

# General Science

## Short Answers

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# **Information & Technology**

**Short Answers**

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# **CHAPTER 3: INFORMATION, COMMUNICATION & TECHNOLOGY**

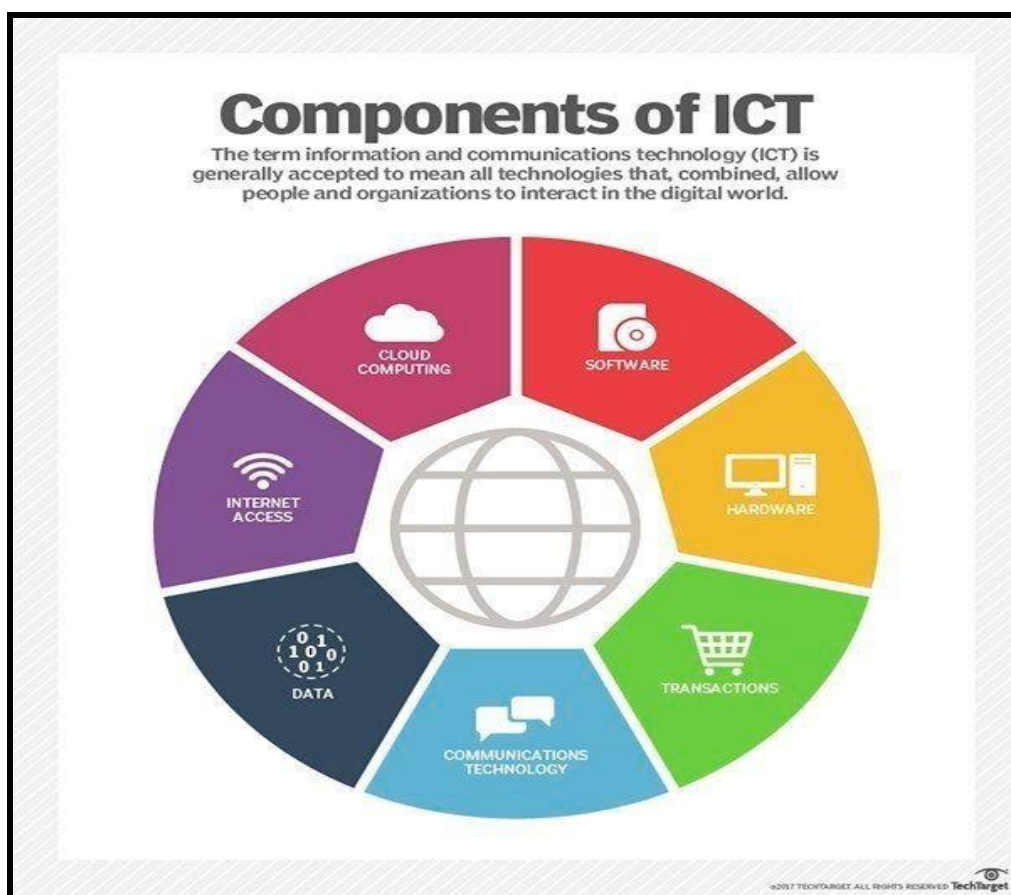
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### 3.1 INTRODUCTION TO INFORMATION AND TECHNOLOGY

Information, Communication & Technology (ICT) generally refers to the role of integrated communications, telecommunications, computers and computing devices, necessary enterprise software, storage devices, middleware, and the audio-visual systems which facilitate its users to store, transmit, manipulate and access information, **i.e. ICT is the convergence of telephone networks and audio visual systems with computer networks through a single cable network etc.** The word Information Technology was officially coined by **Jim Domsic** of Michigan in November 1981.



**Fig 3.1: information communication Technology**

*(Image source: searchcio.techtarget.com)*

**Broadly it can be defined as follows:**

INFORMATION	COMMUNICATION	TECHNOLOGY
<p>Knowledge obtained from reading, studying or research and investigation etc. In other words, information is a knowledge which is used for fulfilling our tasks. For example, warning the public about any forthcoming disaster requires transmission of information. Radio, television, internet, cable network, etc., are the tools which facilitate the transmission of information.</p>	<p>It is a transmission of information and messages between individuals, groups or any entity through the use of mutually understandable symbols, science and semiotic rules. In other words, it is the exchange of information by verbal, written or any other medium such as telephone lines or computers etc. In the 21<sup>st</sup> century the new forms of communication such as the internet, email or video conferencing etc. are becoming more popular.</p>	<p>It is a transmission of information and messages between individuals, groups or any entity through the use of mutually understandable symbols, science and semiotic rules. In other words, it is the exchange of information by verbal, written or any other medium such as telephone lines or computers etc. In the 21<sup>st</sup> century the new forms of communication such as the internet, email or video conferencing etc. are becoming more popular. The scientific knowledge, techniques, skills, methods, and processes are used for creating products and processes for fulfilling human needs. Technology is one of the basic requirements for communication through ICT. Fax machines, telephone and cable networks, etc., are the devices used for extending communication. Satellites, radio, cable networks and the World Wide Web (www) are powerful tools for spreading information.</p>

Humans have been storing, retrieving, manipulating, and communicating information since the Sumerians in Mesopotamia developed writing in about 3000 BC, but general use of the term information communication technology in its **modern sense** had **appeared first** in an article published in the Harvard Business Review; where the authors **Harold J. Leavitt and Thomas L. Whisler** write about it as "the new technology does not yet have a single established name. We shall call it information technology (IT)."

The definition which was given by them consists of three categories: techniques for processing, the application of statistical and mathematical methods to decision-making, and the simulation of higher-order thinking through computer programs.

**Note:- Based on the storage and processing technologies employed, it is possible to distinguish four distinct phases of IT development: pre-mechanical (3000 BC – 1450 AD), mechanical (1450–1840), electromechanical (1840–1940), and electronic (1940–present)**

It was with the beginning of the era of computers that the field of Information Technology gained prominence throughout the world.

### **3.2 EVOLUTION OF COMPUTING TECHNOLOGY AND DEVICES**

Since the period of 1940's five generations of computers have come into existence which can be categorised into:-

<b>GENERATION</b>	<b>CHARACTERISTICS</b>
<b>First generation computers (1946-1959)</b>	In 1946, the first successful electronic computer ENIAC (Electronic Numeric Integrator and Calculator) was developed by Presper Eckert and William Mauchly. The First generation computers used vacuum tubes for circuitry and magnetic drums for memory. The computers in this generation relied on 'machine language' which was the basic programming language.  <b>Examples include</b> ENIAC, EDVAC, UNIVAC, Z3 and IBM etc.
<b>Second generation computers (1956-1963)</b>	In these computers vacuum tubes gave way to transistors. They were superior to vacuum tubes and were faster, small, cheap using less electricity.  <b>Examples:- IBM 1401, IBM 1620, MCR 300, RCA 301 etc.</b>
<b>Third generation computers (1964-1971):</b>	In this phase integrated circuits were developed and transistors were miniaturized and integrated on the silicon chips. This increased the speed and efficiency of computing and enabled machines to run several applications at once.
<b>Fourth generation computers (1971- Present):</b>	The advent of microprocessors brought the era of the fourth generation of computers In 1971, Intel inc. developed the first microprocessor called Intel 4004 by positioning all computer components in a single chip.
<b>Fifth Generation computers (future endeavours)</b>	5th generation computers are based on artificial intelligence which is still in development. Some of the technologies which are emerging include voice recognition systems etc.

### **CONSTITUENTS OF INFORMATION COMMUNICATION TECHNOLOGY (ICT)**

The several components of Information Technology could be grouped as follows:



**1. Computer Technology:** Computer technology has led to immense growth and expansion in the information transformation process and the recent developments in computer and communication technologies have enabled smooth management of information data, several institutions and organizations, and work processes.

**2. Communication Technology:** The fast growth in Communication Technology has created a revolution in the Information Communication Technology sector. Modern technology like silicon chip internet, fibrosis optics, telephone, television, etc., are some of the essential components of the communication network.

**3. Optical communication systems:** optical communications are used in long-distance digital networks which have revolutionized the telecommunication sector. Light is used as the carrier of information and optical fibers act as the medium of transmitting these light signals.

**4. Satellite communication systems:** The system of satellite communication has become one of the most popular and extensively used technologies in the ICT sector. In today's scenario, this system has enabled transmission of information even in difficult geographical areas such as mountains, rugged topographical Zones, and unreachable regions of the world, etc.

### **3.3 UTILITIES OF INFORMATION COMMUNICATION TECHNOLOGY**

- **Speedier communication:** Earlier the transmission of messages and news took a long time to reach its destination. However, with the advent of the internet and other ICT options, communication comparatively became much faster and more efficient. Messages sent via emails, messaging apps such as WhatsApp, Telegram, etc became faster and at an instant.
- **Lower cost of communication:** use of the internet became more cost-effective than the traditional modes of communication such as postal service, courier service, or traditional telephones. Large amounts of data can be accessed at the very low-cost due reduction in the cost of internet services due to the development of ICT technologies such as 4G internet services etc.
- **Reliability in communication:** The growth of the Internet and other IT services has emerged as one of the most reliable modes of communication because the information could be accessed and retrieved anytime from anywhere. With the advent of new modes of communication such as video conferencing, email, databases, it has become easier to perform different business transactions.
- **Data storage efficiency and file management:** The advent of ICT services such as cloud hosting, cloud computing, etc., resulted in better data storage, file management. Today the storing of backup business data has become much more efficient and easy.

It has also reduced the amount of paperwork required for any work and has made transfer and access of data to remote locations more efficient.

- **Efficiency and Productivity:** ICT has made the sharing of information much more efficient and effective for all people around the world. People can share news and information, exchange opinions through ICT services such as the Internet, online forums, discussion groups on WhatsApp, Telegram, etc. All these developments are contributing to the development of a knowledge-based society.
- **Paperless environment:** The advancement and progress of ICT led to the growth of a paperless environment in which information can be stored and retrieved digitally instead of paper. The use of emails, online chat, and instant messaging services for communication is contributing to the development of a paperless environment.
- **Innovation and research:** ICT services are assisting in various research and innovation activities. The use of IT services has been widely credited in the field of innovation and research such as space technology, robotics, artificial intelligence, etc.
- **Entertainment and Recreation industry:** The growth of ICT has improved the options of entertainment for people all over the world. New modes of entertainment have emerged such as cable television, online video streaming, online games, and other over the top Platforms like Amazon, Netflix, etc.
- **Improved social connectivity:** ICT services have led to the emergence of various social networking websites such as Facebook, Twitter, and various social networking applications such as WhatsApp, Telegram, Instagram, etc. All these have led to an improvement of social interactions and inter-relationships among the members of society and now it is easier to connect with our friends and relatives through these social networking websites and apps.
- **ICT Transcends Boundaries:** The speed and faster means of communication through the internet have resulted in rapid information retrieval, accessibility and versatility. All these have created borderless sources for services, information, and communication, and are contributing to the emergence of a borderless world.

### **3.4 NEGATIVE IMPACT OF INFORMATION COMMUNICATION TECHNOLOGY**

- **Social problems:** Today's scenario is such that online communication is getting priority over real-time conversations. People are becoming more individualistic and isolated, which is creating social problems in society like lack of social engagements, which results in alienation and disenchantment with Society. Several Social crimes have also been occurring over the Information Communication Technology Platforms.
- **Issues related to Health:** Extended exposures to computers causes negative impacts on health. Individuals who use information technology devices suffer from bad posture, eye

strain, physical and mental stress, etc. To deal with these issues an ergonomic environment can be created such as an ergonomic chair for reducing back strain, and screen filter for reducing eye strain.

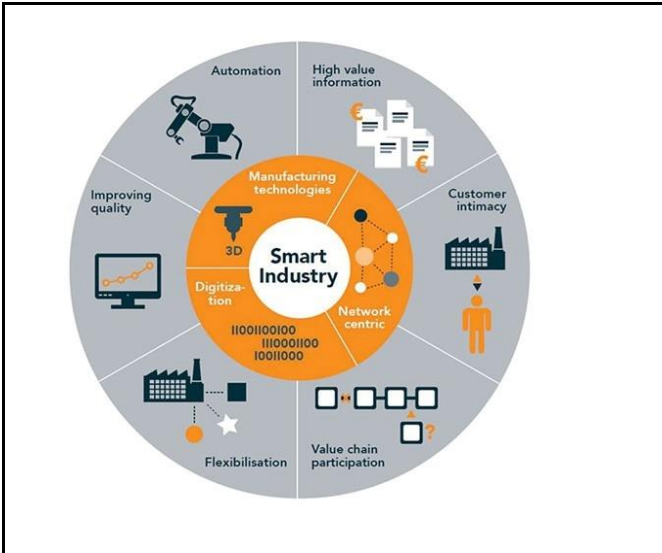
- **Expensive Technology:** ICT is relatively expensive technology and firms operating on a small scale are unable to afford this expensive technology which puts them at a disadvantage. Even The digital India mission of Government Of India is pegged to have a huge implementation cost.

With the exponential growth of information communication technology and rise of several emerging fields like- **automation, artificial intelligence,** and **digitization** of work process among others, certain new concerns have arisen related to:

- **Cyber Security: Growth of Cybercrimes like hacking, phishing, crimes against women, etc**
- **Privacy concerns: The risk is due to the Personal Information of users being** connected through cookies, electronic profile, and spyware, etc. Cookies are used for identifying users by webcasting, e-commerce, and web applications. The electronic profile includes personal details such as age, address, marital status, etc., which are preserved in a database and can be sold to the interested parties. Spyware collects user information without users' knowledge by sneaking in like a computer virus.
- **Loss of Employment: There are concerns related to job losses as ICT Technology has substituted many positions that were occupied by humans. Like the use of Robots in few places to replace manpower.**

#### **APPLICATIONS OF INFORMATION COMMUNICATION TECHNOLOGY (ICT)**

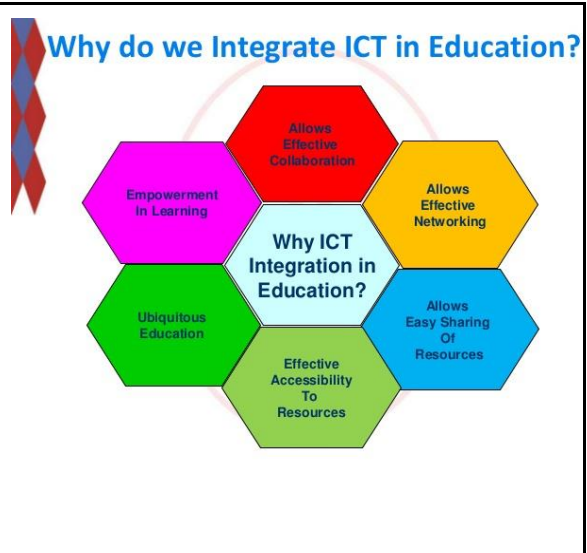
<b>INDUSTRY</b>	<b>EDUCATION</b>
ICT has contributed in the industrial sector right from production, planning, control systems, supply chain and management etc. Buying and selling of bonds in the stock markets have been made possible only due to the contribution of the ICT sector. Research and development activities utilise the latest computer technologies and the information available from different sources such as the internet etc.	ICT has enabled students, teachers and researchers to gain knowledge with the help of computers and the internet. The Internet, digital libraries and electronic sources of information are becoming more popular among students all over the world. ICT has opened new opportunities in the education sector such as Massive Open Online Courses (MOOCs) etc.



**BUSINESS AND COMMERCE**

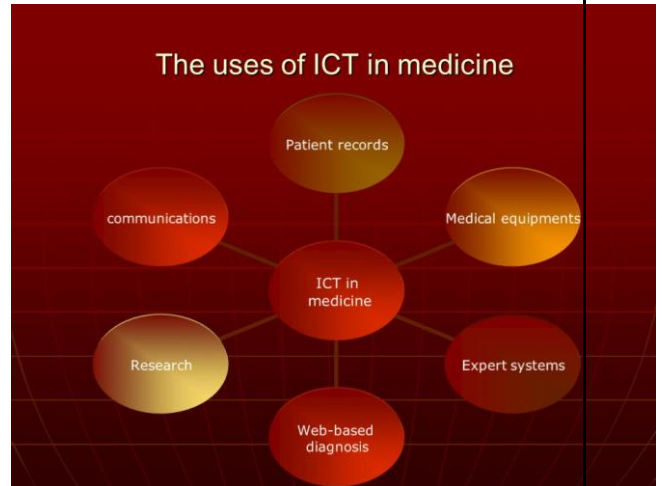
Computers are used for managing the financial and business records, databases of workers and employees etc. Digital Technologies, sophisticated hardware, software and communication technologies are extensively used in day to day commerce and business transactions.


Online buying and selling of products and services through **E-Commerce** platforms have been made possible by the use of Information and Communication Technologies. Computers, internet, software and telecommunication technologies are utilised for connecting the customers and suppliers for carrying out e-commerce transactions.

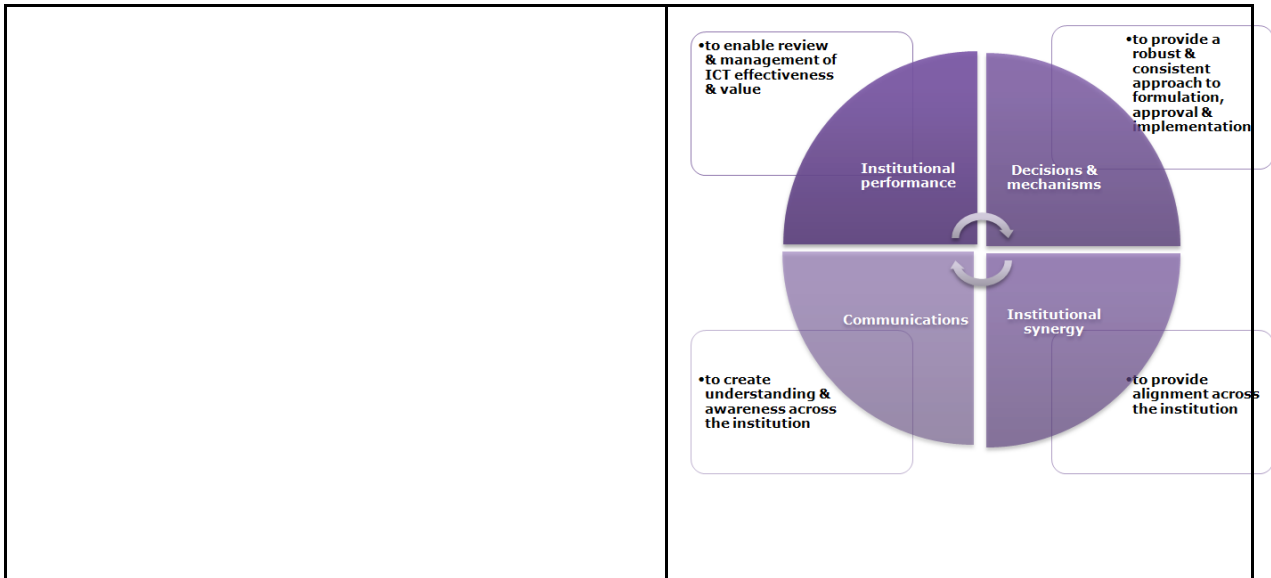


**MEDICINE**

ICT in the field of medicine has immense possibilities. For example, MRI, in which the computer combines the pictures and produces 3D images of bodies organs. New Emerging Technologies such as robotic surgeries performed by specialists from remote locations utilise Information and Communication Technologies.

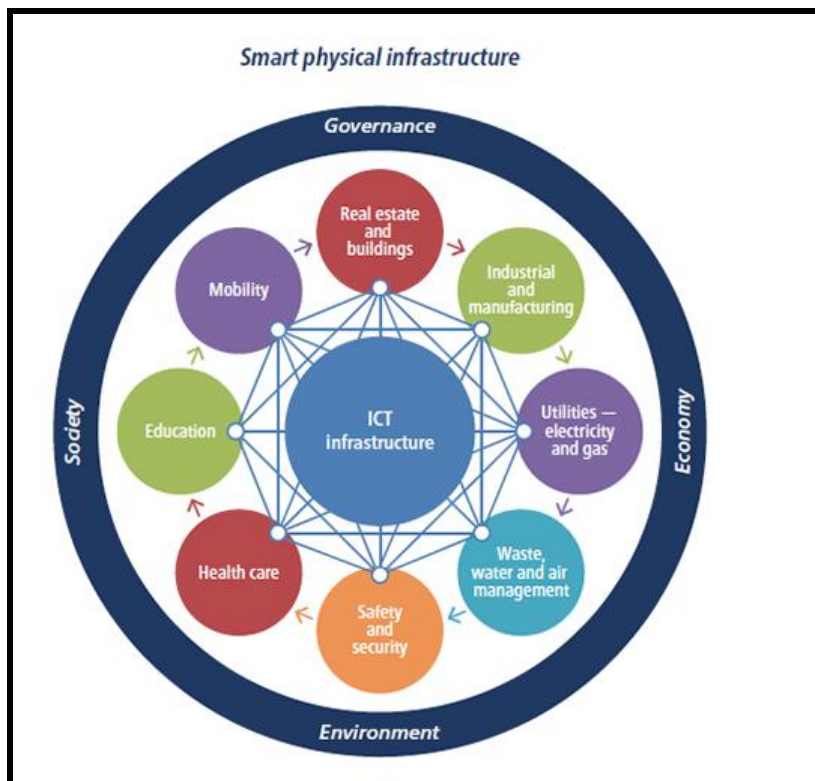


 <p>The diagram illustrates the E-commerce process as a circular flow of eight steps: Search product, Add to cart, Shipping Address, Payment, Sent email, Shipping, Get product, and Search product. A hand cursor icon is positioned in the center of the circle, pointing towards the 'E-commerce' text. The steps are connected by a light blue circular path.</p>	
<p><b>ENTERTAINMENT</b></p>	<p><b>GOVERNANCE PROCESSES</b></p>
<p>Various entertainment options such as online games, streaming music, digital television broadcast, satellite radio, etc have been made possible with the help of internet connections via computers, mobile phones, cable connections or through Wi-Fi, 4G technologies etc.</p>	<p>Information and Communication Technologies have made governance easier, smoother, and citizen centric.</p> <p><b>Administration :-</b> The provision of e-government services such as online post matric scholarships, online filing of income tax returns etc., have been made possible through the application of Information and Communication Technologies.</p> <p><b>Banking:</b> ICT has become the center of the banking system. The rise of electronic banking services which includes services such as electronic fund transfer, automated teller machine (ATM), internet banking, Unified Payment Interface (UPI) etc., have been made possible due to the contribution of the ICT sector.</p>



**CONCLUSION**

The rise of Information Communication Technology (ICT) has changed the world like never before. It has enhanced the human ability to communicate more efficiently and easily and changed the lives of individuals, groups, and entities around the World. The challenges and concerns arising out of ICT needs to be tackled properly in order to ensure its benefits reach all and become inclusive as well as the losses incurred are greatly reduced. In order to achieve this goal the contribution of all the stakeholders including the service providers, users, civil society and the government is necessary. If used to an effective level with proper integration along the mainstream developmental paradigms.



**Fig 3.2: Future of IT**

*(Image source:ITU NEWS MAGAZINE)*

### 3.5 TELECOMMUNICATIONS

Telecommunications, or telecom, refers to exchange of information over significant distances by electronic means and several types of voice, data and video transmission are also included in it. On a broader level the term includes a number of information transmitting technologies such as telephones (wired and wireless), microwave communications, fiber optics, satellites, radio and television broadcasting, the internet and telegraphs.



**Fig 3.3: Telecommunications Process**

There are several types of telecommunications networks, it is quite known that the simplest type of telecommunications takes place between two stations, but it is common for multiple transmitting and receiving stations in order to exchange data between them. Such an arrangement is known as telecommunications network. One of the biggest examples of telecommunications networks is growth of internet services. On a smaller scale, some of the examples include:

- Telephone networks
- Corporate and academic wide-area networks (WANs)
- Cellular networks
- Police and fire communications systems
- Groups of amateur (ham) radio operators
- Taxi dispatch networks
- Broadcasting networks

The rise and initial growth of basic telecommunications technology started with **Evolution of Mobile Networks** which had revolutionized the telecommunication systems all over the world.

#### **MOBILE (CELLULAR) GENERATION**

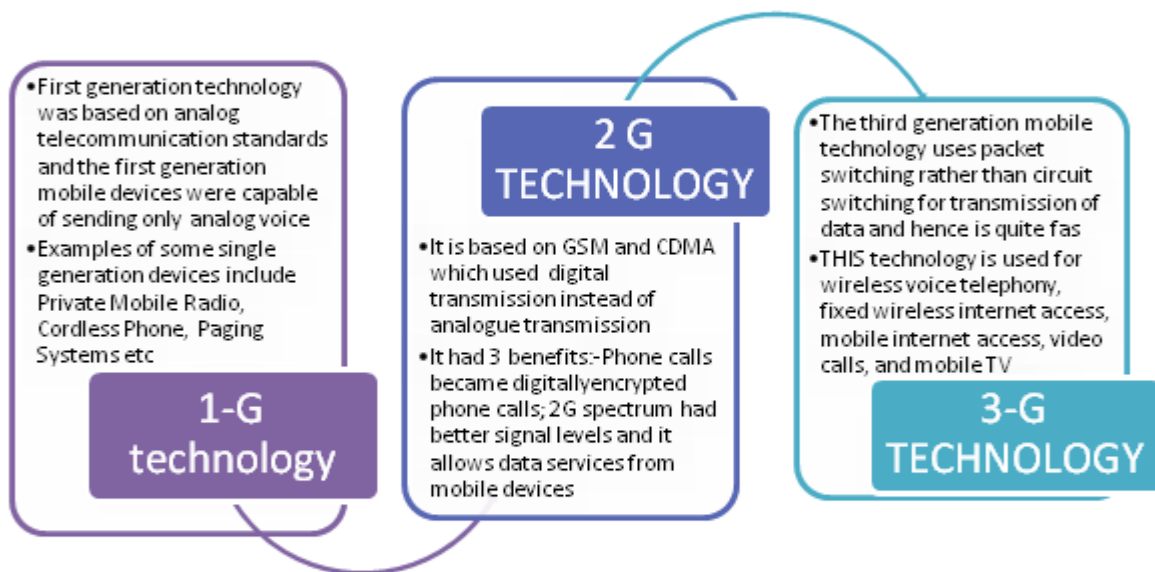
The term mobile generations is generally associated with the change in the nature of **Mobile Networks communication speed**, technology, data capacity, frequency, latency etc. With the evolution and growth of each generation there were some new techniques, new features, and higher capacities which were added to the previous generation of Mobile technology.



The terms usually used for the evolution of mobile communication technologies have been designated as 1G, 2G, 3G, 4G, and 5G.

### 1- G, 2-G and 3-G TECHNOLOGY

Before the advent of Single generation technology (1G), the term 0G was used which referred to **the pre-cell phone mobile technology based on mobile radio telephones**. These systems or technologies were called pre-cellular technology which were mounted on cars and trucks. These systems came to be known as **zero generation systems**.



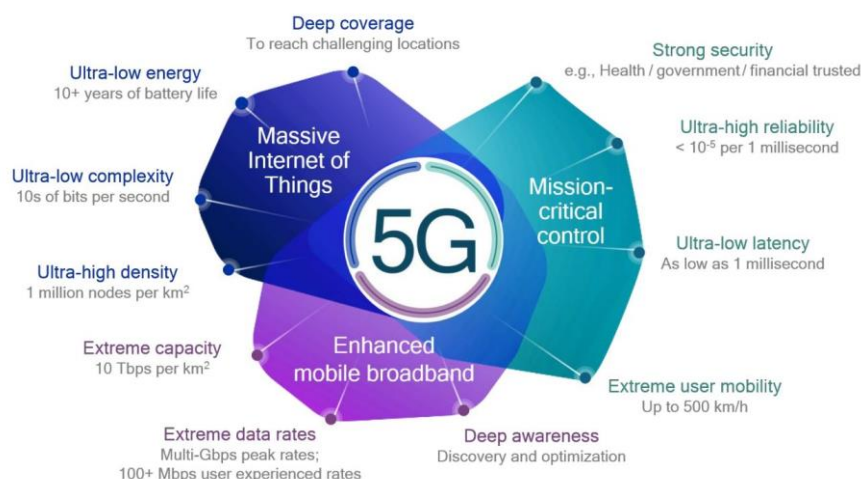


## **FOURTH GENERATION (4G) TECHNOLOGY**

In addition to voice and other services of 3G, the 4th generation mobile technology provides wireless mobile broadband internet. Its various applications include improved web access, IP telephony, video conferencing, cloud computing, gaming services high-definition mobile TV etc. It is to be noted that the data transmission speed provided by 4G technology is up to tenfold of existing 3G mobile networks. 4th Generation technologies eliminate circuit switching which was used in 3G networks while offering Voice over Internet protocol and downloading speeds up to 100mbps and even higher.

## **FIFTH GENERATION (5G) MOBILE TECHNOLOGY**

- 5th generation mobile technology denotes futuristic phase of mobile telecommunication beyond the fourth generation standards which is currently under development.
- Some of the features of 5G technology consists of higher data speeds, lower battery consumption, better coverage, lower traffic fees etc. The broadcasting data speed of 5G networks would be in Gbps.
- 5G Technology is expected to significantly reduce the latency compared to LTE.
- 5th generation mobile technology is expected to provide several simultaneous connections.
- It is expected to be rolled out in 2020 as per the current development.
- 5G technology will facilitate meeting the needs of new evolutions of technology such as the Internet of things etc.
- World Wide Wireless Web (WWWW) and the Cognitive Radio Technology are some of the other concepts associated with 5G technology.



**Fig 3.4: 5G TECHNOLOGY**

*(Image source: qualcomm)*

## **Challenges With 5-G Technology**

There are several limitations associated with 5G Technology that have invoked concerns in policy circles across the world in general and India In particular.

It is difficult to attain the stipulated speed of 5G, considering the inadequate technological support in most parts of the world. While there will be challenges replacing the old devices that do not support 5G.

Issues of speed and latency particularly in India where Average downloading speed is around 9 Mbps compared to a global average of 23 Mbps.

Large numbers of users in India pose significant challenges for increasing the consumer base to meet the demand-supply gap.

The switching to 5G will be infrastructure intensive and developing 5G ready infrastructure is very expensive.

Apart from all these challenges, there has been a recent controversy surrounding the safety and security concerns related to the Huawei Company.

The reason related to Huawei's origin, because the company was owned by Ren Zhengfei, formerly an engineer in the People's Liberation Army of China. His connections to the military and the Communist Party, alongside those of senior Huawei executives, have been cited as a security concern for foreign customers. The US has banned Huawei, citing that the company is funded by Chinese state security. Also, India's Department Of Telecom has flagged concerns over possible bugs in the equipment sold by a Chinese company. Indian Security agencies have also raised fears over the possible presence of embedded spyware or malicious software ('malware') that could allegedly be used by the Chinese intelligence to snoop into conversations and data flowing through the Indian network or even shut down communications in Delhi and Mumbai sitting in Beijing.

However, India recently rolled out the 5G trials in which it permitted the participation of Huawei. But the recent developments on the Strategic and military front where tensions are simmering between India and China may force a possible relook at the approved trials, as India has blocked 59 Chinese apps such as TikTok and WeChat, claiming they are a threat to national security.

Moreover, recently USA has pushed its allies to bar Huawei, a Chinese telecom giant, from building next-generation 5G mobile networks, claiming its equipment can be used to spy for Beijing. It has also made Britain to cut the firm out of the most sensitive "core" elements of 5G that access personal data. After this, India is also reconsidering the country's 5G rollout plans and whether Huawei should be allowed to participate.

### **3.6 SOME CONCEPTS RELATED TO INFORMATION COMMUNICATION TECHNOLOGY**

#### **Voice over internet protocol (VOIP):**

It is an internet-enabled technology WHICH FACILITATES voice calling over the internet. In this protocol Broadband connectivity is used for making calls with computers, smartphones, etc. some of the examples of this version are. Skype, Yahoo Messenger, MSN Messenger, etc., which provide VOIP services.

#### **Internet Protocol Version 6(IPV 6):**

Internet Protocol Version 6 (IPv6) is a network layer protocol that allows communication and data transfers to take place over the network.

Features of IPV 6.0:

- IPv6 came into existence in 1998 intending to replace IPv4.
- It is a 128 bit IP address
- It is an alphanumeric addressing method.
- IPSec (Internet Protocol Security) is built into the IPv6 protocol
- It Allows storing an unlimited number of IP addresses.
- Unicast, multicast, and anycast are types of addresses.

IPv6 was developed to solve the address space exhaustion in IPv4. IPv4 uses a 32-bit address scheme which allows it to store more than 4 billion addresses. IPv6 uses a 128-bit address scheme which allows 340 undecillion unique address space.

#### **WI-FI TECHNOLOGY**

Wi-Fi is a wireless network technology that provides wireless high-speed Data Services and network connections using radio waves.

This technology is based on IEEE 802.11 standards for connecting devices. Wi-Fi can connect devices such as personal computers, video game consoles, smartphones, smart digital headphones, etc., to the internet via a wireless network access point.

WiFi is a new characteristic of networking and has fetched a new feature in the field of networking. The data broadcasting which is finished using radio waves allows users to get easy access to the internet for objective sharing all around the world.

**For example**, Now it is easier to establish a computer network in any type of business like companies, coffee shops, Libraries, campus, Hotels, colleges, universities, private institutes, etc. Wi-

Fi Technology enables us to get more profit from business and facilitates connecting to the client anywhere or at any time.

**Some of the peculiar features of Wi-Fi include: it has more Scalability and efficient performance as compared to other technologies. It has more extensive reach than conventional networking technology and has great power for consumption as compared to other networks. Moreover, WiFi provides more reliability due to its security system which protects your data, and also there is no need for cabling in Wi-Fi Technology.**

**Wi-Fi Calling-** Wi-Fi Calling is a service for smartphones which, just as it sounds, allows you to call over a Wi-Fi network. Wi-Fi calling relies on a technology called SIP/IMS that tunnels your call through the internet, instead of a cell tower. Consequently, you're not using the cell tower to place the call, which means that you don't need cellular service. When placing a WiFi call it's just like placing a regular call, without logging in or using an app. Your carrier and phone will determine if you can call through WiFi or not.

### **Recent Development**

The Government of India has given its go-ahead for Wi-Fi services in flights. Passengers will be now allowed to use Wi-Fi during flights in the Indian airspace as the government has issued a notification in this regard. The government notification says that subject to permission by the main captain, all flights will be able to switch on in-flight Wi-Fi for the benefit of fliers.

But the availability of the Wi-Fi during flights will be -- broadly -- subjected to two conditions:

- The main captain will have the authority to switch on or switch off the Wi-Fi in flights, and the captain will be required to follow certain guidelines on this matter. For example, Wi-Fi would be switched on only when the plane is at the cruising speed. During take-off or landing, it will not be available. Also, if the weather is not clear, chances are that the captain will not turn on Wi-Fi.
- Each plane that offers in-flight Wi-Fi will have to be certified by DGCA for this purpose before fliers in it can enjoy connectivity.

The official notice by the Civil Aviation Ministry states: The pilot-in-command may permit the access of internet services by passengers on board an aircraft through Wi-Fi onboard when a laptop, smartphone, tablet, smartwatch, e-reader or a point of sale device is used in flight mode or airplane mode. Provided that the director-general shall certify the aircraft for the usage of internet in-flight through Wi-Fi onboard subject to procedures as specified in this behalf.

The notice further states that an aircraft shall be deemed to be in flight when all its external doors are closed, following embarkation until the moment when any such door is opened for disembarkation.

The latest notification also states that the use of mobile phones may be permitted by the pilot-in-command after the aircraft has landed and cleared the active runway, except when the landing takes place in low visibility conditions as may be determined by the director-general.

### **Long Term Evolution (LTE)**

Long term evolution is a standard for wireless broadband technology offering reduced latency, incremental data speed, bandwidth capacity that can be Scalable with the present GSM, and UMTS Technology in use.

### **WiMAX technology**

WiMAX Technology: Worldwide Interoperability for Microwave Access (WiMAX) is a wireless technology for providing Point to multipoint (PMP) wireless broadband internet access. It can provide wireless broadband access up to 10 miles for the mobile stations and around 30 miles for fixed stations... It can provide data services at speeds up to 72 Mbps.

### **LI-FI(Light Fidelity) TECHNOLOGY**

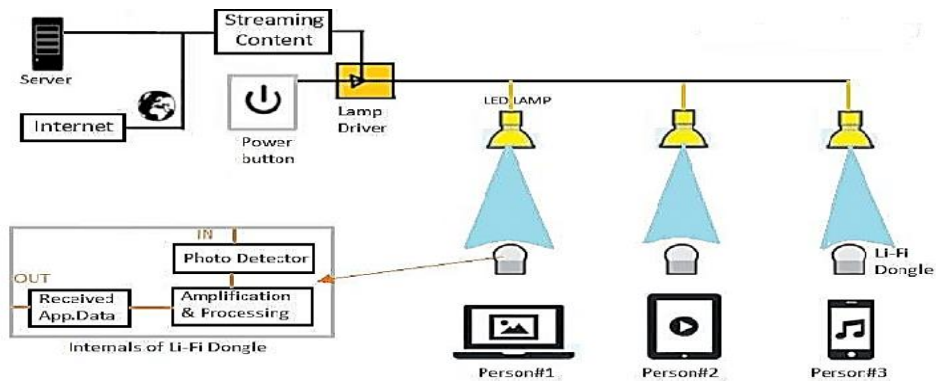
LiFi(Light Fidelity) is a high-speed wireless communication technology that uses visible light to transmit information. It has some similarities to existing Wi-Fi technology, as well as some huge differences.

Wi-Fi and LiFi are similar because both technologies are wireless, but also very different because unlike Wi-Fi, which relies on radio waves, LiFi uses visible light communication (VLC) or infrared and near-UV spectrum waves.

In other words, LiFi works by using visible light, like the light that is emitted by any regular lamp or bulb.

#### **How does LI-FI work?**

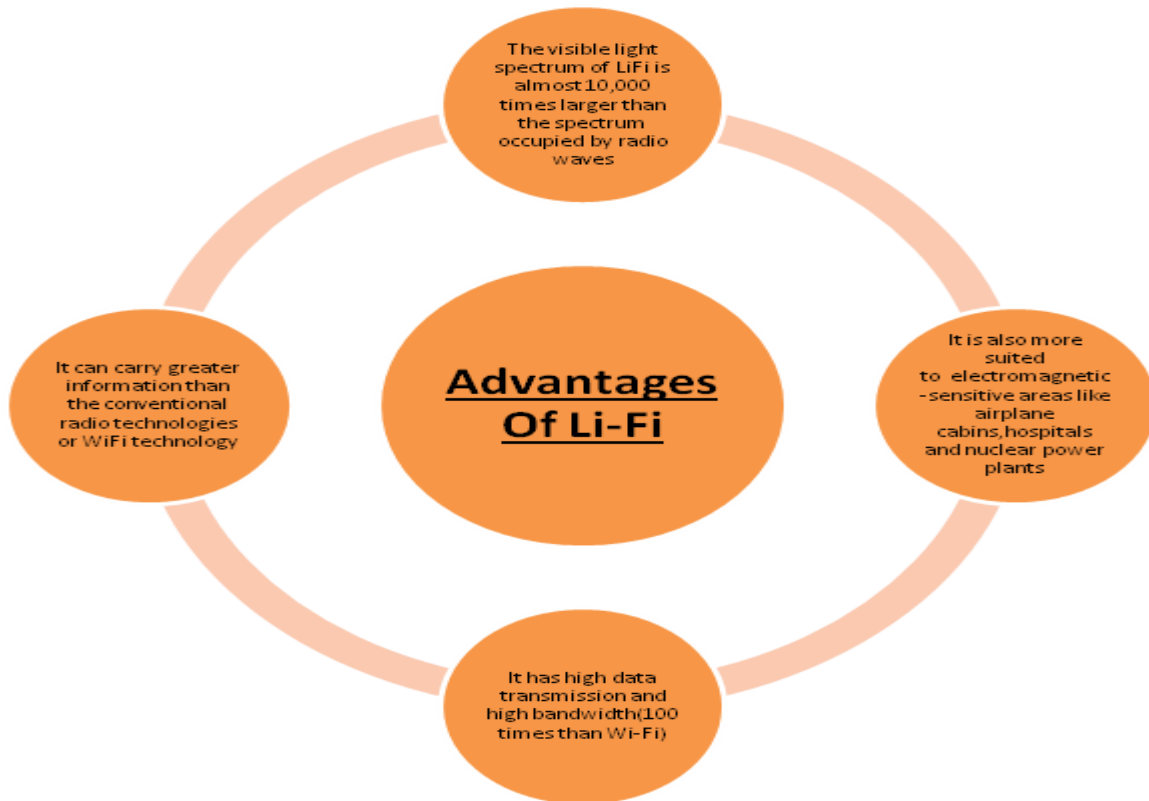
- Light Fidelity is a Visible Light Communications (VLC) system and can accommodate photo-detectors for receiving light signals and uses a signal processing element to convert the data into streamable content.
- It runs on visible light instead of radio waves used in Wi-Fi.
- In LiFi technology the data is fed into an LED light bulb (with signal processing technology), after which data is sent at rapid speeds to the photo-detector (photodiode).
- The tiny changes in the rapid dimming of LED bulbs are then converted by the 'receiver' into electrical signals.
- The signal is then converted back into a binary data stream that the user would recognize as web, video, and audio applications that run on internet-enabled devices.



**Fig 3.5: Working Of Li-Fi Technology**

(Image source: scienceabc.com)

**Advantages of Li-Fi:**

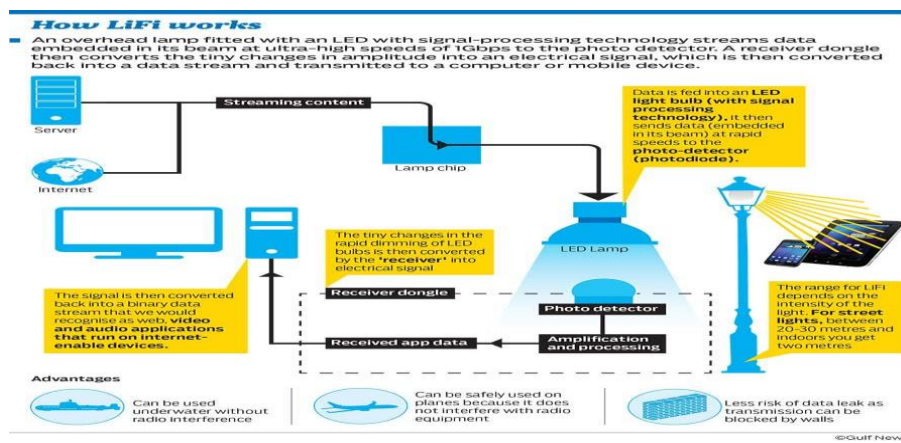


**Issues Related To Light Fidelity Technology:**

<p>Li Fi uses visible light to transmit data but in case of Darkness or lack of visibility it may not be very useful.</p>	<p>If you have a WiFi router installed in one room of your house, you can connect your devices sitting anywhere in the house, but this is not the case with</p>
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	LiFi
There are issues of reliability in this technology (due to it being dependent on visible light) and has high installation charges.	The use of lifi Technology can disrupted by physical obstacle in its way since visible light cannot pass through Opaque objects does a user has to be close to internet source in case there is any hindrance in between

**UTILITIES OF Li-Fi Technology:**



**Fig 3.6: LI-FI Technology Applications**

(Image source: Gulf news)

- It can be used in street and traffic lights. In order to communicate with the vehicles and with each other the traffic lights would be useful.
- LiFi can be used for real time traffic control and each traffic and street light post can be converted into access points to convert roadsides into wireless hotspots.
- Accidents can be prevented as vehicles with LED headlights may be able to communicate with each other or exchange real time information.
- LiFi can be used in aircraft, where most for control communication in place of current radio waves.
- It will also have applications in military and navigational operations, as it can work underwater.
- In future it may open opportunities for wireless transmission of power, wherein the smartphone will not only receive data through Li-Fi, but will also receive power to charge itself.

## LIGHT EMITTING DIODE (LED)

- A light releasing diode is an electric component that emits light when the electric current flows through it.
- It is a light source based on semiconductors.
- When current passes through the LED, the electrons recombine with holes emitting light in the process.
- It is a specific type of diode having similar characteristics as the p-n junction diode.
- Which means that an LED allows the flow of current in its forward direction while it blocks the flow in the reverse direction.
- Light-emitting diodes are built using a weak layer of heavily doped semiconductor material.
- Based on the semiconductor material used and the amount of doping, an LED will emit a coloured light at a particular spectral wavelength when forward biased.

### Applications Of Light Emitting Diode (LED):

<b>TV Backlighting</b>	A TV's backlight is the major power consuming source. Uses of LEDs can give an efficient power reduction. In the edges of TV, using an LED will be a cost reduction choice. Using LEDs directly behind the display provides better contrast. LEDs has been replacing CFLs and LCDs when it comes to TV backlighting
<b>Smartphone Backlighting</b>	With the use of LED, the backlight design of the smartphone can be thinner and be made within low cost. The price of LED may vary according to the size of the smartphone display. Due to the lower output voltage, they ensure longer battery life
<b>Displays</b>	LEDs display boards are common now these days and are used outdoors like storage signs, billboards, road signs etc. In sign boards which has multiple languages conveying signals, use of more LEDs will be beneficial in terms of less power consumption
<b>Automotives</b>	The Use of LEDs in the automotive industry is growing. With LEDs, energy is saved and there is a clearer visibility. These are extensively used in the back and rear of an automobile for better accessibility. LED lighting can improve safety of pedestrians and drivers as it enhances visibility when it is ON, OFF and dimmed in any part of the journey.
<b>Dimming of Lights</b>	Few LED applications include dimming of lights which helps in reducing energy consumption: <ul style="list-style-type: none"><li>● This dimming feature is also used in Appliances where it is of two types.</li><li>● Global Dimming where all LEDs are dimmed together.</li><li>● Local Dimming where LEDs are dimmed indepently.</li></ul>



**LEDs vs LCDs (differences):**

<b>LCD</b>	<b>LEDs</b>
LCD production uses mercury thus harm environment	LEDs use no mercury thus environment friendly.
All LCDs are not a subset of LED TV's	All LEDs are a subset of LCD TV's.
LCDs primarily use fluorescent lights	LEDs use light emitting diodes
Fluorescent lights used are usually placed behind the screen.	Light emitting diodes are usually placed behind the screen or around the edges.
LCDs are usually thicker in size and lack energy efficiency compared to LEDs	LEDs are much thinner in size and are much more energy efficient.

**ORGANIC LIGHT EMITTING DIODE(OLED)**

OLED is a Light emitting diode (LED) in which the emissive electroluminescent layer is a film made of organic material containing carbon like wood, plastic, polymers etc which emits light on the flow of electric current. The organic layer is placed between two electrodes - a transparent anode and a metallic cathode.

OLED is capable of producing light of different colours and they do not require a backlight and directly produce a correct colour which also saves power and space. In low light conditions, OLED displays provide a higher contrast ratio compared to the LCD displays.

OLED displays are considered better than the existing display technologies due to their fast response time, better contrast levels, wide viewing angles, and perfect brightness.

OLEDs are used for creating digital displays on television screens, smartphones, computer monitors, handheld game consoles, and personal digital assistants.

An OLED display can be based on the passive matrix (PMOLED) or active matrix (AMOLED) control schemes. In PMOLED, each row in the display is controlled sequentially one by one.

In the AMOLED scheme, a thin film transistor backplane is used for directly accessing and switching each individual pixel on or off. This provides higher resolution and larger display sizes.

**Advantages of OLED Technology:**

Better picture quality	Environment Friendly	Thinner and have better Power Efficiency
Response time is fast and rapid	Strong durable and break resistant	Future production costs may be Scalable

**Disadvantages of OLED Technology:**

Lower lifetime due to limited lifetime of organic materials	Water and other liquid materials may cause damage
Poor readability and visibility in outdoors or bright light	Power consumption in OLED displays is uneven.

**LIGHT DETECTION AND RANGING (LiDAR):**

LiDAR, or light detection and ranging, is a popular remote sensing method used for measuring the exact distance of an object on the earth’s surface. LiDAR didn’t get the popularity it deserved, Even though it was first used in the 1960s when laser scanners were mounted to airplanes. However, after the introduction of GPS, in the 1980s it became a popular method for calculating accurate geospatial measurements.

LiDAR uses a pulsed laser to calculate an object’s variable distances from the earth's surface. These light pulses — put together with the information collected by the airborne system — generate accurate 3D information about the earth's surface and the target object.

There are three primary components of a LiDAR:- the scanner, laser, and GPS receiver. Other elements that play a vital role in the data collection and analysis are photodetector and optics. Most government and private organizations use helicopters, drones, and airplanes for acquiring LiDAR data

LiDAR systems are divided into two types based on their functionality:

- **Airborne LiDAR**-Airborne LiDAR is installed on a helicopter or drone for collecting data. As soon as it’s activated, Airborne LiDAR emits light towards the ground surface, which returns to the sensor immediately after hitting the object, giving an exact measurement of its distance. Airborne LiDAR is further divided into two types — Topological LiDAR and Bathymetric LiDAR.
- **Terrestrial LiDAR**- these systems are mounted on moving vehicles or tripods on the earth surface for collecting accurate data points and are quite common in observation

**and monitoring of highways, analyzing infrastructure, or even collecting point clouds from the inside and outside of buildings. Mobile LiDAR and Static LiDAR are two types of terrestrial LIDAR systems.**

### **ISSUES WITH LiDAR**

- It can measure the distance of objects up to 5 meters away but won't work well for objects in the vicinity
- It fails to detect glass wall or door
- It also cannot function well in snow, fog, dust or rain

## **3.7 EMERGING TECHNOLOGIES IN FIELD OF INFORMATION TECHNOLOGY**

### **INTERNET OF THINGS(IoT):**

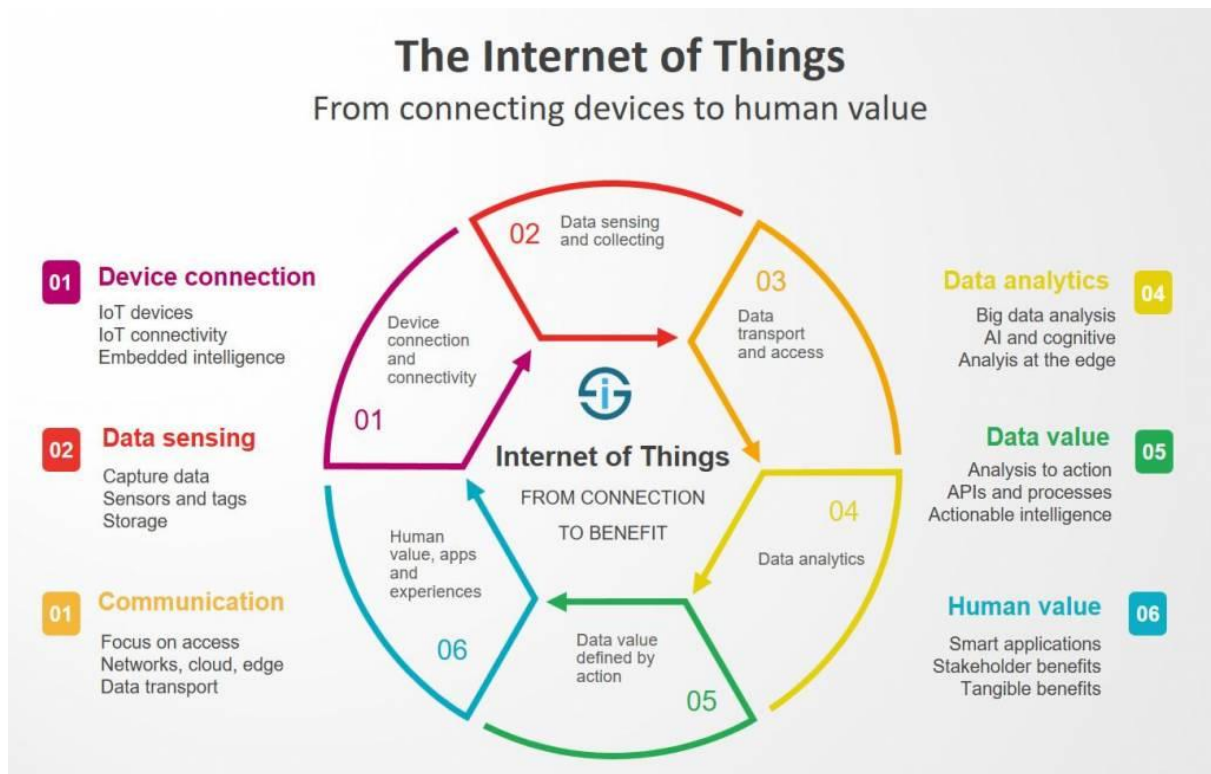
IoT is the interlinking of digital devices, people, machines, appliances, and other objects with one another through wireless networks.

It allows machines and people to be connected and communicate as well.

It is considered the future of the internet. This version of the internet is about data that is created by things.

### **Internet of Things Explained:**

1. Any device that can be connected will be connected.
2. Any device that can be switched on and off will be connected.
3. Most of the connected devices will have an Internet Protocol (IP) address. With IPv6, billions of devices can be connected with ease.
4. Things can be connected with IoT:
  - Connected Homes: interlinking of household appliances to the network.
  - Connected Wearables: smartphones, smartwatches, fitness bands, etc.
  - Connected Cars: vehicles connected to the network.
  - Connected Cities: smart meters that can analyze the usage of gas, water, electricity, etc.; connected traffic signals; smart bins, etc.
  - Different networks would be connected, like as mentioned below:
    - BAN (Body Area Network) – Wearables
    - LAN (Local Area Network) – Smart Homes
    - WAN (Wide Area Network) – Connected Cars
    - VWAN (Very Wide Area Network) – Smart City



**Fig 3.7: Internet of Things**

*(Image source: Pib)*

**APPLICATIONS OF INTERNET OF THINGS:**

<p>Daily life: IoT can be used to do small tasks in daily life such as coffee-making as soon as the owner of the house returns home, refrigerator indicating that vegetables need to be bought and/or ordering them automatically from the e-store, etc. It can also be used in offices.</p>	<p><b>Agriculture:</b> IoT can be used to improve overall productivity through better weather forecasting, soil nutrient content, pest infestation, etc</p>	<p><b>Transportation:</b> IoT can be used on toll booths, traffic management, driverless cars, etc. It can also be used in fleet management, safety assistance, improved logistics, etc.</p>	<p><b>Smart Cities:</b> IoT can be used to make cities better places to live. It can be applied in solid waste management, smart power grids, smart energy management systems, etc</p>
<p><b>Industry:</b> IoT can be used to reduce human error, increase efficiency, and improve productivity, etc.</p>	<p><b>Healthcare:</b> there are several benefits in the medical industry. Better diagnosis of diseases, wearable monitors of vitals, sophisticated</p>	<p><b>Media/Advertising:</b> Companies can use IoT to analyse and predict consumer behavior and apply target marketing for better ROI in</p>	<p><b>Government policies and services:</b> the government can use IoT to offer better citizen services.</p>

	connected equipment, etc	advertising/marketing campaigns, etc. Big data and data mining concepts can be used in this regard.	
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**SCENARIO IN INDIA:**

The Government of India envisages to use Internet of Things (IoT) as part of the Digital India Mission. The National Digital Communications Policy was launched in 2018 to develop and apply IoT, 5G technology, machine to machine (M2M) communication, etc.

The government also permitted 100% FDI in the telecom sector. This should also aid the development of IoT in India. The Department of Electronics and Information Technology (DeiTY) also published a draft policy for IoT in India.

**The government has set a target of USD 15 billion for the IoT market by the year 2020. This would be 5 – 6 % of the global Internet of Things (IoT) industry.**

**ISSUES AND CONCERNS RELATED TO INTERNET OF THINGS:**

- Loss of jobs because of the replacement of humans with machines.
- There is the issue of misusing personal data without consent of the owning party by internet/social media companies thus privacy and safety issues are there..
- Digital surveillance also poses challenges like there are concerns that smart homes are susceptible to privacy invasions.
- Risks of financial frauds and hacking of banking and financial details of people or state authorities. By non state individuals or cyber hackers.



**Fig 3.8: IoT Developers Survey**

*(Image source: Secureworld)*

There is a need to have better regulation and policy frameworks for regulating and monitoring Internet of Things applications. Firewalls and safety software should be improved and data confidentiality should be priority for all stakeholders.

### **3.8 FOURTH INDUSTRIAL REVOLUTION AND INFORMATION TECHNOLOGY**

#### **INTRODUCTION:**

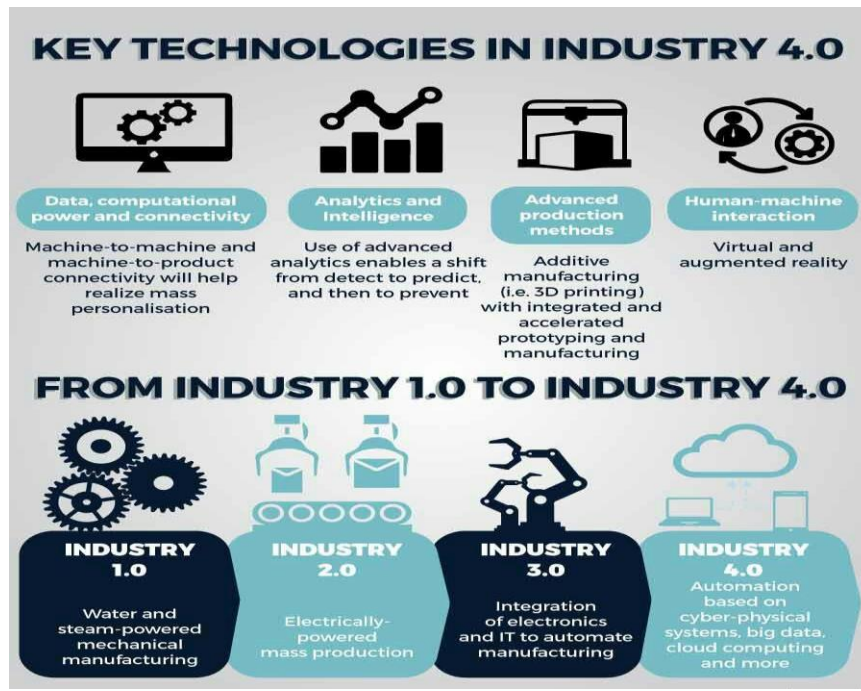
Human history has been one big roller coaster ride. First, we discovered fire, then agriculture, wheels, then factories and trading which were followed by steam power, electricity and mass production. Then came the age of computers, the internet, gene-editing, block chain, self-driving cars, and artificial intelligence, to neuro-technological brain enhancements.

The evidence of dramatic change is all around us and it is occurring at an exponential speed.

**The industrial revolution was one of the most significant game-changing periods of human history.** Also termed as the industrial age, it was a period of immense technological, socio-economic and cultural changes. This period introduced mass production and replaced hand tools with machines.

**The first and the second stages of the industrial revolution** span a period from 1760 till 1914. It is widely agreed to have begun in England and later spread to Europe and then to other countries. Previous industrial revolutions liberated human-kind from animal power, made mass-production possible, and brought digital capabilities to billions of people.

**The third industrial revolution** used electronics and information technology to automate production. The third industrial revolution created the foundational infrastructure for an emerging, collaborative age. The fourth industrial revolution is built on the third.



**Fig 3.9: Phases Of Industrial Revolution**

*(Image source: ASEAN Post)*

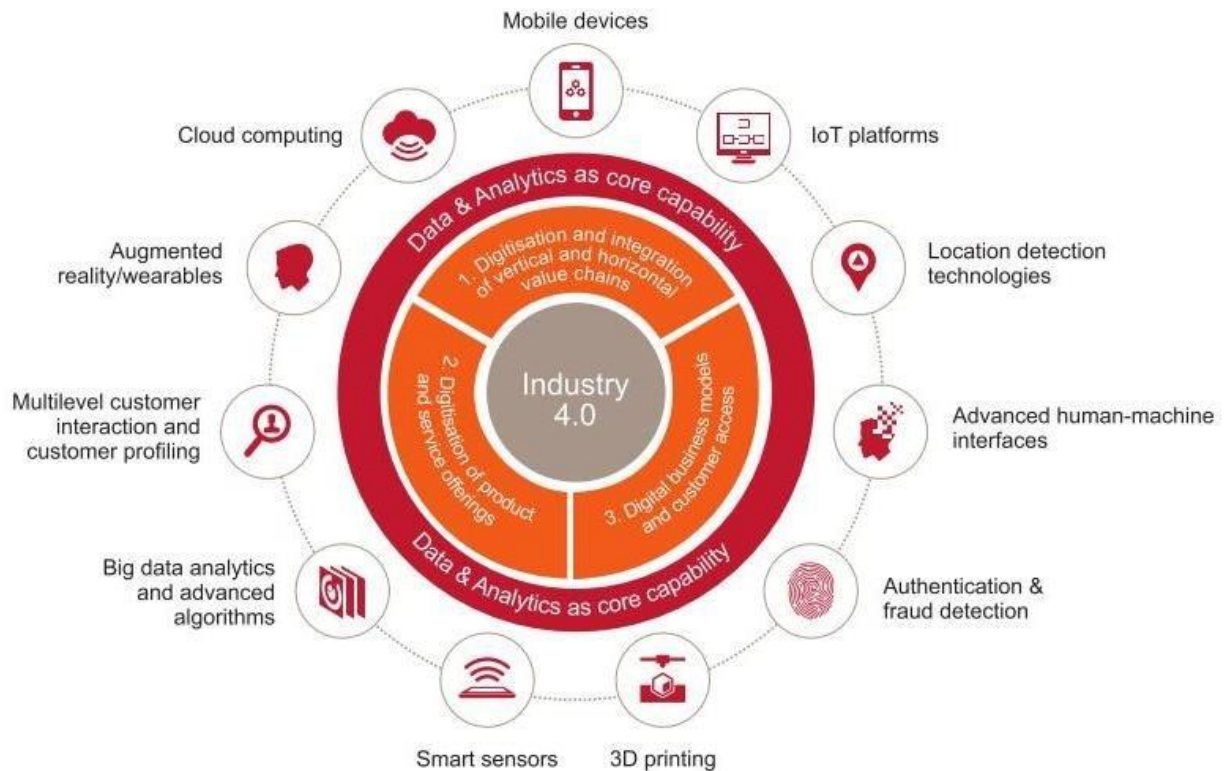
The fourth industrial revolution (Industry 4.0) is characterized by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres. It is meant to impact all disciplines, economies and industries, and it even challenges the idea of what it means to be human. According to Professor **Klaus Martin Schwab**, founder and executive chairman of the **World Economic Forum**, and author of the “Fourth Industrial Revolution”, the new age is differentiated by the speed of technological breakthroughs, the pervasiveness of scope and the tremendous impact of new systems.

In the fourth industrial revolution, the process is moving from electronic towards becoming a combination of human beings and electronics. Thus, processes like artificial intelligence have broken the distinction between man, machine and intelligence. The fourth industrial revolution is marked by emerging technology breakthroughs in a number of fields, including robotics, artificial intelligence; block chain, Nano-technology, quantum computing, biotechnology, the Internet of Things (IoT), 3D printing, and autonomous vehicles.

Like most software applications and electronic devices, the industry 4.0 refers to a software revision meant to indicate the overall shift towards digital platforms. It is in our hands to proactively shape the 4th industrial revolution. As these fundamental transformations are underway in our society, the 4th industrial revolution needs to be more human centric and inclusive.

This revolution can be looked at as an opportunity to unite global communities and to build sustainable economies. **The 4th industrial revolution is therefore not a prediction of the future, but a call to action.**





**Fig 3.10: INDUSTRY 4.0**

*(Image Source: Researchgate)*

### **INDUSTRY 4.0 FROM INDIAN PERSPECTIVE:**

The Fourth Industrial Revolution is a term that defines our present technological age. It is the fourth industrial era since the initial industrial revolution of the 18th century.

Recently, Prime Minister Narendra Modi gave an institutional shape to the expression, by launching the **center for the 4th industrial revolution- which is an initiative of the World Economic Forum**. This will initially focus on **artificial intelligence** and **machine learning**.

The fourth industrial revolution is marked by diverse technological breakthroughs due to fusion of technologies, ranging from physical to digital to biological spheres that bring together the fields of robotics, artificial intelligence, nanotechnology, biotechnology, and a host of others

**India has become the fourth country in the world, where the World Economic Forum (WEF) had opened its Centre for the Fourth Industrial Revolution.** With this, India will endeavor towards massive digital and technological transformation. The Centre for the Fourth Industrial Revolution India would work in collaboration with the NITI Aayog, to co-design new policies and protocols for emerging technologies with an initial focus on artificial intelligence, block-chain technology, and drones. Artificial Intelligence, Machine Learning, the Internet of Things (IoT), Blockchain Technology, Big Data, can act as a catalyst towards making India's growth story to newer heights. Many employment opportunities can be created that can make the lives of every Indian better.



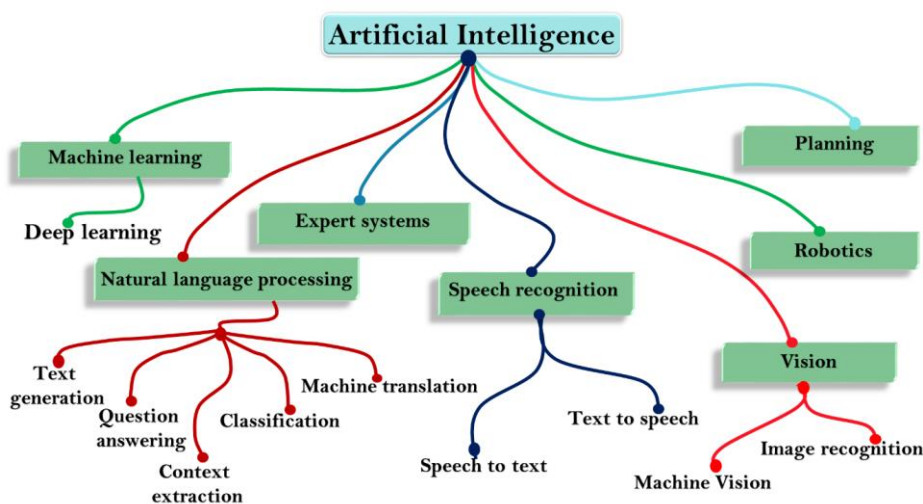
The government is working to improve people’s lives and prepare the youth for changing technologies through schemes like Atal Innovation Mission (AIM), Digital India, Skill India, Startup India, and others. Several areas where the fourth industrial revolution can help in transforming India like in the fields such as:

- Poverty alleviation;
- Better and low-cost healthcare;
- Doubling farmers’ income with the help of new technology and equipment
- Improvement of infrastructure and connectivity to villages and remote towns
- Artificial intelligence can be used to empower and enable differently-abled people.
- It will improve the ease of living and the ease of doing business.

The fourth industrial revolution will usher in a series of social, political, economic, and cultural upheavals that will unfold over the 21st Century.

### 3.9 ARTIFICIAL INTELLIGENCE AND ROBOTICS

Artificial intelligence is an emerging technology that facilitates intelligence and human capabilities of sense, comprehend, and act with the use of machines. Some of the technologies that can allow these systems in analyzing and understanding all the information that is received are natural language processing and inference engines. Artificial Intelligence is a system that provides action through technologies such as expert systems and inference engines to undertake operations in the physical world.



**Fig 3.11: Artificial Intelligence**

(IMAGE SOURCE: Down to Earth)

### 3.10 DEVELOPMENT IN ARTIFICIAL INTELLIGENCE

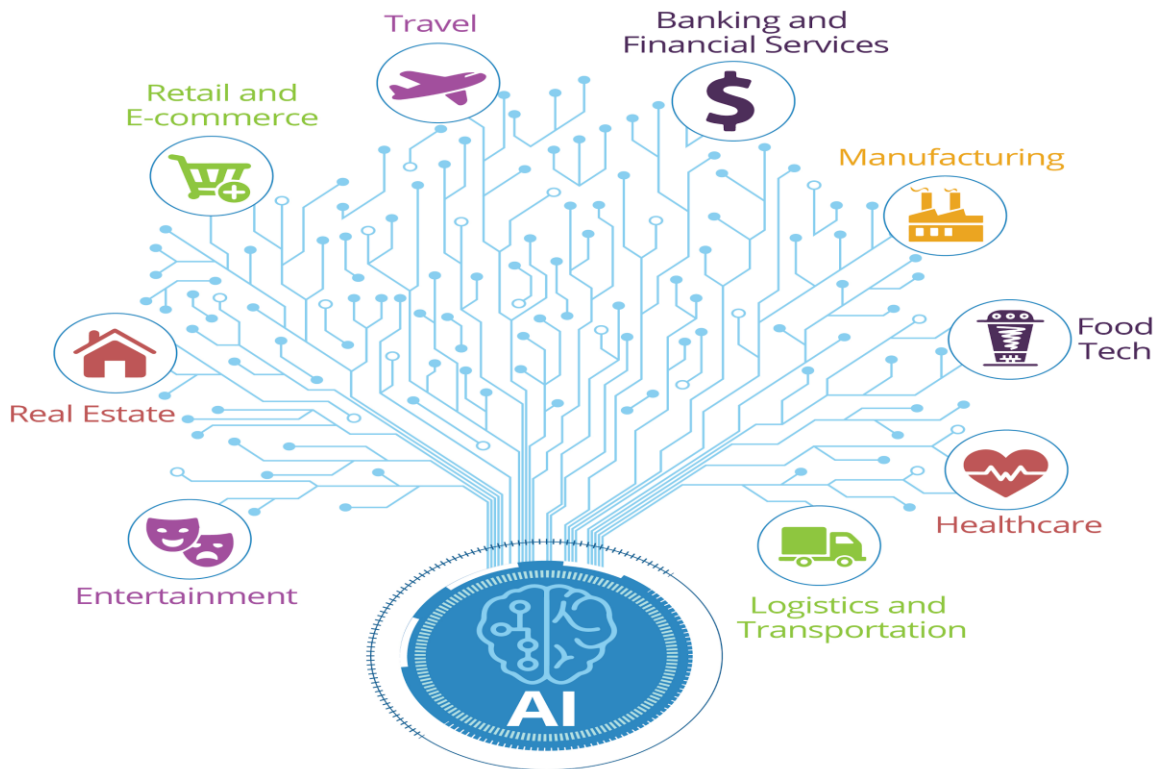
The economic and social benefits of applied AI are familiar in all the countries of the world. In the area of core research in AI and related technologies, universities and research institutions from the US, China and Japan have led the publication volume on AI research topics between 2010 and 2016. The AI Governance structures have the potential for enabling all the above mandates across countries. Many countries have instituted dedicated public offices such as the Ministry of AI (UAE), and Office of AI and AI Council (UK) while China and Japan have allowed existing ministries to take up AI implementation in their sectoral areas.

#### **POTENTIAL OF ARTIFICIAL INTELLIGENCE:**

Artificial Intelligence has the potential to provide sizable incremental value to a wide range of sectors globally and is expected to be the key source of competitive advantage for firms.

<b>Healthcare</b>	<b>Transports, Logistics and Smart Mobility</b>	<b>Manufacturing</b>	<b>Smart Cities</b>
AI plays an important role in the field of healthcare by addressing issues of high barriers particularly in rural areas that lack poor communication and professional healthcare systems. Some of the emerging application includes AI-driven diagnostics, personalised treatment, early identification of potential pandemics, and imaging diagnostics.	This domain mainly includes various autonomous and semi-autonomous features, for example, monitoring and maintaining predictive engines along with driver-assist. Other applications of AI include improved traffic management, autonomous trucking and delivery.	It can enable 'Factory of the Future' through flexible and adaptable technical systems to facilitate various processes and machinery to respond to unfamiliar or unexpected situations by making smart decisions. Impact areas include · engineering, supply chain management, production, maintenance, quality assurance, and in-plant logistics and warehousing.	Incorporation of applied AI in developing cities could also help in meeting the demands of a rapidly growing population and providing them with enhanced quality of life. Traffic control for reducing congestion enhanced security by providing improved crowd management are some of the potential uses of AI system.
<b>Agriculture</b>	<b>Retail</b>	<b>Energy</b>	<b>Education and Skilling</b>
AI has a major role to play in driving a food revolution and meeting the increased demand for food. Applied AI addresses challenges such as lack of assured	Being one of the early adopters of AI solutions, it provides applications such as developing user experience by personalized	The potential use of Artificial Intelligence also includes modelling and forecasting of the energy system to reduce unpredictability. AI	AI plays a major role in the Indian education sector by providing solutions for quality and access issues including augmentation and enhancement of the

<p>irrigation, inadequate demand prediction, excess use of the pesticides, fertilisers and fungicides. Some uses include improved crop production through advanced detection of pest attacks, prediction of crop prices and real-time advisory.</p>	<p>suggestions, image-based product search and preference-based browsing. Other uses include customer demand anticipation, improved inventory management, and efficient delivery management</p>	<p>also focuses on increasing the efficiency of power balancing and enabling the storage of energy in renewable energy systems. This process uses smart meters to enable intelligent grids, thus, improving the affordability and reliability of solar energy. Apart from these, AI may also be deployed for predictive maintenance of grid infrastructure.</p>	<p>learning experience through personalized learning, automating and expediting administrative tasks, and predicting the need for student intervention to reduce dropouts or recommend vocational training.</p>
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**Fig: 3.12: AI: APPLICATIONS**

(IMAGE SOURCE: Dzone.com)

**CHALLENGES WITH ARTIFICIAL INTELLIGENCE IN INDIA**

- Absence of collaborative effort between various stakeholders

- **Concerns on privacy and security** of data, including lack of formal regulation around anonymisation of data.
- **Lack of sufficient talent** to build and deploy AI systems at scale. An estimate claims that only 4% of AI professionals in India have worked on emerging technologies such as deep learning and neural networks. There is also a significant gap in PhD research scholars in the field.
- **Difficulty in access to industry-specific** data required to build customised platforms and solutions is currently in the hands of a few major players. It is challenging for new beginners to provide customised services that can compete with the existing data that includes rich incumbents such as Facebook or Google. This phenomenon results in the creation of a virtuous cycle which reinforces the hegemony of the big few, creating a huge entry barrier for start-ups.
- **High cost and low availability** of computing infrastructure required for development, training and deployment of AI-based services. Cloud infrastructure, though growing rapidly, has limited capability.
- **Lack of infrastructure** is the major reason for many Indian AI start-ups that aim to incorporate their business outside the country, thus, making AI outside the reach of Indian researchers in government labs and many industries. Initiatives like GI Cloud (MeghRaj), are in the right direction.
- **Lack of AI awareness** in resolving business-related issues in most of the public enterprises and government agencies has led to the scarcity of AI professionals in obstructing adoption.

### **THREATS ASSOCIATED WITH AI**

- **Data Protection:** one of the most important challenges to adopting AI is the question of data security. The data stored or assimilated in the AI systems can fall into the wrong hands and the repercussions could be catastrophic.
- **Understanding:** The AI systems are built based on algorithms, which can be far too technical for the common man to understand. This makes it difficult for the public to understand its functioning too.
- Lack of enabling data ecosystems
- The low intensity of AI research
- Core research in fundamental technologies
- Transforming core research into market applications
- Lack of AI expertise, and manpower skills
- Uncertain privacy, security, and ethical regulations
- **Data democratization**

- Unattractive Intellectual Property regime to incentivize research and adoption of AI
- It can result in the replacement of **manpower**.

Apple and most of the Chinese brands of mobile phones have facial recognition technology imbibed in their software. This could lead to the possibility of “mass surveillance”, which also violates the privacy concerns of an individual.

The assimilated data in the AI systems could be passed onto the wrong hands which can prove to be a threat to national security.

The increasing reliance on the use of machines, machine learning, and the use of smart algorithms to power artificially intelligent systems, makes it prudent to regulate AI. The regulations should be focussed on the intended usage of the technology rather than restricting the usage of the technology itself.

#### **WAY FORWARD TO HARNESS THE POWER OF AI-BASED TECHNOLOGY:**

- **Instigating Core and Applied Research in AI:** Advanced research, both core and applied, provides the basis for commercialization and utilization of any emerging technology, more so for technologies like AI. A considerable amount of dedication and effort is required to build comprehensive research focusing on AI strategy for India.
- **Getting India ready for the AI wave:** India may appear to be relatively well-positioned to take advantage of the disruption in AI system through its advanced IT sector and large youth demographic potential to establish itself as the future hub for AI-related activities. However, given the reduced availability of qualified faculty and researchers, this advantage could quickly change into a liability without urgent government interventions towards promoting access to such skills. This is a critical component of AI development and should be a national priority.
- **Accelerating Adoption:** Adoption of AI in India has been slow and remains limited. Estimates indicate that only 22% of the firms in India use AI in any business process. Government intervention is needed to promote AI adoption, lest India loses the chance to secure a prominent position on the global AI map. While acknowledging the need to improve AI, governments at different levels, along with their various instrumentalities, should adopt proactive measures to accelerate AI adoption in multiple processes.
- **Ethics, Privacy, Security, and Artificial Intelligence:** AI is going to be the tipping point in the technological evolution of mankind, with human dependence on machines and algorithms for decision making never been so profound. Thus, any strategy document on promoting AI necessarily needs to be conscious of the probable factors of the AI ecosystem that may undermine ethical conduct, impinge on one’s privacy, and undermine the security protocol. Appropriate steps to mitigate these risks need to be an integral part of any such strategy. E.g., National Cyber Security Policy (NCSP – 2013) talks about the Sensitization of citizens, consumers, and employees on cybersecurity threats and basic and best practices Sensitization towards the safety of cyber threats and in pursuance of security programs.

These challenges, if addressed by relevant stakeholders, with the government playing a leading role could lead to fundamental building blocks that form the core to India's march towards leadership in AI in an expeditious manner through concerted and collaborative efforts.

### **3.11 ROBOTICS**

Robotics relates to the industry that deals with the engineering, design, manufacture, and operation of robots for various commercial industries and consumer uses. Robotics also refers to a branch of engineering that deals with the conceptualization, designing, manufacture, and operationalization of robots.

Robotics is an interdisciplinary branch that consists of various fields of engineering as well as artificial intelligence, nanotechnology bioengineering, etc.

#### **Developments Related to Robotics**

Robots have become an essential component of many modern manufacturing industries. As the modern manufacturing industries increase the use of robots, the number of jobs performed by robots is steadily rising. The use of robots in industries has increased their efficiency and productivity, and today robots are seen as a long term investment for benefactors.

All these developments have increased the concern over unemployment due to the risk of automation. According to a study, 47% of US jobs are at risk of automation over some unspecified number of years. However, the claims on artificial intelligence and robotics causing unemployment have been criticized on the ground that social policy and not artificial intelligence is responsible for this. Robotics and Robots present both challenges and opportunities for occupational safety and health. The benefits include the substitution of humans with robots in unhealthy and dangerous environments.

Robots are useful in space, defense and security, nuclear industry, logistics, maintenance, and inspection. They can replace humans performing a dirty, dull, and unsafe task and avoid workers' exposure to hazardous conditions and reduce risks. For example, robots are used for handling radioactive materials and for working in an explosive atmosphere.

Despite these advancements, there are certain skills to which only humans will be better suited, and therefore, it is important to achieve the best combination of robot and human skills.

The advantages of humans include creative decision making, flexibility and adaptability, whereas robotics has the advantage of performing heavy-duty jobs with precision and repeatability.

This combination of humans and robots sharing a common workplace has led to the development of new standards and approaches for ensuring the safety of the "man-robot merger".

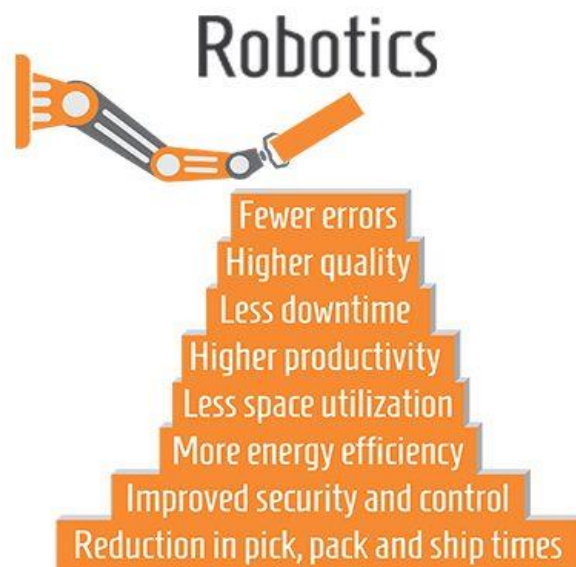
In the future, the cooperation between humans and robots will diversify into new forms. The current approaches and technical standards for the protection of employees from the risk of working will have to be revised.

#### **Advantages of Robots:**

- It is believed that recent developments in the robotics world have made robots more user friendly, intelligent, and most importantly, affordable. With these benefits of robotics, it is no

wonder that they have found jobs in every field. That is right, from industrial manufacturing to the medical field robots are being used.

- The benefits of robots have increased their flexibility by being capable of performing a variety of tasks and applications. They are more precise and consistent than human workers. Robots also allow for increased production and profit margins because they can complete tasks faster. Robots can work around the clock since they do not require vacations, sick days, or breaks. They also make fewer mistakes than humans, saving companies time.
- Other benefits of robotics are that they can work in any environment, adding to their flexibility. Robots eliminate dangerous jobs for humans because they are capable of working in hazardous environments. They can handle lifting heavy loads, toxic substances, and repetitive tasks. This has helped companies to prevent many accidents, also saving time and money.
- In the medical field, robots are used for intricate surgeries such as prostate cancer surgery. Robots can reach and fit where human hands cannot, allowing greater accuracy. Some robotic benefits in the medical field are less invasive procedures and less pain for the patient when recovering.
- Their ability to be customized provides companies with the flexibility to use them for a variety of tasks.



**Fig 3.13: Benefits of Robotics**

(Image source: [plastvision.org](http://plastvision.org))

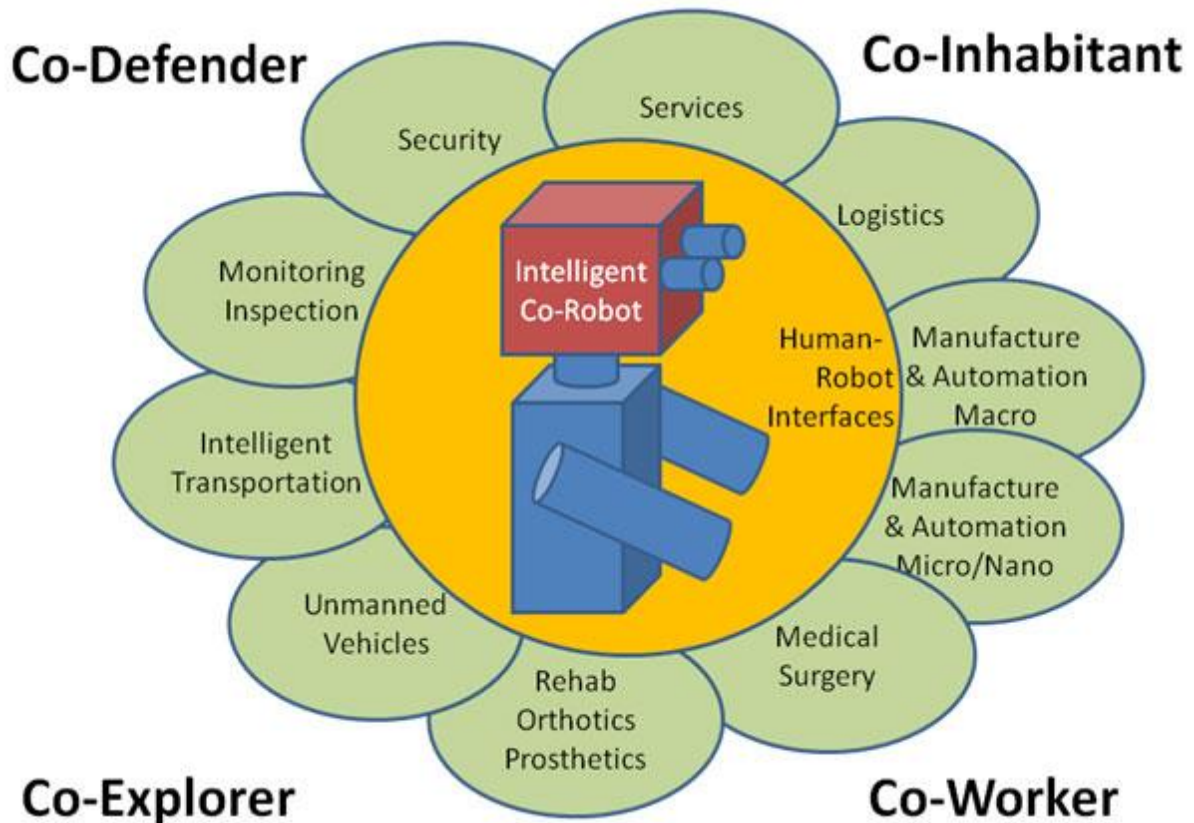
### **Disadvantages of Robotics**

- There are issues regarding job losses of people as also the extensive consumption of energy

- Moreover the cost associated with Development of software or techniques for robotics may be too high.
- Robots cost much money in maintenance & repair. The programs need to be updated to suit the changing requirements, and the machines need to be made smarter, In case of breakdown, the cost of repair may be very high, The procedures to restore lost code or data may be time-consuming & costly.
- The robot is not able to act any different from what they are programmed to do. With the heavy application of robots, the humans may become overly dependent on the machines, losing their mental capacities. If the control of robots goes in the wrong hands, Robots may cause destruction.
- They are not intelligent or sentient, and They can never improve the results of their jobs outside of their predefined programming. They do not think, They do not have emotions or conscience, This limits how the robots can help & interact with people.
- Robots can take the place of many humans in factories, So, the people have to find new jobs or be retrained, They can take the place of the humans in several situations, If the robots begin to replace the humans in every field, They will lead to unemployment.
- Robots inspire two types of fear: firstly, that they might take over our jobs, and secondly, that they could take over the world, Robots will steal our jobs, Robots have the effect of increasing productivity rather than eliminating jobs.
- Robots become increasingly present in our everyday life, with household robots, medical, industrial, on production lines, not to mention airports, banks, and hotels, So, Robots may dominate the human species. Robots can operate on the basis of information fed to them through a chip; when one thing goes wrong, the entire company bears a loss.
- Although They can save times, it can also result in a lag, It is a machine so you can't expect too much from them, If the robot has malfunctioned, you need extra time to fix it, which would require reprogramming, If robots would do all the work, and the humans will just sit and monitor them, health hazards will increase rapidly, Obesity will be on top of the list and less labour at workplaces.



Applications of Robotics:



**Fig 3.14: Various Fields For Applications**

*(Image source: National Science Foundation)*

### 3.12 CYBORG

Cyborg can be considered as the real version of technological advancement that was once considered as fiction. The term cyborg was first coined in 1960. The scientists described cyborg as a man-machine system in which the control mechanisms of the human portion are modified externally by drugs or any other device so that the man can be able to live in an environment different from the normal one.

Cyborg is a short version for the cybernetic organism. Although an older term, modern research and increased use of technology in biomedicine make cyborg the future of human development. As the name suggests, cyborg consists partly of humans and part machines. Those people who are having a cardiac pacemaker, contact lenses or implants come under the cyborg.

The last two decades see the ever-fast pace in the development of cyborgs. Various successful implantation like embedment of the antenna inside the skull, bionic limb connection through nerve-muscle grafting and many others show that cyborg does not remain merely a fiction that we see in comics like Justice League and Avengers, but it's a modern world reality.

Cyborg is said to be an open field by modern scientists. As technology advances, more and more augmentation of the body with machines will occur. This augmentation, no doubt, will make humans more agile and stronger. However, all this will also impact the basic behaviour of human beings. The

effect may both be positive as well as negative. Therefore, there exist serious ethical issues in this regard.

This augmentation will make humans more agile and stronger. However, all the effect may both be positive as well as negative. Therefore, there exists serious ethical issues in this regard.

### **Challenges**

- Firstly, artificial limbs do not provide a sense of touch that connects us with our family or allow us to feel the outer world as before. The real cause is less evolution in the field of development of sensing skin.
- Secondly, as we have already discussed that there exists a serious ethical dilemma in the future of cyborg, there are many people with implants inserted in their bodies to increase the innate human capacities, both mental and physical. All these activities may redefine the meaning of humanness, the change that may cause problems.
- They have a limited lifespan thus issues of durability, replacements may arise that may complicate the problems.

The cyborg technology has already taken the next stage of integration beyond the medical field. The machines are not serving merely as an alternative to the human body part. The cyborg technology is setting the stage for the next chapter of human evolution. The contemporary field of cyborg research lies in the brain-machine interface. Any breakthrough may change our view of humanity.

The criticism and problems associated with cyborg cannot be avoided. However, the solution lies not in closing, but in more responsible and ethical research in this field. Keeping this in mind, the first Cyborg Olympics were organized in Zurich, Switzerland, in 2016. It was the first time that the official celebration of cyborg sports was conducted. It is believed that cyborgs are the next step in human evolution of mankind. The establishment of colonies on different planets is imminent in the near future, and so is the development in cyborg technology. There is a need for all the ethical and moral questions to be resolved over the global stage. Like all other inventions, the cyborg can work both as a boon or a bane, and the choice is ours.

## **3.13 SUPERCOMPUTERS**

### **INTRODUCTION**

Supercomputers, comparatively, have a very high level of computing performance with respect to general purpose computers and their performance is generally measured in FLOPS (floating point operations per second). These computers are known for their high level of memory and performance speeds. Their performance is generally evaluated in petaflops (1 followed by 15 zeros). Supercomputers have utilities in solving problems that are too complex and huge for standard computers.

### **SUPERCOMPUTERS IN INDIA**

India started its journey towards supercomputers because of the denial by USA to export Cray supercomputers due to the arms embargo imposed on India after Nuclear tests in the 1970s. It was believed that India might use the supercomputers for the development of military purposes since supercomputers came under dual-use technology groups.

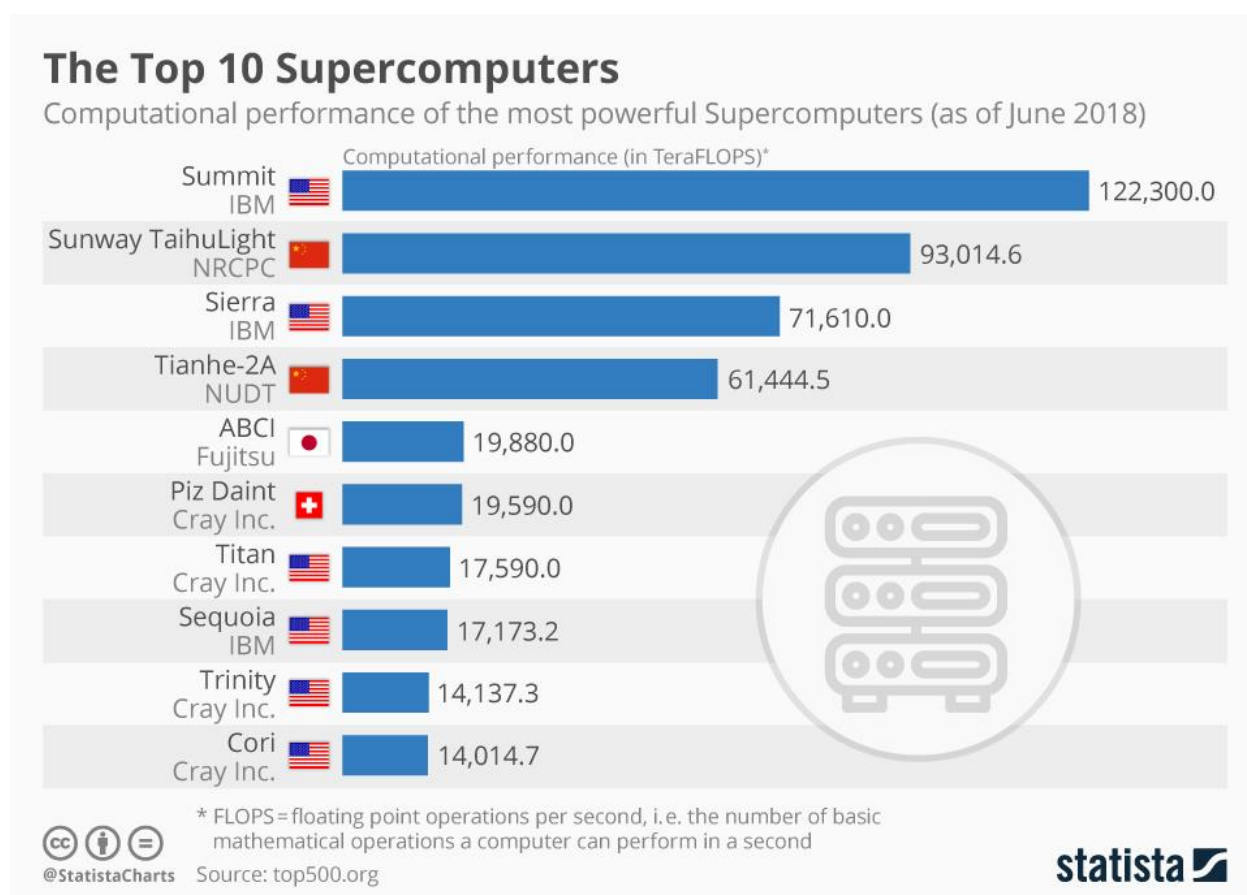
Ideation phase was started in the 1980s.

**India developed its first indigenous supercomputer in the year 1991.** The Centre for Development of Advanced Computing was instrumental in this which named the supercomputer as PARAM 8000. It was assisted by Russia in this project.

PARAM 8000 was replicated and installed at ICAD Moscow in 1991 under Russian collaboration. In 2007, India held top 10 spots for speeds of supercomputers. India has nine supercomputers with speeds in top 500 but not any in top 10.

It unveiled PRATYUSH and MIHIR ,one of the worlds’ fastest supercomputers under its **National Supercomputing Mission.**

**NOTE:- Summit (USA), Sunway TaihuLight And Sierra** are the top three Supercomputers of the world.



**Fig 3.15: World’s Fastest Supercomputers**

(Image source: statista)

### 3.14 NATIONAL SUPERCOMPUTING MISSION

National Supercomputing Mission, is a mission of the Government of India to boost the supercomputing capabilities of India.

- This mission consists of designing and manufacturing 73 supercomputers in India.

- These clusters of supercomputers will be connected to various academic and research institutions across India. This grid will be connected to the National Knowledge Network (NKN).
- This is a Rs 4,500 Crore project.
- In 2018, the Government of India awarded a contract to French company Atos to build supercomputers under this mission. Atos has collaborated with Indian partners in Chennai and Pune to build most of the required parts.

Currently, Pratyush and Mihir are the Fastest Supercomputers in India. These are the 2 High-Performance Computing Units (HPC) with a combined speed of 6.8 PetaFlops. Pratyush is established in Indian Institute of Tropical Meteorology (IITM), Pune. Mihir is established in the National Centre for Medium-Range Weather Forecast (NCMRWF), Noida.

**Pratyush and Mihir are used for the following applications:**

- Weather forecasting
- Air quality
- Fishing
- To detect natural calamities

The Nodal Agencies for the Mission are :

- **Department of Science and Technology (Government of India)**
- **Department of Electronics and Information Technology (DeitY)**
- **Centre for Development of Advanced Computing (C-DAC)**
- **Indian Institute of Science (IISc)**

The Supercomputers which will be developed under the mission can be used for many new-age applications. Few examples are given below:-

- Weather forecasting
- Natural disaster predictions
- Drug discovery
- Space applications
- Aerodynamic research
- 3D nuclear test simulations.

### **3.15 QUANTUM COMPUTING**

A group of physicists including Max Born, Wolfgang Pauli and Werner Heisenberg in the early 1920s at the University of Göttingen had coined the term “Quantum Mechanics”. The gradual

acknowledgment by scientists that matter has wave-like properties and radiation has particle-like properties provided the momentum for the development of quantum mechanics.

It is the branch of physics that deals with the behavior of light and matter on a subatomic and atomic level. It attempts to explain the properties of atoms and molecules and their fundamental particles like protons, neutrons, electrons, gluons, and quarks. The properties of particles include their interactions with each other and with electromagnetic radiation.

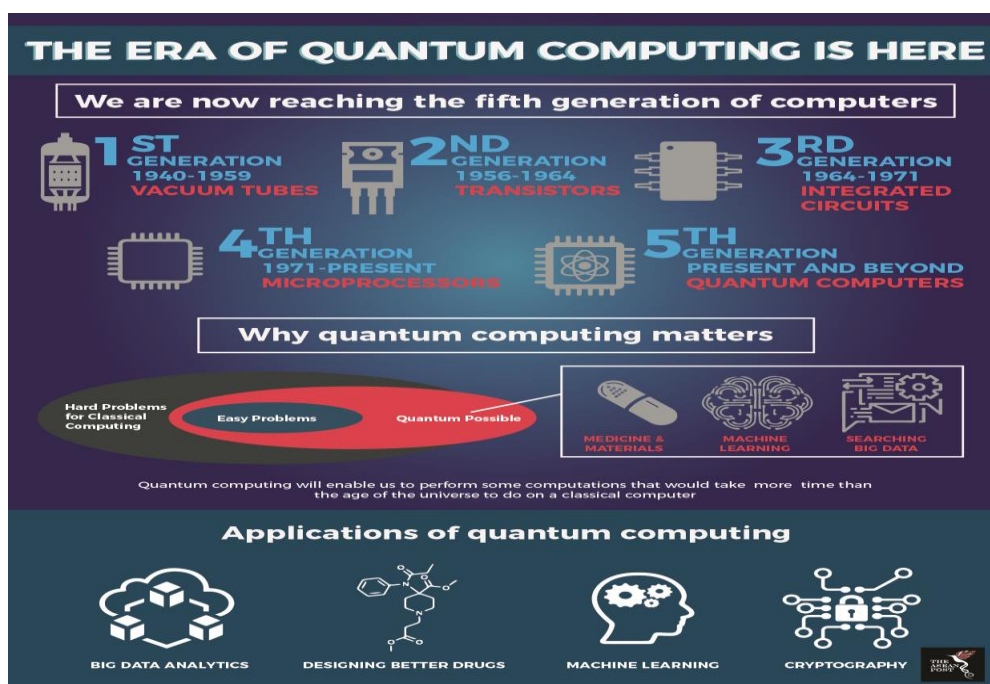
Quantum mechanics is here to stay and taking it as a thing of the past will be a mistake. Till now it was not as popular but recently,. Quantum mechanics has been applied and accepted into many fields like thermodynamics, cryptography, optics, computers and also meteorology. Research is going on in these fields.

## QUANTUM MECHANICS AND COMPUTERS

Computers have come a long way since their inception in the 18th century (The Analytical Engine). Today Computers have become so powerful that they can do the mathematical and scientific high performing millions of calculations every second, predicting the weather and also, beating humans at chess, which has been possible due to Advancements in technology.

Fundamentally, a normal computer can encode information as a string of binary digits consisting of 0s and 1s. Quantum computers take this to the next level with “Qubits”, bits that equal 0s and 1s at the same time. What this means is it can perform certain tasks like molecular modeling and factoring numbers much faster than an ordinary computer.

Quantum computers are different from binary digital electronic computers that are based on transistors (a semiconductor device used to amplify or switch electronic signals and electrical power). The common digital computing requires the data to be encoded into binary digits (bits), each of which is always in one of two definite states (0 or 1).

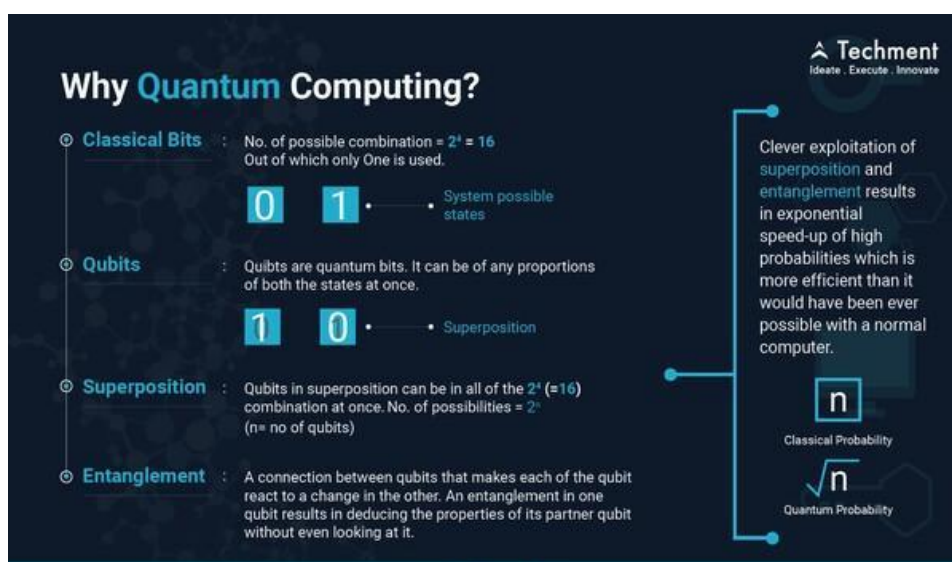


**Fig 3.16: Quantum Computing**

(Image source: IBM)

### Working of Quantum Computers:

- They work according to two key principles of quantum physics: **superposition** and **entanglement**.
- When each qubit can represent both a '1' and a '0' at the same time it is known as superposition.
- When qubits in a superposition state can be correlated with each other; that is when states of qubits are interdependent, it is called entanglement.
- It means that particles remain connected so that actions performed on one affect the other, even when separated by great distances. Albert Einstein had called this phenomenon "spooky action at a distance."
- With these two principles, the qubits enable quantum computers to solve difficult problems that are unmanageable using today's computers.



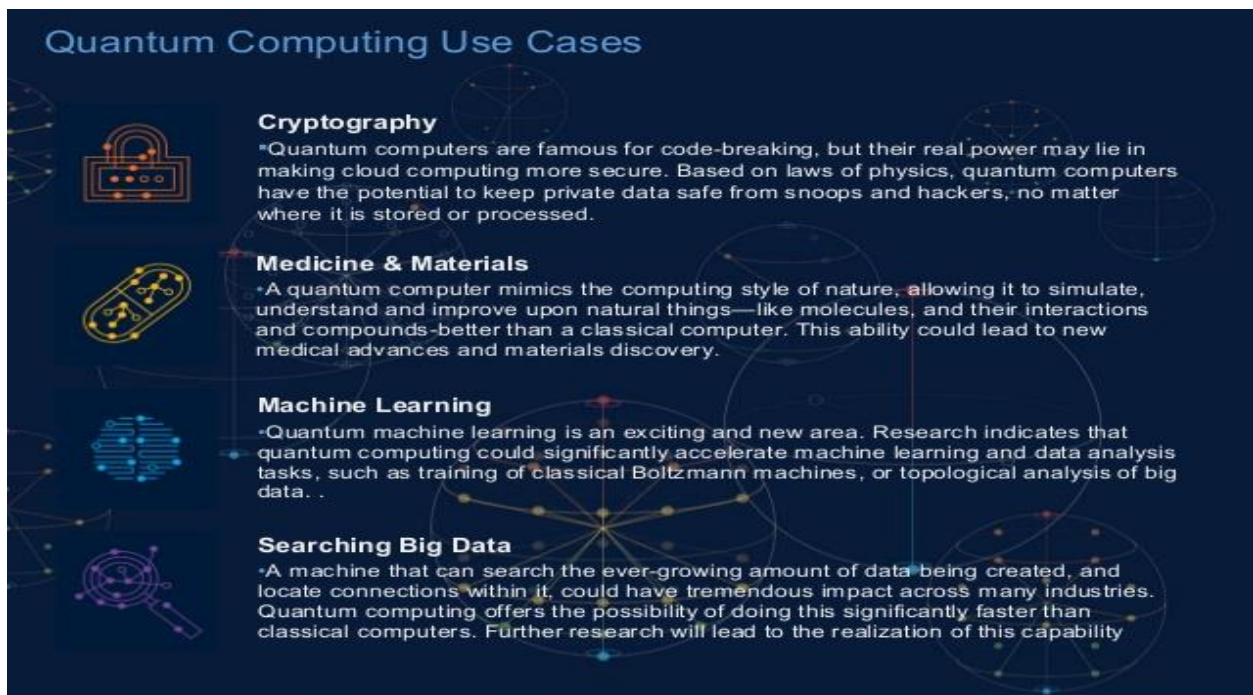
**Fig 3.17 QUANTUM COMPUTING**

(Image source: IBM)

### QUANTUM SUPREMACY

In quantum computing, quantum supremacy refers to quantum computers being able to solve a problem that a classical computer cannot. In the year 2011 by John Preskill, Professor of Theoretical Physics at the California Institute of Technology, coined the term 'quantum supremacy'.





**Fig 3.18 QUANTUM COMPUTING (UTILITIES)**

*(Image source: Enabler space)*

### **INDIAN INITIATIVE**

- In 2018, the Department of Science & Technology unveiled a program called Quantum-Enabled Science & Technology (QuEST) and committed to investing ₹80 crores over the next three years to accelerate research. The ostensible plan is to have a quantum computer built in India within the next decade.
- National Mission on Quantum Technologies & Applications (NM-QTA):
- India has joined a select few countries that chase “Quantum Supremacy” with an Rs 8,000-crore national mission to crack into the next-generation technology, which promises exponential ‘compute’ power and to rewrite the rules of present-day computing.
- The Department of Science and Technology will build a homegrown 50 Qubit ‘Quantum Computer’ in 4-5 years as part of the mission, which will also include building solutions for quantum communications, storage and encryption.
- Quantum technologies are rapidly developing globally with huge disruptive potential. The next-generation transformative technologies that will receive a push under this mission include quantum computers and computing, quantum communication, quantum key distribution, encryption, cryptanalysis, quantum devices, quantum sensing, quantum materials, quantum clock and so on. The areas of focus for the Mission will be in fundamental science, translation, technology development, human and infrastructural resource generation, innovation and start-ups to address issues concerning national priorities.

- The Mission will be able to address the ever-increasing technological requirements of the society and take into account the international technology trends and road maps of leading countries for the development of next-generation technologies.

### **Significance of the mission:**

Implementation of the mission would help develop and bring quantum computers, secure communications through fiber and free space, quantum encryption and crypt-analysis, and associated technologies within reach in the country and help address India specific national and regional issues.

The mission will help prepare next-generation skilled manpower, boost translational research and also encourage entrepreneurship and start-up ecosystem development. By promoting advanced research in quantum science and technology, technology development and higher education in science, technology and engineering disciplines India can be brought at par with other advanced countries and can derive several direct and indirect benefits.

## **3.16 RECENT DEVELOPMENTS IN ICT**

### **1. Digital India Mission:-**

The Indian Government launched the Digital India campaign to make available government services to citizens electronically by online infrastructure improvement and also by enhancing internet connectivity. It also aims to empower the country digitally in the domain of technology. Prime Minister Narendra Modi launched the campaign on 1st July 2015.

Digital India was an initiative taken by the Government of India for providing high-speed internet networks to rural areas.

### **2. Vision of Digital India:**

Digital India Mission is mainly focused on three areas:

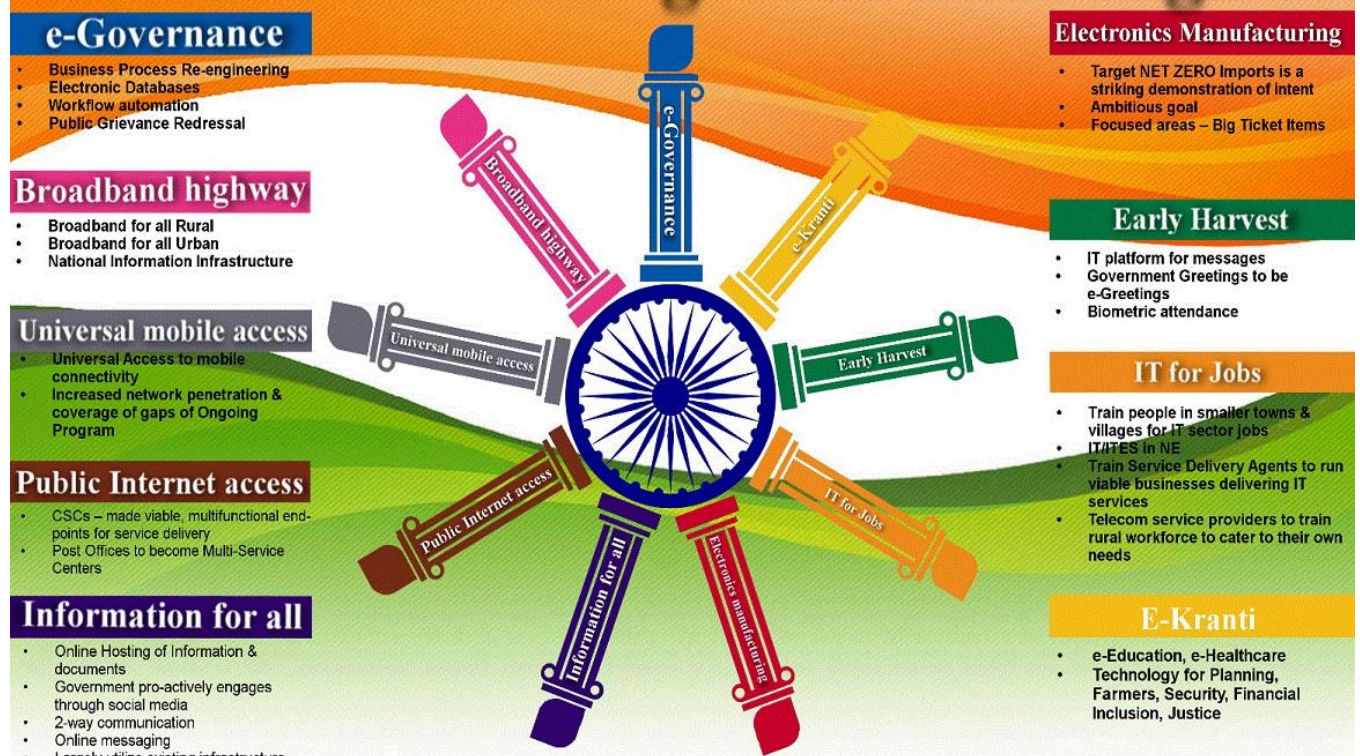
- Providing digital infrastructure as a source of utility to every citizen.
- Governance and services on demand.
- To look after the digital empowerment of every citizen.

Digital India was established with a vision of inclusive growth in areas of electronic services, products, manufacturing and job opportunities.

**There are major nine pillars of Digital India are:**



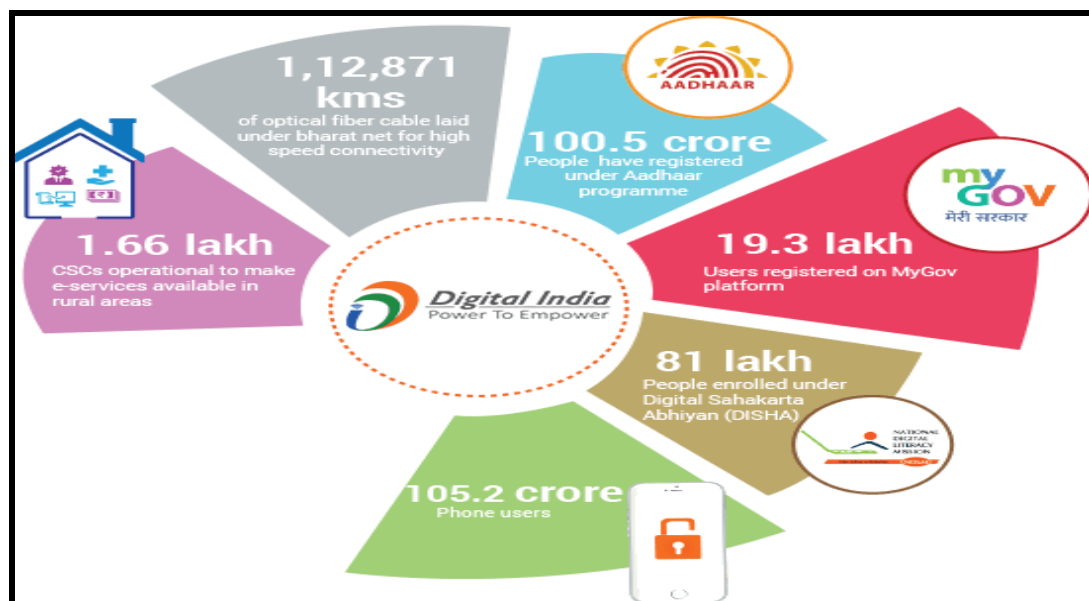
# The 9 Pillars of Digital India Program



**Fig 3.19: Components of Digital India**

(Image source: Pib)

In the last 4 years since its launch several achievements have been made under the Digital India Mission as given below:



**Fig 3.20: Achievements Under Digital India, (IMAGE SOURCE:MYGOV)**

### **Objectives of Digital India:**

The motto of Digital India Mission is '**Power to Empower**'. While there are three core components to the Digital India initiative. They are - **digital infrastructure creation, digital delivery of services and digital literacy.**

The major objectives of this initiative are listed below:

- To provide high-speed internet in all gram panchayats.
- To provide easy access to the Common Service Centre (CSC) in all the localities.
- Digital India is an initiative that combines a large number of ideas and thoughts into a single, comprehensive vision so that each of them is seen as part of a larger goal.
- The Digital India Programme also focuses on restructuring many existing schemes that can be implemented in a synchronized manner

### **3.17 ADVANTAGES OF DIGITAL INDIA MISSION**

Digital India Mission is an initiative that encompasses plans to connect the rural areas of the country with high-speed internet networks. On the platform of digital adoption, India ranks amongst the top 2 countries globally and the digital economy of India is likely to cross \$1 trillion by the year 2022.

Some of the advantages of Digital India are:

- Around 12000 post office branches in the rural areas have been linked electronically.
- There is an increase in electronic transactions related to e-governance.
- Optical fiber network of 2, 74,246 km has connected over 1.15 lakh Gram Panchayats under the Bharat Net programme.
- A Common Service Center (CSC) is created under the National e-Governance Project of the Indian government which provides access for information and communication technology (ICT)., the CSCs provide multimedia content related to e-governance, education, health, telemedicine, entertainment, and other government and private services with the help of computer and internet access.
- Digital villages along with well-equipped facilities such as solar lighting, LED assembly unit, sanitary napkin production unit and Wi-Fi choupal will be set up under the mission.
- Delivery of services with the internet and other digital technologies and the urban internet penetration has reached 64%.
- Presently, the number of daily active internet users has reached 300 million from 10-15 million daily users. Also, it is estimated that the number would double by the year 2020.

### **Challenges of Digital India:**

The Government of India has taken an initiative through the Digital India Mission to connect the rural areas of the country with high-speed internet networks. Apart from the various initiatives taken by Digital India, there are several challenges faced by it.

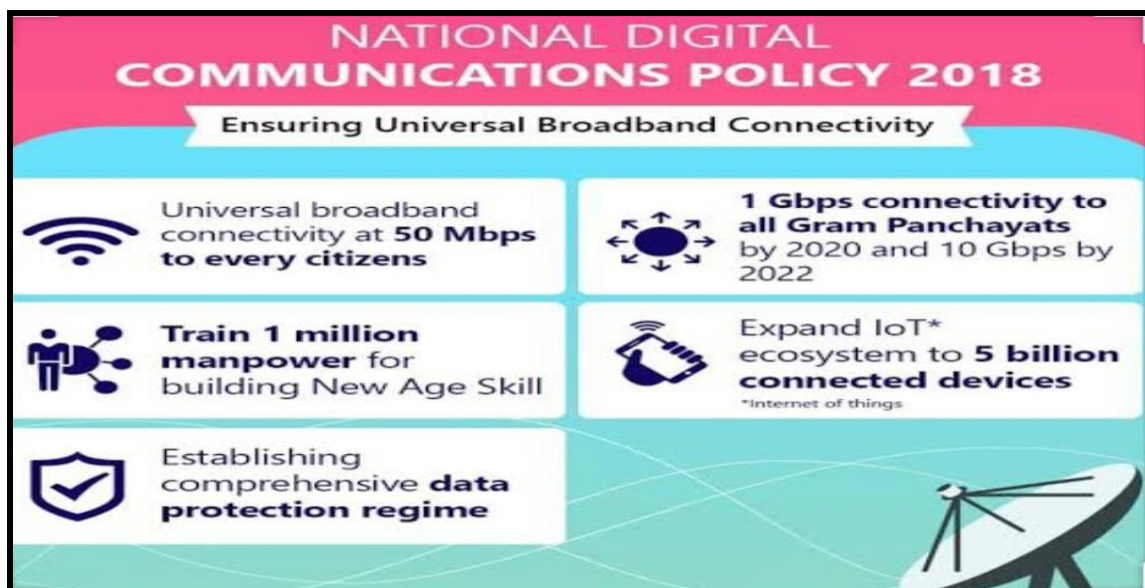
Some of the challenges and drawbacks of Digital Mission are mentioned below:

- The daily internet speed, as well as the Wi-Fi hotspots, are slow as compared to other developed nations.
- Adapting to the new modern technology is an issue for Most of the small and medium scale industry has to struggle a lot for
- Lack of sufficient availability of smartphones with digital enabled technology.
- Lack of enough skilled manpower in the field of digital technology.
- Cyber security is a concern with rising cases of frauds
- Lack of digital education.

### **3.18 NATIONAL DIGITAL COMMUNICATIONS POLICY (2018)**

As the present world has entered the era of modern technological advancements in the Telecom Sector such as 5G, IoT, M2M etc., a need was being felt to introduce a 'customer focused' and 'application driven' policy for the Indian Telecom Sector, which can form the main pillar of Digital India by addressing emerging opportunities for expanding not only the availability of telecom services but also telecom based services. Thus in place of the existing National Telecom Policy-2012, a new National Digital Communications Policy - 2018 has been formulated, to cater to the modern needs of the digital communications sector of India.

The policy envisions India's transition to a digitally empowered society and information/knowledge economy and in this light it seeks to fulfil the information and communications needs of citizens and enterprises by establishment of affordable digital infrastructure.

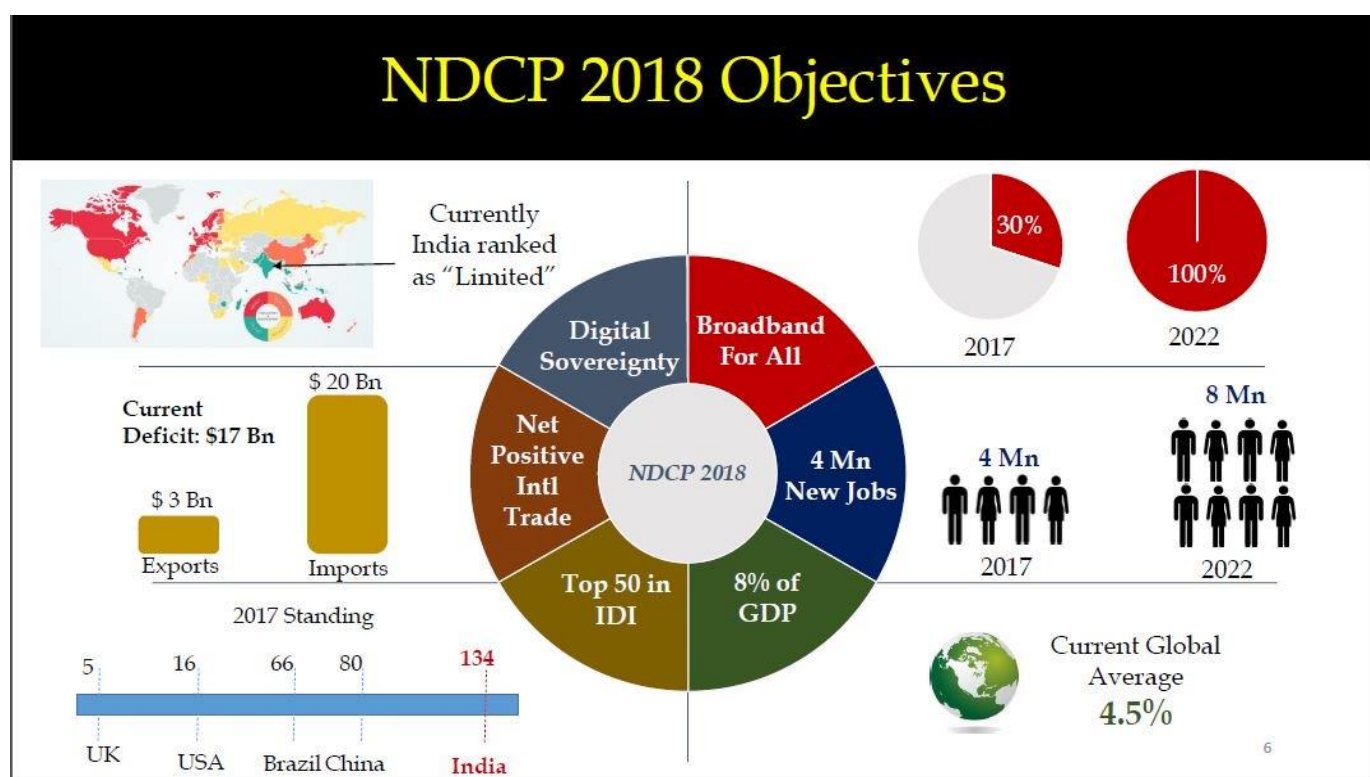


**Fig 3.21 National Digital Communications Policy, (Image source: Mygov.in)**



## Objective of the Policy

These objectives are to be achieved by 2022:-



**Fig 3.22 Objectives of NDCP-2018**

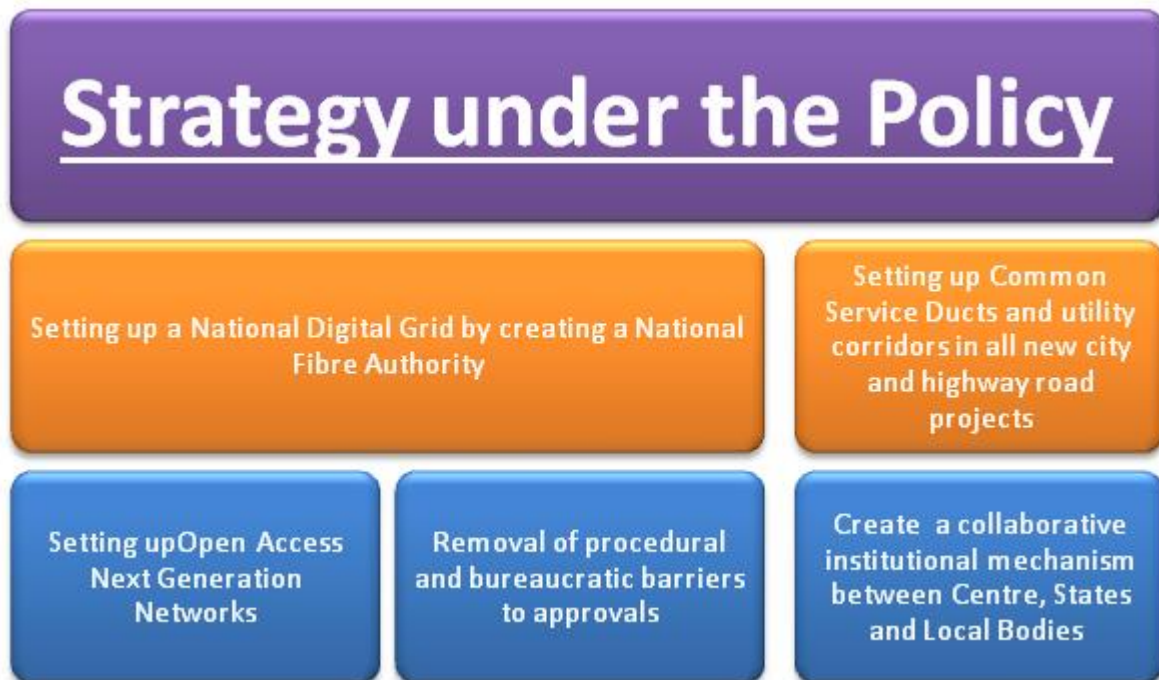
(Image source: Inc42.com)

### **3.19 FEATURES OF THE POLICY**

The policy aims to:

- Provide universal broadband connectivity at 50 Mbps to every citizen;
- Provide 1 Gbps connectivity to all Gram Panchayats by 2020 and 10 Gbps by 2022;
- Ensure connectivity to all uncovered areas;
- Attract investments of USD 100 billion in the Digital Communications Sector;
- Train one million manpower for building New Age Skill;
- Expand IoT ecosystem to 5 billion connected devices;
- Establish a comprehensive data protection regime for digital communications that safeguards the privacy, autonomy and choice of individuals
- Facilitate India's effective participation in the global digital economy;
- Enforce accountability through appropriate institutional mechanisms to assure citizens of safe and
- Secure digital communications infrastructure and services.

**Strategy under the Policy:**



**3.20 CLOUD COMPUTING**

According to a recent report, more than a million jobs will be created in the Cloud Computing sector of India by 2022. The area of cloud computing is rapidly becoming more prevalent and dominant in both small scale medium and large businesses and companies. Also, it could be seen that large businesses and firms are gradually investing heavily in the cloud infrastructure and the sector is expected to grow very fast by the year 2022.

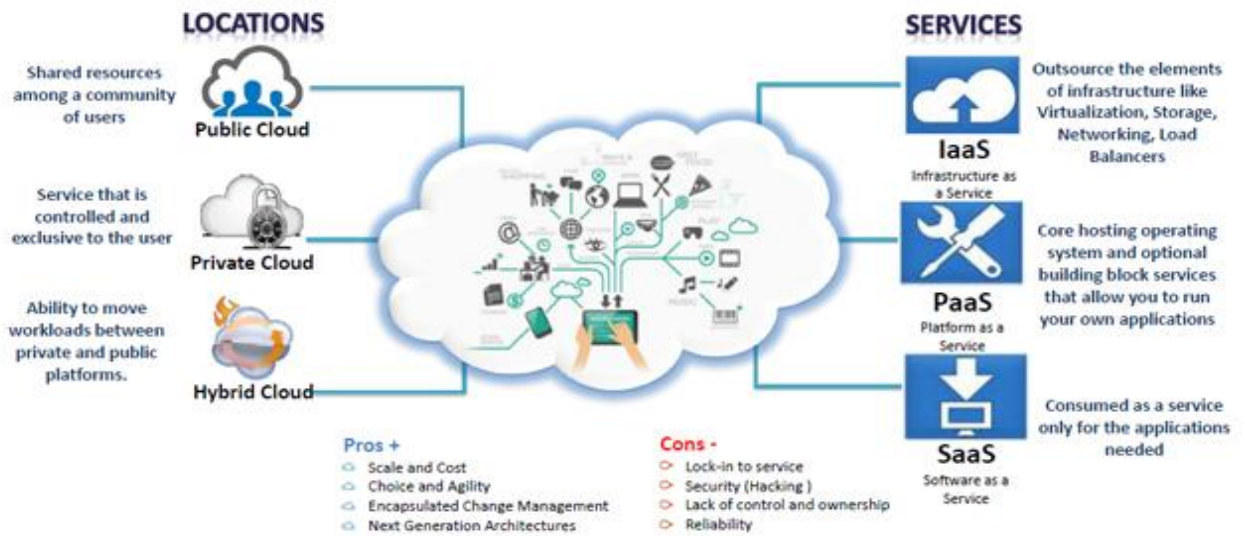
There has been a growing application of Cloud computing in India in the last few years as they are used in everyday activities of people such as social networking, mail, online purchases, and large-scale operations of MNCs including big data, Internet of Things (IoT), etc.

It has been realized by the Government and Indian Private Businesses that it offers huge potential for firms to grow, expand, and is opening up new windows of opportunities not only locally but also globally. Several sectors like retail, banking, manufacturing, railways, education, and healthcare among Others have started the adaptation of cloud services.

**CLOUD COMPUTING:**

Cloud computing relates to delivering hosted services over the internet. The cloud computing process involves providing a pool of shared resources like networks, servers, storage, applications, and services that can be provided to the consumer rather than the consumer managing them on her own which is costly and time-consuming. The Internet is at the core of the evolution of this technology.

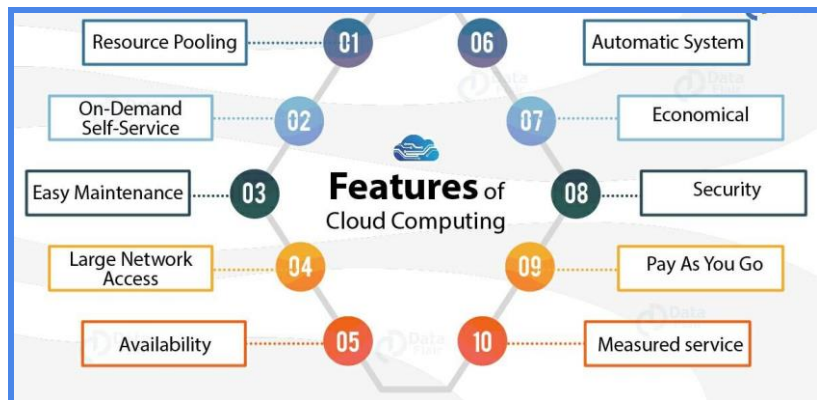
## What is Cloud Computing?



**Fig 3.23: Cloud Computing**

(Image source: dataflair.training)

### Features of Cloud Computing:



**Fig 3.24 :Cloud computing features**

(Image source: Data flair)

### **Benefits of Cloud Computing:**

<b>Improved disaster recovery</b>	<b>Disaster recovery can be made possible by Moving the business data to the cloud ie., retrieving data in case of a hardware compromise.</b>
<b>Cloud computing services minimize IT requirements and physical storage, which helps small businesses cut significant business costs.</b>	<b>Environmental friendly as Carbon footprint is minimised due to low energy consumption</b>

### **Disadvantages of Cloud Computing:**

<b>Issues of high maintenance Cost</b>	<b>Security as Companies with sensitive data will require their own IT department to keep data secure because when the data is stored in the cloud, the company is trusting a third party to keep it safe.</b>	<b>Need of Continuous internet connectivity</b>	<b>There are challenges of integrating cloud computing at smaller scale and adaptability of Small-scale companies and servers is still a question</b>
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## **3.21 BHARAT-NET PROJECT**

BharatNet Project is the world's largest rural broadband connectivity program using Optical fiber. It is implemented by Bharat Broadband Network Limited (BBNL) – a special purpose vehicle under the Telecom Ministry and is the Government of India's ambitious rural internet connectivity program. It has subsumed all the ongoing and proposed broadband network projects. The project is being executed by BSNL, RailTel, and Power Grid and is being funded by the Universal Service Obligation Fund (USOF).

### **OBJECTIVES:**

- It aims to connect all of India's households, specifically rural households through demand, affordable high-speed internet connectivity to fulfill the objectives of the Digital India program in partnership with the states and the private sector.
- The Bharat Net project proposes broadband connectivity to households under village Panchayats and even to government institutions at the district level.
- It intends to cover all 2.5 lakh Gram Panchayats for the provision of E-governance, E-healthcare, E-Commerce, E-Education, and Public Interest Access services.

- The first phase of the Bharat Net project will be completed in December 2017, providing internet access to 1 lakh Gram Panchayats. So far, 83000 Gram Panchayats have been connected.
- The equipment for the program are indigenously designed and are manufactured in India, under the “Make in India” initiative.

**Recent Development:**

Under Phase -II, implementation is done through the State Model, Private Sector Model, and CPSU Model. Not only will this phase include an optimum mix of channels for connectivity (Optical Fibre Cables, Radio, and Satellites), but will also be providing last-mile connectivity through Wi-Fi or similar technology to ensure that internet is available at the home/office. This is based on the recommendations of the committee on the National Open Fiber Network which submitted its report in 2015.

About eight states have opted for a State-led model while the satellite model is being implemented mostly in states which have a difficult terrain. Uttar Pradesh is implementing the project through both BSNL (CPSU Led) and PPP Model.

As on 06 March 2020, Optical Fiber Cables have been laid for over 4.27 lakh kilometers connecting more than 1.5 Lakh gram panchayats. Around 1.37 lakh of these have been made service ready as per the latest data on BBNL website.