FUNDAMENTAL OF COMPUTERS
&
EMERGING TECHNOLOGIES

KCA-101

Contents of Unit-3

- Internet : Overview, Architecture
- Functioning of Internet
- Basic services like WWW, FTP, Telnet, Gopher etc., Search engines, E-mail, Web Browsers.
- Internet of Things (IoT): Definition
- Sensors, their types and features
- Smart Cities
- Industrial Internet of Things.

Internet: Overview

Internet is defined as an interconnection of networks. Internet allows computers on different kinds of networks to interact with each other. Any two computers, often having different software and hardware, can exchange information over the Internet, as long as they obey the technical rules of Internet communication.

The Internet (or internet) is the global system of interconnected computer networks that uses the Internet protocol suite (TCP/IP) to communicate between networks and devices. It can be defined in many ways as follows:

- Internet uses the standard Internet Protocol (TCP/IP).
- Every computer in internet is identified by a unique IP address which identifies a computer location.
- Internet is accessible to every user all over the world.
- Internet is a world-wide global system of interconnected computer networks.

History of Internet

- The origin of Internet in **1969** devised from the concept of Advanced Research Project Agency Network (ARPANET) by United States Department of Defense.
- Basic purpose of ARPANET was to provide communication among the various bodies of government. In 1060, there were only four nodes, formally called Hosts.
- In 1972 (Birth of Internet), the ARPANET spread over the globe with 23 nodes located at different countries and thus became known as Internet**.**
- In **1981,** developed Computer Science Network (CSNET) developed by National Science Foundation to provide networking services to all university computer scientists. CSNET – Milestone in the history of Internet.
- 1983, ARPANET split into MILNET (Military) and ARPANET (Civil)
- NSFNET went online in **1986** and connected the 5 supercomputer centers at 56,000 bits per second.
- **1990** ARPANET retired. In **1991**, NSFNET partners with Merit Network, IBM, and MCI developed ANSNET (Advanced Network and Services) to run the network infrastructure with high-speed internet backbone.

Advantages of Internet

- Communication Forum: The Internet has helped us in connecting with our friends and families.
- Inexhaustible Education: Students can gain readily available help for his or her homework online.
- Entertainment for everybody, an alternative of TV.
- Online Services and E-commerce: Many services of emails, online banking, online shopping, etc. are there. E-commerce enables one in America to shop for things in Asia, Africa, or other areas within the world through some simple clicks of the mouse.
- Social network: Social networking is the sharing of data with people across the planet.
- Learning: The web has now become a neighborhood of education.
- GPS technology helps in getting the direction of the destination in an unknown place.

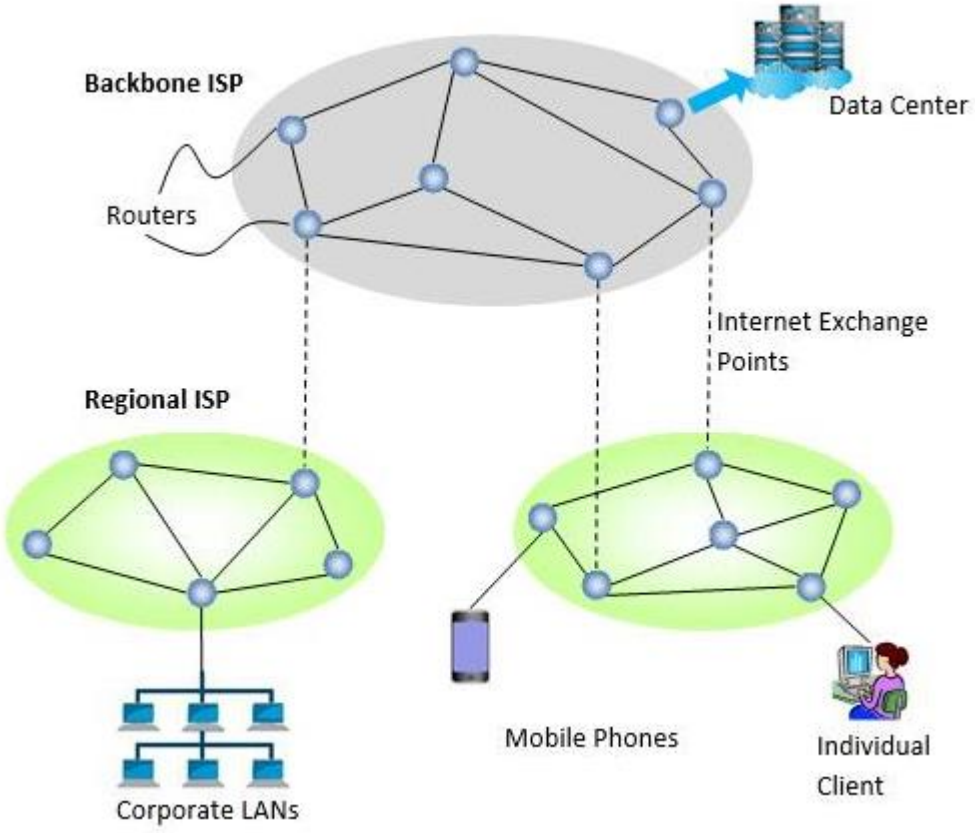
Disadvantages of Internet

- Internet Addiction Disorder: Internet addiction is detrimental to not only fitness but also psychological state.
- Cyber Crime: Hacker programs a virus that gets into the pc and ruins valuable data. Users' personal information like name, address, master card, bank details, and other information are often accessed by culprits when used on the web, leading to significant economic loss.
- Social Alienation: Time spent online flies fast without consciousness. After getting attracted the user is trapped into the trap, users are trapped by a "net", spending less time with people in the real world. Less interaction and face-to-face communication, actually, may end in a decrease in social abilities.
- Spam: The unnecessary emails, advertisements, etc. are sometimes said to be spam because they need the power to hamper the system and make the users face many problems.
- Health issues: Playing games and spending too much time on monitors leads to obesity and an unhealthy lifestyle.

Architecture of Internet

The architecture of the Internet is ever-changing due to continuous changes in the technologies as well as the nature of the service provided.
The overall architecture can be described in three levels:

- Backbone ISP (Internet Service Provider)
- Regional ISPs
- Clients



Client

Client (user of computer) at home or in a LAN network is at the lowest level in hierarchy.

Internet Service Provider (ISP)

- Local Internet Service Provider (ISP) is at the next higher level.
- An ISP is an organization that has its own computers connected to the Internet and provides facility to individual users to connect to Internet through their computers
- Local ISP is the local telephone company located in the telephone switching office, where the telephone of client terminates. Examples of local ISP in India are JIO, Airtel, Vodafone, Bharat Sanchar Nigam Ltd. (BSNL), Mahanagar Telephone Nigam Ltd. (MTNL), and Airtel.
- The client calls local ISP using a modem or Network Interface Card.

Regional ISP

- Regional ISP is next in the hierarchy. The local ISP is connected to regional ISP.
- A router is a special hardware system consisting of a processor, memory, and an I/O interface, used for the purpose of interconnecting networks. A router can interconnect networks having different technologies, different media, and physical addressing schemes or frame formats.
- The regional ISP connects the local ISP’s located in various cities via routers.
- If the packet received by regional ISP is for a client connected to this regional ISP, then the packet is delivered; otherwise, packet is sent to the regional ISP’s backbone.

Backbone

- Backbone is at top of the hierarchy.
- Backbone operators are large corporations like AT&T which have their own server farms connected to the backbone. There are many backbones existing in the world.
- The backbone networks are connected to Regional ISP’s with a large number of routers through high-speed fiber-optics.
- Network Access Point (NAP) connects different backbones, so that packets travel across different backbones.
- If a packet at the backbone is for a regional ISP connected to this backbone, the packet is sent to the closest router to be routed to local ISP and then to its destination; otherwise, packet is sent to other backbone via NAP. The packet traverses different backbones until it reaches the backbone of regional ISP for which it is destined.

Functions of Internet

1. Communication
2. Online transaction
3. Entertainment
4. Getting information
5. Map navigation
6. Weather forecasting information
7. News
8. Data interchange
9. Shopping

Internet services

To access/exchange a large amount of data such as software, audio clips, video clips, text files, other documents, etc., we need internet services. You must use an Internet service to connect to the Internet. Data can be sent from Internet servers to your machine via Internet service. Some of the commonly used internet services are

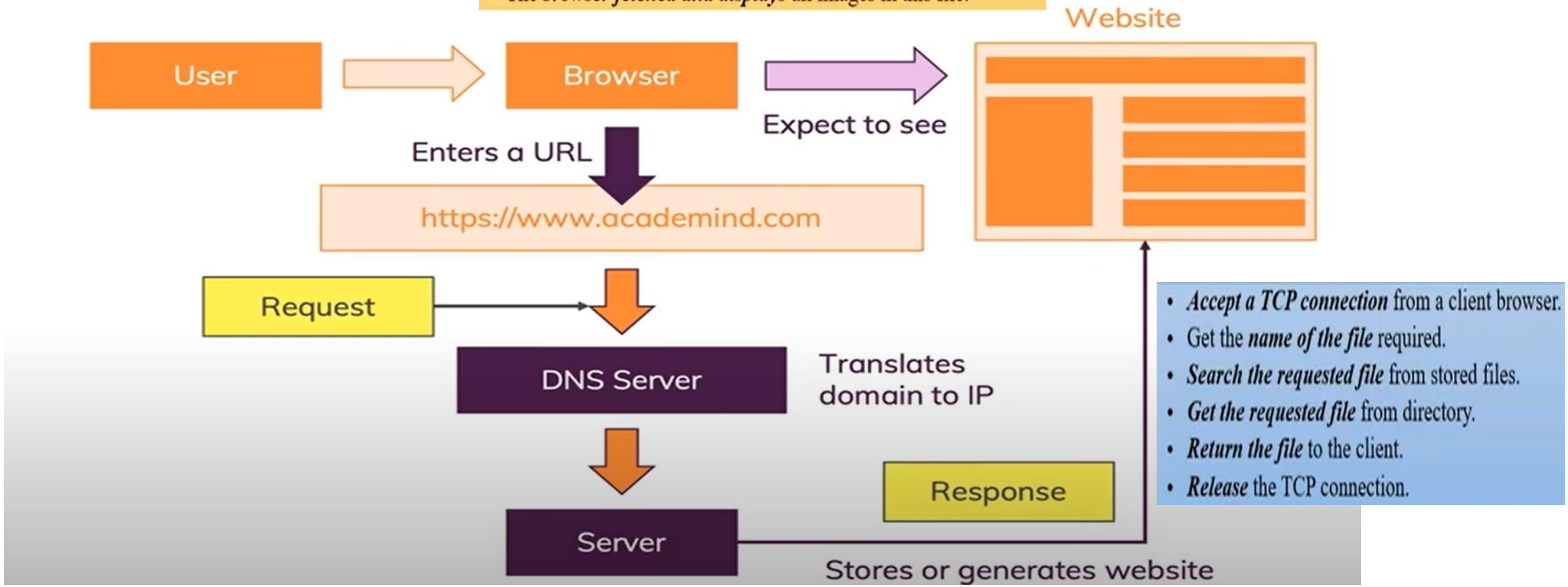
- WWW
- FTP
- Telnet
- Gopher
- Search engines
- E-mail
- Web Browsers.

WWW

- **World Wide Web**, which is also known as a Web, is a collection of websites or web pages stored in web servers and connected to local computers through the internet. Invented by Tim Berner Lee in 1989
- Web Pages is a collection of text pages, images, audios, videos, hyperlinks etc. Users can access the content of these sites from any part of the world over the internet using their devices such as computers, laptops, cell phones, etc.
- The WWW, along with internet, enables the retrieval and display of text and media to your device. The system we know today as "the Web" consists of several components:
  - Uniform Resource Locator (URL): serves as a system for resources on the web.
  - Hypertext Transfer Protocol (HTTP): specifies communication of browser and server.
  - Hyper Text Markup Language (HTML): defines the structure, organization and content of a webpage.

How WWW works?

- User enter an URL in Browser. **Ex., www.facebook.com**
- The browser asks DNS for the ***IP address of URL***
- DNS ***replies with IP Address*** ex.,172.16.16.1
- The browser make a ***TCP connection to port 443*** on 172.16.16.1
- ***Sends a request to server*** for Webpage
- Client ***receive*** the requested file
- TCP connection is ***released***.
- The ***browser fetched and displays*** all images in this file.



- ***Accept a TCP connection*** from a client browser.
- Get the ***name of the file*** required.
- ***Search the requested file*** from stored files.
- ***Get the requested file*** from directory.
- ***Return the file*** to the client.
- ***Release*** the TCP connection.

Web Application	Website
Web application is designed for interaction with end users.	Website basically contains static content.
The user of web application can read the content of web application and also manipulate the data.	The user of website only can read the content of website but not manipulate .
The web application site should be precompiled before deployment.	The website does not need to be precompiled .
Web application is interactive for users.	Web site is not interactive for users.
The browser capabilities involved with a web application is high.	The browser capabilities involved with web site is high.
EXAMPLE: Amazon, Facebook, etc.	EXAMPLE: Breaking News, AKTU website, etc.

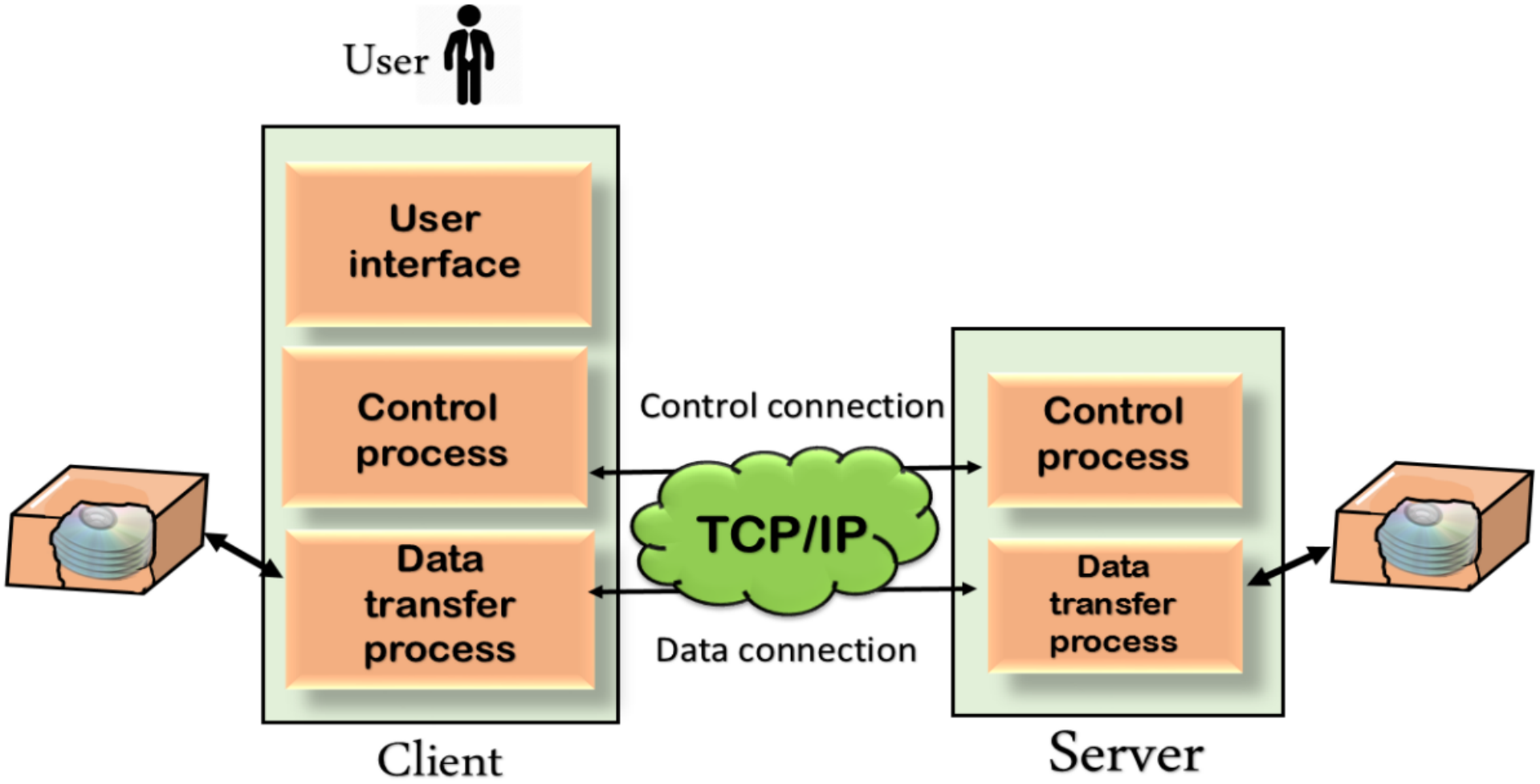
FTP (File Transfer Protocol)

- FTP stands for File transfer protocol.
- FTP is a standard internet protocol provided by TCP/IP used for transmitting the files from one host to another.
- It is mainly used for transferring the web page files from their creator to the computer that acts as a server for other computers on the internet.
- It is also used for downloading the files to computer from other servers.

How FTP works: FTP is a client-server protocol that relies on two communications channels between the client and server

1. A user typically needs to log on to the FTP server, although some servers make some or all of their content available without a login, a model known as anonymous FTP.
2. The client initiates a conversation with the server when the user requests to download a file.
3. Using FTP, a client can upload, download, delete, rename, move and copy files on a server.

Mechanism of FTP (File Transfer Protocol)



Search Engines:

- Search Engine refers to a huge database of internet resources such as web pages, newsgroups, programs, images etc. It helps to locate information on World Wide Web. User can search for any information by passing query in form of keywords or phrase. It then searches for relevant information in its database and return to the user.
- It looks for the results in its own database, sorts them and makes an ordered list of these results using unique search algorithms. This list is called a search engine results page (SERP).

Search Engine Components

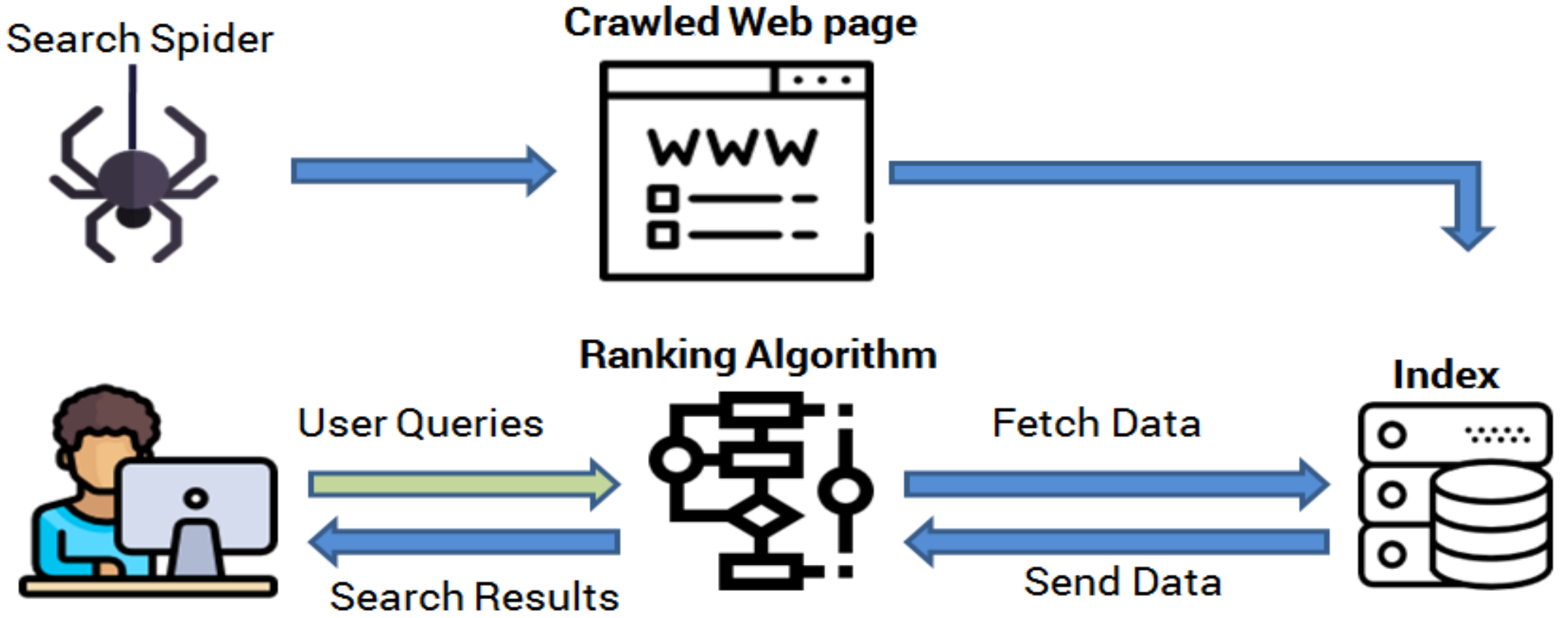
- Web Crawler: It is also known as spider or bots. It is a software component that traverses the web to gather information.
- Indexing: All the information on the web is stored in database. It consists of huge web resources.
- Retrieval/ creating results: User query is fetched and displayed.

How Search Engine works?

Crawling
Finds web pages and queues for indexing

Indexing
Analyses the web page content and saves the pages with quality content in index.

Ranking
Fetches relevant pages from index based on search query and order them based on ranking factors.



Email

Email is a service which allows us to send the message in electronic mode over the internet. It offers an efficient, inexpensive and real time mean of distributing information among people.

E-Mail Address

Each user of email is assigned a unique name for his email account. This name is known as E-mail address. Different users can send and receive messages according to the e-mail address.

E-mail is generally of the form username@domainname. For example, webmaster@tutorialspoint.com is an e-mail address where webmaster is username and tutorialspoint.com is domain name.

E-mail System

E-mail system comprises of the following three components:

- Mailer
- Mail Server
- Mailbox

Mailer- It is also called **mail program, mail application** or **mail client.** It allows us to manage, read and compose e-mail.

Mail Server- The function of mail server is to receive, store and deliver the email. It is must for mail servers to be Running all the time because if it crashes or is down, email can be lost.

Mailboxes- Mailbox is generally a folder that contains emails and information about them.

Web Browser

Web Browser is an application software that allows us to view and explore information on the web. User can request for any web page by just entering a URL into address bar. Web browser can show text, audio, video, animation and more. It is the responsibility of a web browser to interpret text and commands contained in the web page.

Earlier the web browsers were text-based while now a days graphical-based or voice-based web browsers are also available. Following are the most common web browser available today:

Browser	Vendor
Internet Explorer	Microsoft
Google Chrome	Google
Mozilla Firefox	Mozilla
Opera	Opera Software
Safari	Apple
Sea Monkey	Mozilla Foundation
K-meleon	K-meleon

Functions of Web Browsers

- The main function is to retrieve information from the World Wide Web and making it available for users
- Visiting any website can be done using a web browser. When a URL is entered in a browser, the web server takes us to that website
- It makes Internet surfing easy as once we reach a website, we can easily check the hyperlinks and get more and more useful data online
- Multiple webpages can be opened at the same time on a web browser
- Options like back, forward, reload, stop reload, home, etc. are available on these web browsers, which make using them easy and convenient

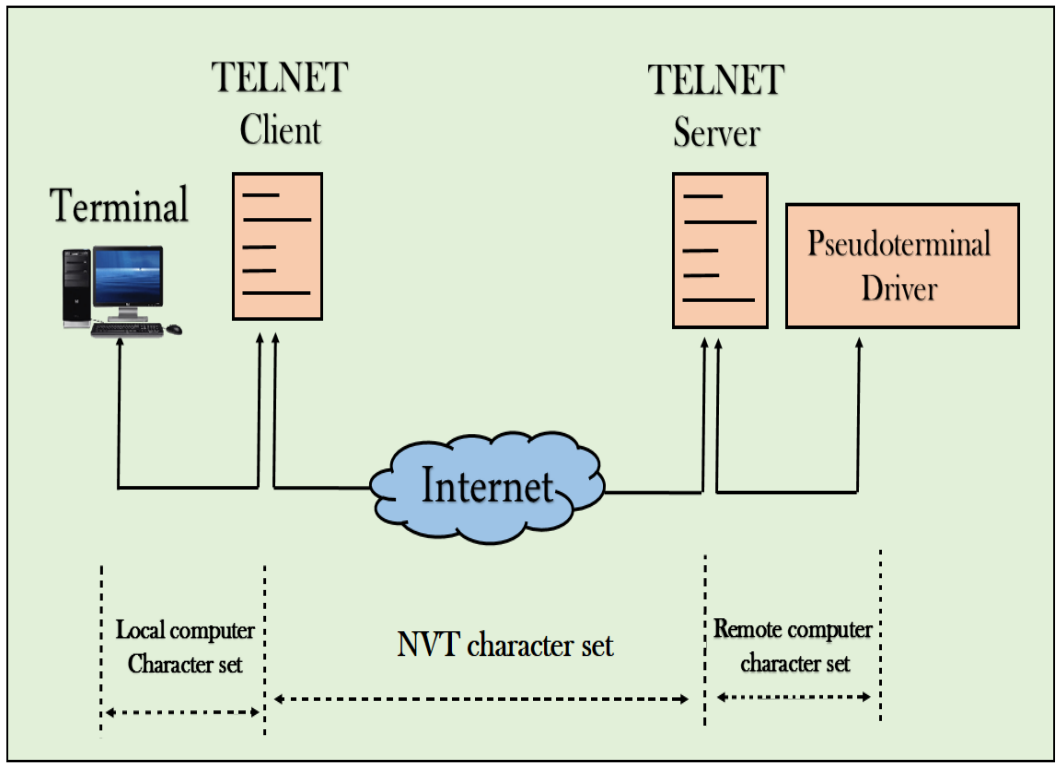
Gopher

- The Gopher technology was invented at the University of Minnesota.
- Gopher is an application-based communication protocol designed for distributing, searching and retrieving documents in internet protocol.
- The gopher system allows people to search for and retrieve information using a text interface. The technology is based on a client-server structure, where a gopher client program is used to search gopher servers.
- These servers can store documents, articles, programs, and other information. Instead of hyperlinks, the gopher interface uses menus of links to other documents and programs.
- The University of Minnesota began a licensing program for the gopher technology in 1993 as the use of gopher was spreading rapidly over the Internet.
- 1993 was the same time during the World Wide Web was introduced. Because the Web used hypertext and images, it soon became the preferred way to search and browse for information. While there are still servers and client programs that use gopher technology, their use is not nearly as widespread as the Web. Gopher is preferred by Network Administrators.

Telnet (TErminaL NETwork)

- TELNET stands for TErminaL NETwork. It is a type of protocol that enables one computer to connect to local computer.
- It is a used as a standard TCP/IP protocol for virtual terminal service which is given by ISO.
- Computer which starts connection known as the local computer. Computer which is being connected to i.e., which accepts the connection known as remote computer. When the connection is established between local and remote computer. During telnet operation whatever that is performing on the remote computer will be displayed by local computer.
- Telnet operates on client/server principle. Local computer uses telnet client program, and the remote computers uses telnet server program.

How Telnet (TErminaL NETwork) works?



- The network virtual terminal is an interface that defines how data and commands are sent across the network.
- TELNET solves this issue that systems are heterogeneous by defining a universal interface known as network virtual interface.
- The TELNET client translates the characters that come from the local terminal into NVT form and then delivers them to the network. The Telnet server then translates the data from NVT form into a form which can be understandable by a remote computer.

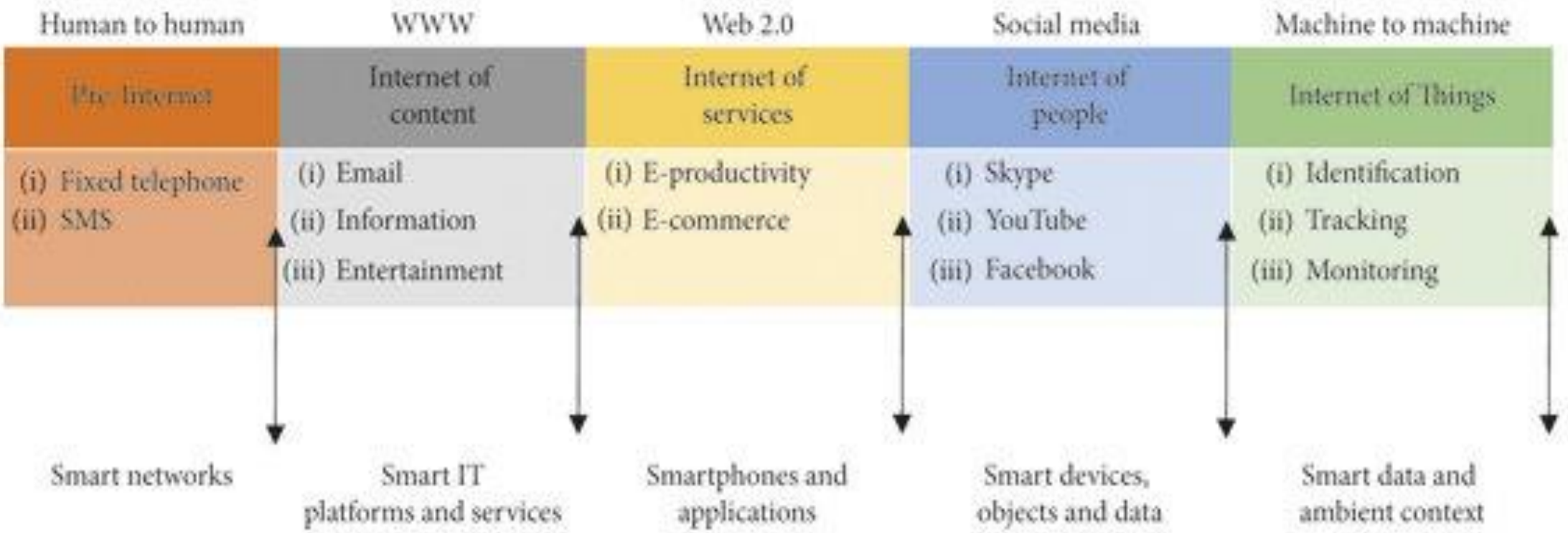
Internet of Things (IoT)

Internet of Things (IoT)

The Internet of Things (IoT) describes the network of physical objects - “things” - that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

The term "Things" in the Internet of Things refers to anything and everything in day-to-day life which is accessed or connected through the internet.

Evolution of Internet of Things (IoT)



Advantages of IoT

- Minimize human effort: As IoT devices interact and communicate with each other, they can automate the tasks helping to improve the quality of a business's services and reducing the need for human intervention.
- Save time: By reducing the human effort, it saves a lot of our time. Saving time is one of the primary advantages of using the IoT platform.
- Enhanced data collection: Information is easily accessible, even if we are far away from our actual location, and it is updated frequently in real-time. Hence these devices can access information from anywhere at any time on any device.
- Efficient resource utilization: We can increase resource utilization and monitor natural resources by knowing the functionality and how each device works.
- Reduced use of other electronic equipment: Electric devices are directly connected and can communicate with a controller computer, such as a mobile phone, resulting in efficient electricity use. Hence, there will be no unnecessary use of electrical equipment.

Disadvantages of IoT

- Security issues: IoT systems are interconnected and communicate over networks. So, the system offers little control despite any security measures, and it can lead to various kinds of network attacks.
- The complexity of the system: The designing, developing, maintaining, and enabling the extensive technology to IoT system is quite complicated.
- High chances of the entire system getting corrupted: If there is a bug in the system, it is possible that every connected device will become corrupted.
- Lack of international standardizations: As there is no international standard of compatibility for IoT, it is problematic for devices from different manufacturers to communicate with each other.
- High dependency on the internet: They rely heavily on the internet and cannot function effectively without it.
- Reduced mental and physical activity: Overuse of the internet and technology makes people ignorant because they rely on smart devices instead of doing physical work, causing them to become lethargic and inactive.

Building Blocks Of IoT Architecture

Sensors

- These form the front end of the IoT devices. These are the so-called “Things” of the system. Their main purpose is to collect data from its surroundings (sensors) or give out data to its surrounding (actuators).
- These have to be uniquely identifiable devices with a unique IP address so that they can be easily identifiable over a large network.
- These have to be active in nature which means that they should be able to collect real-time data. These can either work on their own (autonomous in nature) or can be made to work by the user depending on their needs (user-controlled).
- Examples of sensors are gas sensor, water quality sensor, moisture sensor, etc.

Smart Sensors: Smart sensors include an embedded Digital Motion Processor (DMP), whereas base sensors don't. A DMP is, essentially, just a microprocessor that is integrated into the sensor. It enables the sensor to perform onboard processing of the sensor data like filtering noise otherwise performing different kinds of signal conditioning.

The features of the smart sensor are self-identification, digital sensor data, smart calibration & compensation, multi-sensing capacity, sensor communication for configuration of remote & remote monitoring, etc.

Sensor	Smart Sensor
A sensor is a device used to detect the physical changing & chemical environment.	The part of a sensor is known as a smart sensor that is used for the computer.
A sensor doesn’t include a DMP or digital motion processor.	A smart sensor includes a DMP or Digital Motion Processor.
The normal sensor includes three components like sensor element, packaging & connections, and signals processing hardware.	Smart sensors include different components like amplifiers, transducers, analog filters, excitation control, and compensation sensors.
The different types of normal sensors are pressure, position, temperature, vibration, force, humidity & fluid property.	The different types of smart sensors are electric current, level, humidity, pressure, proximity, temperature, heat, flow, etc.
Normal sensor output cannot be used directly because we should convert it into a usable format.	The output of the smart sensor is ready to use.
Normal sensors are preferred when an engineer designing a device that requires complete control on sensor input	Smart sensors are generally preferred over base sensors because they include native processing capabilities.
Normal sensors are not expensive because they contain fewer components	Smart sensors are expensive as compared to normal sensors

Types of Sensors

1. Active & Passive Sensors
2. Contact & Non-contact Sensors
3. Absolute & Relative Sensors
4. Analog & Digital Sensors
5. Miscellaneous Sensors

Active & Passive Sensors

Active Sensors are sensors that require a dedicated external power supply in order to function. Example GPS, Ultrasonic Sensors

Passive sensors do not require any external supply and can receive enough electrical signal from the environment to function. Example: Thermal Sensors, NFC, tags etc.

Contact & Non-contact Sensors

Contact sensors are sensors that require physical contact with the environmental stimulus the sensor is measuring. Example: touch sensors, temperature sensors etc.

Non-contact sensors are sensors that do not require direct contact with the environmental stimulus it measures. Example: Optical Sensors, Magnetic Sensors, Thermometers etc.

Absolute & Relative Sensors

Absolute Sensors provide an absolute reading of the stimulus. Example: Thermistors

Relative Sensors provide measurements relative to something that is either fixed or variable. Example: Thermocouple where temp difference is measures as opposed to direct measures.

Analog & Digital Sensors

Analog Sensors produce a continuous output signal proportional to the measurement. Example: Thermometers, LDR, Pressure Sensors etc.

Digital Signals are sensors that convert the measurement into digital signal. Example: Inertial Measurement Sensors, Ultrasonic Sensors

Miscellaneous Sensors

There are many more types of sensors that may not necessarily fit into above categories. Those sensors will be called as miscellaneous sensors and theses include biological, chemical, radioactive sensors etc.

Processors

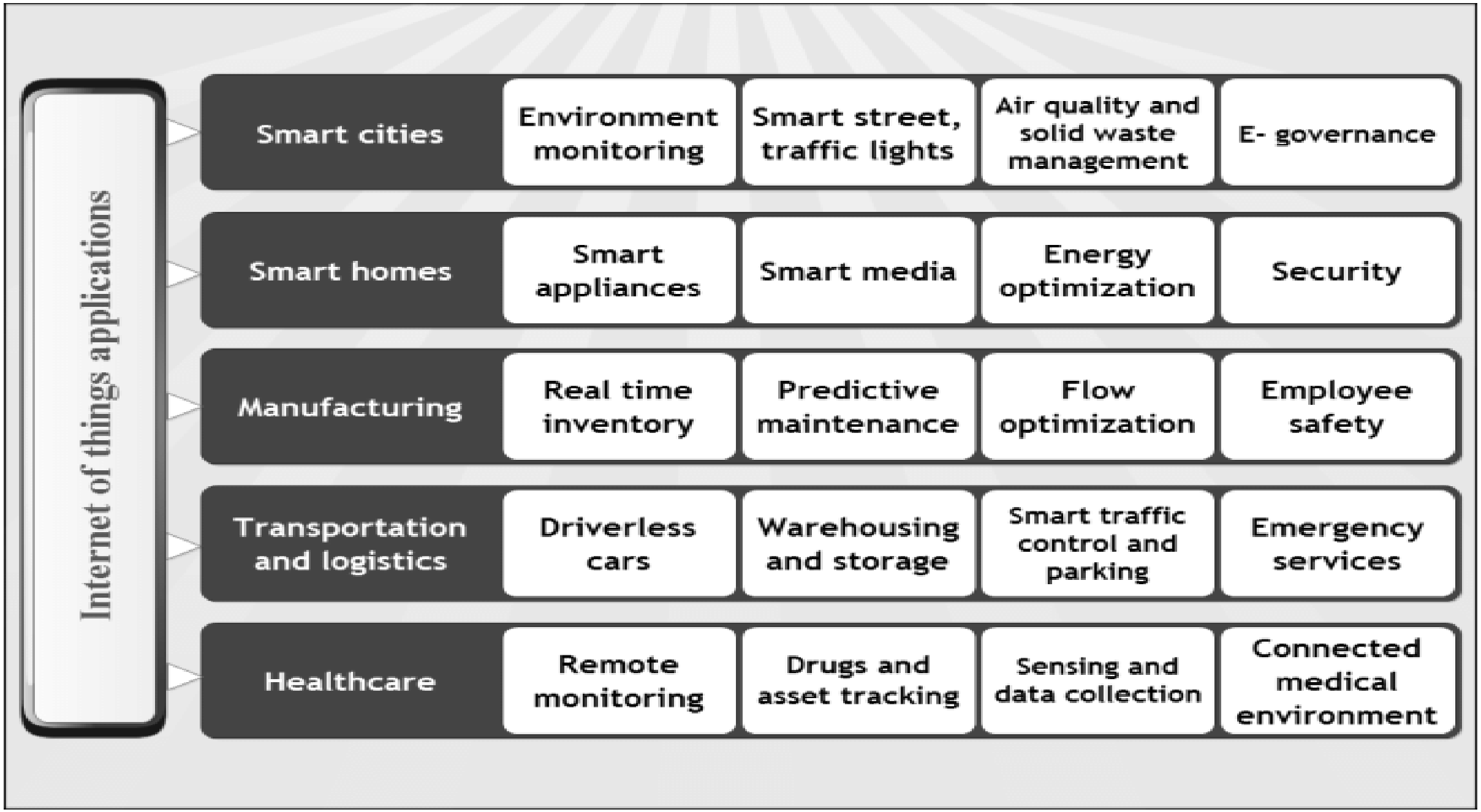
- Processors are the brain of the IoT system. Their main function is to process the data captured by the sensors and process them so as to extract the valuable data from the enormous amount of raw data collected. In a word, we can say that it gives intelligence to the data.
- Processors mostly work on real-time basis and can be easily controlled by applications. These are also responsible for securing the data – that is performing encryption and decryption of data.
- Embedded hardware devices, microcontroller, etc are the ones that process the data because they have processors attached to it.

Gateways

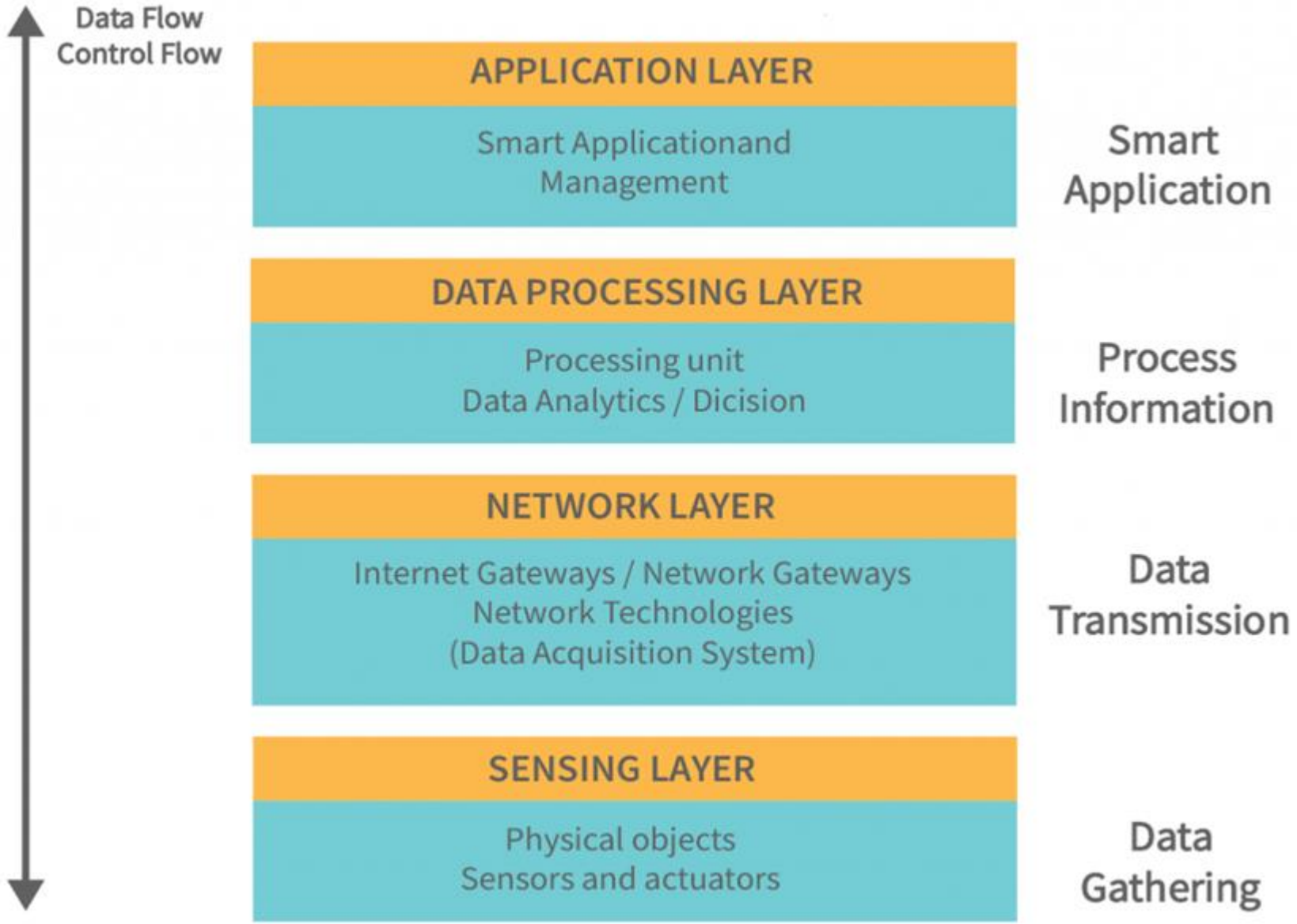
- Gateway is a device that’s used for the basic analysis of data coming from connected sensors.
- Gateways are responsible for routing the processed data and sending it to proper locations for its (data) proper utilization.
- Work as decision points, sending certain control commands to actuators which, in turn, perform appropriate actions.
- Gateway helps in to and from the communication of the data.
- It provides network connectivity to the data.
- Network connectivity is essential for any IoT system to communicate.
- LAN, WAN, PAN, etc are examples of network gateways.
- Both microcomputers and microprocessors can be used as gateways for IoT applications.

Applications

- Applications provide a user interface and effective utilization of the data collected.
- Applications form another end of an IoT system. Applications are essential for proper utilization of all the data collected.
- These cloud-based applications which are responsible for rendering the effective meaning to the data collected. Applications are controlled by users and are a delivery point of particular services.
- Examples of applications are home automation apps, security systems, industrial control hub, etc.


Internet of things applications
Smart cities
Environment monitoring
Smart street, traffic lights
Air quality and solid waste management
E- governance
Smart homes
Smart appliances
Smart media
Energy optimization
Security
Manufacturing
Real time inventory
Predictive maintenance
Flow optimization
Employee safety
Transportation and logistics
Driverless cars
Warehousing and storage
Smart traffic control and parking
Emergency services
Healthcare
Remote monitoring
Drugs and asset tracking
Sensing and data collection
Connected medical environment

Different Layers of IoT Architecture



Perception Layer: This is the first layer of IoT architecture. Perception refers to the physical layer, which includes sensors and actuators that are capable of collecting, accepting, and processing data over the network. The main function of this layer is to get information from surroundings and to pass data to another layer so that some actions can be done based on that information.

Network Layer: it is the connecting layer between perception and middleware layer. It gets data from perception layer and passes data to middleware layer using networking technologies like 3G, 4G, UTMS, Wi-Fi, infrared, etc. This is also called communication layer because it is responsible for communication between perception and middleware layer.

Different Layers of IoT Architecture

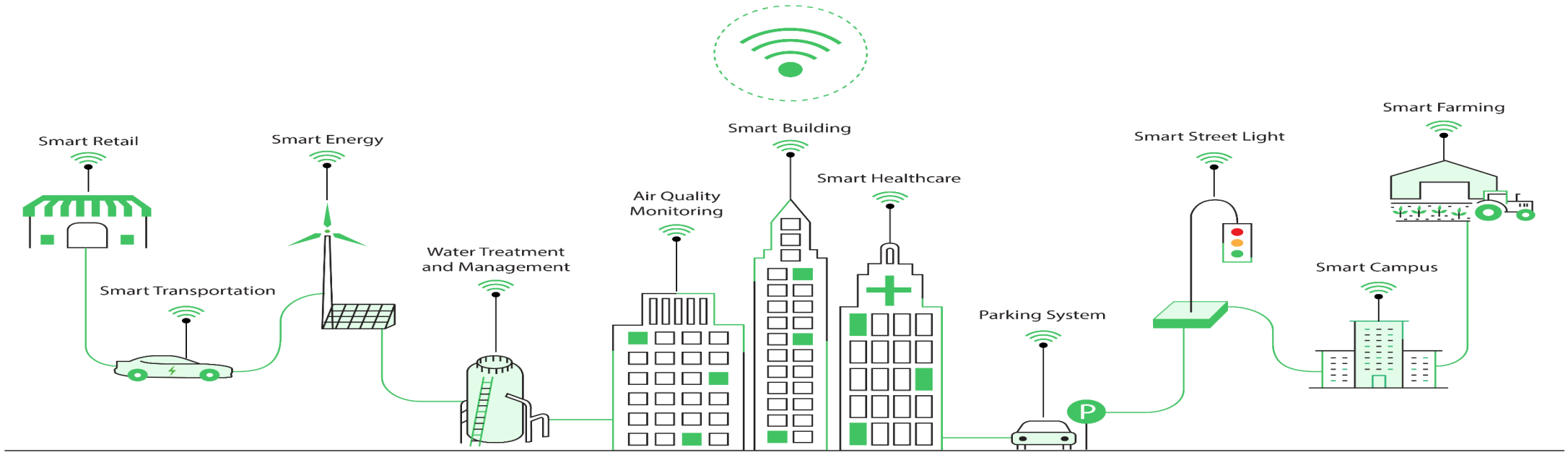
Processing Layer: The processing layer is the brain of the IoT ecosystem. Typically, data is analyzed, pre-processed, and stored here before being sent to the data center, where it is accessed by software applications that both monitor and manage the data as well as prepare further actions. This is where Edge IT or edge analytics enters the picture.

Application Layer: User interaction takes place at the application layer, which delivers application-specific services to the user. An example might be a smart home application where users can turn on a coffee maker by tapping a button in an app or a dashboard that shows the status of the devices in a system. There are many ways in which the Internet of Things can be deployed such as smart cities, smart homes, and smart health.

Different Layers of IoT Architecture

What is a smart city?

Smart cities use IoT devices such as connected sensors, lights, and meters to collect and analyze data. The cities then use this data to improve infrastructure, public utilities and services, and more. The main goal of a smart city is to optimize city functions and promote economic growth while also improving the quality of life for citizens by using smart technologies



Smart Solutions

E-Governance and Citizen Services

1. Public Information, Grievance Redressal
2. Electronic Service Delivery
3. Citizen Engagement
4. Citizens - City's Eyes and Ears
5. Video Crime Monitoring

Waste Management

6. Waste to Energy & fuel
7. Waste to Compost
8. Waste Water to be Treated
9. Recycling and Reduction of C&D Waste

Water Management

10. Smart Meters & Management
11. Leakage Identification, Preventive Maint.
12. Water Quality Monitoring

Energy Management

13. Smart Meters & Management
14. Renewable Sources of Energy
15. Energy Efficient & Green Buildings

Urban Mobility

16. Smart Parking
17. Intelligent Traffic Management
18. Integrated Multi-Modal Transport

Others

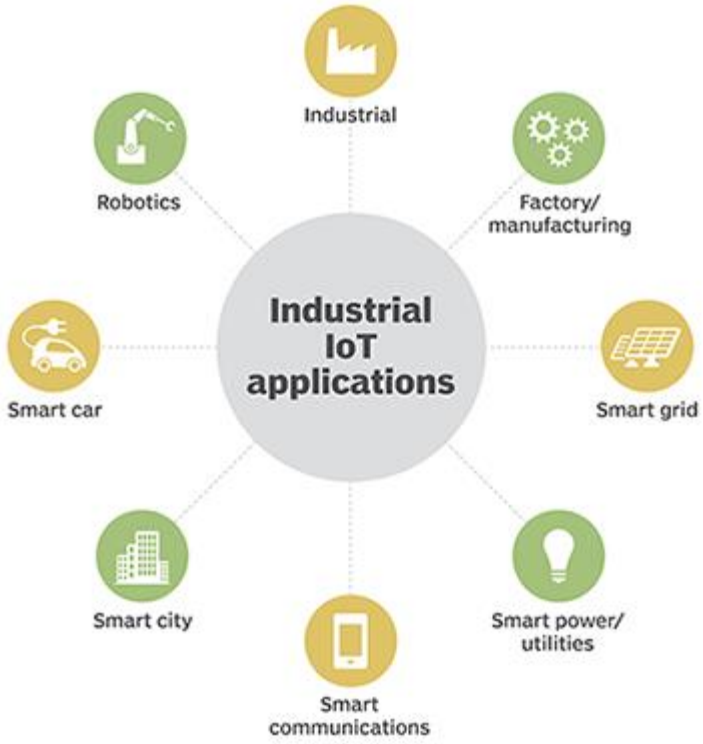
19. Tele-Medicine & Tele Education
20. Incubation/Trade Facilitation Centers
21. Skill Development Centers

Applications of IoT in Smart Cities

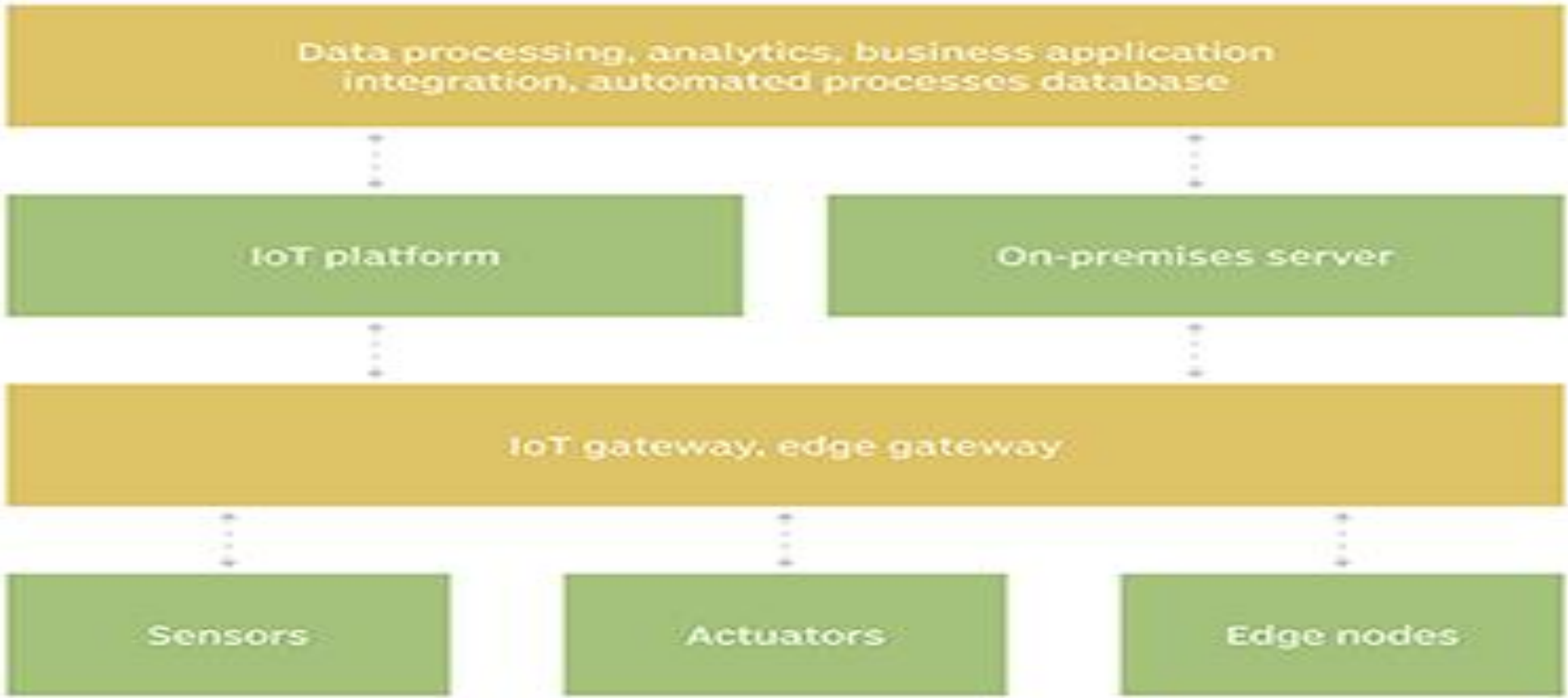
- Smart Lighting Systems: IoT-enabled smart lighting systems for smart cities help manage a city's lighting system autonomously and more efficiently to save energy and reduce costs.
- Smart Traffic Management: IoT-based smart traffic lights and sensors that can automatically sense high volumes of traffic and adjust the duration of green lights accordingly. Likewise, a smart city can also embed sensors in bridges and roads to keep tabs on their condition and repair them immediately in case of wear and tear.
- IoT-based Smart Waste Management in Cities: cities can install IoT sensors in trash cans to remotely monitor when they are full. This way, cities can dispose of the waste more quickly and efficiently.
- IoT-based Transport and Healthcare: IoT-based connected vehicles are easier to track to inform the public when a bus or train will arrive. Additionally, IoT data can also help optimize public transportation routes. Similarly, IoT can provide better healthcare to citizens, such as microbots, remote patient monitoring

What is industrial IoT?

- Industrial IoT is an ecosystem of devices, sensors, applications, and associated networking equipment that work together to collect, monitor, and analyze data from industrial operations.
- IIoT is used across a range of industries from manufacturing, logistics, oil and gas, transportation, mining, aviation, energy, and more. Its focus is to optimize operations--particularly the automation of processes and maintenance. IIoT capabilities enhance asset performance and better manage maintenance.



IIoT infrastructure



How does IIoT work?

IIoT is a network of intelligent devices connected to form systems that monitor, collect, exchange and analyze data. Each industrial IoT ecosystem consists of:

- connected devices that can sense, communicate and store information about themselves;
- public and/or private data communications infrastructure;
- analytics and applications that generate business information from raw data;
- storage for the data that is generated by the IIoT devices; and
- people.

Important Questions

1. How is industrial IoT different from other types of IoT?
2. Why should organizations consider adopting industrial IoT?
3. What is the role of IT in industrial IoT
4. Summarize the applications of Industrial IoT
5. Define the information exchange patterns in IoT
6. In what ways IoT is energy efficient?
7. What are the most widely used sensors in IoT?
8. On what basis can a city be called be smart city? Illustrate the role of technology for making a city to be a smart city?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