IoT Unit-1

IoT

Internet of Things describe the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices. It refers to the network of physical devices embedded with sensors, software and network connectivity, which allow these objects to collect and exchange data. This data can be used to automate processes and control devices remotely.

Features of IoT:-

1. Dynamic and Self Adapting
   IoT devices have the capability to adapt themselves according to the surroundings. Example: CCTV cameras can change their modes based on day or night.
2. Self configuring
   IoT devices are capable of self configuration that allows large number of devices to work together.
3. Interoperable Communication Protocol
   IoT devices can communicate with other devices without special efforts.
4. Integrated into Information Network
   It allows the device to communicate and exchange data with other devices in the network.

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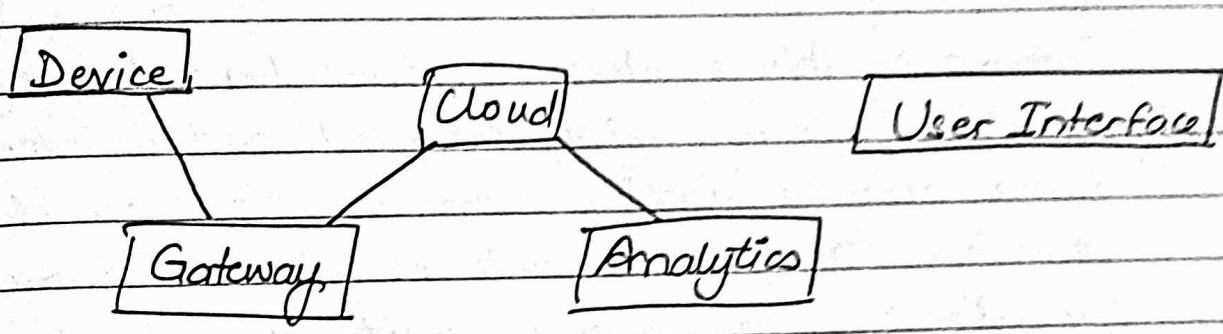
Components of IoT



1. Device
Fitted with sensors and actuators. Sensors collect data from environment and give to gateway where actuators perform the actions.

2. Gateway
Acts as level of security for the data transmitted over the network.

3. Cloud
Data after being collected is uploaded to cloud. Cloud is basically a server connected to internet 24x7.

4. Analytics
Various algorithms are applied over data for proper analysis.

5. User Interface
User end application to monitor data.

Difference b/w Arduino UNO and Raspberry Pi

Arduino UNO	Raspberry Pi
→ Not fully functional computer, Microcontroller.	A fully functional computer
→ Doesnot run a full OS	Has all trappings of computer
→ Executing simple code is easier.	Runs a special version of Linux OS.
→ Designed for small-scale embedded system projects.	Designed for complex projects
→ Limited memory and processing power.	More memory and processing power.
→ Runs single program at a time	Manages simultaneous compl tasks at a time.

IoT Applications

1. Smart Homes
   To control and monitor various aspects of home, such as lightning, security, appliances, temperature.

2. Healthcare
   For remote patient monitoring and providing real-time health data to doctors.

3. Smart Cities
   To manage traffic, parking, waste management.

4. Agriculture
   For precision farming, monitoring soil moisture, temperature to optimize crop yields and reduce waste.

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5. Energy management
To monitor energy consumption in homes, buildings and industries and to optimize energy usage and reduce waste

6. Transportation
Vehicle tracking, maintainence monitoring, to improve safety, efficiency and reduce costs.

7. Retail
for inventory management, customer tracking and personalised marketing, to improve customer experience and increase sales.

7 Layers of IoT
1. Sensors
2. Sensors to Gateway Network
3. Gateway
4. Gatewdys to Internet Network
5. Data Ingestion and Information Processing
6. Internet to User Network
7. Value added information

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Sensors

Sensors are the devices that are used to detect and measure physical phenomenon or environmental conditions such as temperature, pressure, humidity, light, motion and sound.
They convert detected signal to electrical signal that can be analysed and processed by a computer.

Types of sensors:-

1. Temperature sensors → Used to measure temperature variations in the environment.
2. Pressure sensors → Used to meosure pressure variation in the environment.
3. Humidity sensors → Used to measure amount of water vapour in the air
4. Light sensors → Used to detect amount of light in enviroonment.
5. Motion sensors → Used to detect motion of objects
6. Magnetic sensor → Used to detect magnetic field.

Actuators

A component that moves or controls the mechanism of the system. Sensors sense the environment and then controls, are signals sent by actuators acuording to the actions needed to perform.
Example: Servo Motor

[Sensor] → [Control Centre] → [Actuators]

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Types of Actuators:-

1. Hydraulic Actuators

It uses hydraulic power to perform mechanical operations. The mechanical motion is converted to rotary, linear or oscillatory motion, according to the need of IoT devices.

Advantage:-

* Can produce large amount of force
* High speed
* Used in welding

Disadvantages:-

* Hydraulic fluid leaks can cause efficiency loss.
* It is expensive
* High maintanence

2. Pneumatic Actuators

It uses energy formed by vaccum or compressed air at high pressure to convert it into & either linear or rotary motion.

Advantages:-

* Low cost option
* Used at extreme temperatures
* Low maintanence
* Very quick in starting and stopping the motion.

Disadvantage:-

* Loss of pressure can make it less efficient
* Air can be polluted
* Air compressor should be running continously.

3. Electrical Actuators

It uses electrical energy that converts electrical energy to mechanical torque.

Advantage:-

* Less noise
* Safe to use, no fluid leakages
* Can be re-programmed.

Disadvantages

* Expensive
* Depends on environmental conditions

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Chapter 1.2

Requirements for IoT industrial application

1. Reliability
IoT devices should be reliable, able to perform on-site activities.

2. Robustness
IoT device should be robust and adapted to the task and hard working conditions.

3. Reasonable Cost
Cost should be fully justifiable. There should be right balance b/w the cost and the benefit.

4. Security and Safety
IoT device should be safe and secure maintaining the security preventing from security threats along with maintaining the privacy of the user data.

5. Simple Use
IoT devices should be easy to use, intuitive, user-friendly

6. Low/No maintainance
IoT devices should be maintainance free or reduced maintenance.

Challenges faced by IoT industry application:-

1. Security :→ Security is a major challenge for the IoT industry as devices and networks are often vulnerable to cyber attacks.

2. Scalability → IoT applications generate large amount of data which can be difficult to manage and store. As the number of devices increases data size increases which makes it more challenging to handle.

3. Data Management → Managing and analysing vast amount of data generated by IoT devices is a challenging task.

4. Energy Efficiency → Many devices are battery powered and require low power consumption therefore optimizing energy consumption is a challenging task.

5. Cost → Cost can be a challenge as it should be @ the correct balance b/w right amount and benefit also small businesses are not able to invest much which makes cost a major challenge.

6. Reliability → IoT devices should be reliable. Any disruption in the device can cause harm.

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Types of IoT Networks:-

1. Cellular Network → Widely used for IoT applications that require high speed connectivity such as smart ~~cards~~ cars and industrial automation. These networks use standard cellular protocols such as 4G, 5G and LTE to provide reliable and secure connectivity.

2. Local and Personal Area Network (LAN/PAN) Networks that cover fairly short distance are called personal area networks (PAN) and local area networks. PAN and LAN networks are considered to be fairly cost effective but transfer of data can sometimes be unreliable.

3. Low-Power Wide Area Network (LPWAN) → They are designed for low-power IoT devices that require long-range connectivity and can operate for years on a single battery. LPWANs use low power, low-bandwidth communication technologies.

4. Mesh Networks → Best described by their connectivity configuration — how components communi-cate with each other. In mesh networks, all the sensor nodes cooperate to distribute data amongst each other to reach gateway.

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OSI Model → 7 layers

Application
Presentation
Session
Transport
Network
Data Link
Physical

TCP/IP Model

Application
Transport
Internet
Network Access & physical

IoT Critical for Human Progression

The Internet of Things (IoT) has the potential to revolutionize the way we live and work, and it has already begun to do so in many ways. From smart homes to smart cities, IoT is transforming our daily lives and making it easier to connect and communicate with the world around us.

IoT is critical for human progression because it enables us to collect, analyze, and act on data in real-time. This has significant implications for various industries, such as healthcare, agriculture, transportation, and manufacturing. For example, IoT can be used to monitor patients remotely, track the health of crops, optimize logistics and supply chain management, and improve the efficiency and safety of manufacturing processes.

In addition to improving productivity and efficiency, IoT can also improve our quality of life by making our homes and cities smarter and more sustainable. For example, smart homes can automatically adjust temperature, lighting, and security systems based on user preferences and behavior, while smart cities can use sensors to monitor air quality, traffic, and energy consumption, enabling city planners to make data-driven decisions and improve the overall quality of life for citizens.

Furthermore, IoT has the potential to address some of the world's most pressing challenges, such as climate change, food security, and healthcare access. For example, IoT can be used to optimize agricultural practices, reduce waste and carbon emissions, and improve access to healthcare in underserved communities.

Overall, IoT is critical for human progression because it has the potential to transform the way we live and work, and address some of the world's most pressing challenges. However, it is important to ensure that IoT is deployed in a way that prioritizes privacy, security, and ethical considerations, to ensure that it benefits society as a whole.

why is IoT important

The Internet of Things (IoT) is important for several reasons, including:

1. Improved Efficiency and Productivity: IoT devices can help businesses and industries to optimize processes, automate tasks, and collect data in real-time. This can lead to increased efficiency, productivity, and cost savings.
2. Better Decision Making: IoT devices can provide real-time data and insights that can be used to make data-driven decisions. This can help businesses and industries to make more informed decisions and respond to changing conditions more quickly.
3. Enhanced Customer Experience: IoT devices can be used to personalize products and services and provide a more seamless customer experience. For example, smart homes can automatically adjust lighting and temperature settings based on user preferences, while retailers can use IoT devices to offer personalized promotions and recommendations.
4. Improved Safety and Security: IoT devices can be used to monitor and control safety and security systems, such as surveillance cameras, smoke detectors, and access control systems. This can help to improve safety and security in homes, businesses, and public spaces.

5. Environmental Sustainability: IoT devices can be used to monitor and reduce energy consumption, waste, and carbon emissions. This can help to promote environmental sustainability and mitigate the impact of climate change.

iot as network of networks

IoT can be considered as a "network of networks" because it consists of multiple interconnected networks that work together to enable communication and data exchange between devices and systems.

IoT networks can be categorized into different layers, including the physical layer (sensors and devices), the network layer (communication protocols and gateways), and the application layer (data analytics and decision-making systems).

At the physical layer, IoT devices and sensors collect and transmit data to the network layer using various communication technologies, such as Bluetooth, Wi-Fi, cellular, and satellite. The network layer consists of gateways that enable communication between devices and systems using different protocols, such as Zigbee, Z-Wave, and MQTT. These gateways can also perform tasks such as data aggregation, filtering, and compression to optimize network performance.

At the application layer, data from IoT devices and systems is analyzed and processed to generate insights and enable decision-making. This layer includes applications such as data analytics, machine learning, and artificial intelligence that help organizations to derive value from IoT data.

The "network of networks" concept highlights the importance of interoperability and standardization in IoT, as devices and systems from different vendors and networks must be able to communicate and exchange data seamlessly. The use of open standards and protocols, such as MQTT and OPC UA, can help to enable interoperability and facilitate the integration of different IoT networks.

Overall, the "network of networks" concept highlights the complexity and interconnectedness of IoT networks, and the importance of collaboration and standardization to enable seamless communication and data exchange between devices and systems.

iot today

Today, IoT has become increasingly ubiquitous, with IoT devices and systems being used in a wide range of applications and industries. Some of the key trends and developments in IoT today include:

1. Industry 4.0: IoT is playing a central role in the fourth industrial revolution, or Industry 4.0, which is characterized by the integration of advanced technologies such as artificial intelligence, big data, and robotics to create smart factories and supply chains.

2. Smart cities: IoT is being used to create smart cities that are more efficient, sustainable, and livable, by enabling better management of resources such as energy, water, and transportation.
3. Healthcare: IoT is being used to improve healthcare outcomes by enabling remote monitoring of patients, better tracking of medical devices and equipment, and more efficient healthcare delivery.
4. Agriculture: IoT is being used to create smart agriculture systems that can monitor and optimize crop growth, improve animal welfare, and reduce waste and environmental impact.
5. Smart homes: IoT is being used to create smart homes that are more convenient, energy-efficient, and secure, by enabling remote control of home appliances and systems, such as lighting, heating, and security.
6. Edge computing: Edge computing is emerging as a key trend in IoT, enabling data processing and analysis to be done closer to the edge of the network, which can improve latency, reduce bandwidth requirements, and enhance data privacy and security.

Overall, IoT is continuing to evolve and expand, with new applications and use cases emerging all the time. As IoT networks become more complex and interconnected, it is important to prioritize security, privacy, and interoperability to ensure that IoT delivers on its promise of creating a more efficient, sustainable, and connected world.