Local Addresses are intended to allow routing over a network that expands over multiple links and routing hops, and even can expand over multiple networks. Can these addresses prevent address collision?

a. Yes

b. No

c. Not Applicable

Unique Local Addresses are designed to be used in local networks larger than a single link, but not for communications through the Internet. However, these are designed to provide adequate uniqueness in order to have extremely small risk of address collision.

Question No: 15

Which of the following is an example of vector sensor?

a. Pressure sensor
b. Strain sensor
c. Both pressure and strain sensors
d. Sound sensor

Question No: 15

Which of the following is an example of vector sensor?

a. Pressure sensor
b. Strain sensor
c.Both pressure and strain sensors
d. Sound sensor

Physical quantities such as sound, image, velocity, acceleration, orientation, etc. are all vector quantities, as only their magnitude is not sufficient to convey the complete information.

Question No: 16

Which of the following areas are identified as IoT enablers?

a. RFID
b. Smart Networks
c. Nanotechnology
d. All of the above

Question No: 16

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a. RFID
b. Smart Networks
c. Nanotechnology
d. All of the above

Question No: 17

Which of the following is a digital sensor?

a. KY-013
b. LX1972
c. DHT11
d. LM35D

Question No: 17

Which of the following is a digital sensor?

a. KY-013
b. LX1972
c. DHT11
d. LM35D

Question No: 18

- Which of the following is considered as long range radio used in IoT?

a. Bluetooth
b. RFID
c. LoRa
d. None of them

Question No: 18

- Which of the following is considered as long range radio used in IoT?

a. Bluetooth
b. RFID
c. LoRa
d. None of them

Question No: 19

- Solenoid valve finds application in _____ equipment

a. Both hydraulic & electrical
b. Both electrical & pneumatic
c. Both electrical & mechanical
d. Both hydraulic & pneumatic

Question No: 19

- Solenoid valve finds application in _____ equipment

a. Both hydraulic & electrical
b. Both electrical & pneumatic
c. Both electrical & mechanical
d. Both hydraulic & pneumatic

Question No: 20

Which of the following connects an IoT LAN with a WAN, and to the Internet?

a. IoT node
b. IoT proxy
c. IoT gateway
d. IoT Network

Question No: 20

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Question No: 21

Which of the following is NOT a function of IoT Gateways?

a. Switching
b. Firewall & VPN services
c. Protocol conversion
d. None of the above

Question No: 21

Which of the following is NOT a function of IoT Gateways?

a. Switching
b. Firewall & VPN services
c. Protocol conversion
d. None of the above

Question No: 22

Which of the following is NOT a characteristic of IoT?

a. Intermittent connectivity
b. Ambiguous naming & addressing
c. Scalable architecture
d. Abundance of sleeping nodes

Question No: 22

Which of the following is NOT a characteristic of IoT?

a. Intermittent connectivity
b. Ambiguous naming & addressing
c. Scalable architecture
d. Abundance of sleeping nodes

Question No: 23

Rack & pinion is an example of _____ actuator

a. Hydrodynamic
b. Electrical
c. Mechanical
d. None of these

Question No: 23

Rack & pinion is an example of _____ actuator

a. Hydrodynamic
b. Electrical
c. Mechanical
d. None of these

Question No: 24

Which of the following is NOT true?

a. M2M is not a subset of IoT
b. IoT is a subset of CPS
c. IoT and M2M are same
d. All of the above

Question No: 24

Which of the following is NOT true?

a. M2M is not a subset of IoT
b. IoT is a subset of CPS
c. IoT and M2M are same
d. All of the above

Question No: 25

IoT gateway WAN address changes without change in LAN address” - Which of the following helps in achieving it?

a. Unique local address
b. Network Prefix Translation
c. Tunneling
d. None of the above

Question No: 25

IoT gateway WAN address changes without change in LAN address” - Which of the following helps in achieving it?

a. Unique local address
b. Network Prefix Translation
c. Tunneling
d. None of the above

Question No: 26

If the output signal differs from the correct value by a constant, the sensor has an _____.

a. Sensitivity issue
b. offset error
c. drift issue
d. noise

Question No: 26

If the output signal differs from the correct value by a constant, the sensor has an _____.

a. Sensitivity issue
b. offset error
c. drift issue
d. noise

Question No: 27

Which of the following is NOT a part of service layer in service-oriented architecture of IoT?

a. Service division
b. Contract
c. Business logic
d. Service repository

Question No: 27

Which of the following is NOT a part of service layer in service-oriented architecture of IoT?

a. Service division
b. Contract
c. Business logic
d. Service repository

Question No: 28

Which of the following is the preferred method for dynamic allocation of addresses in an IPv6 network?

a. DHCP
b. SLAC
c. IETF
d. SLAAC/DHCPv6

Question No: 28

Which of the following is the preferred method for dynamic allocation of addresses in an IPv6 network?

a. DHCP
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c. IETF
d. SLAAC/DHCPv6

Question No: 29

- A proxy-based approach is used to manage multiple IP addresses and map them to _____ addresses.

a. source
b. unique
c. global
d. link local

Question No: 29

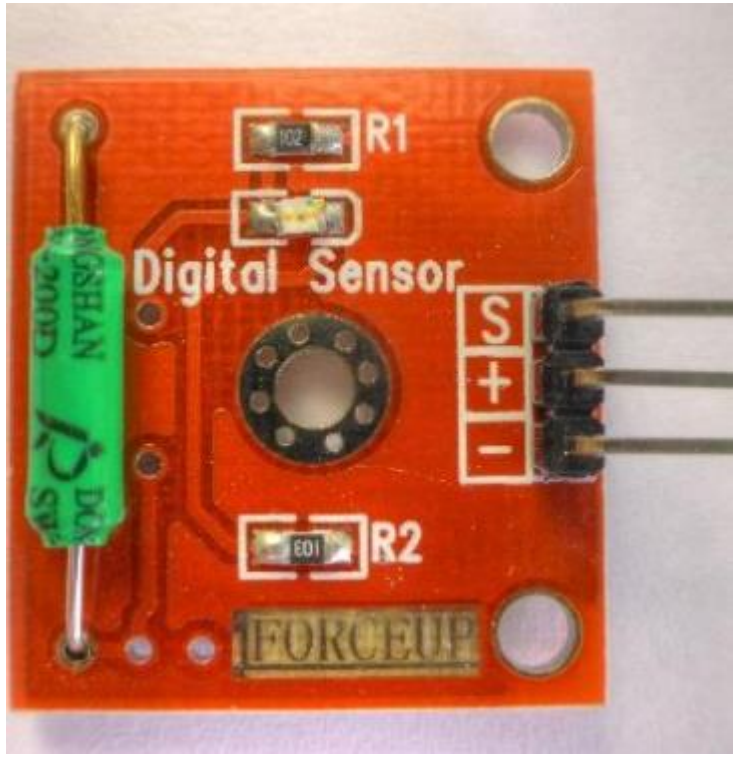
- A proxy-based approach is used to manage multiple IP addresses and map them to _____ addresses.

a. source
b. unique
c. global
d. link local

Question No: 30

- Identify the component shown below.

a. Gas sensor
b. Tilt sensor
c. Light sensor
d. Speaker



Question No: 30

- Identify the component shown below.

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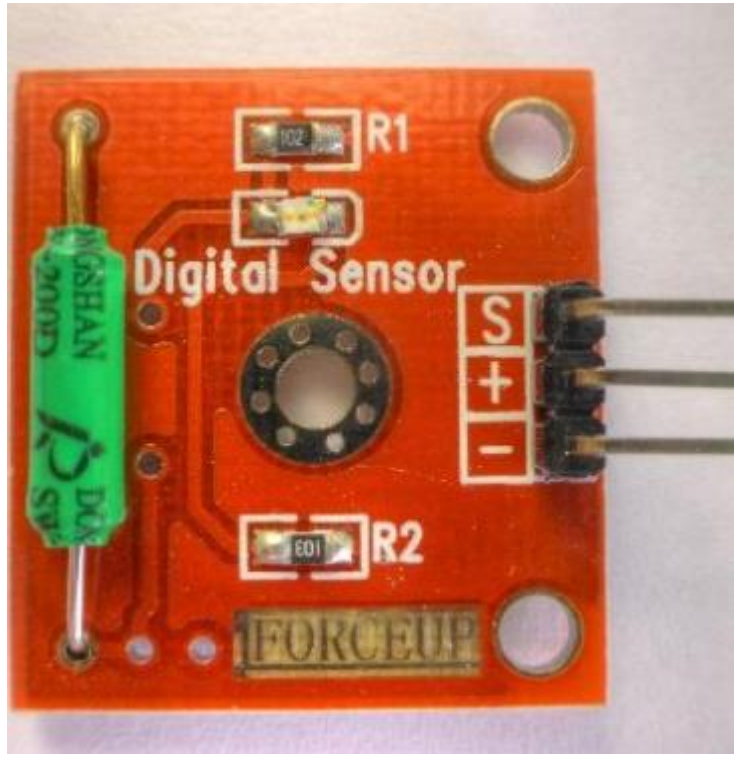

Question No: 31

Which of the following is/are the characteristics of IoT?

a. Efficient, scalable and associated architecture.
b. Unambiguous naming and addressing.
c. Abundance of sleeping nodes, mobile and non-IP device.
d. All of the these

Question No: 31

Which of the following is/are the characteristics of IoT?

a. Efficient, scalable and associated architecture.
b. Unambiguous naming and addressing.
c. Abundance of sleeping nodes, mobile and non-IP device.
d. All of the these

Question No: 32

A _____ allows us to use our smartphones to lock and unlock our door remotely at our homes or our businesses.

a. Smart Meter
b. ATM
c. Digital Lock
d. Web

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Question No: 33

The function/functions of an IoT Gateway is/are to?

a. Forward packets between LAN and WAN and on the IP layer
b. Connect IoT LAN to a WAN
c. Both (a) and (b)
d. None of these

Question No: 33

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Question No: 34

Multi-homing is the concept where a node can be connected to multiple networks for _____.

a. Reduced Reliability
b. Improved Reliability
c. None of these
d. Both (a) and (b)

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Question No: 35

A Passive Infrared Ray (PIR) sensor is used for _____?

a. Humidity Detection
b. Tilt Detection
c. Obstacle Detection
d. Smoke Detection

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Question No: 36

For which of the following Vectors Sensors are required to measure or sense them?

a. Color, Pressure, Temperature
b. Orientation, Image
c. None of these
d. Both (a) and (b)

Question No: 36

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Question No: 37

The sensitivity of a sensor under real conditions may differ from the value specified. This is called _____?

a. Maximal Error
b. Minimal Error
c. Median Error
d. Sensitivity Error

Question No: 37

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Question No: 38

A random deviation of the signal that varies in time is called _____.

a. Noise
b. Sound
c. Bias
d. None of these

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b. Sound
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d. None of these

Question No: 39

A Relay Switch is an example of _____.

a. A Sensor
b. An Actuator
c. A Transducer
d. None of These

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d. None of These

Question No: 40

What is a Pneumatic Actuator?

a. It is a type of actuator driven by compressed air or vacuum
b. It is a type of actuator driven by fluid
c. It is a type of actuator driven by solid
d. None of these

Question No: 40

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Question No: 41

Which type of actuators tend to be compact, lightweight, economical, and with high power density?

a. Thermal or Magnetic Actuators
b. Hydraulic Actuators
c. Both (a) and (b)
d. None of these

Question No: 41

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b. Hydraulic Actuators
c. Both (a) and (b)
d. None of these

Question No: 42

Polymer based actuators designed to handle fragile objects like fruit harvesting in agriculture or manipulating internal organs in biomedicine are called?

a. Pneumatic Actuators
b. Soft Actuators
c. Software Actuators
d. Hardware Actuators

Question No: 42

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b. Soft Actuators
c. Software Actuators
d. Hardware Actuators

Question No: 43

Full form of SMP is _____?

a. Soft Memory Polymer
b. Shape Memory Polymer
c. Software Memory Polymer
d. None of these

Question No: 43

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d. None of these

Question No: 44

Duty Cycling of the sensors is managed by which component of IoT?

a. Application
b. Real-Time Kernel
c. Radios
d. Power Management Unit

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c. Radios
d. Power Management Unit

Question No: 45

Which of the following are challenges of IoT

a. Security
b. Complexity Management
c. Modeling and Analysis
d. All of these

Question No: 45

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b. Complexity Management
c. Modeling and Analysis
d. All of these

Thank You