

# Science and Technology



# Syllabus

- Science and Technology- developments and their applications and effects in everyday life
- Achievements of Indians in science & technology
- Indigenization of technology and developing new technology
- Awareness in the fields of
  - IT
  - Space
  - Computers
  - Robotics
  - Nano-technology
  - Bio-technology
  - Issues relating to intellectual property rights.

# 2021 Questions

1. How is S-400 air defence system technically superior to any other system presently available in the world? (Answer in 150 words)
2. What are the research and developmental achievements in applied biotechnology/? How will these achievements help to uplift the poorer sections of the society? (Answer in 250 words)
3. The Nobel Prize in Physics of 2014 was jointly awarded to Akasaki, Amano and Nakamura for the invention of Blue LEDs in 1990s. How has this invention impacted the everyday life of human beings ? (Answer in 250 words)

# Past Year Questions - Mains

- **Space technology**
  - What is India“s plan to have its own space station and how will it benefit our space programme? 2019
  - India has achieved remarkable successes in unmanned space missions including the Chandrayaan and Mars Orbitter Mission, but has not ventured into manned space mission, both in terms of technology and logistics? Explain critically. 2017
  - Discuss India“s achievements in the field of Space Science and Technology. How the application of this technology has helped India in its socio-economic development? 2016
  - What do you understand by „Standard Positioning Systems“ and „Protection Positioning Systems“ in the GPS era? Discuss the advantages India perceives from its ambitious IRNSS programme employing just seven satellites. 2015
- **Biotechnology**
  - How can biotechnology improve the living standards of farmers? 2019
  - Why is there so much activity in the field of biotechnology in our country? How has this activity benefitted the field of biopharmacy? 2018
  - Stem cell therapy is gaining popularity in India to treat a wide variety of medical conditions including Leukaemia, Thalassemia, damaged cornea and several burns. Describe briefly what stem cell therapy is and what advantages it has over other treatments. 2017

# Past Year Questions - Mains

- **Nanotechnology**
  - What do you understand by nanotechnology and how is it helping in health sector? 2020
  - Why is nanotechnology one of the key technologies of the 21st century? Describe the salient features of Indian Government's Mission on Nanoscience and Technology and the scope of its application in the development process of the country. 2016
- **Robotics**
  - What are the areas of prohibitive labour that can be sustainably managed by robots? Discuss the initiatives that can propel research in premier research institutes for substantive and gainful innovation. 2015
- **IPR Related Issues**
  - How is the government of India protecting traditional knowledge of medicine from patenting by pharmaceutical companies? 2019
  - India's Traditional Knowledge Digital Library (TKDL) which has a database containing formatted information on more than 2 million medicinal formulations is proving a powerful weapon in the country's fight against erroneous patents. Discuss the pros and cons making this database publicly available under open-source licensing. 2015
  - In a globalised world, intellectual property rights assume significance and are a source of litigation. Broadly distinguish between the terms – copyrights, patents and trade secrets. 2014

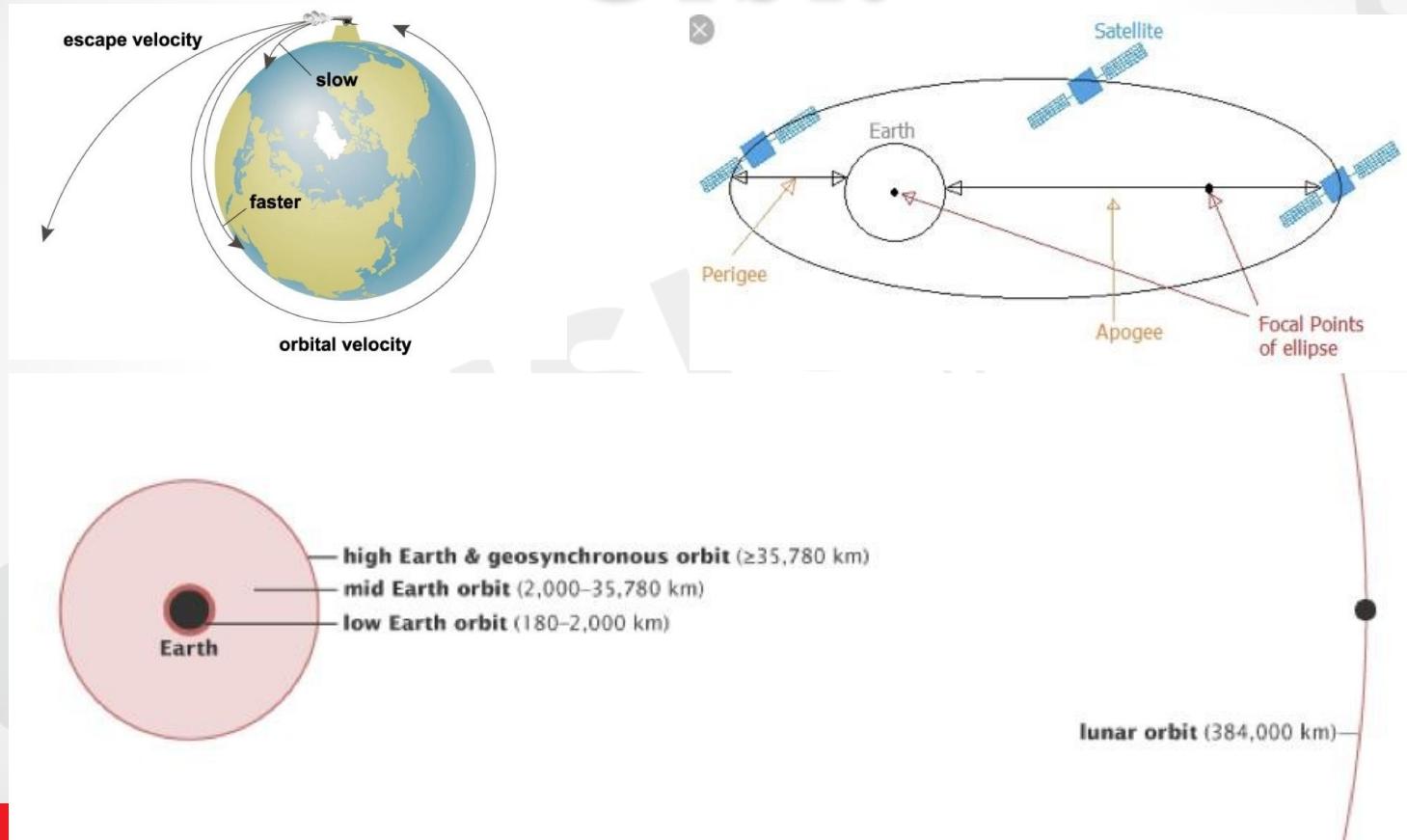
# Past Year Questions - Mains

- **Nuclear Technology**
  - With growing energy needs should India keep on expanding its nuclear energy programme? Discuss the facts and fears associated with nuclear energy. 2018
  - Give an account of the growth and development of nuclear science and technology in India. What is the advantage of fast breeder reactor programme in India? 2017
- **Contributions of India in Science and Technology**
  - How was India benefited from the contributions of Sir M. Visvesvaraya and Dr. M. S. Swaminathan in the fields of water engineering and agricultural science respectively? 2019
  - Discuss the work of „Bose-Einstein Statistics“ done by Prof. Satyendra Nath Bose and show how it revolutionized the field of Physics. 2018
- **Science and Technology – Developments and Applications**
  - COVID-19 pandemic has caused unprecedented devastation worldwide. However, technological advancements are being availed readily to win over the crisis. Give an account of how technology was sought to aid management of the pandemic. 2020
  - How is science interwoven deeply with our lives? What are the striking changes in agriculture triggered off by the science-based technologies? 2020
  - Scientific research in Indian universities is declining, because a career in science is not as attractive as our business operations, engineering or administration, and the universities are becoming consumer oriented. Critically comment. 2014
  - Can overuse and the availability of antibiotics without doctor’s prescription, the contributors to the emergence of drug-resistant diseases in India? What are the available mechanisms for monitoring and control? Critically discuss the various issues involved. 2014

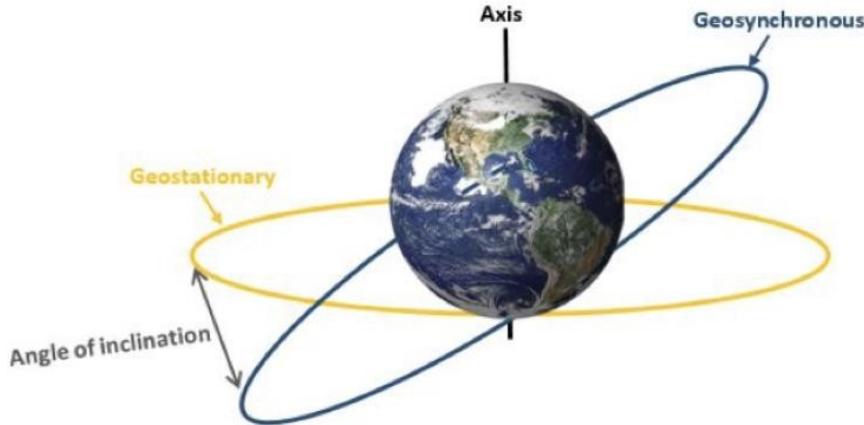


# Space Technology

# Orbit



# Geosynchronous, Geostationary and Geo Transfer orbit

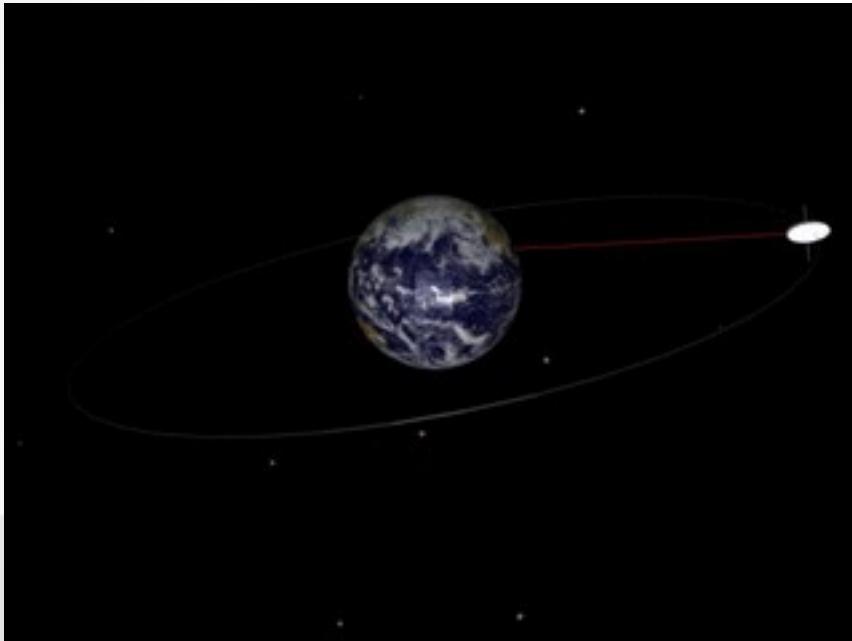


## Geosynchronous orbit

- satellite completes one orbit around the earth in one sidereal day (23 hours 59 minutes, 4.091 seconds)
- an altitude of about 35,786 km
- Communications and surveillance satellites

<https://www.youtube.com/watch?v=sj7zsGkpZxg>

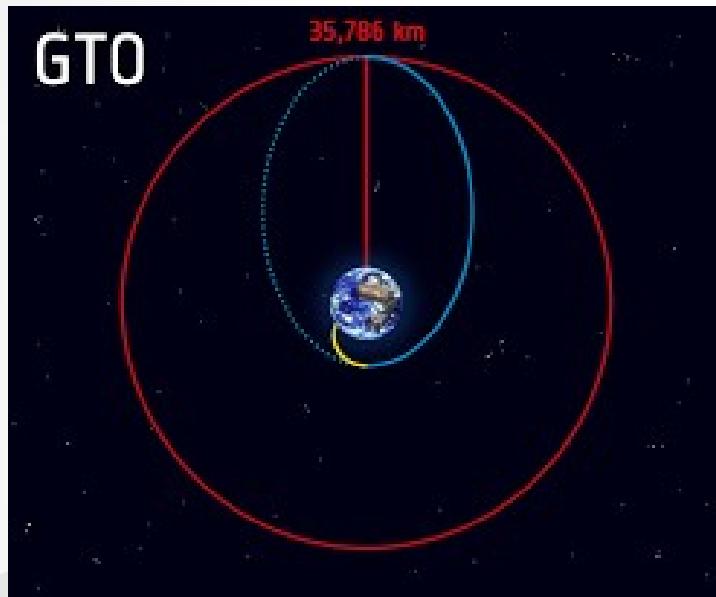
# Geosynchronous, Geostationary and Geo Transfer orbit



## Geostationary orbit

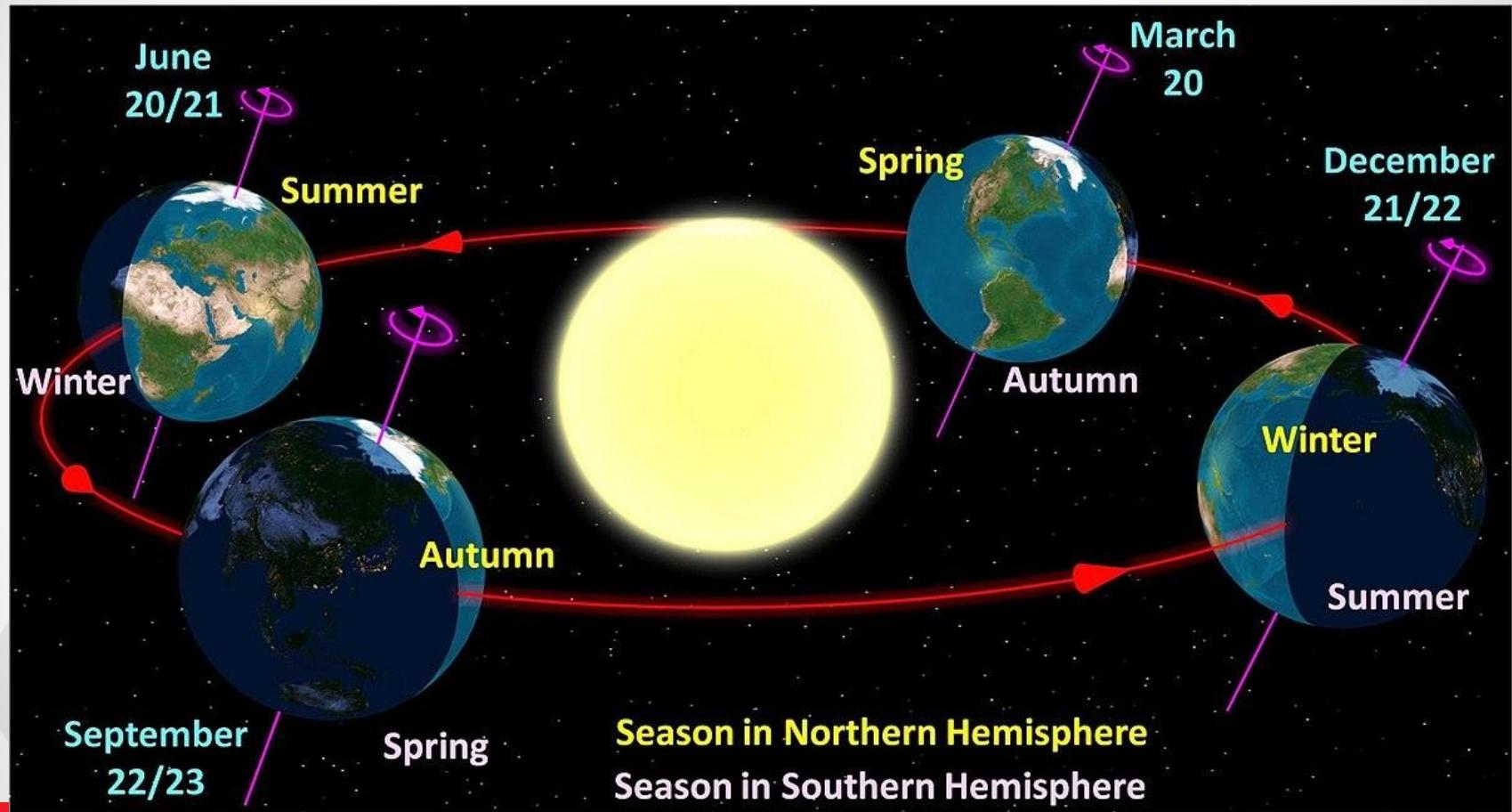
- Circular Orbit
- a special case of a geosynchronous orbit
- stay over the same point of the earth's equator
- Orbit lies in Equatorial plane

# Geosynchronous, Geostationary and Geo Transfer orbit

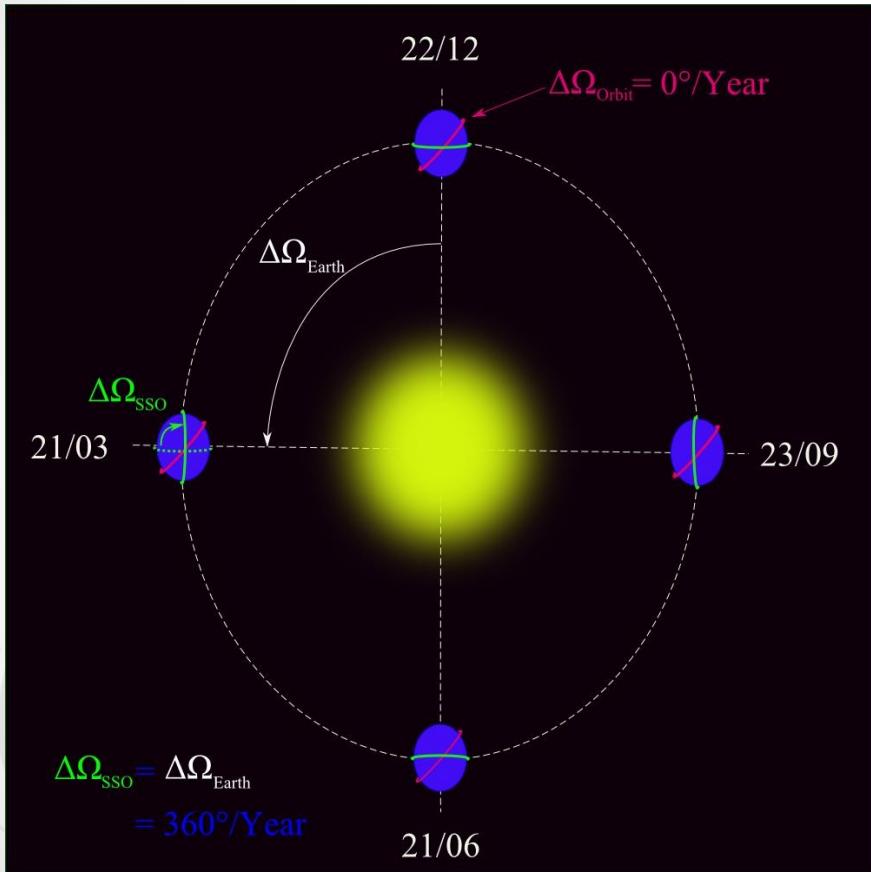


## Geo Transfer orbit

- an elliptical orbit used to transfer a spacecraft from a low altitude orbit or flight trajectory to geostationary/geosynchronous orbit.
- Apogee – 35,786 km



# Polar Sun synchronous orbit (PSSO)

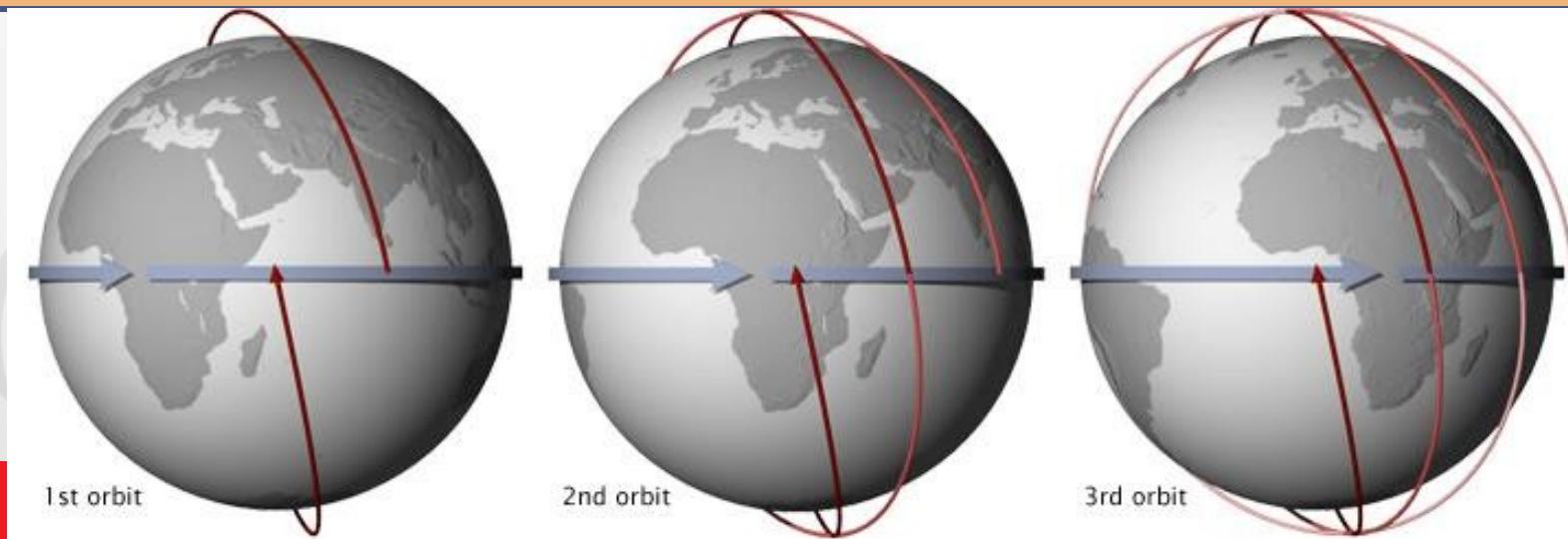


## Polar Sun synchronous orbit

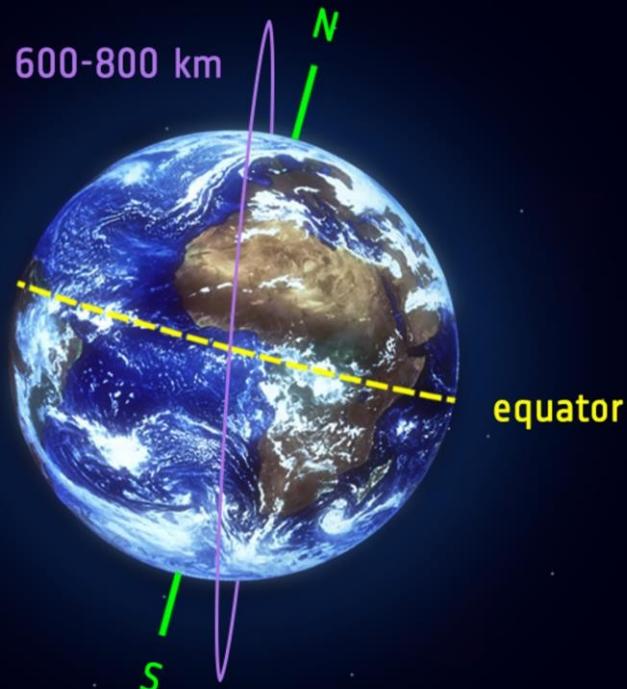
- satellite's orientation is fixed relative to the Sun throughout the year
- whenever the satellite observes a given ground location, the Sun is always in the same location in the sky.
- satellite passes over any given point of the planet's surface at the same local solar time.

# Polar Sun synchronous orbit (PSSO)

- This consistent lighting is a useful characteristic for satellites that image the Earth's surface
  - can compare images from the same season over several years
  - very useful thing for a weather or Earth Observation/Remote Sensing satellite
  - precession of the orbital plane around the Earth due to gravitational irregularities keeps the plane at a constant angle with respect to a line between the Earth and Sun throughout the year.
  - 96–98°, LEO



# SSO



# UPSC Prelims Questions

An artificial satellite orbiting around the Earth does not fall down. This is so because the attraction of Earth.

- (a) Does not exist at such distance
- (b) Is neutralized by the attraction of the moon
- (c) Provides the necessary speed for its steady motion
- (d) Provides the necessary acceleration for its motion

Satellites used for telecommunication relay are kept in a geostationary orbit. A satellite is said to be in such an orbit when

- 1. The orbit is geosynchronous.
- 2. The orbit is circular.
- 3. The orbit lies in the plane of the Earth's equator.
- 4. The orbit is at an altitude of 22,236 km.

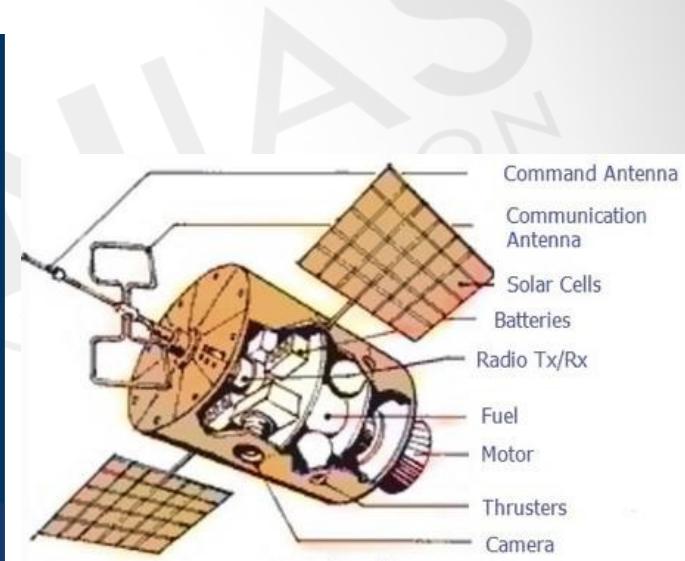
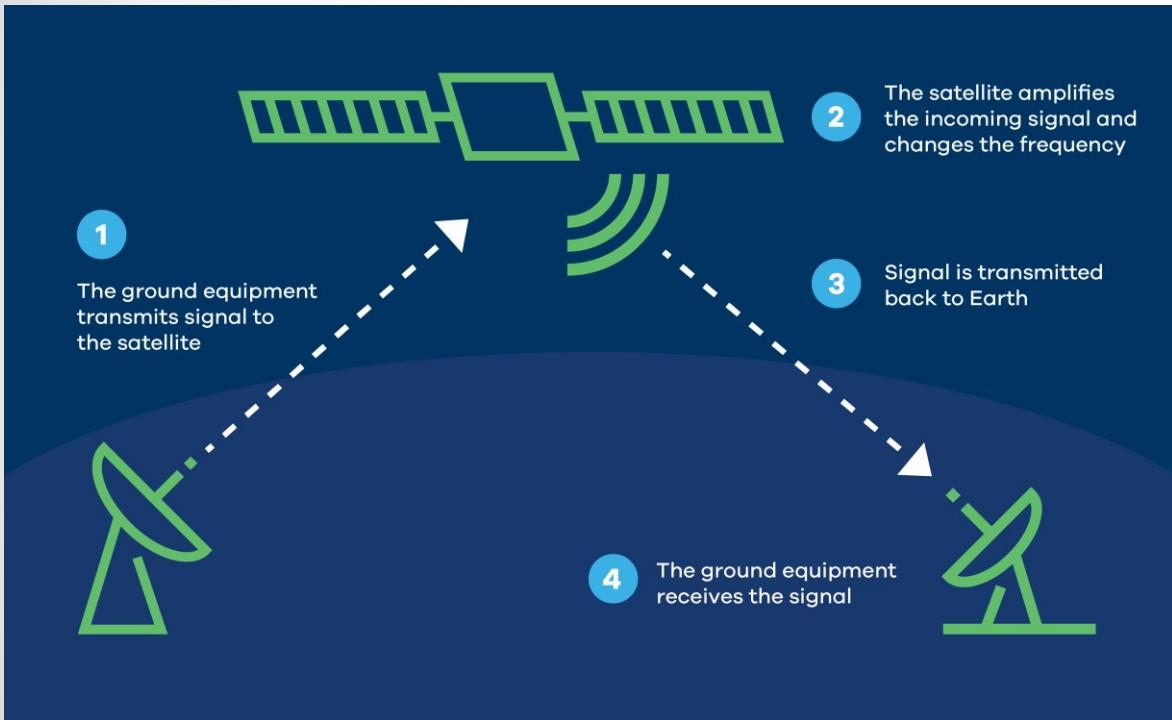
Select the correct answer using the codes given below:

- (a) 1,2 and 3 only
- (b) 1, 3 and 4 only
- (c) 2 and 4 only
- (d) 1, 2, 3 and 4

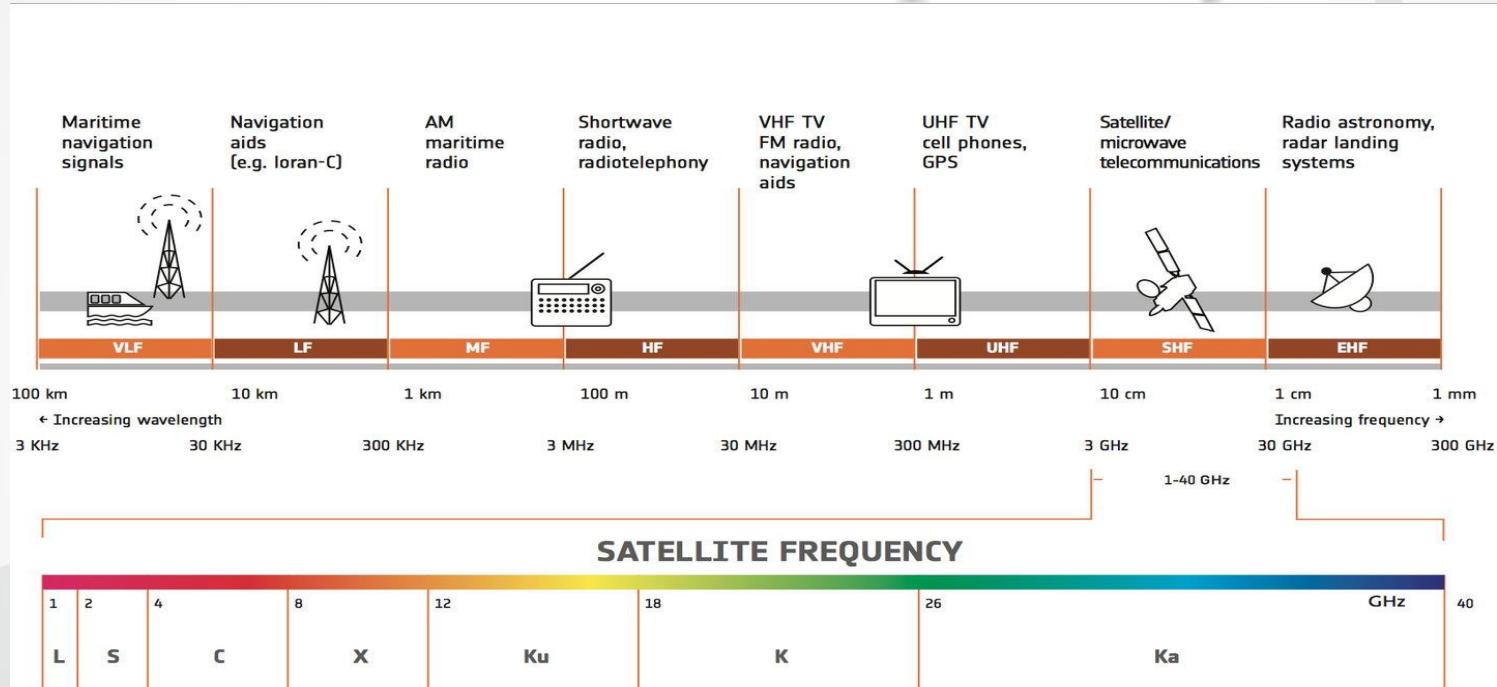
# ISRO Classification of Satellites

- Communication
- Earth Observations
- Navigation
- Space Science
- Experimental
- Small Satellite
- University / Academic Institute Satellites

# Communication Satellites



# Satellite frequency



# IDRSS

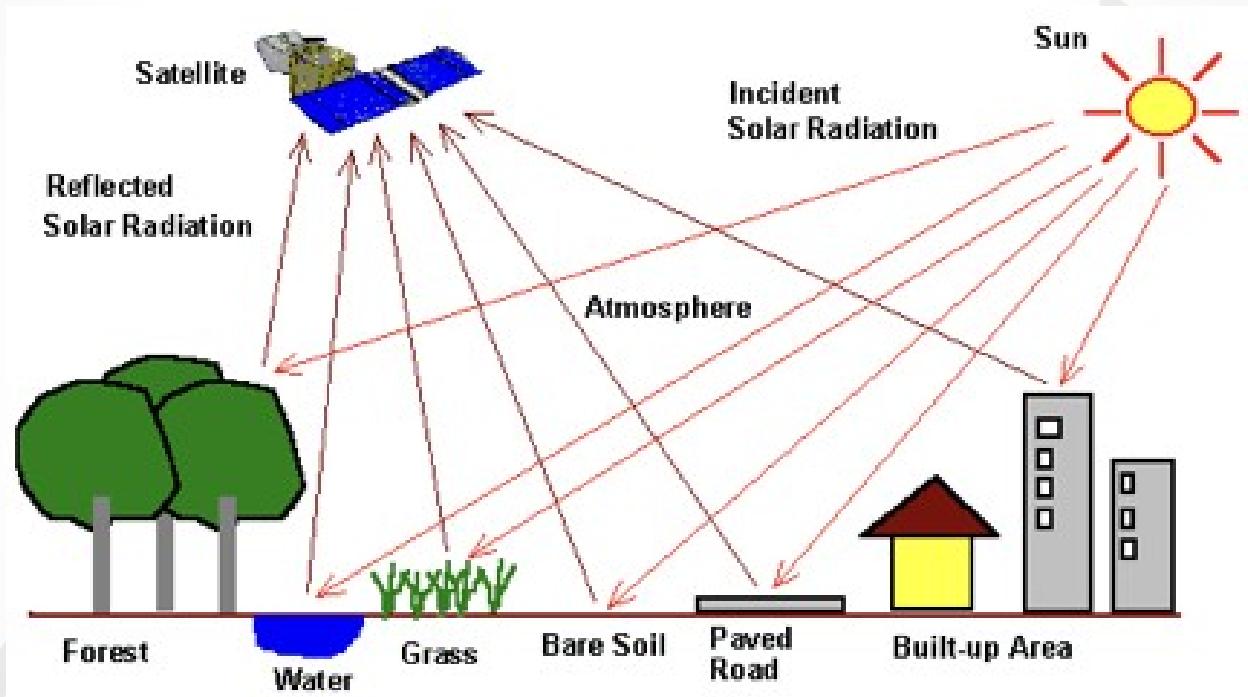
- New satellite series: **Indian Data Relay Satellite System (IDRSS)**.
  - **Now CMS 04**
- Satellites in orbit cannot pass along their information to the ground stations on Earth if the satellite does not have a clear view of the ground station.
- To reduce the dependence on the ground stations
- Therefore, DRS serves as a way to pass along the satellite's information.



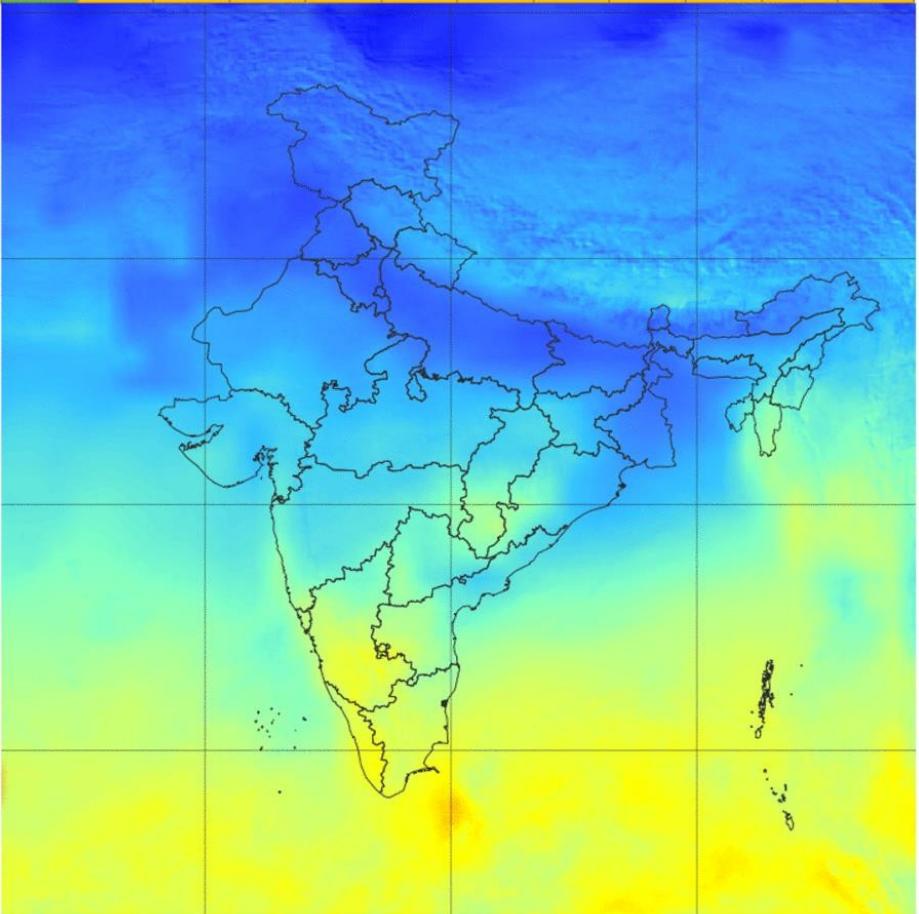
# IDRSS

- **2 satellites** in geostationary orbit
- track, send and receive signal from satellites even in low-earth orbits (LEO)
- Helpful in future missions – Gaganyaan, expedition to moon, Venus, Mars
- Only US, China, Japan and Europe have DRS system.

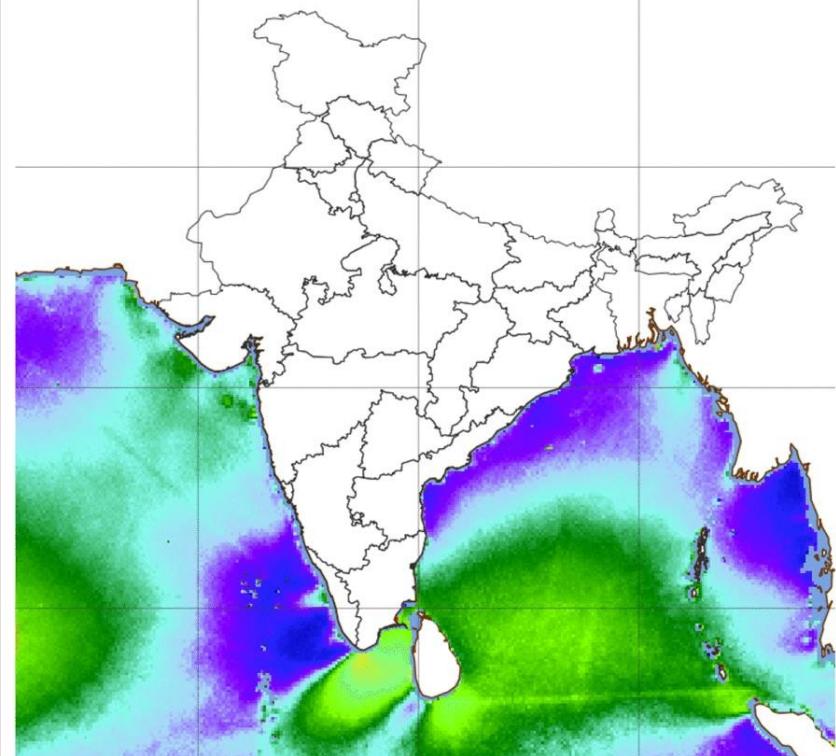
# Remote sensing satellite



Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



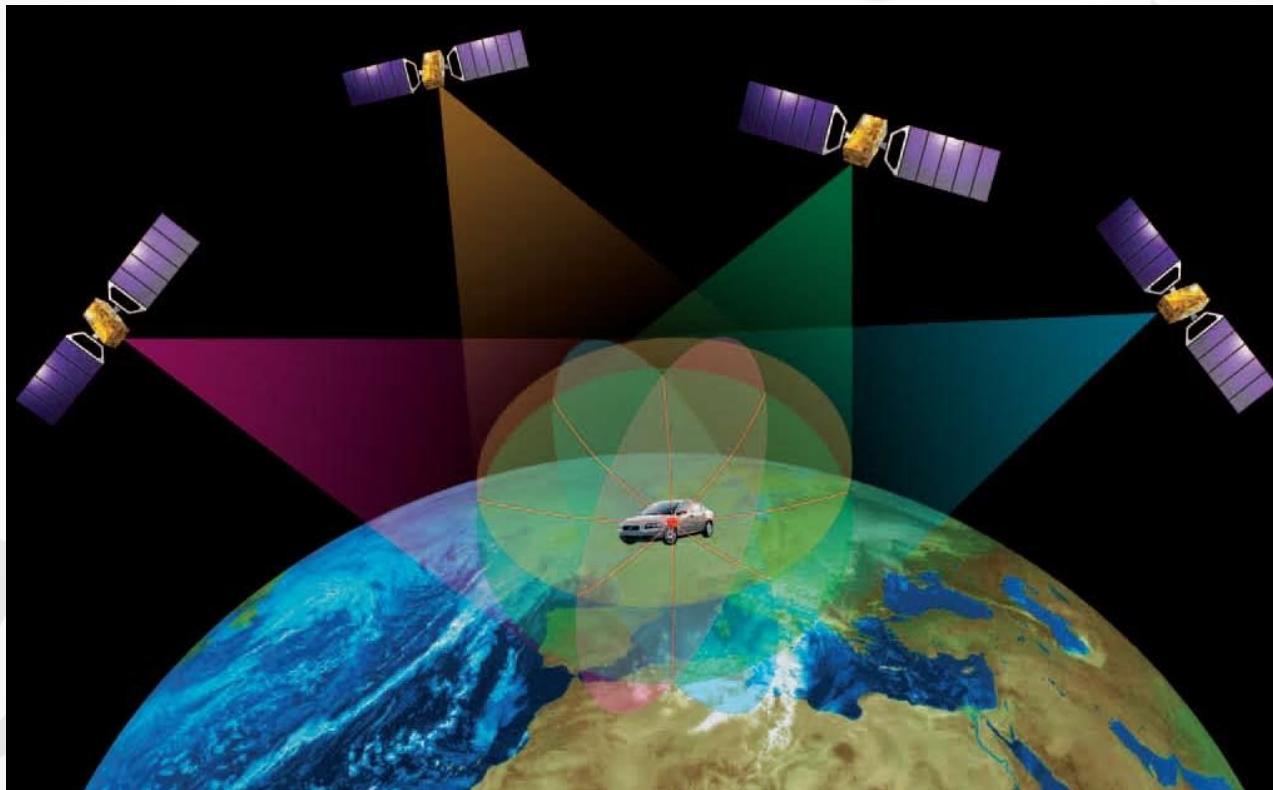
# GISAT-1

- Earth Observation satellite in Geo-Stationary orbit
- 2275 kg, 7 years, GSLV Mk II
- for providing near real time imaging and real time monitoring.
- multi-spectral (Visible and Near-InfraRed, and Short Wave-InfraRed), multi-resolution imaging instruments.
- will provide imaging of large areas of earth and atmosphere very frequently

# NISAR Mission

- NASA-ISRO Synthetic Aperture Radar
  - a technique for producing fine-resolution images
  - It requires that the radar be moving either on an airplane or orbiting in space.
- **dual frequency L-band and S- band radar mission,**
- map Earth every 12 days from two directions.
- **studying hazards and global environmental change**
  - ecosystem disturbances, ice-sheet collapse, and natural hazards such as earthquakes, tsunamis, volcanoes and landslides

# Satellite Navigation



## IRNSS

# Indian Regional Navigation Satellite System

IRNSS (NavIC) is designed to provide accurate real-time positioning and timing services to users in India as well as region extending up to 1,500 km from its boundary

**NAVIGATION CONSTELLATION CONSISTS OF SEVEN SATELLITES**

**3** in geostationary earth orbit (GEO) and

**4** in geosynchronous orbit (GSO) inclined at 29 degrees to equator

Each sat has three rubidium atomic clocks, which provide accurate locational data

### IT WILL PROVIDE TWO TYPES OF SERVICES

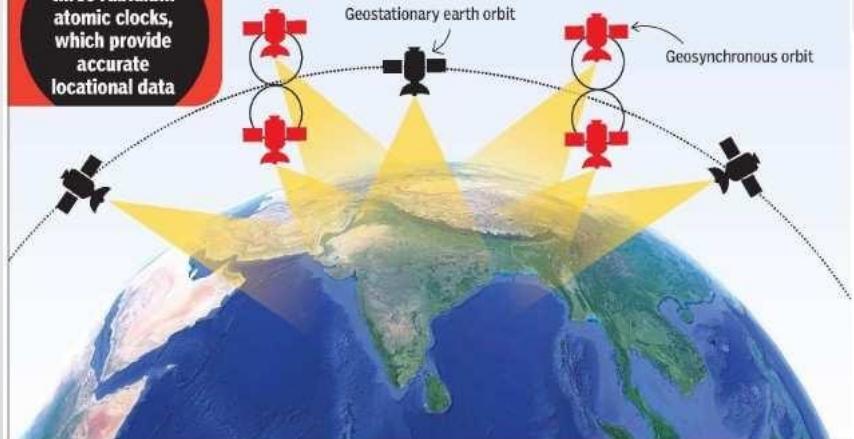
**1** Standard positioning service | Meant for all users

**2** Restricted service | Encrypted service provided only to authorised users (military and security agencies)

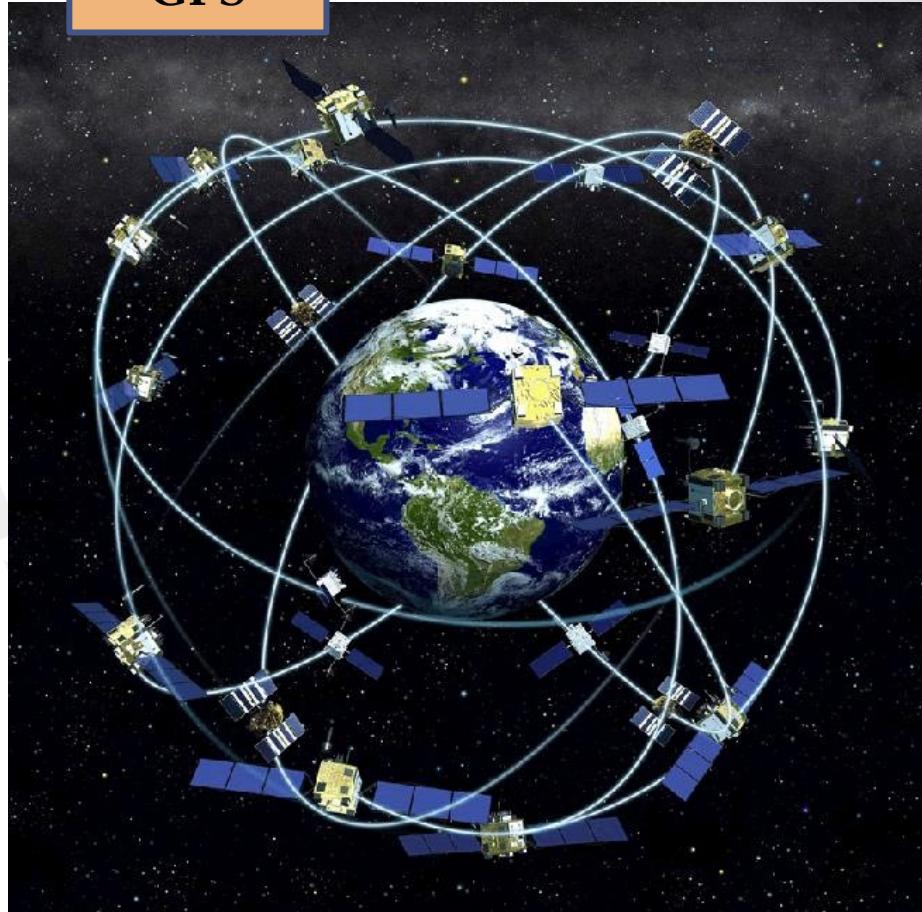
#### Applications of IRNSS are:

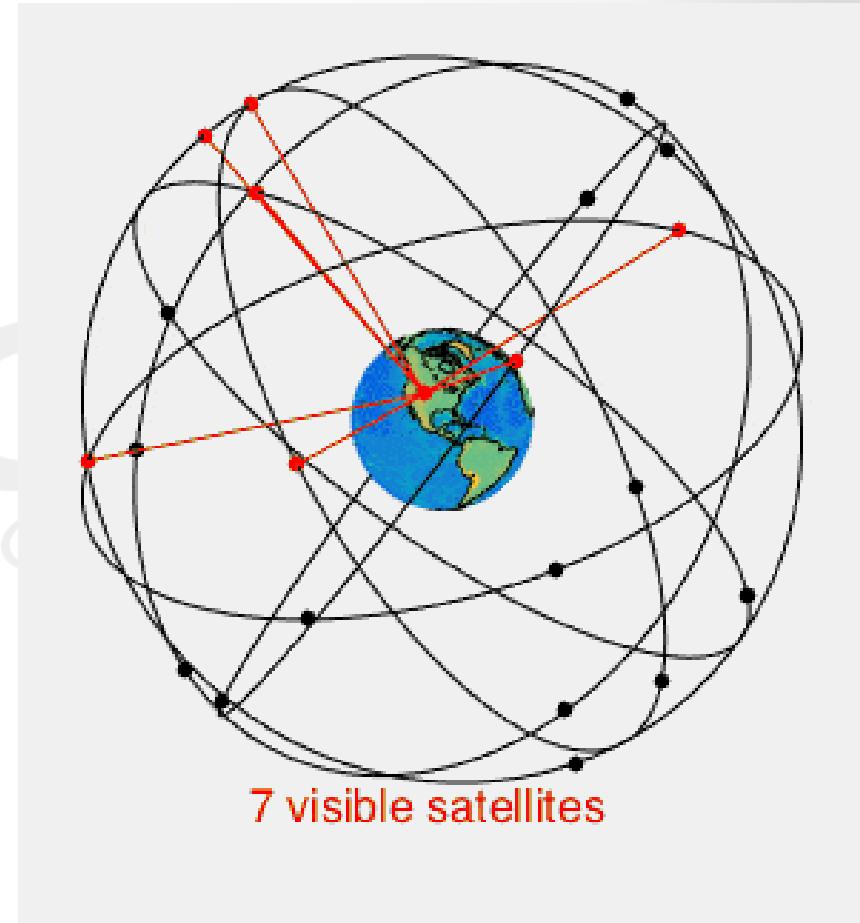
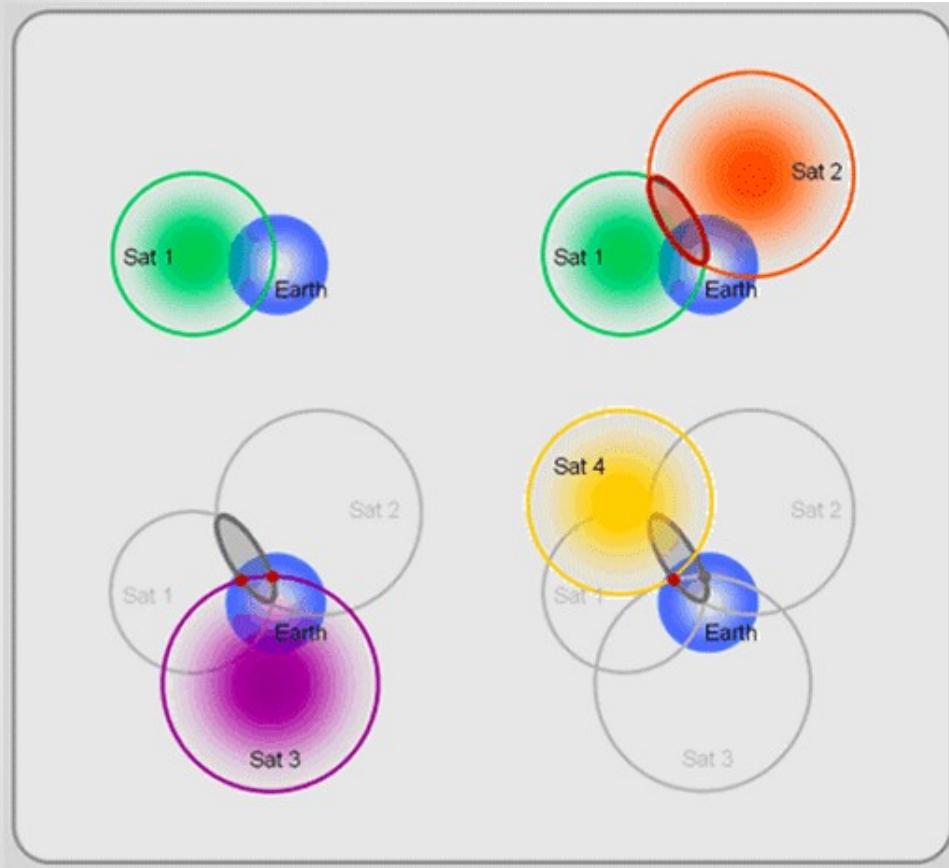
Terrestrial, aerial and marine navigation; disaster management; vehicle tracking and fleet management; precise timing mapping and geodetic data capture; terrestrial navigation aid for hikers and travellers; visual and voice navigation for drivers

While **American GPS** has **24 satellites** in orbit, the number of sats visible to ground receiver is limited. In **IRNSS**, **four satellites** are always in geosynchronous orbits, hence always visible to a receiver in a region **1,500 km** around India



## GPS



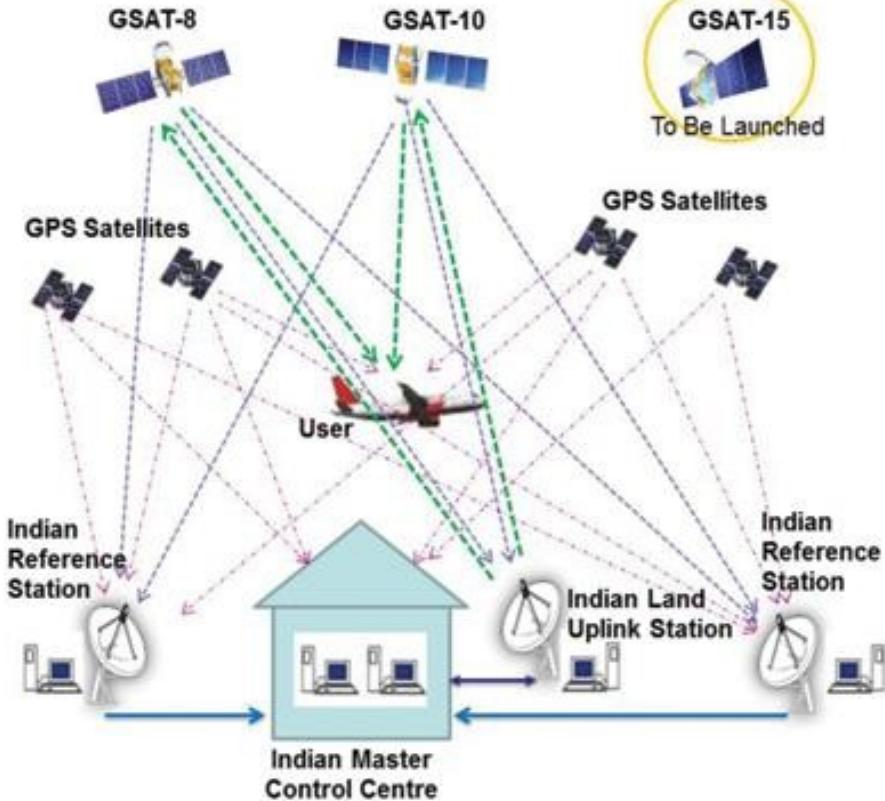


# NAVIC

- an independent regional navigation satellite system being developed by India
- to provide Reliable **Position, Navigation and Timing** services over India and its neighbourhood
- **1500 km beyond border**
- consists of the IRNSS constellation of seven satellites
- 3 satellites in the geostationary orbit and the remaining 4 in geosynchronous orbits
- **Standard Positioning and Restricted Services**

# GAGAN

- Airports Authority of India (AAI) and ISRO
- to provide Satellite-based Navigation services for civil aviation applications
- to provide better Air Traffic Management over Indian Airspace



# GAGAN

- The main components of the GAGAN Architecture are:

Space  
segment:

- three operational GEO satellites:  
The GSAT-8, GSAT-10 and GSAT-15 satellites

Ground  
segment

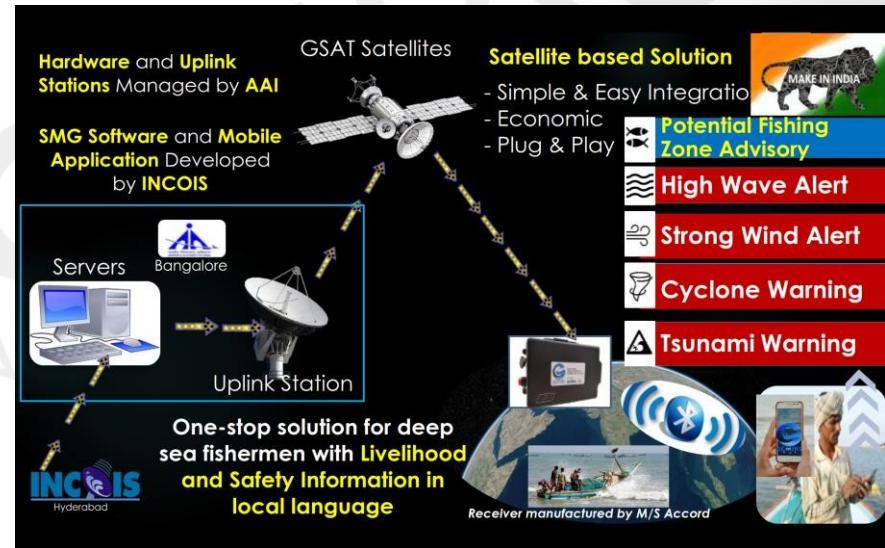
- On the ground, the GPS data is received and processed in the 15 Indian Reference Stations (INRES). Indian Master Control Centre processes the data from the INRESs to compute the differential corrections and the estimate of its level of integrity.

User  
segment

- GAGAN-enabled GPS receivers, with the same technology as WAAS Receivers, capable to use the GAGAN Signal-in-Space (SIS).

# GEMINI

- **Gagan Enabled Mariner's Instrument for Navigation and Information (GEMINI) device**
- A soap box sized device fitted to fishing boats
- Servers in INCOIS (Indian National Centre for Ocean Information Services), an autonomous body under the Ministry of Earth Sciences
- satellite-based advisory service for deep-sea fishermen.
  - Disaster warnings
  - Potential Fishing Zones (PFZ) – 3 days in advance
  - Ocean States Forecasts



# EVOLUTION OF THE INDIAN LAUNCH VEHICLES

## Satellite Launch Vehicle (SLV-3):

**Height:** 22m  
**Fuel:** Four solid stages  
**Weight:** 17 tonnes  
**Capability:** Placing 40kg class payloads in low earth orbit



## Augmented Satellite Launch Vehicle

**Height:** 23.8m  
**Weight:** 40 tonnes, 23.8 m tall  
**Fuel:** Five stage, all-solid propellant  
**Capability:** Orbiting 150kg class satellites into 400km circular orbits



## Polar Satellite Launch Vehicle

**Height:** 44.4m  
**Weight:** 295 tonnes  
**Capability:** 1600kg satellites in 620km sun-synchronous polar orbit and 1050kg satellite in geo-synchronous transfer orbit (GTO)  
**Fuel:** Four stages using solid and liquid propulsion systems alternately



## GSLV Mark I and II

**Height:** 49 m  
**Weight:** 414 tonne  
**Capability:** Placing INSAT-II class of satellites (2000 - 2,500kg) into GTO  
**Fuel:** Three stages, S125 solid booster with four liquid (L40) strap-ons, GS2 liquid engine and GS3 cryogenic stage

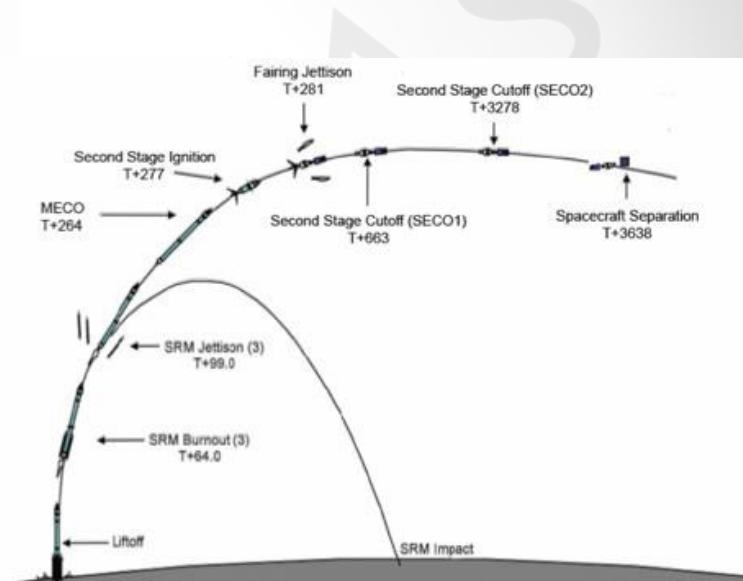
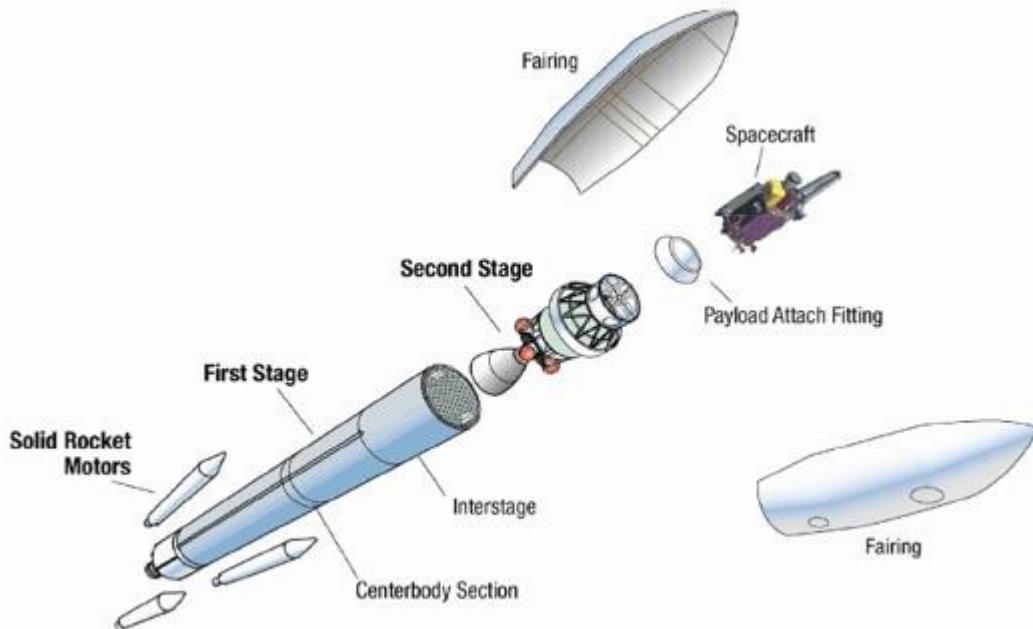


## GSLV Mark III

**Height:** 42.4m  
**Weight:** 630 tonnes  
**Fuel:** Three stage; two identical S200 Large Solid Booster (LSB) with 200 tonne solid propellant, the L110 re-startable liquid stage, the cryogenic stage  
**Capability:** Placing communication satellites of INSAT-4 class, weighing 4,500-5,000kg in GTO, LEO, polar and intermediate circular orbits



# Stages of a Launch vehicle



#### **PSLV-CA**

- No. of strap-on motors : Nil
- Payload capability to SSPO (600 km) : 1019 Kg



#### **PSLV-DL**

- No. of strap-on motors : Two
- Payload capability to SSPO (600 km) : 1257 Kg



#### **PSLV-QL**

- No. of strap-on motors : Four
- Payload capability to SSPO (600 km) : 1523 Kg



#### **PSLV-XL**

- No. of strap-on motors : Six
- Payload capability to SSPO (600 km) : 1673 Kg
- Payload capability to sub GTO (284 x 20650 km) : 1425 Kg





### PSLV

- 1750 kg payload to 600 km
- 1425 kg to GTO
- 4 stage: S-L-S-L
- For LEO



### GSLV MK II

- 5000 kg payload to LEO
- 2500 kg to GTO
- S-L-C



### GSLV MK III

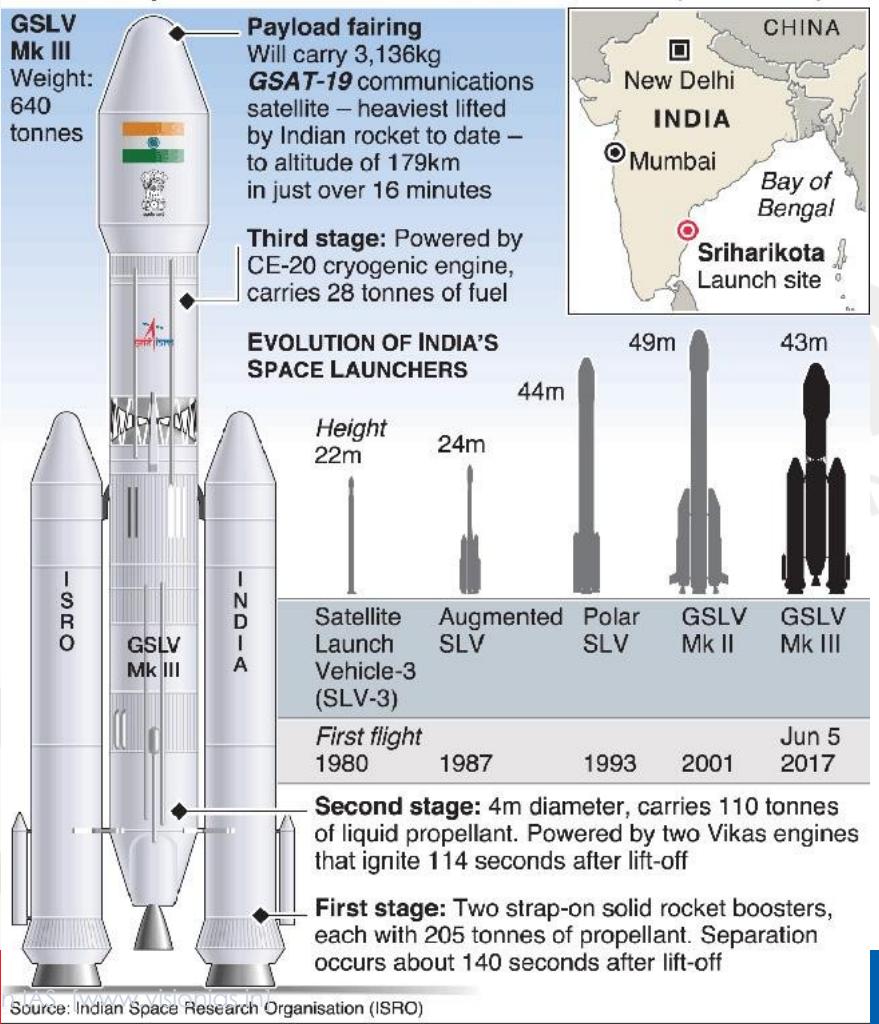
- 8000 kg payload to 600 km
- 4000 kg to GTO
- 3 stage: S-L-C



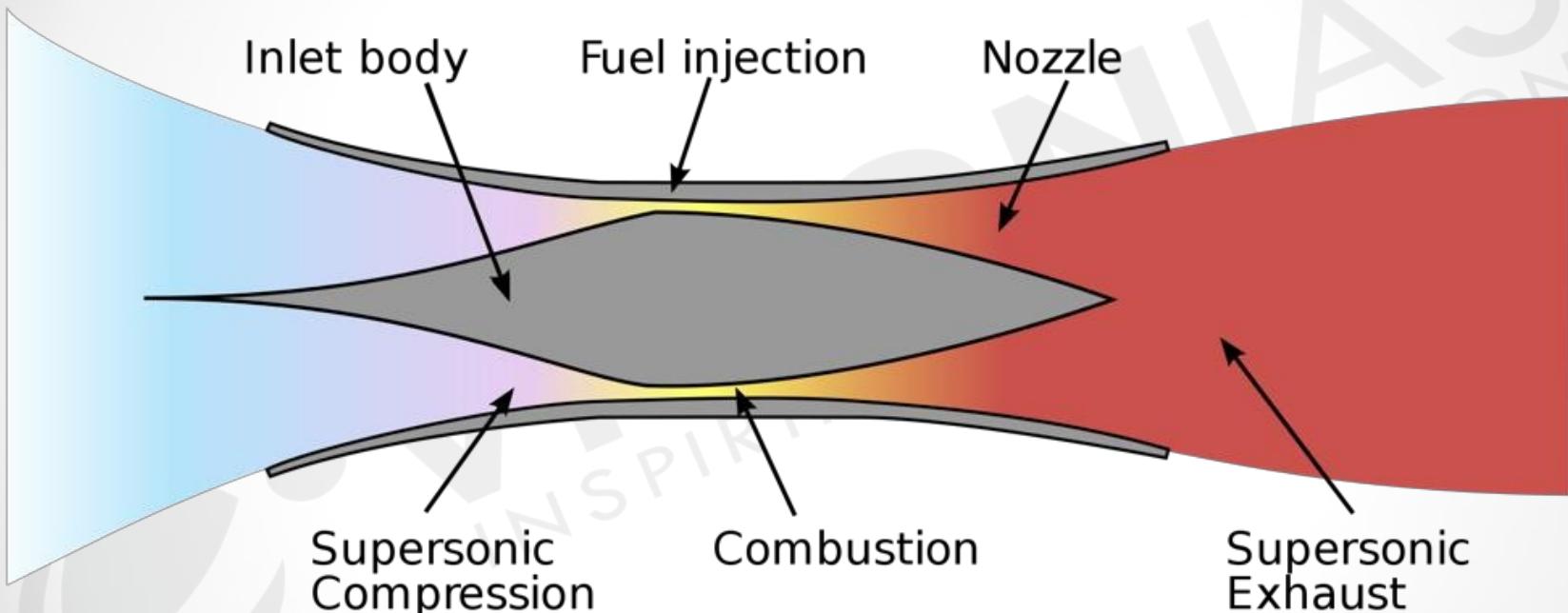
### Small Satellite Launch Vehicle (SSLV)

- Cost effective launcher, launch on demand
- LEO: 500 kg, SSO: 300 kg
- 3 solid propulsion stages and Liquid Velocity Trimming module as terminal stage

India has launched its most powerful homegrown rocket to date – the Geosynchronous Satellite Launch Vehicle Mark III (GSLV Mk III)



# Scramjet



# Private Sector Participation in Space

- Announcements under Aatmanirbhar Bharat
- Indian National Space Promotion and Authorization Centre (IN-SPACe)
  - Under Department of Space
  - A level playing field for private players
  - Friendly regulatory environment
  - empower private companies in creation of launch vehicles and launch pads
  - ISRO to allocate more time and resources for R&D endeavours.
- Concerns
  - Security and strategic concerns
  - highly risky business
- Draft Space Activities Bill, 2017

# UPSC Prelims Questions

With reference to 'Astrosat', the astronomical observatory launched by India, which of the following statements is/are correct?

1. Other than USA and Russia, India is the only country to have launched a similar observatory into space.
2. Astrosat is a 2000 kg satellite placed in an orbit at 1650 km above the surface of the Earth.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

With reference to the Indian Regional Navigation Satellite System (IRNSS), consider the following statements:

1. IRNSS has three satellites in geostationary and four satellites in geosynchronous orbits.
2. IRNSS covers entire India and about 5500 sq. km beyond its borders.
3. India will have its own satellite navigation system with full global coverage by the middle of 2019.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) None

# UPSC Prelims Questions

In which of the following activities are Indian Remote Sensing Satellites used?

1. Assessment of crop productivity
2. Locating groundwater resources
3. Mineral Exploration
4. Telecommunications
5. Traffic studies

Select the correct answers using the code given below.

- (a) 1, 2 and 3 only
- (b) 4 and 5 only
- (c) 1 and 2 only
- (d) 1, 2, 3, 4 and 5

For the measurement/estimation of which of the following are satellite images/remote sensing data used?

1. Chlorophyll content in the vegetation of a specific location
2. Greenhouse gas emissions from rice paddies of a specific location
3. Land surface temperatures of a specific location

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 and 3 only
- (c) 3 only
- (d) 1, 2 and 3

# UPSC Prelims Questions

With reference to India's satellite launch vehicles, consider the following statements:

1. PSLVs launch the satellite useful for Earth resources monitoring whereas GSLVs are designed mainly to launch communication satellites.
  2. Satellites launched by PSLV appear to remain permanently fixed in the same position in the sky, as viewed from a particular location in Earth.
  3. GSLV Mk III is a fourstaged launch vehicle with the first and third stages using solid rocket motors; and the second and fourth stages using liquid rocket engines.
- Which of the statements given above is/are correct?
- (a) 1 only    (b) 2 and 3  
(c) 1 and 2    (d) 3 only

The Mangalyaan launched by ISRO

1. is also called the Mars Orbiter Mission
2. made India the second country to have a spacecraft orbit the Mars after USA
3. made India the only country to be successful in making its spacecraft orbit the Mars in its very first attempt

Which of the statements given above is/are correct?

- (a) 1 only  
(b) 2 and 3 only  
(c) 1 and 3 only  
(d) 1, 2 and 3

# GAGANYAAN

- Gaganyaan National Advisory Council: Overall project status of Gaganyaan
- Precursor missions to Gaganyaan
  - **Space Capsule Recovery Experiment (SRE-2007)**
  - **Crew module Atmospheric Reentry Experiment (CARE-2014)**
  - **GSLV Mk-III (2014)**
  - **Reusable Launch Vehicle- Technology Demonstrator (RLV-TD)**
  - **Crew Escape System and Pad Abort Test**
- Help from France and Russia
- 3 people (or maybe only 1) for 7 days, LEO (300-400 km), collaboration with IAF
- If successful – India will be 4<sup>th</sup> country after USSR, USA and China



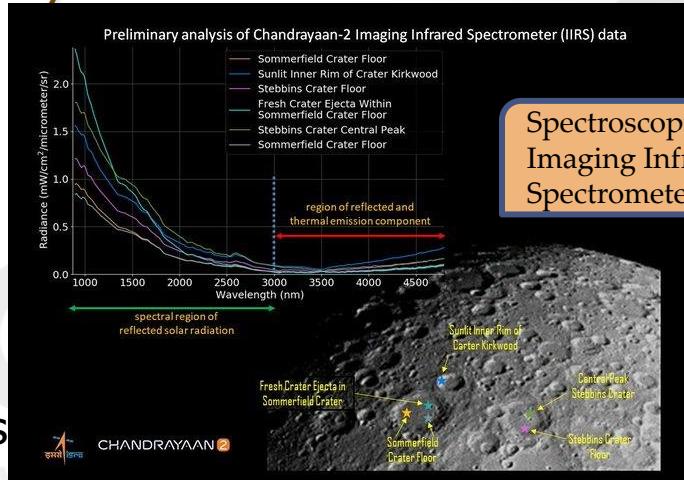
Vyom Mitra: half humanoid, AI based robotic system for Unmanned mission before Gaganyaan, developed by ISRO and IISc

## Human Space Flight Centre (HSFC)

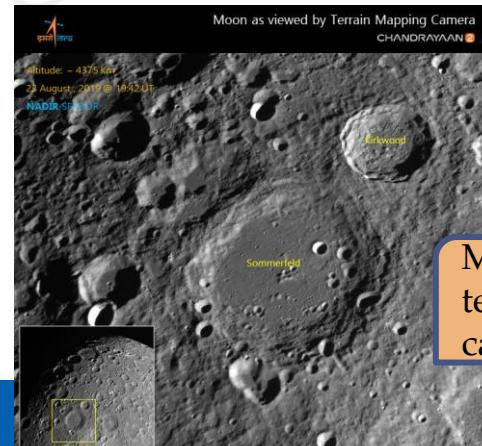
- responsible for the implementation of Gaganyaan project.
- ISRO has proposed a **consolidated HSFC**, which will be established at **Challakere, Karnataka**.

# Chandrayaan 2

- Orbiter, Lander (Vikram) and Rover (Pragyan), GSLV MK III
- 14 payloads (8+4+2)
- Chandrayaan 3: Lander and Rover to lunar south pole
- Chandrayaan 1: Detection of water, Magma ocean hypothesis  
Spinel rich rock, X-Ray signs!
- South Pole Region:
  - remains in shadow
  - much larger than that at the North Pole.
  - possibility of the presence of water in fossil record of the early Solar System.
  - untapped source of essential resources.
- Spectroscopy



Spectroscopical analysis by Imaging Infrared Spectrometer (IIRS).



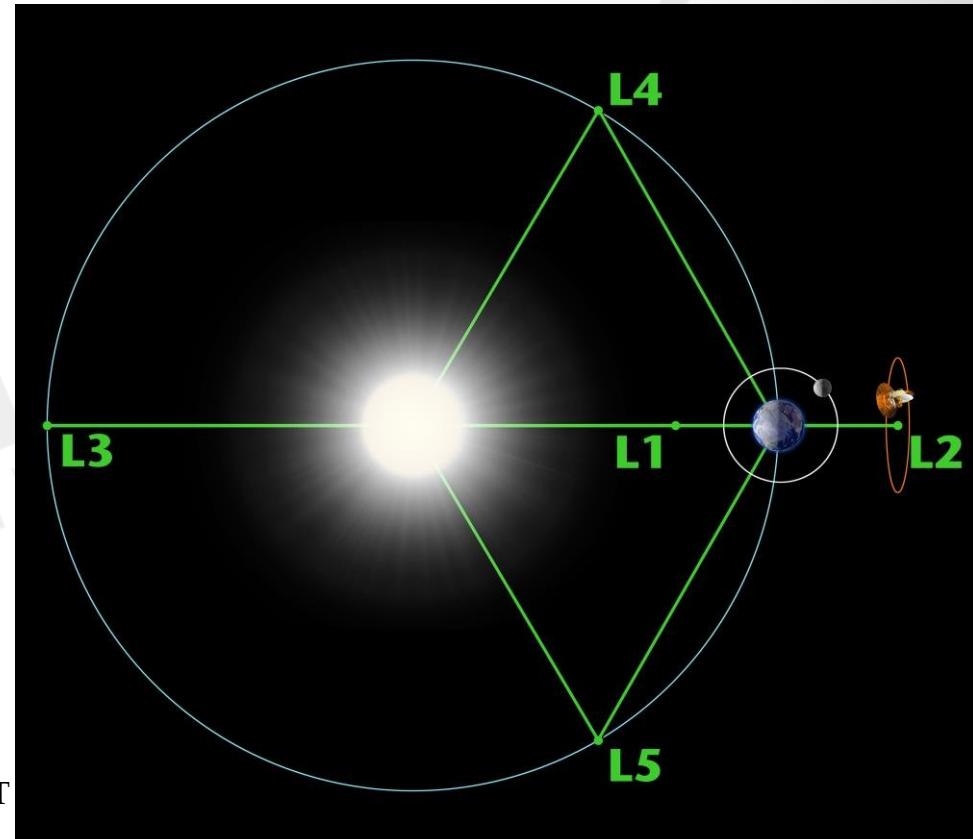
Moon as viewed by terrain mapping camera.

# Newspace India LTD.

- Commercial arm of ISRO **NewSpace India Limited (NSIL), Bengaluru.**
- Manufacturing and production **Satellite Launch Vehicle (SSLV)** and **Polar Satellite Launch Vehicle (PSLV)**
- **Budget 2019**
- **Antrix:** commercial arm of ISRO, Mini Ratna

# Aditya L1 mission

- halo orbit around the **Sun-Earth Lagrangian point (L1)**,
- about 1.5 million km from the Earth.
- ISRO's first scientific expedition to study Sun
- 400 kg-class satellite
- **7 payloads on board** to study Sun's corona, solar emissions, solar winds and flares, and Coronal Mass Ejections, and will carry out round-the-clock imaging of Sun.

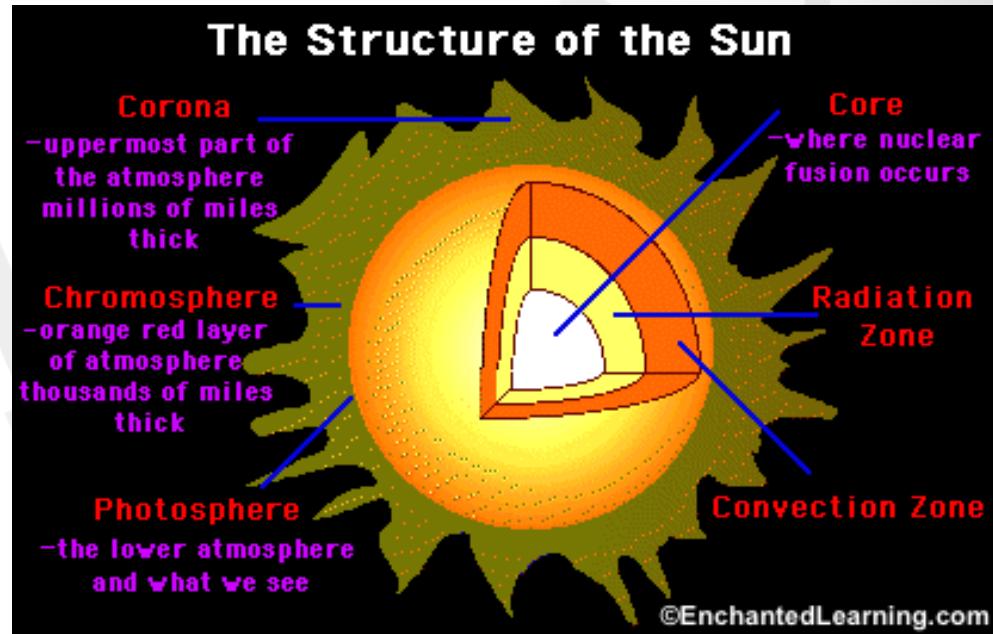
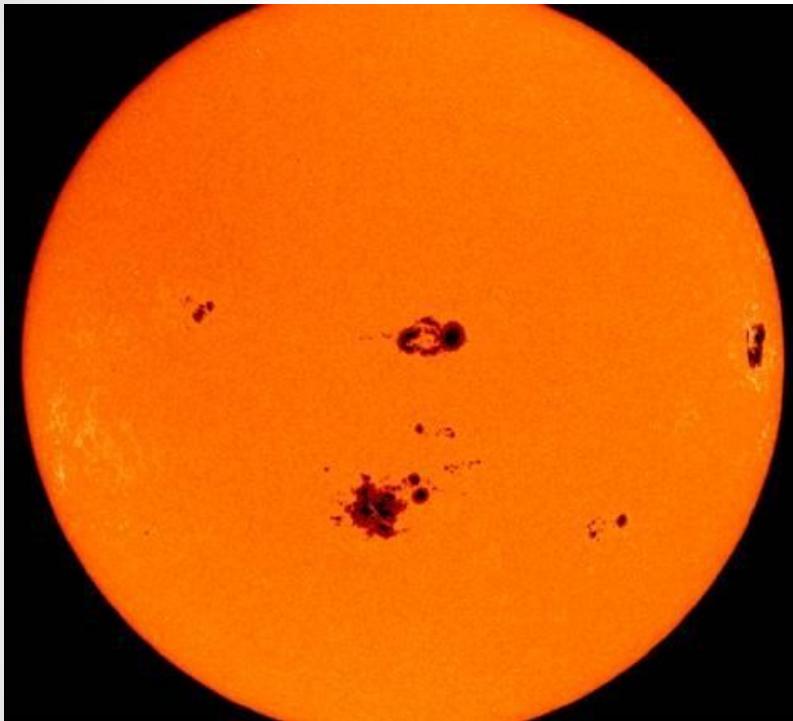


<https://www.youtube.com/watch?v=6cUe4oMk69E&list=TGJG8tIphgpDAHkyNzAxMjAyMg&t=1s>

# Lagrangian Points and Halo Orbit

- 5 special points where a small mass can orbit in a constant pattern with two larger masses.
- gravitational pull of two large masses precisely equals the centripetal force required for a small object to move with them.
- **The orbits around the Lagrangian point is called Halo Orbit.**
- **The L1 point** of the Earth-Sun system affords an uninterrupted view of the sun and is currently home to the **Solar and Heliospheric Observatory Satellite SOHO**.
- **L2 is ideal for astronomy** because a spacecraft is close enough to readily communicate with Earth, can keep Sun, Earth and Moon behind the spacecraft for solar power and provides a clear view of deep space for our telescopes.

# Sun Spot Cycle



# Sun Spot Cycle

- Sunspots are areas that appear dark on the surface of the Sun
- cooler than other parts of the Sun’s surface.
- **Strong magnetic fields:** they some of the heat within the Sun from reaching the surface
- **Sun Spot Cycle:** the recurring increase and decrease in the number of sunspots over a period averaging about eleven years.
- Solar Maximum and Solar Minimum

# ASTROSAT

- 1500kg, 650 km orbit
- first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands simultaneously
- Minimum useful life – 5 years
- The scientific objectives of AstroSat mission are:
  - To understand high energy processes in binary star systems containing neutron stars and black holes;
  - Estimate magnetic fields of neutron stars;
  - Study star birth regions and high energy processes in star systems lying beyond our galaxy;
  - Detect new briefly bright X-ray sources in the sky;
  - Perform a limited deep field survey of the Universe in the Ultraviolet region.



# Other proposed missions

- XPOSAT
  - X-ray Polarimeter Satellite, is a planned dedicated mission **to study polarisation.**
  - degree and angle of polarisation of bright X-ray sources
  - 5 years, 500-700km orbit
  - study neutron stars, supernova remnants, pulsars and regions around black holes.
- Shukrayaan
- Mangalyaan 2

# Space Debris

- RemoveDEBRIS mission: led by the Surrey Space Centre from the University of Surrey.
  - Net capture: It involves a net that will be deployed at the target CubeSat.
  - Harpoon Capture: Which will be launched at a target plate made of “representative satellite panel materials”
  - Vision-based navigation: Using cameras and LiDAR (light detection and ranging), the platform will send data about the debris back to the ground for processing.
  - De-orbiting process: As it enters Earth’s atmosphere, the spacecraft will burn up, leaving no debrisbehind



# Science and Technology



Q1. Recently Radioisotope Thermoelectric Generators (RTG) technology was in the news. Consider the following statements regarding the Radioisotope Thermoelectric Generators (RTG) technology:

1. It can be a steady source of both heat and electric energy for space missions.
2. It will help in launching missions deeper into space.
3. It uses a fission chain reaction to generate energy.
4. Plutonium-238 is used to provide heat and electricity in RTG.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only
- (b) 2, 3 and 4 only
- (c) 1, 3 and 4 only
- (d) 1, 2 and 4 only

Q2. With reference to the use of nano technology in health sector, which of the following statements is/are correct?

1. Targeted drug delivery is made possible by nanotechnology.
2. Nanotechnology can largely contribute to gene therapy.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Q3. With respect to nuclear technology, consider the following statements:

1. The energy released in a nuclear fusion reaction is greater than the energy released by nuclear fission.
2. Nuclear Fusion does not normally occur in nature but fission occurs in stars.
3. At present, nuclear fission reaction is used in nuclear power plants and fusion is still in experimental stage for producing power.

Which of the statements given above is/are correct?

- (a) 3 only
- (b) 1 and 3 only
- (c) 1 and 2 only
- (d) 2 and 3 only

Q4. With reference to the different types of nuclear reactors used in the Indian power plants, consider the following pairs:

<b>Type of Reactor</b>	<b>Power Plant</b>
------------------------	--------------------

- |                                    |             |
|------------------------------------|-------------|
| 1. Pressurised Water Reactor.      | Kudankulam  |
| 2. Pressurized Heavy Water Reactor | Rawatbhatta |
| 3. Fast breeder Reactor            | Tarapore    |

Which of the pairs given above is/are correctly matched?

- (a) 1 only
- (b) 1 and 2 only
- (c) 1, 2 and 3
- (d) 3 only

**Q5. Why are nanomaterials and nanotechnology considered revolutionary for modern scientific and technological development:**

1. Even though the physical properties of nanomaterials don't change, their chemical reactivity enhances significantly.
2. Size of Nanomaterials is directly proportional to its surface area, and decreased surface area is an important requirement for self assembly.
3. They are considered environment friendly because of no negative impact on ecosystems.

Select the correct answer using the code given below.

- (a) 1 and 2 only
- (b) 2 only
- (c) 2 and 3 only
- (d) None

**Q6. Which of the following best describes the rationale for fast breeder reactor (FBR) in India, which is integral to 3 staged Nuclear programme:**

- (a) To convert Natural Uranium in Pu-239, which is a good fissile material.
- (b) To utilize the potential of efficient fission by FBR compared to other reactors
- (c) To use fission base energy and use it for Nuclear fusion
- (d) To use Thorium reserves and convert it into good fissile material

**Q7.** India is an important member of the 'International Thermonuclear Experimental Reactor'. If this experiment succeeds, what is the immediate advantage for India?

- (a) It can use thorium in place of uranium for power generation
- (b) It attain a global role in satellite-navigation
- (c) It can drastically improve the efficiency of its fission reactors in power generation
- (d) It can build fusion reactors for power generation

**Q8.** Consider the following statements:

- 1. Other than those made by humans, nanoparticles do not exist in nature.
- 2. Nanoparticles of some metallic oxides are used in the manufacture of some cosmetics.
- 3. Nanoparticles of some commercial products which enter the environment are unsafe for humans.

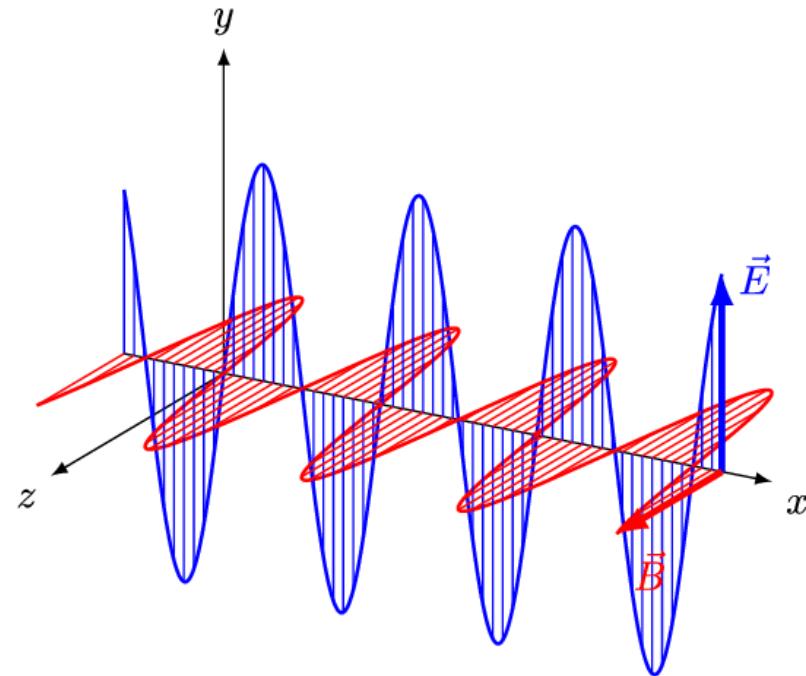
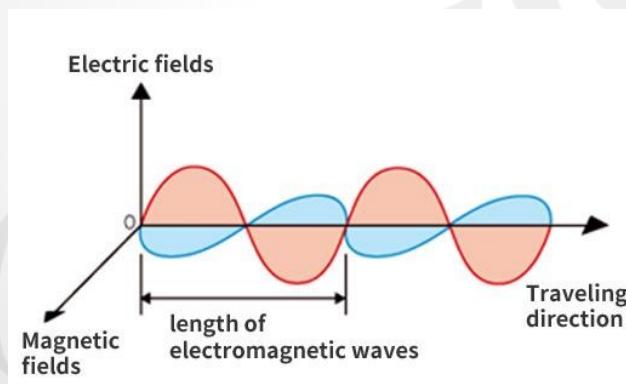
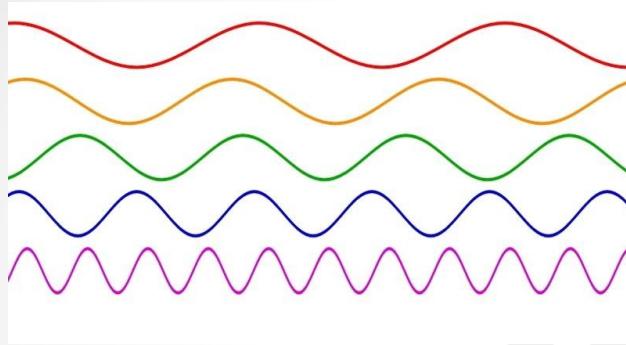
Which of the statements given above is/are correct?

- (a) 1 only
- (b) 3 only
- (c) 1 and 2
- (d) 2 and 3

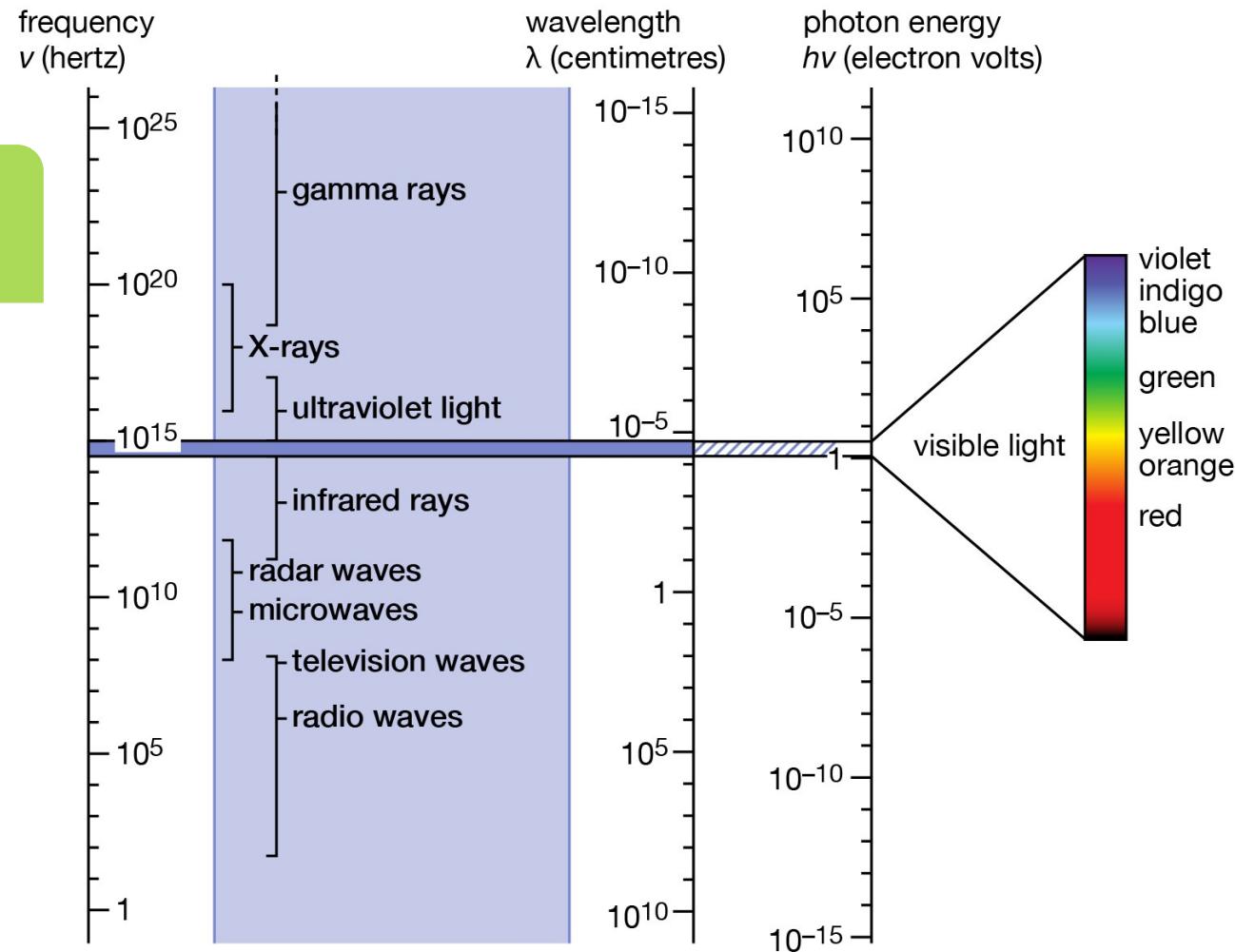
# Topics

- 5G
- Internet – ICANN, Net neutrality, Dark Net, Space Based Internet
- Deep Learning, Machine Learning, AI
- Blockchain Technology and Cryptocurrencies
- Super Computing, Cloud Computing and Edge Computing
- Quantum Technologies
- Data Localization and Data Protection Regime

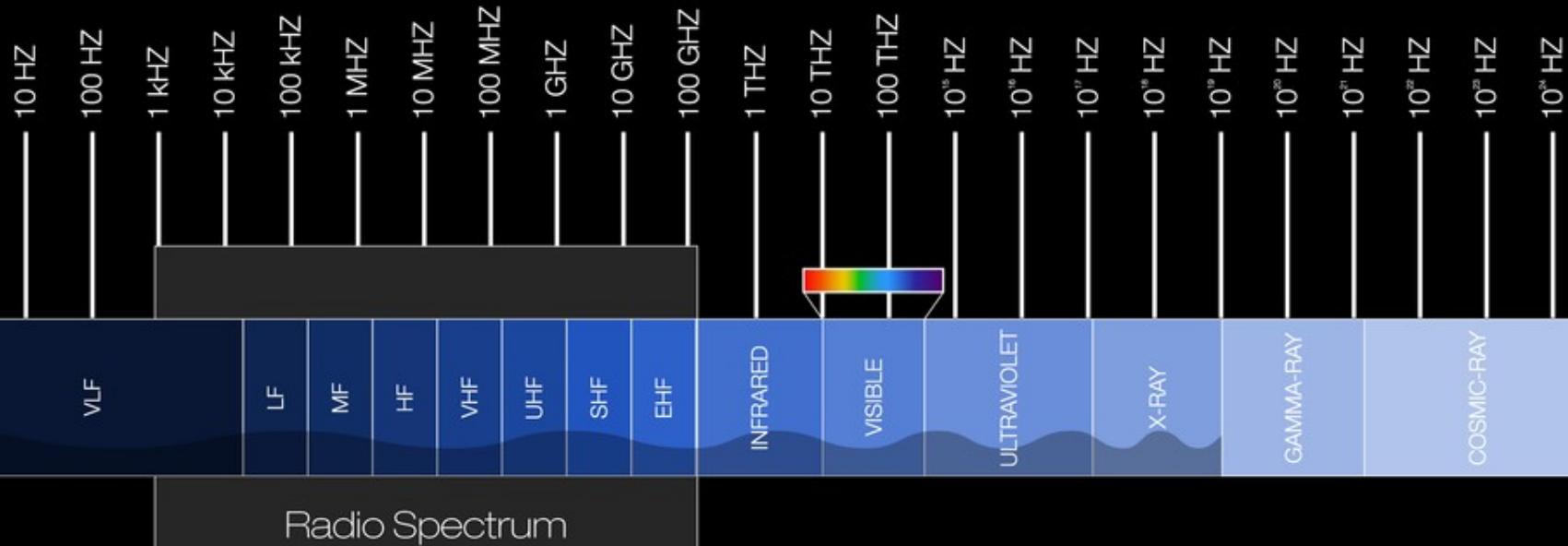
# Electromagnetic Waves



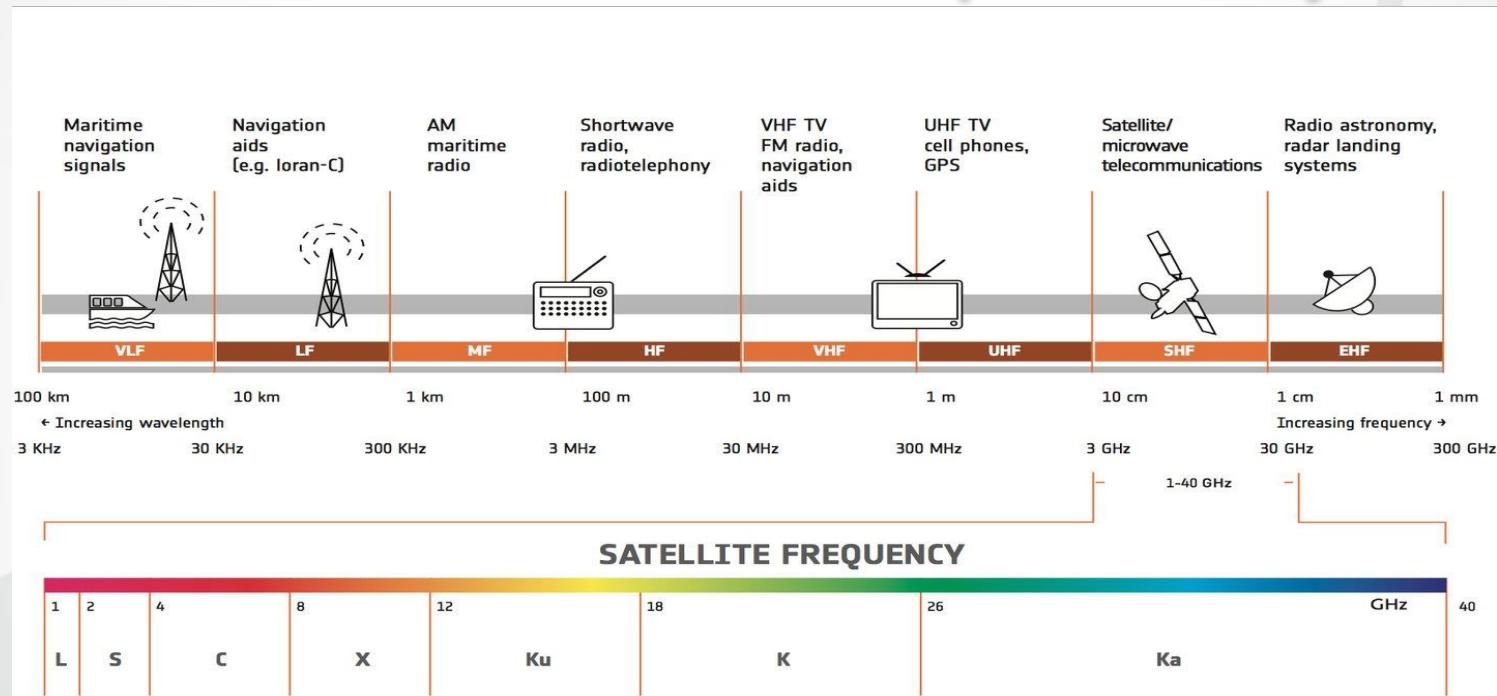
# Electromagnetic Spectrum



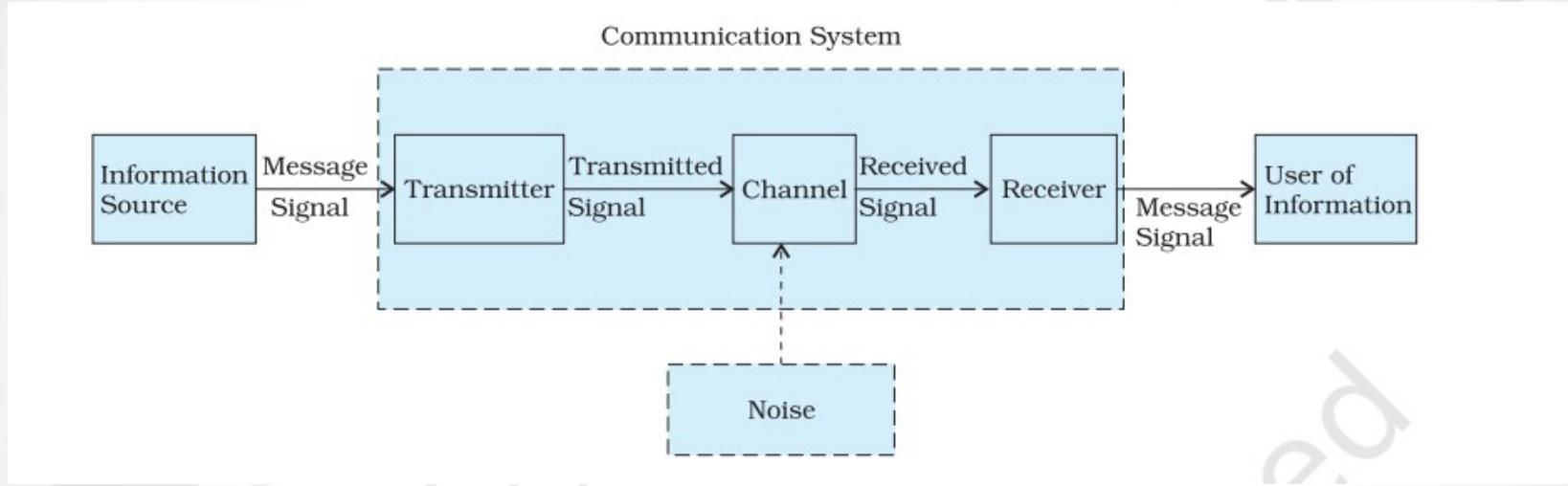
# Electromagnetic Spectrum



# Satellite Frequency



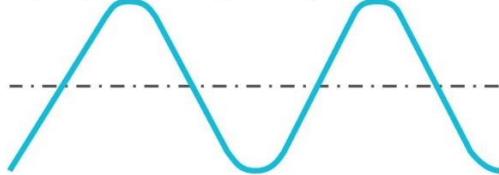
# Generalized Communication System



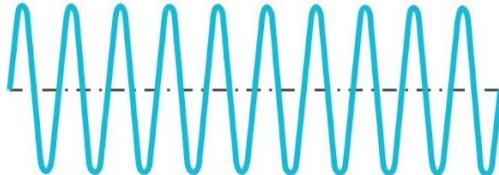
# Modulation

## Amplitude Modulation (AM)

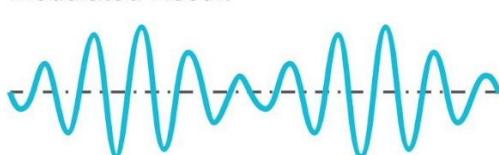
Input (Modulating Wave)



Carrier

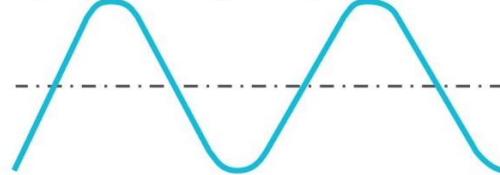


Modulated Result

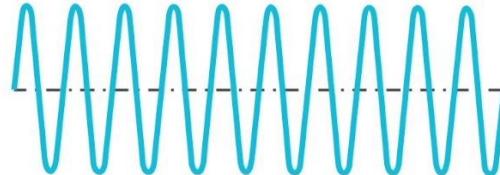


## Frequency Modulation (FM)

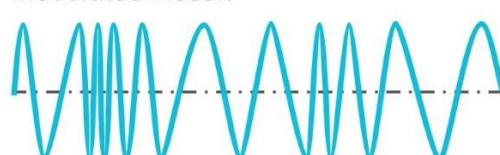
Input (Modulating Wave)



Carrier

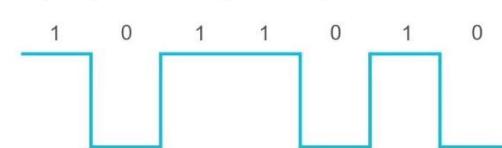


Modulated Result

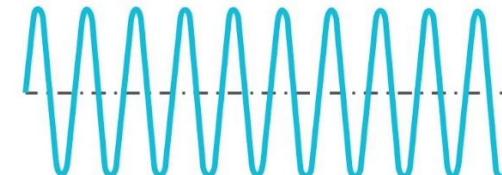


## Digital Modulation

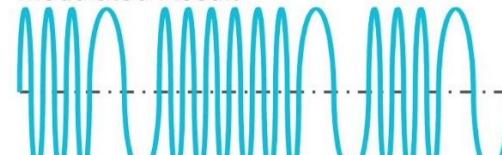
Input (Modulating Wave)



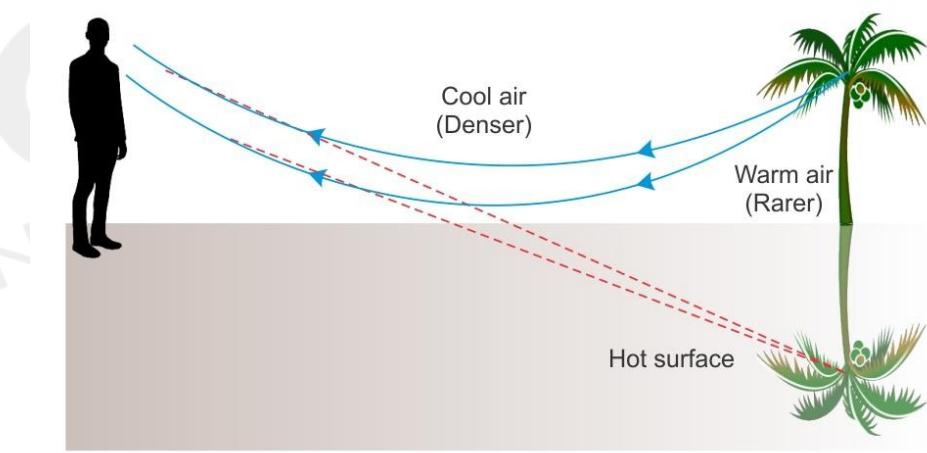
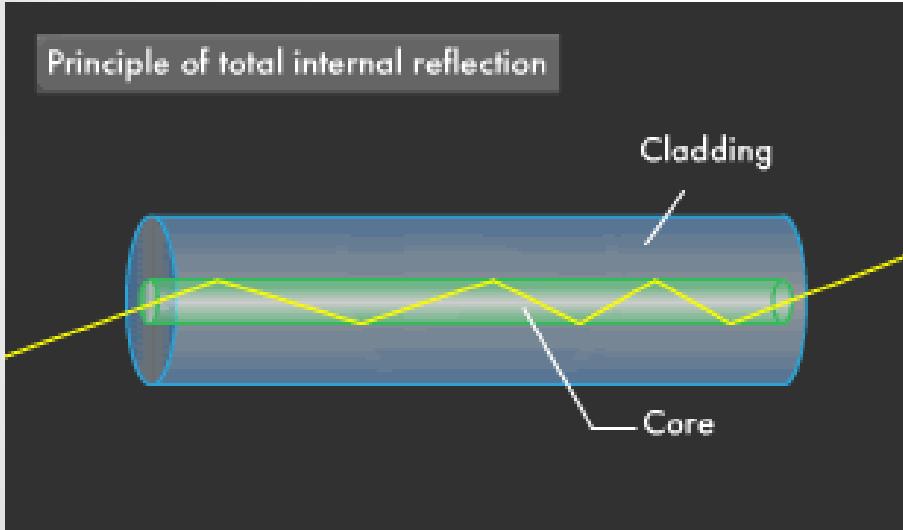
Carrier



Modulated Result



# Optical Fibre Cables



# History of Mobile Technology

SYNOPSYS®

**1G**



Analog  
Technology



**2G**



Digital  
Technology



**3G**



Wireless  
Capability



**4G**



Phones Became  
Computers



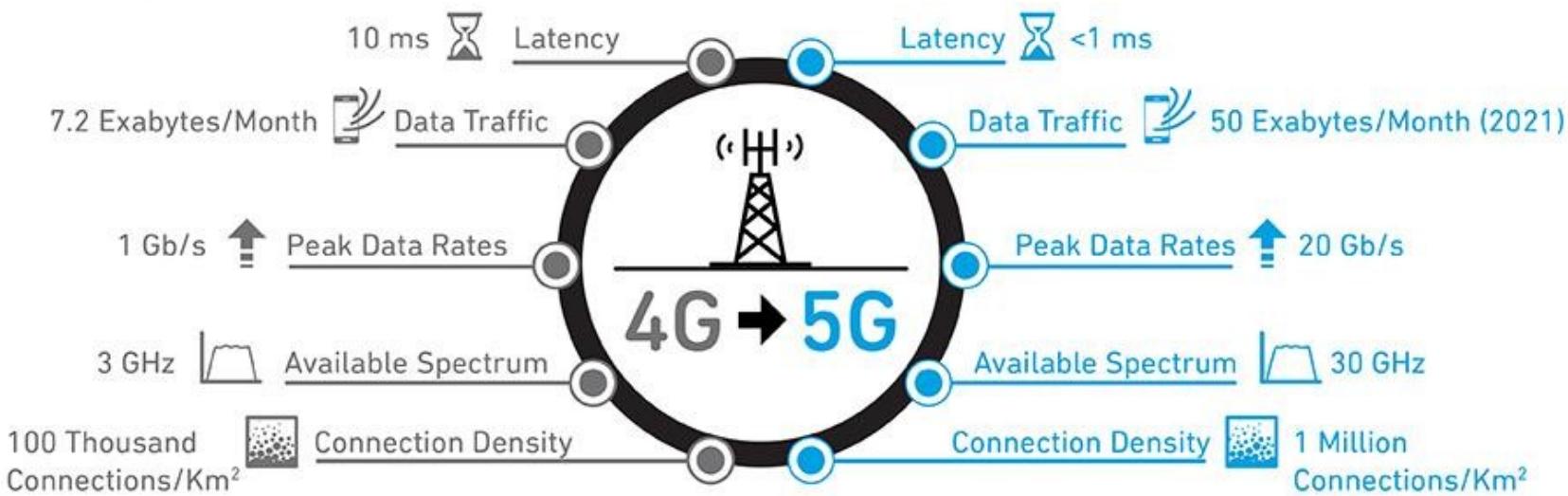
**5G**



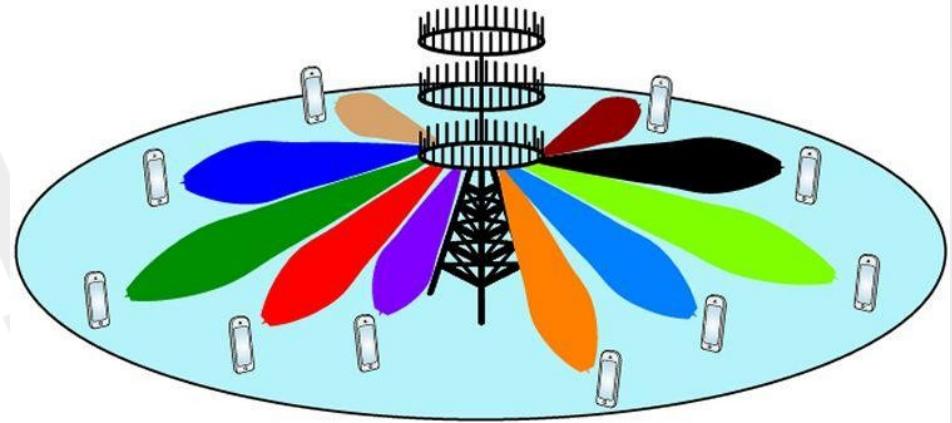
Unparalleled  
Latency



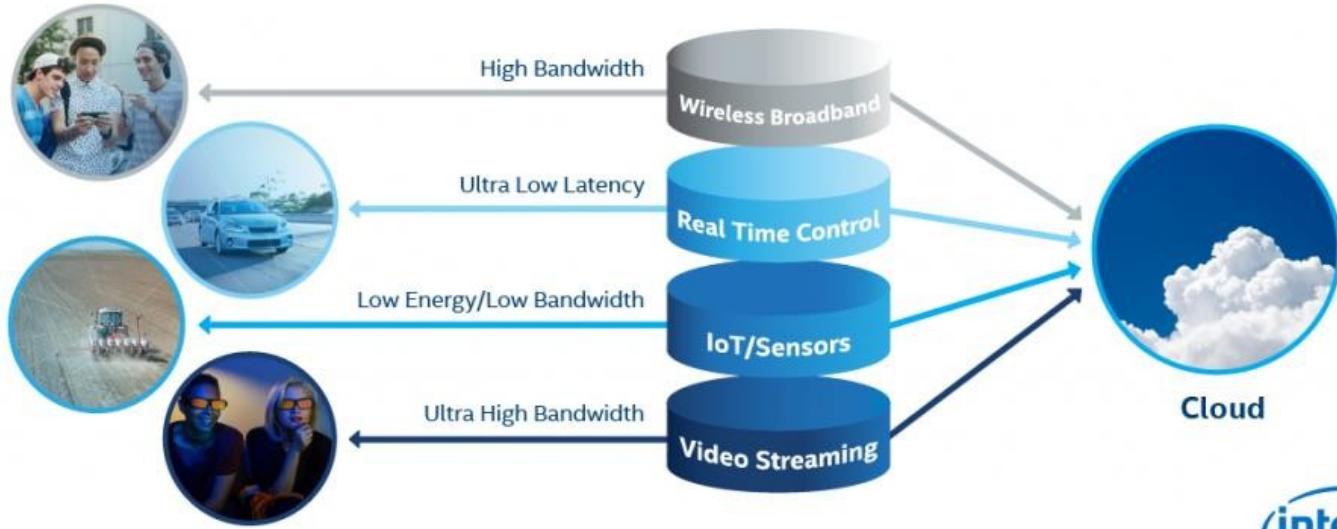
## Comparing 4G and 5G



# 5G Technologies



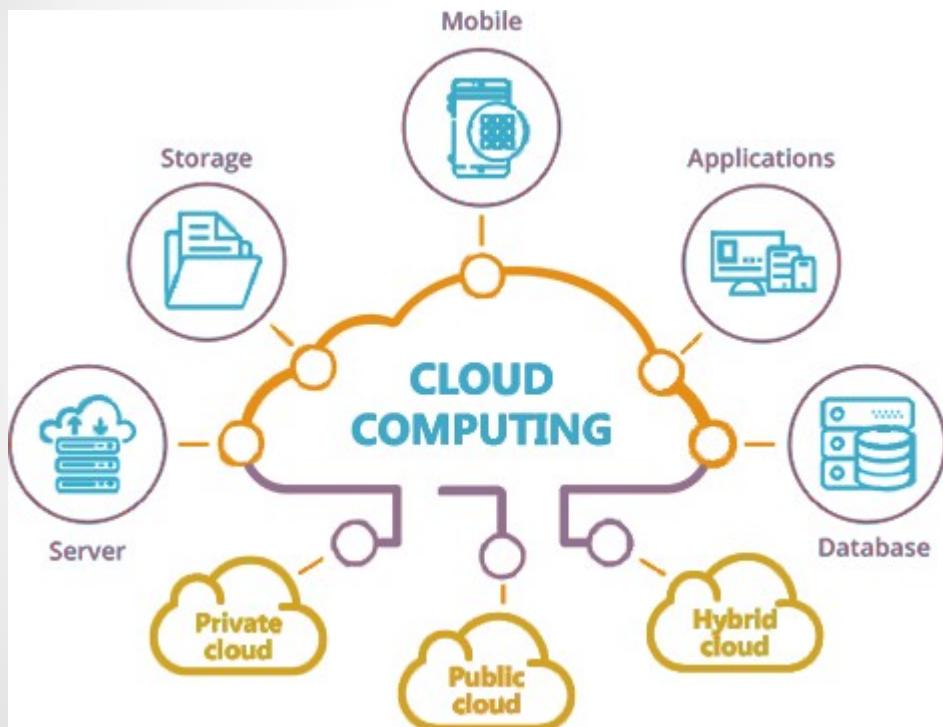
## 5G Network Slices



# Param Siddhi Supercomputer

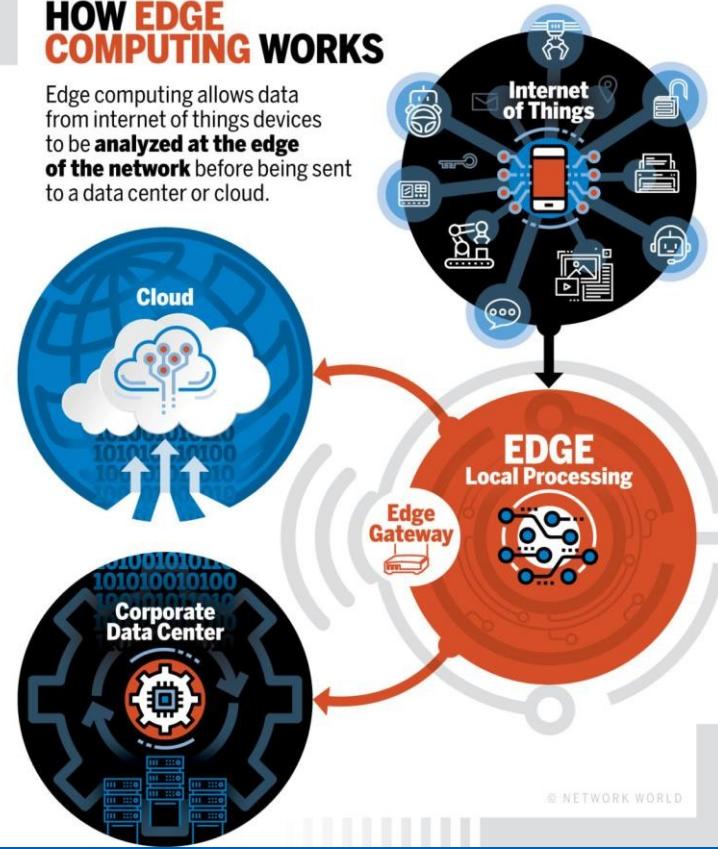


# Cloud and Edge Computing



## HOW EDGE COMPUTING WORKS

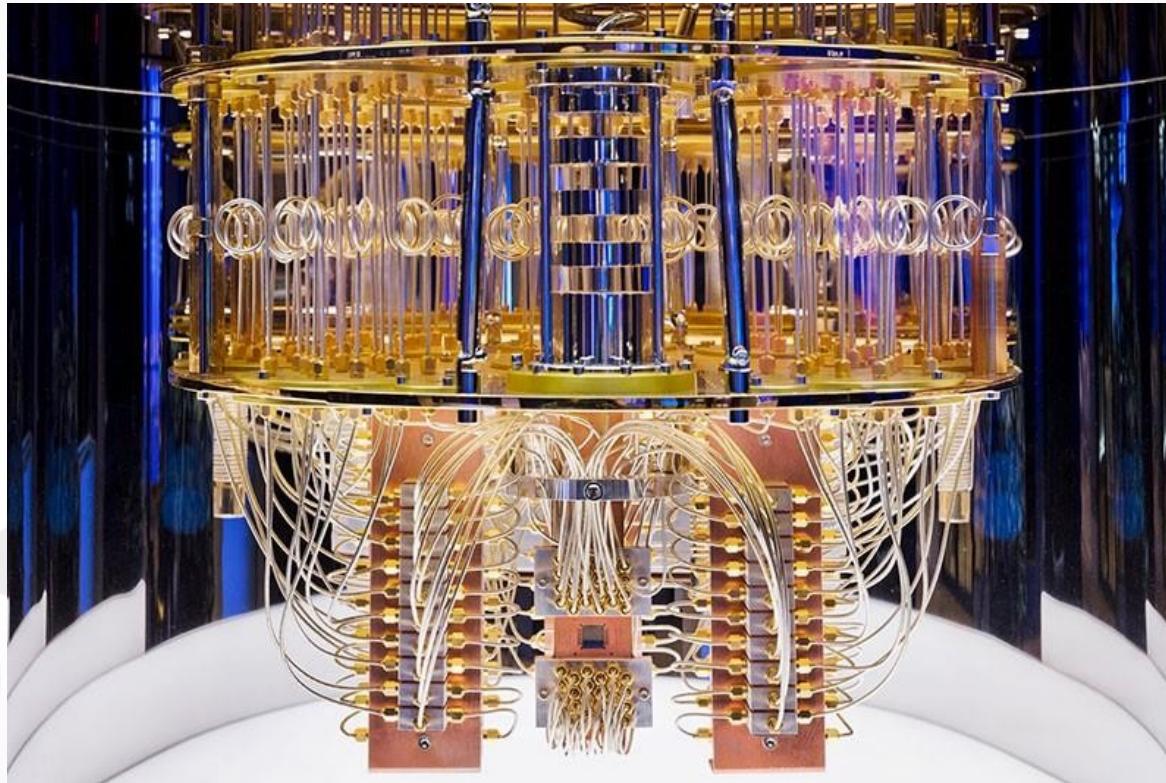
Edge computing allows data from internet of things devices to be **analyzed at the edge of the network** before being sent to a data center or cloud.



# Internet of Things

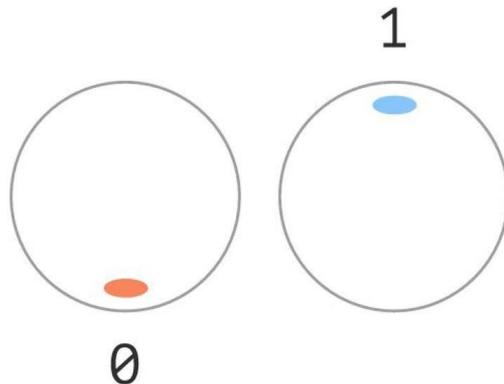


# Quantum Computer

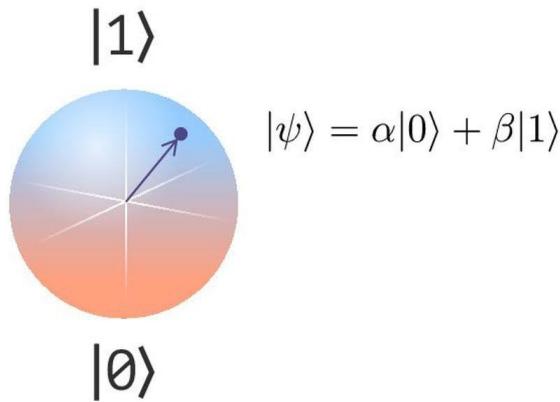


# Qubit

Bit

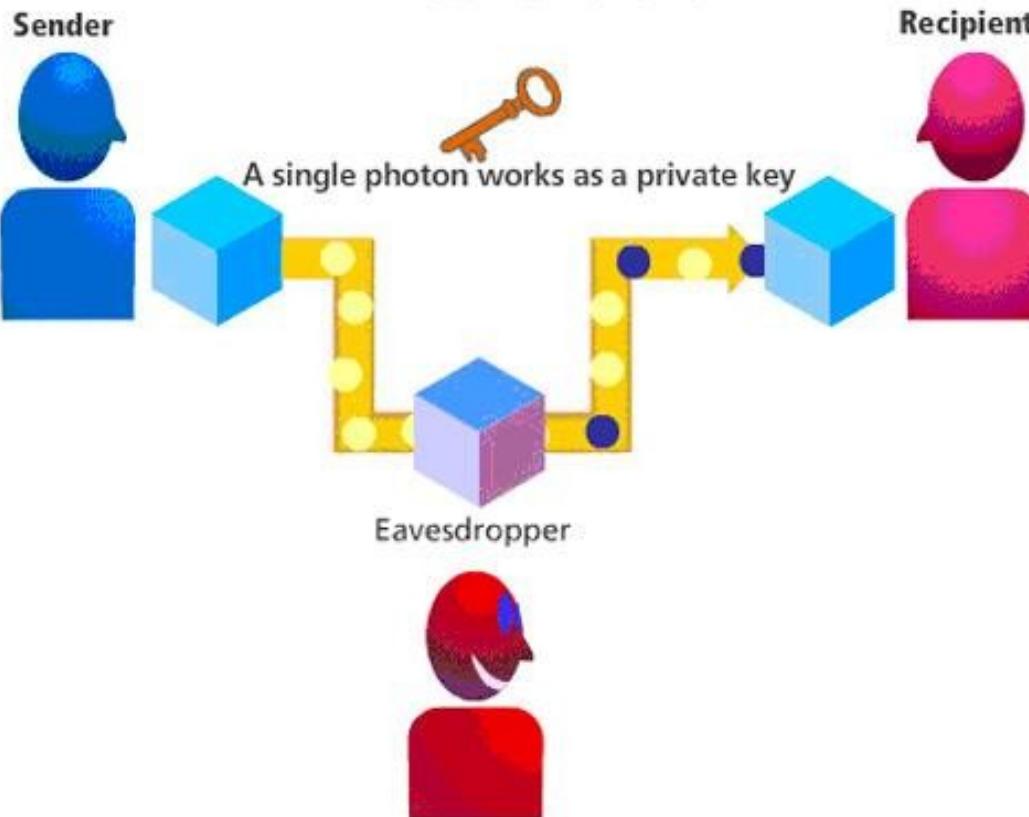


Qubit



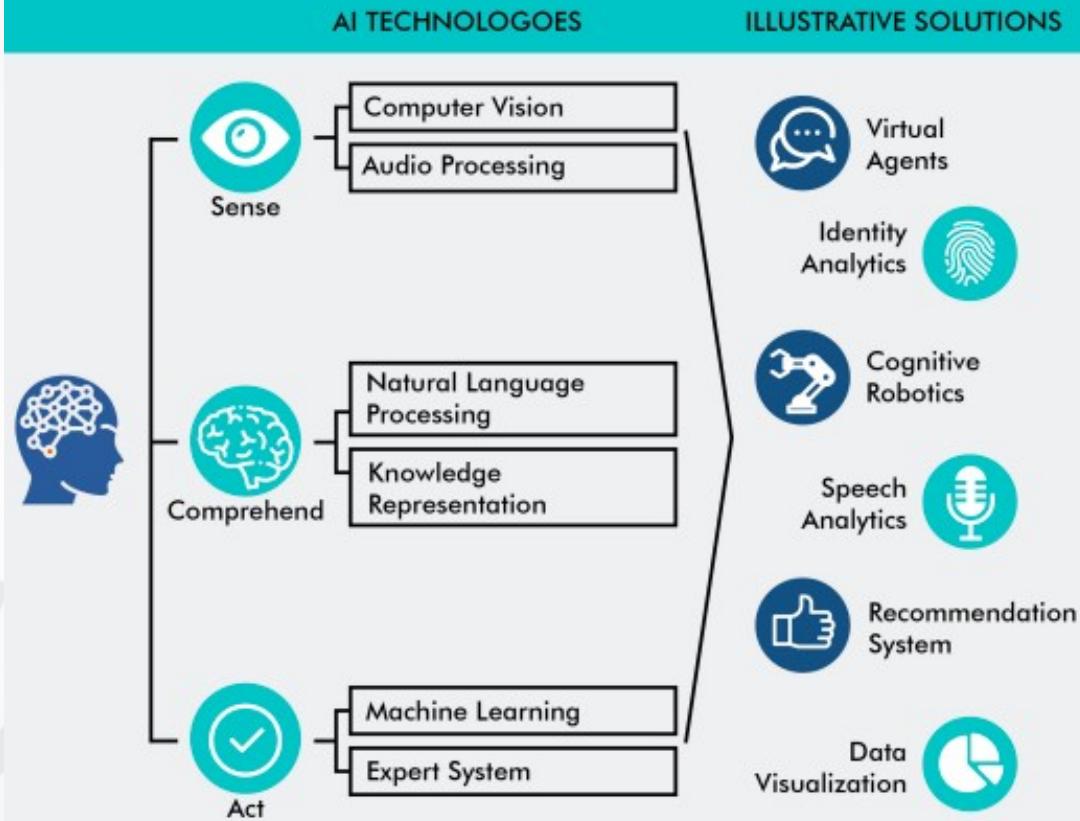
$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

## Quantum cryptography system

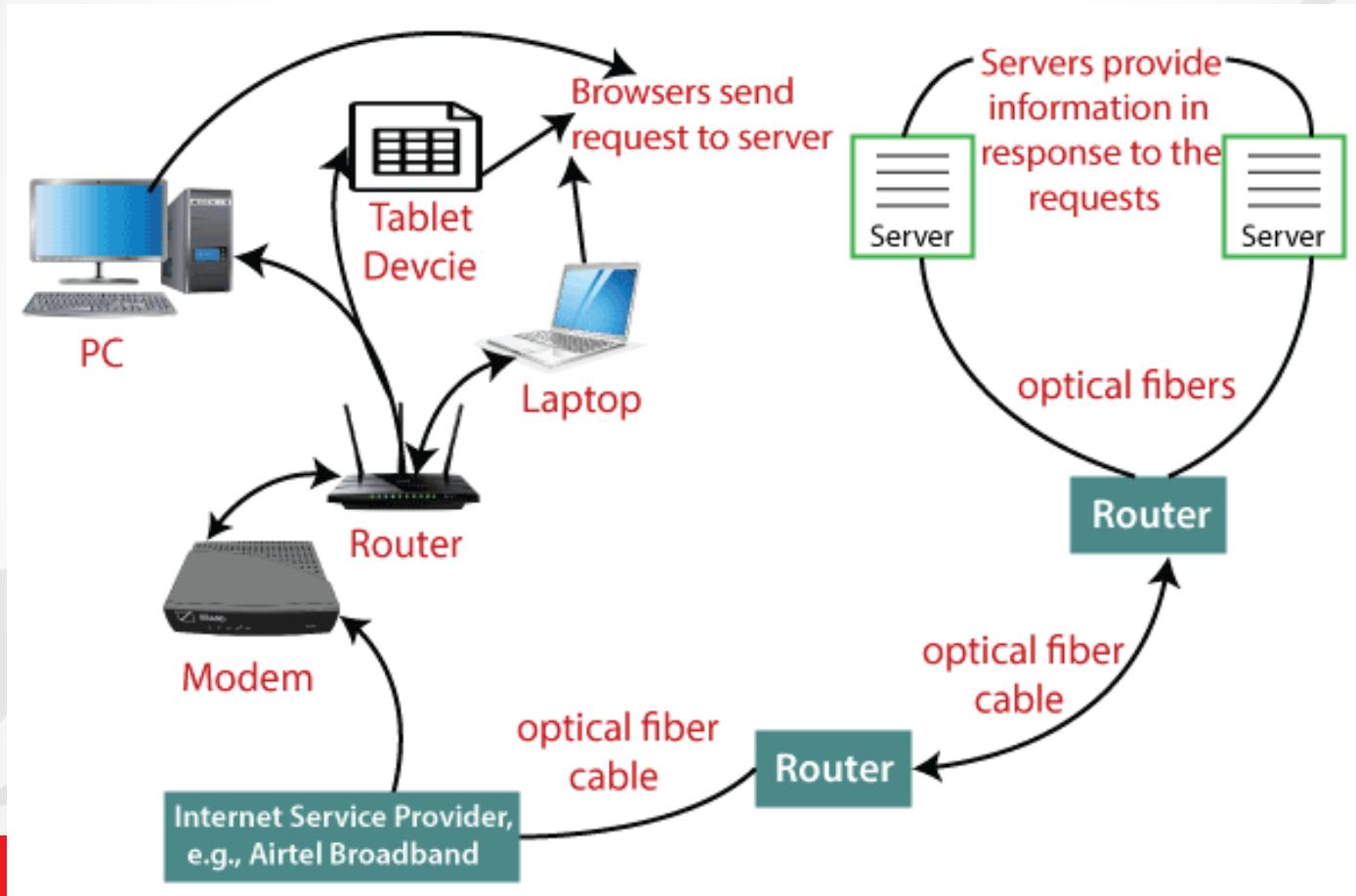


Recipients can discern the presence of eavesdroppers because the quantum state has changed due to observation.

# Artificial Intelligence

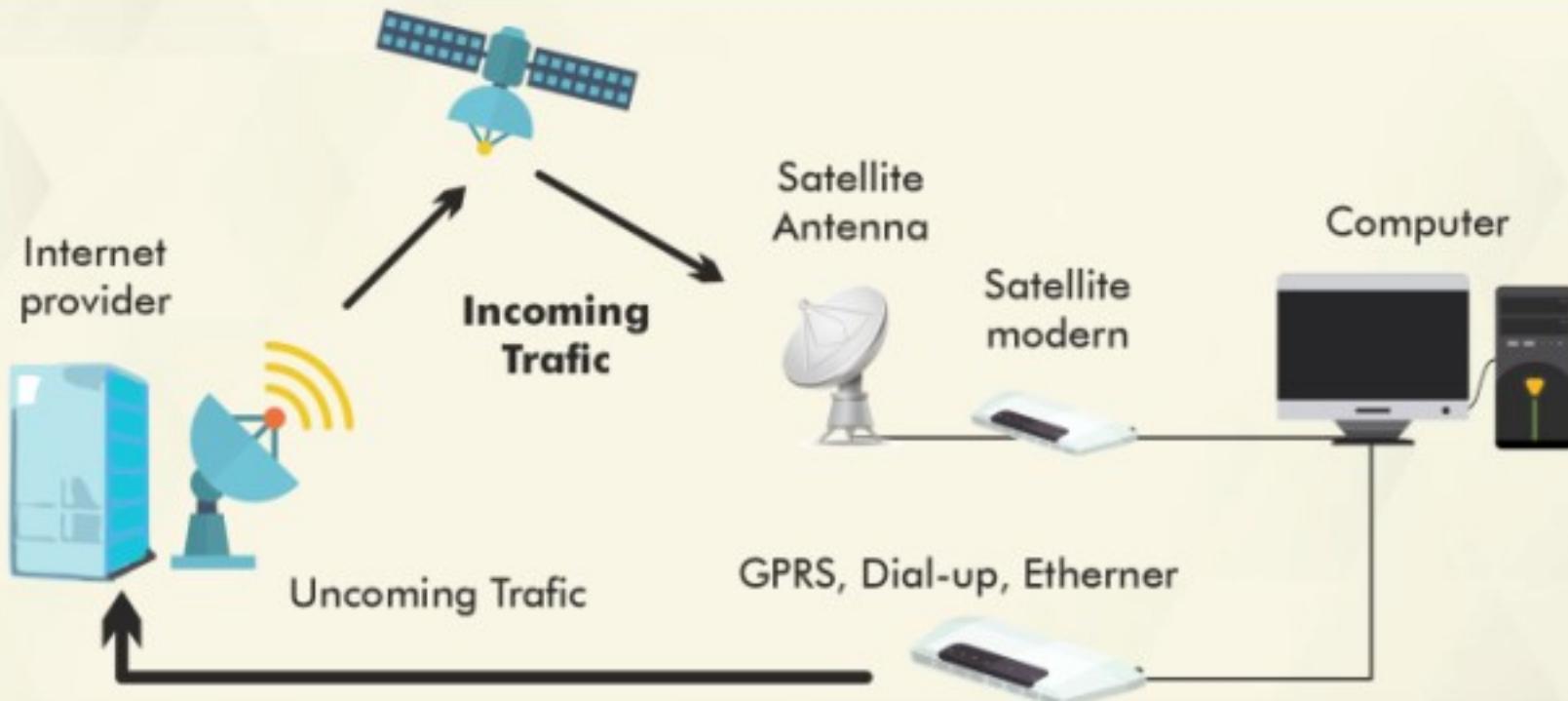


# Internet



# Space Based Internet

## Working of Satellite services



**Q1.** With reference to Visible Light Communication (VLC) technology, which of the following statements are correct?

1. VLC uses electromagnetic spectrum wavelengths 375 to 780 nm
2. VLC is known as long range optical wireless communication.
3. VLC can transmit large amounts of data faster than Bluetooth
4. VLC has no electromagnetic interference.

Select the correct answer using the code given below:

- (a) 1, 2 and 3 only
- (b) 1, 2 and 4 only
- (c) 1, 3 and 4 only
- (d) 2, 3 and 4 only

**Q2.** With reference to communications technologies, what is/are the difference/differences between LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution)?

1. LTE is commonly marketed as 3G and VoLTE is commonly marketed as advanced 3G.
2. LTE is data-only technology and VoLTE is voice-only technology.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

**Q3.** In the context of digital technologies for entertainment, consider the following statements:

1. In Augmented Reality (AR), a simulated environment is created and the physical world is completely shut out.
  2. In Virtual Reality (VR), images generated from a computer are projected onto real-life objects or surroundings.
  3. AR allows individuals to be present in the world and improves the experience using the camera of smartphones or PC.
  4. VR closes the world, and transposes an individual, providing complete immersion experience.
- Which of the statements given above is/are correct?
- (a) 1 and 2 only
  - (b) 3 and 4
  - (c) 1, 2 and 3
  - (d) 4 only

**Q4.** Organic Light Emitting Diodes (OLEDs) are used to create digital display in many devices. What are the advantages of OLED displays over Liquid Crystal displays?

1. OLED displays can be fabricated on flexible plastic substrates.
  2. Roll-up displays embedded in clothing can be made using OLEDs.
  3. Transparent displays are possible using OLEDs.
- Select the correct answer using the code given below:
- (a) 1 and 3 only
  - (b) 2 only
  - (c) 1, 2 and 3
  - (d) None of the above statements is correct

Q5. With reference to 'LiFi', recently in the news, which of the following statements is/are correct?

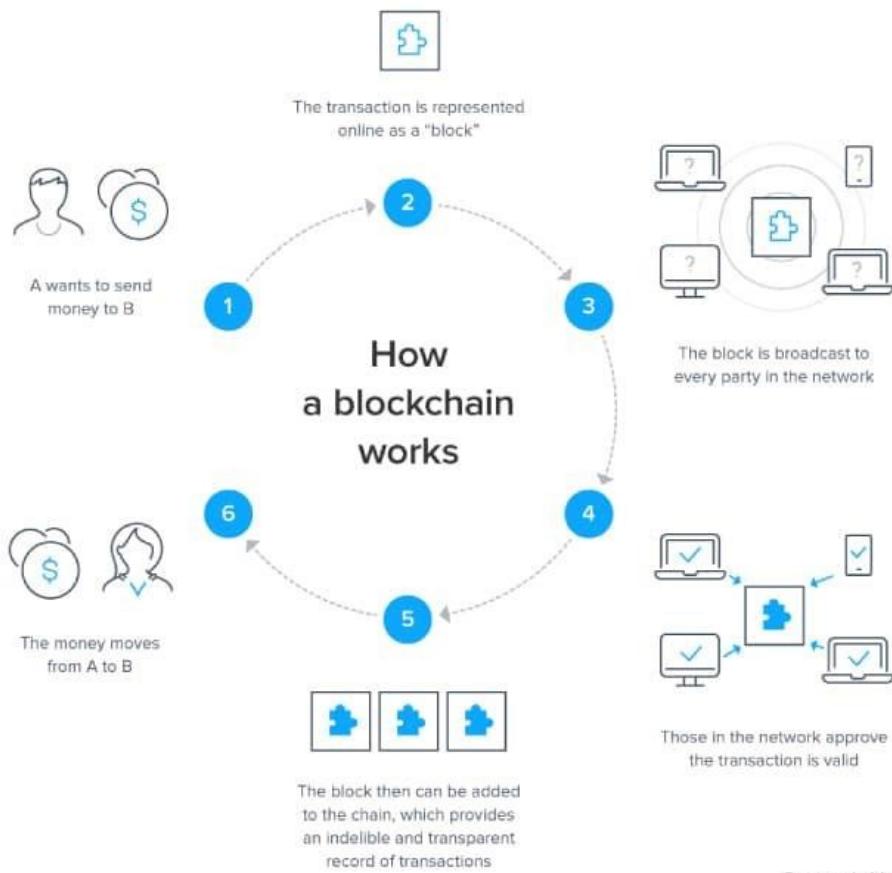
1. It uses light as the medium for high-speed data transmission.
2. It is a wireless technology and is several times faster than 'WiFi'.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

# How a Blockchain Works

F  
M



[https://www.youtube.com/watch?v=\\_160oMzblY8](https://www.youtube.com/watch?v=_160oMzblY8)

Source: Lykke

# Science and Technology



Q1. Recently Radioisotope Thermoelectric Generators (RTG) technology was in the news. Consider the following statements regarding the Radioisotope Thermoelectric Generators (RTG) technology:

1. It can be a steady source of both heat and electric energy for space missions.
2. It will help in launching missions deeper into space.
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4. Plutonium-238 is used to provide heat and electricity in RTG.

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1. Targeted drug delivery is made possible by nanotechnology.
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1. The energy released in a nuclear fusion reaction is greater than the energy released by nuclear fission.
2. Nuclear Fusion does not normally occur in nature but fission occurs in stars.
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Which of the statements given above is/are correct?

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- (c) 1 and 2 only
- (d) 2 and 3 only

Q4. With reference to the different types of nuclear reactors used in the Indian power plants, consider the following pairs:

<b>Type of Reactor</b>	<b>Power Plant</b>
------------------------	--------------------

- |                                    |             |
|------------------------------------|-------------|
| 1. Pressurised Water Reactor.      | Kudankulam  |
| 2. Pressurized Heavy Water Reactor | Rawatbhatta |
| 3. Fast breeder Reactor            | Tarapore    |

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**Q6. Which of the following best describes the rationale for fast breeder reactor (FBR) in India, which is integral to 3 staged Nuclear programme:**

- (a) To convert Natural Uranium in Pu-239, which is a good fissile material.
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- (c) To use fission base energy and use it for Nuclear fusion
- (d) To use Thorium reserves and convert it into good fissile material

**Q7.** India is an important member of the 'International Thermonuclear Experimental Reactor'. If this experiment succeeds, what is the immediate advantage for India?

- (a) It can use thorium in place of uranium for power generation
- (b) It attain a global role in satellite-navigation
- (c) It can drastically improve the efficiency of its fission reactors in power generation
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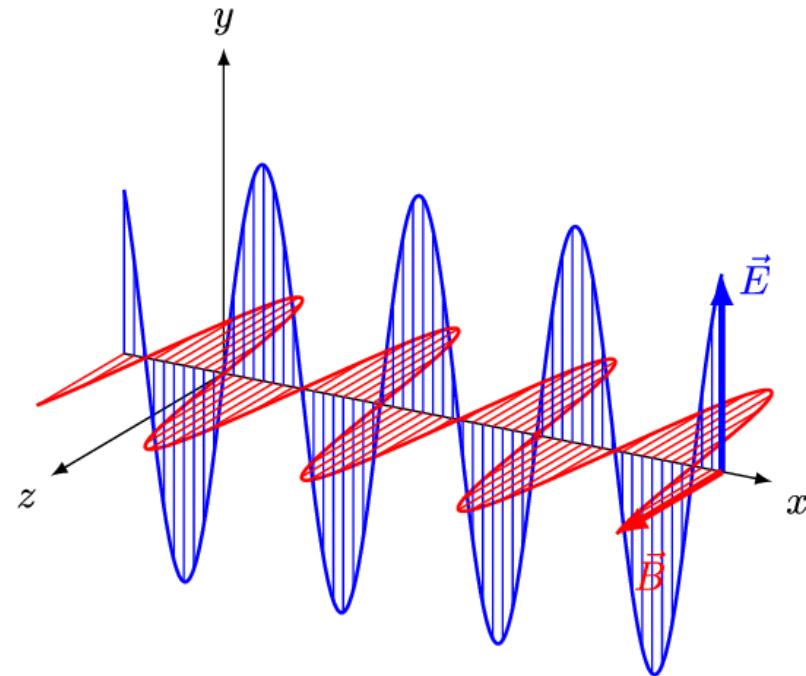
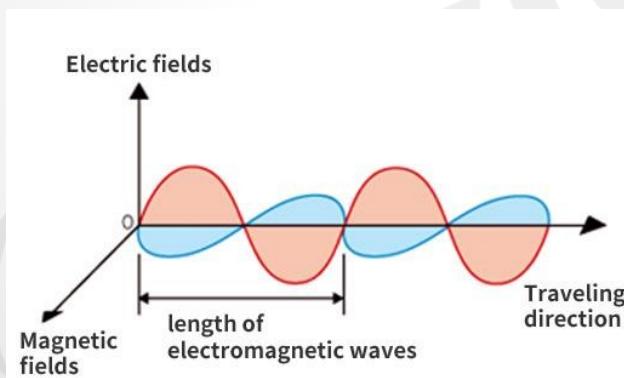
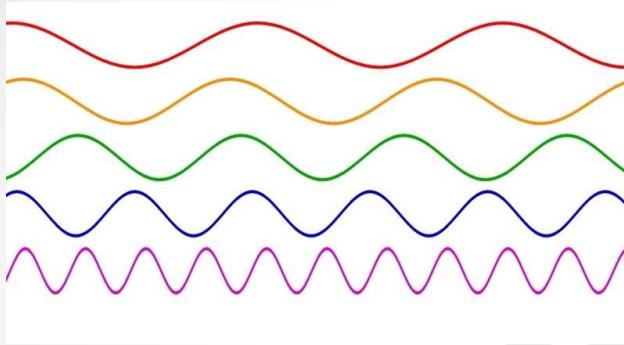
Which of the statements given above is/are correct?

- (a) 1 only
- (b) 3 only
- (c) 1 and 2
- (d) 2 and 3

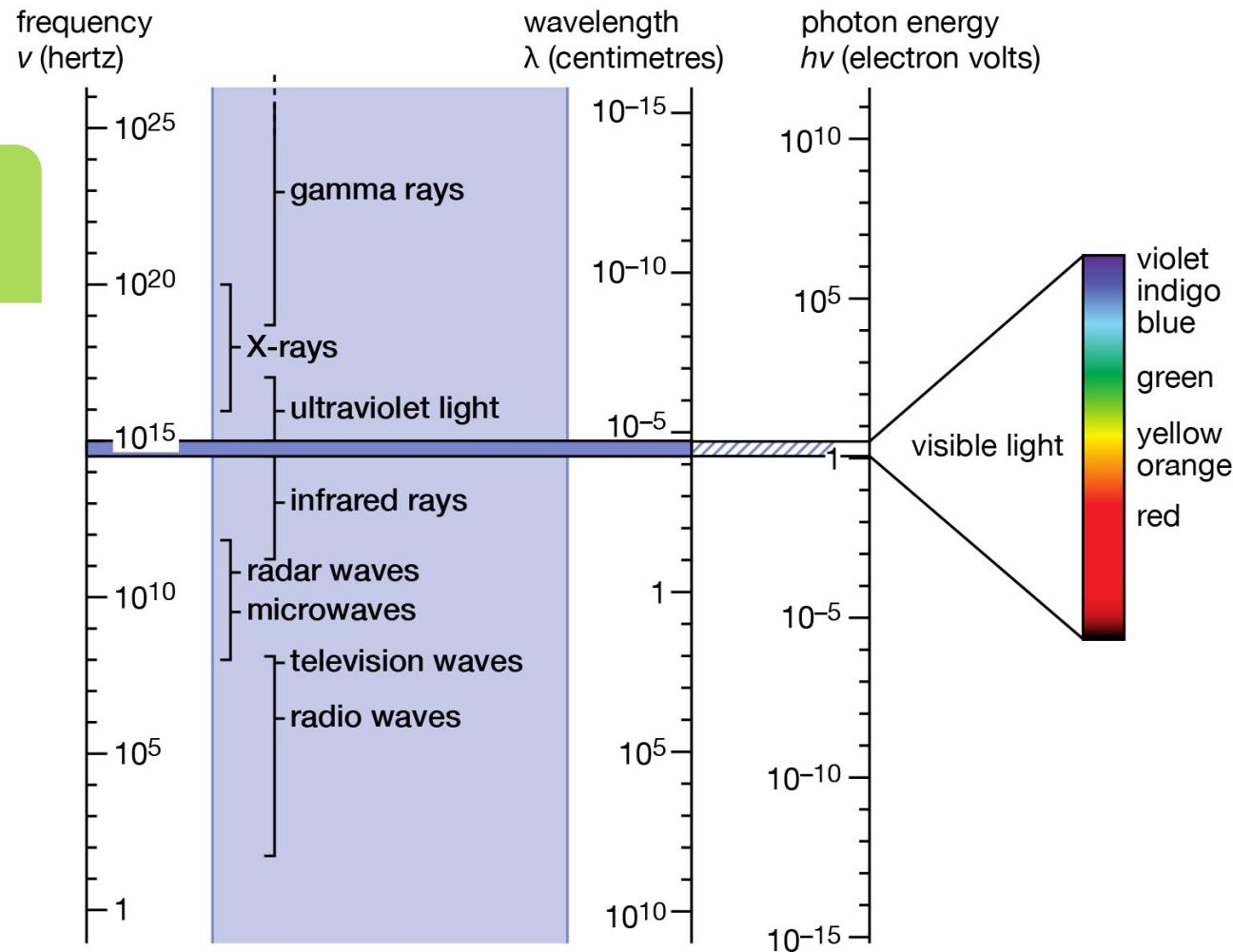
# Topics

- 5G
- Internet – ICANN, Net neutrality, Dark Net, Space Based Internet
- Deep Learning, Machine Learning, AI
- Blockchain Technology and Cryptocurrencies
- Super Computing, Cloud Computing and Edge Computing
- Quantum Technologies
- Data Localization and Data Protection Regime

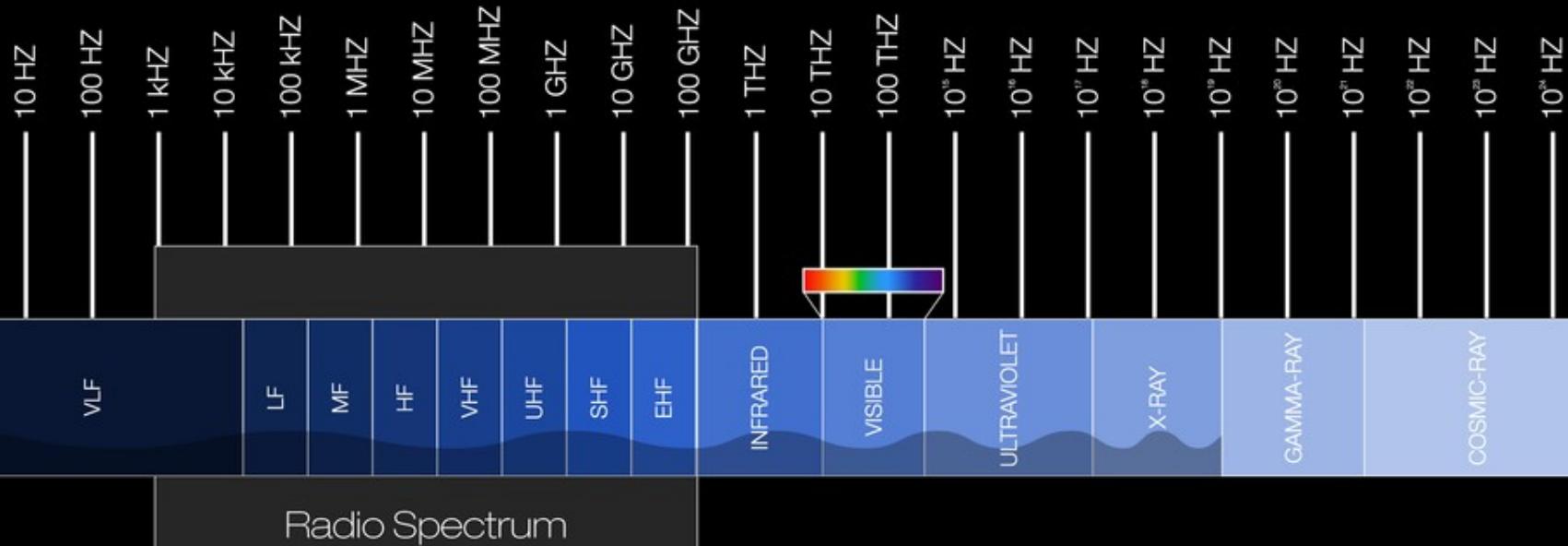
# Electromagnetic Waves



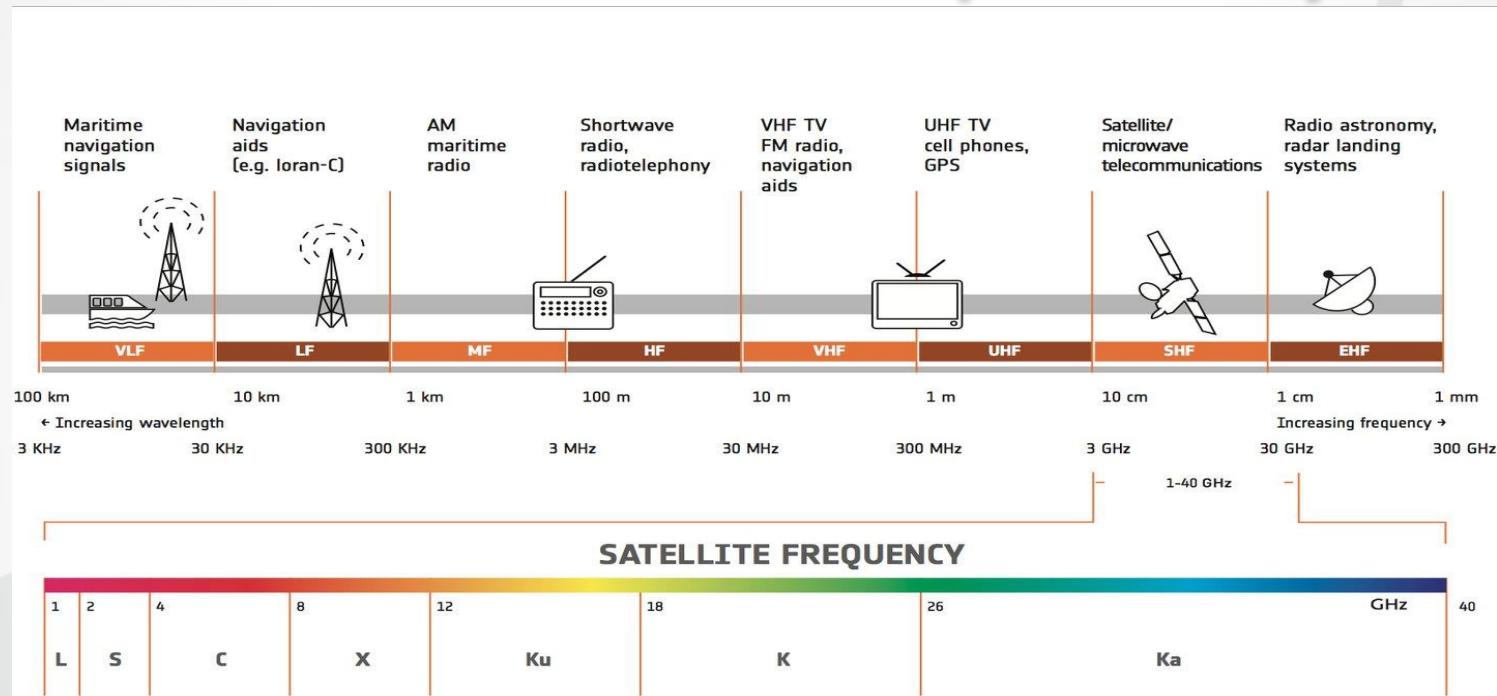
# Electromagnetic Spectrum



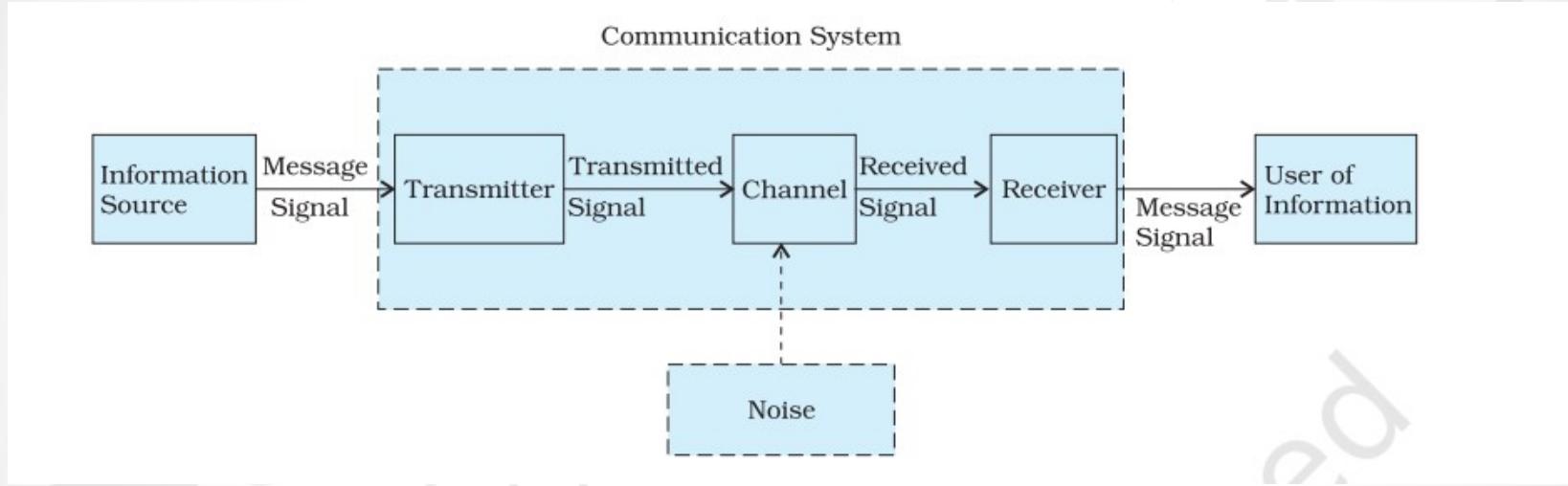
# Electromagnetic Spectrum



# Satellite Frequency



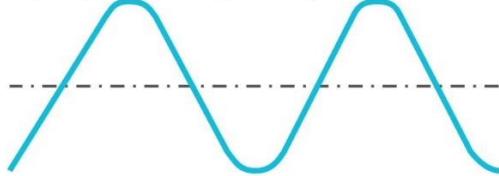
# Generalized Communication System



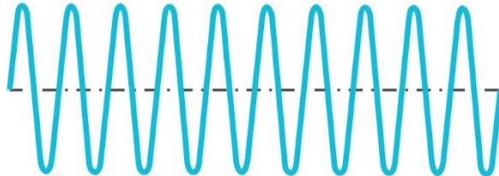
# Modulation

## Amplitude Modulation (AM)

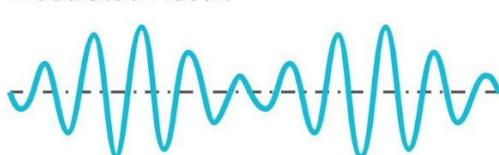
Input (Modulating Wave)



Carrier

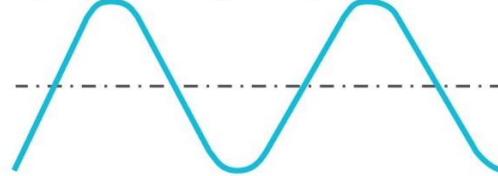


Modulated Result

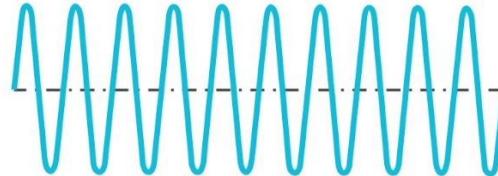


## Frequency Modulation (FM)

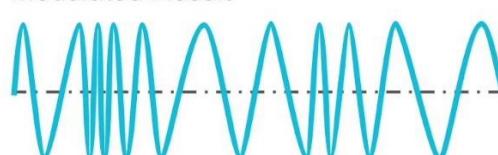
Input (Modulating Wave)



Carrier

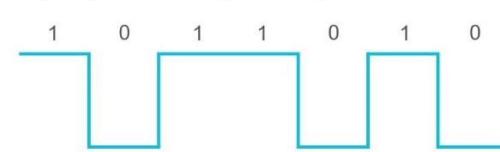


Modulated Result

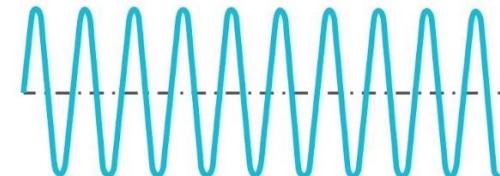


## Digital Modulation

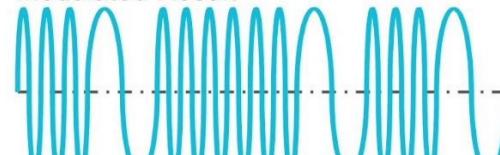
Input (Modulating Wave)



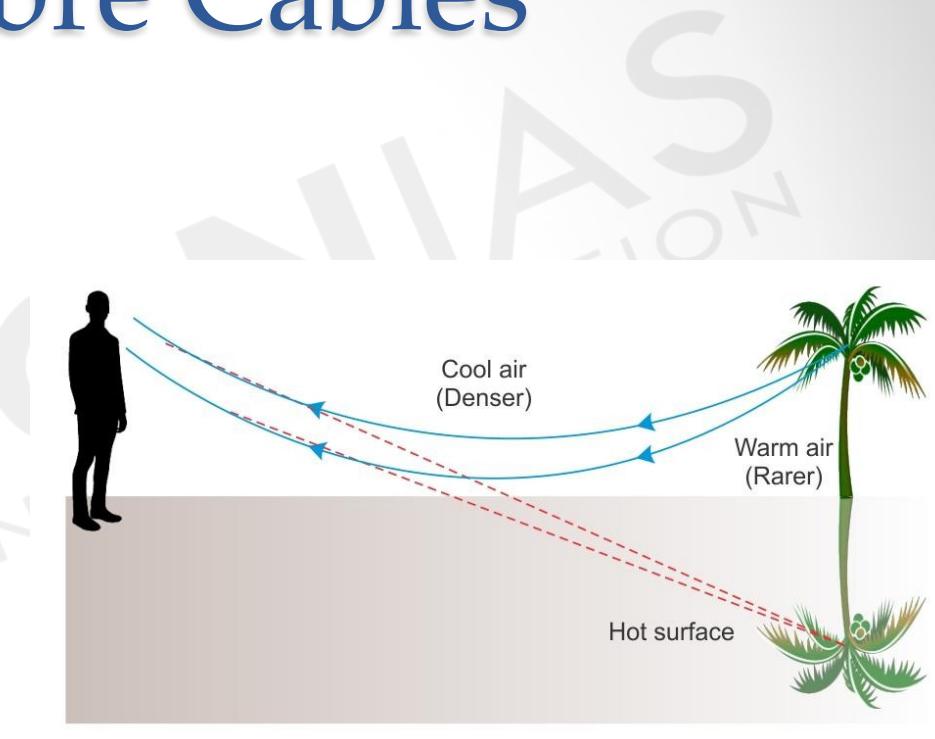
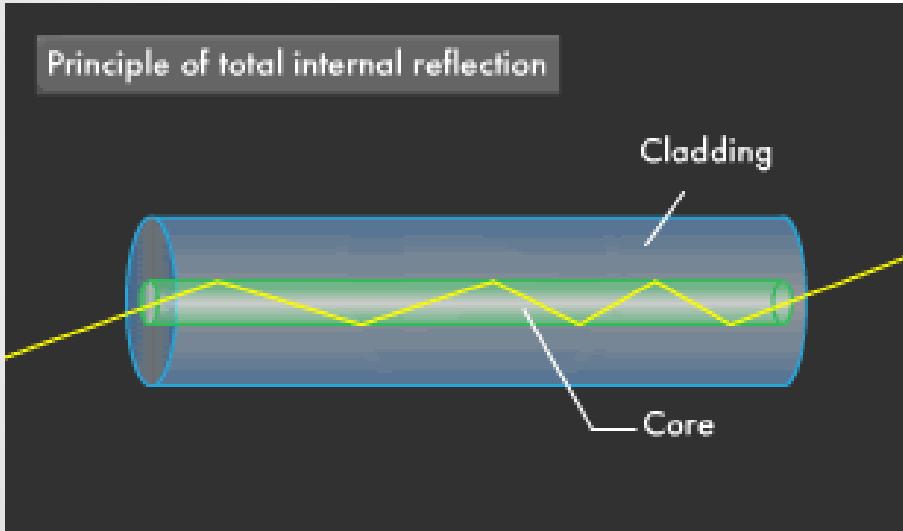
Carrier



Modulated Result



# Optical Fibre Cables



# History of Mobile Technology

SYNOPSYS®

**1G**



Analog  
Technology



**2G**



Digital  
Technology



**3G**



Wireless  
Capability



**4G**



Phones Became  
Computers



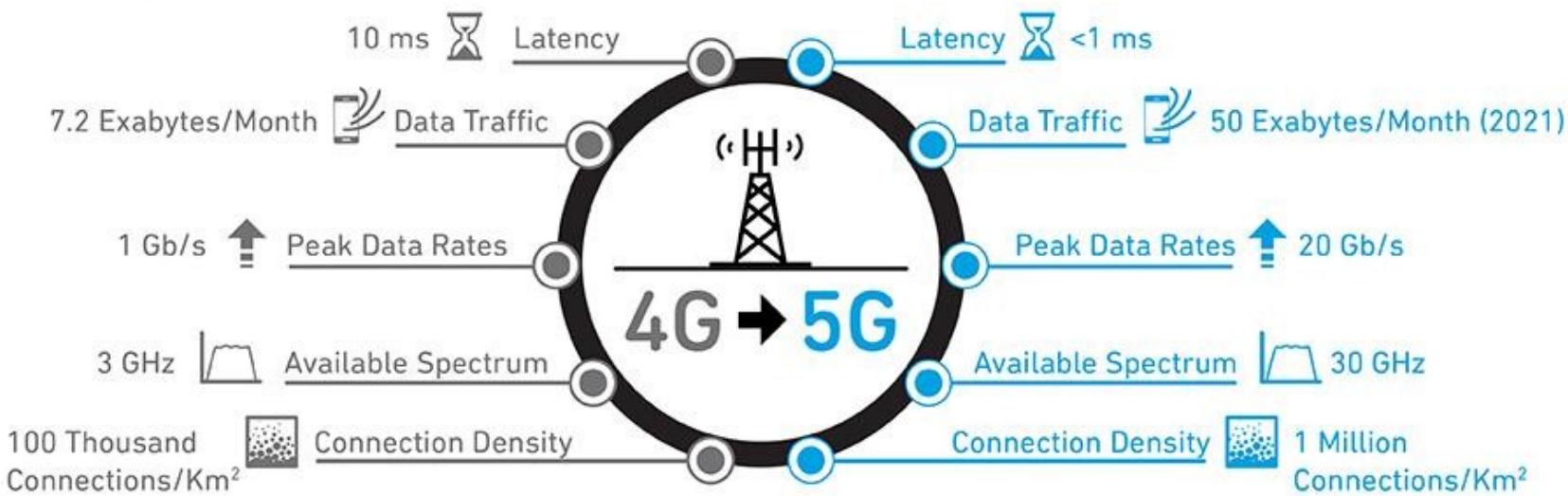
**5G**



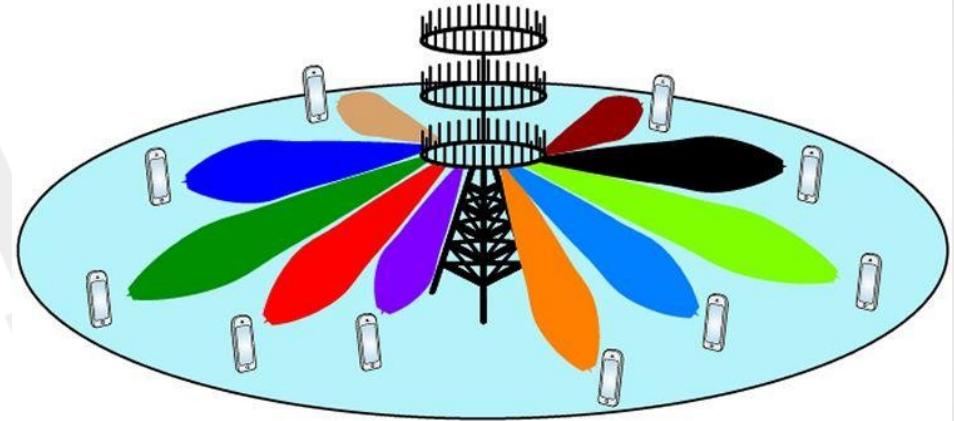
Unparalleled  
Latency



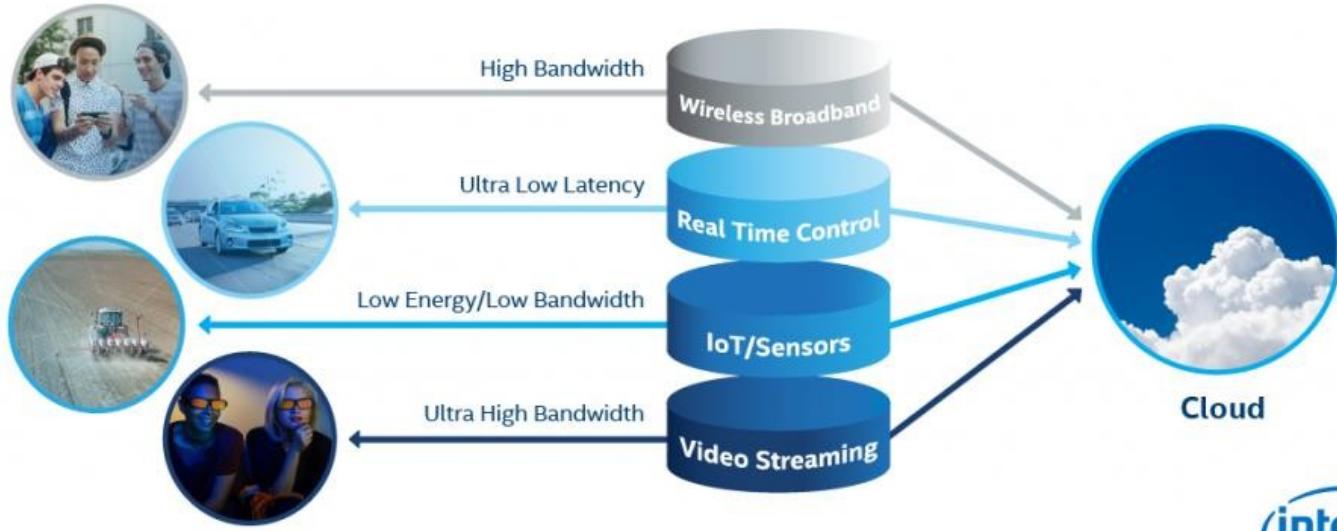
## Comparing 4G and 5G



# 5G Technologies



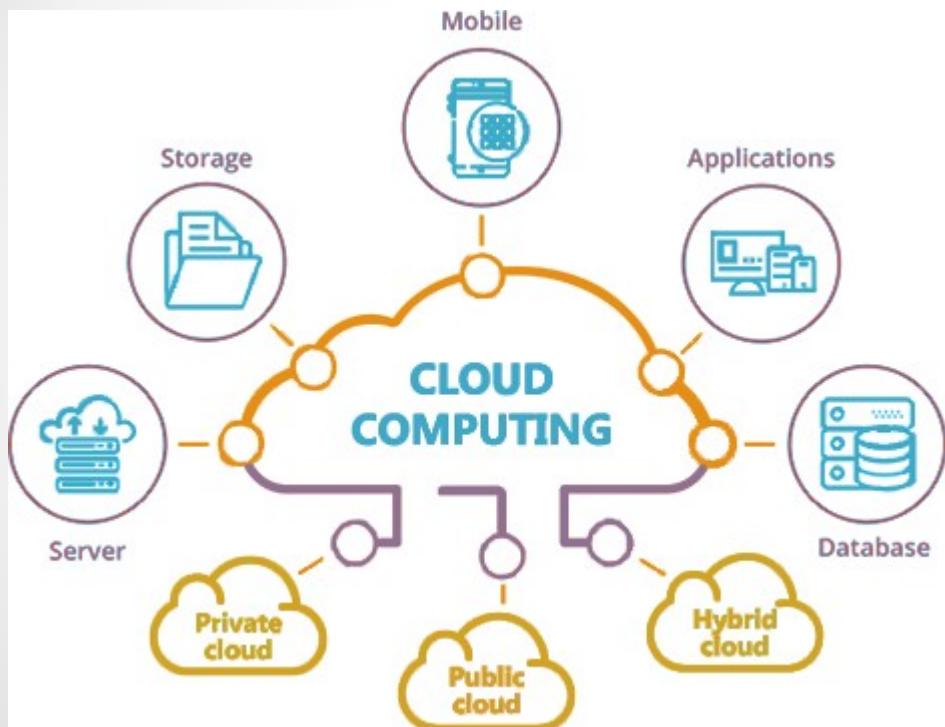
## 5G Network Slices



# Param Siddhi Supercomputer

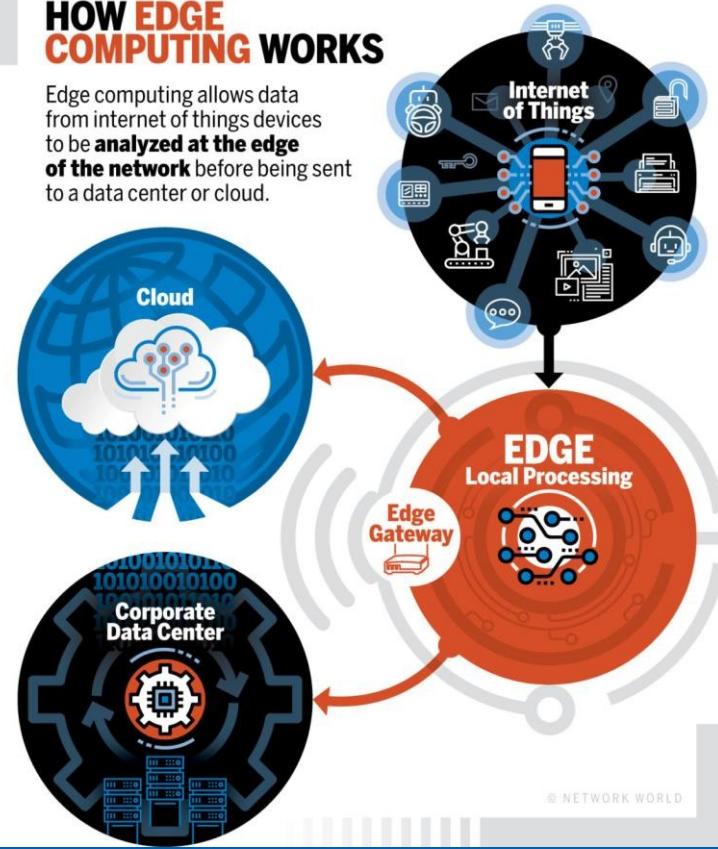


# Cloud and Edge Computing



## HOW EDGE COMPUTING WORKS

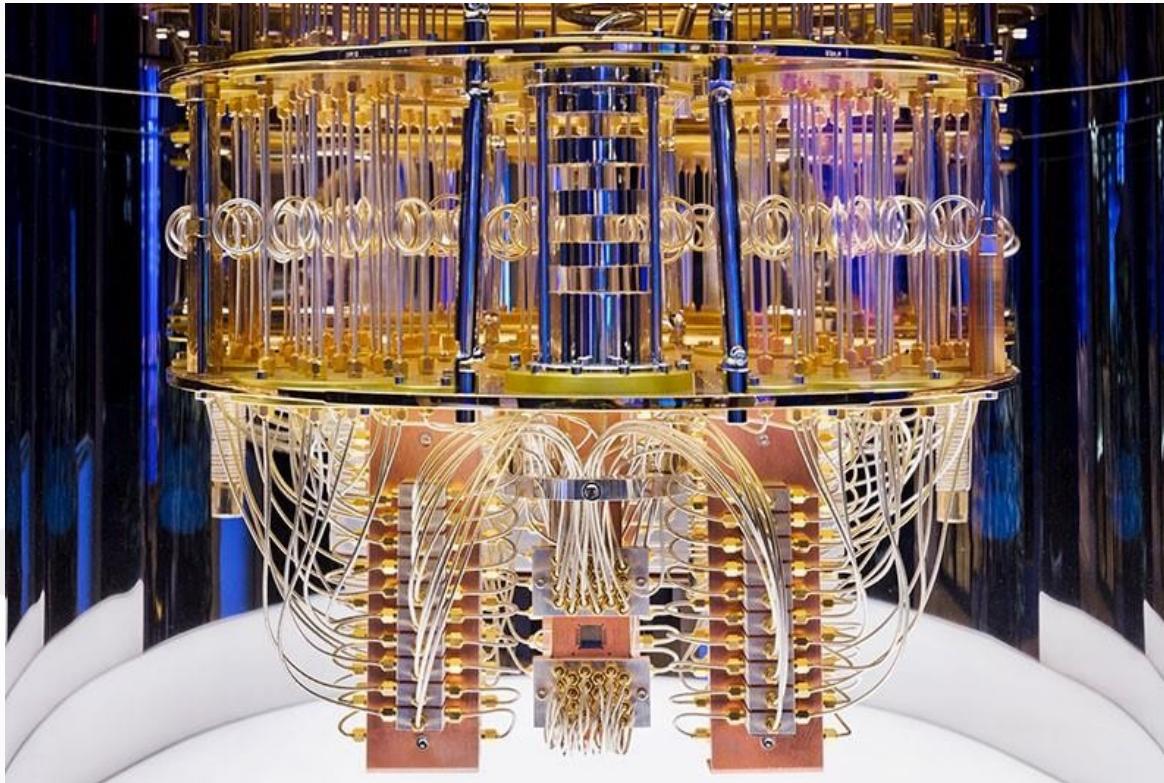
Edge computing allows data from internet of things devices to be **analyzed at the edge of the network** before being sent to a data center or cloud.



# Internet of Things

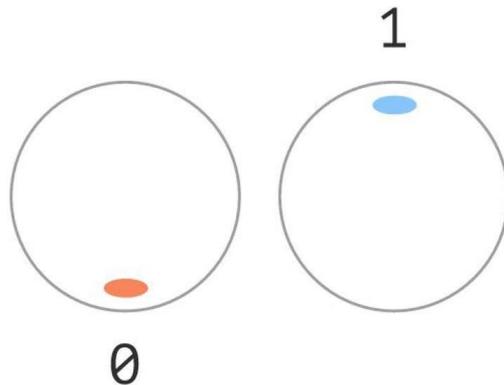


# Quantum Computer

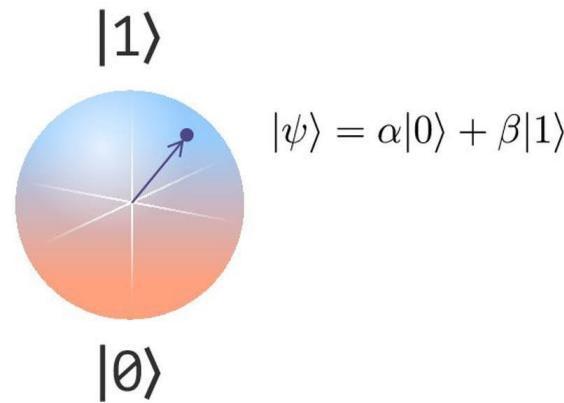


# Qubit

Bit

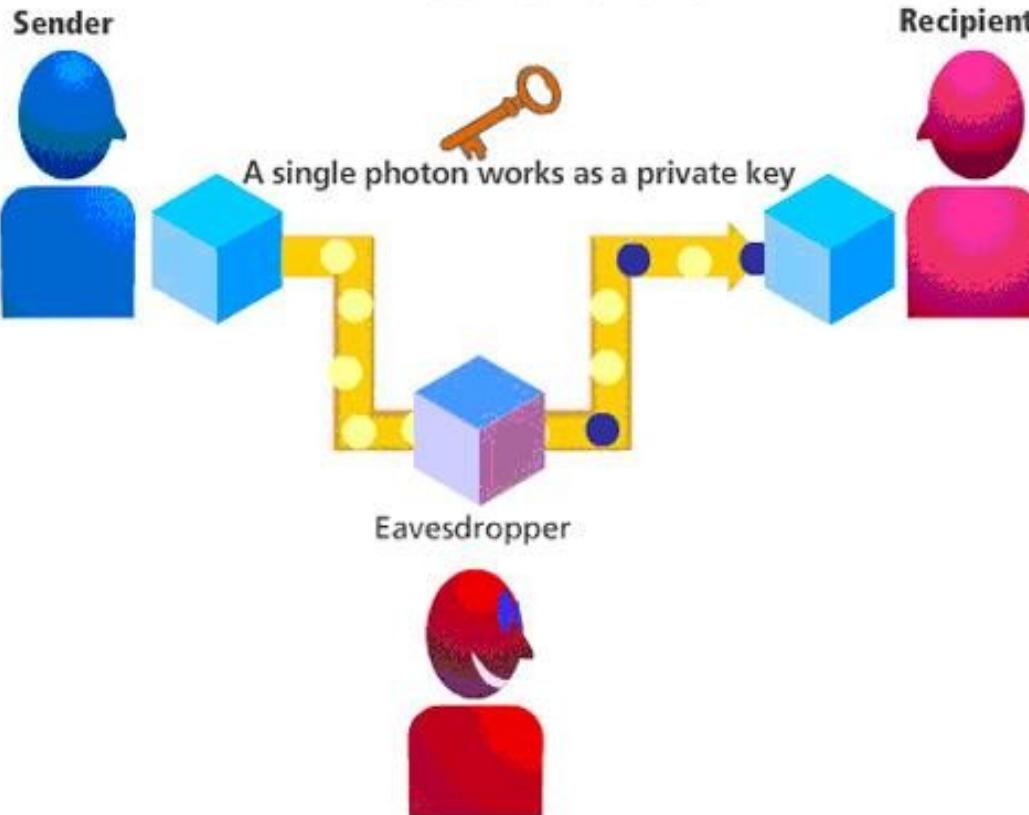


Qubit



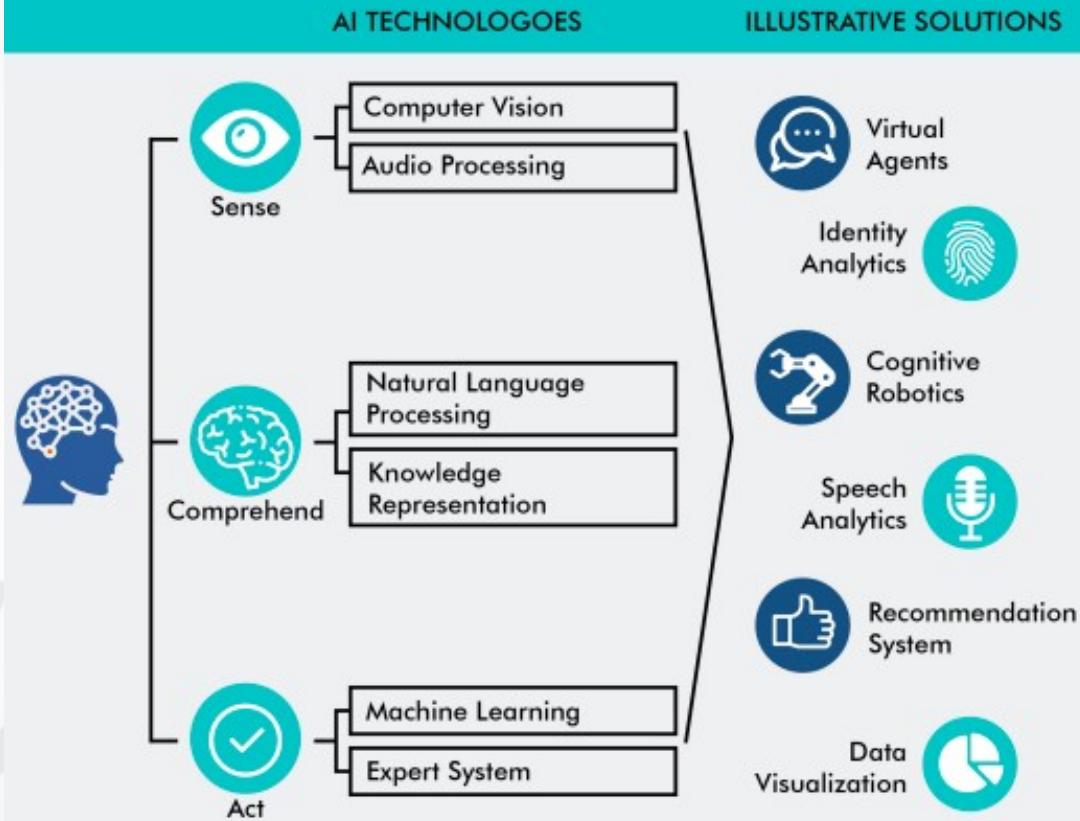
$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

## Quantum cryptography system

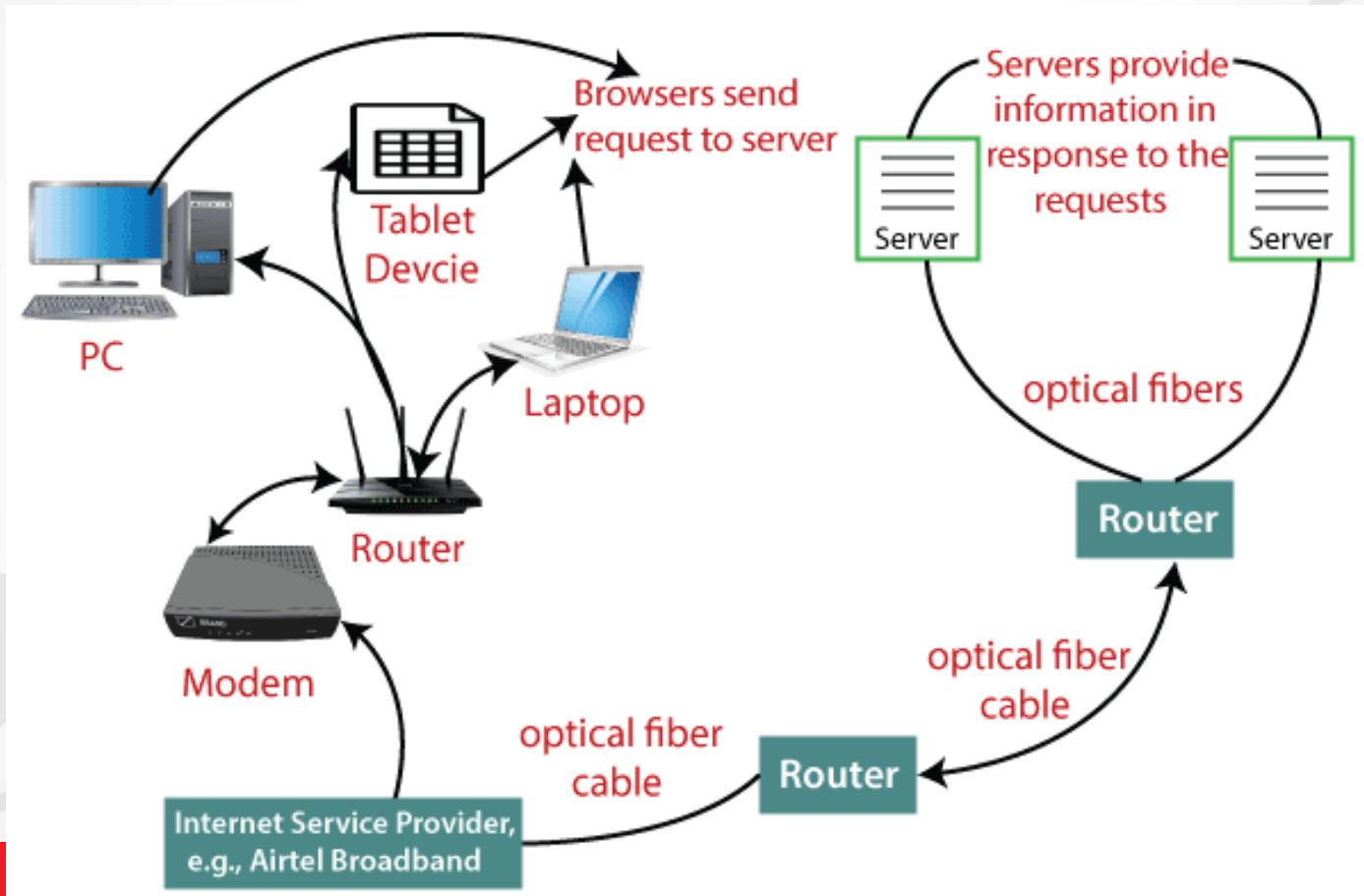


Recipients can discern the presence of eavesdroppers because the quantum state has changed due to observation.

# Artificial Intelligence

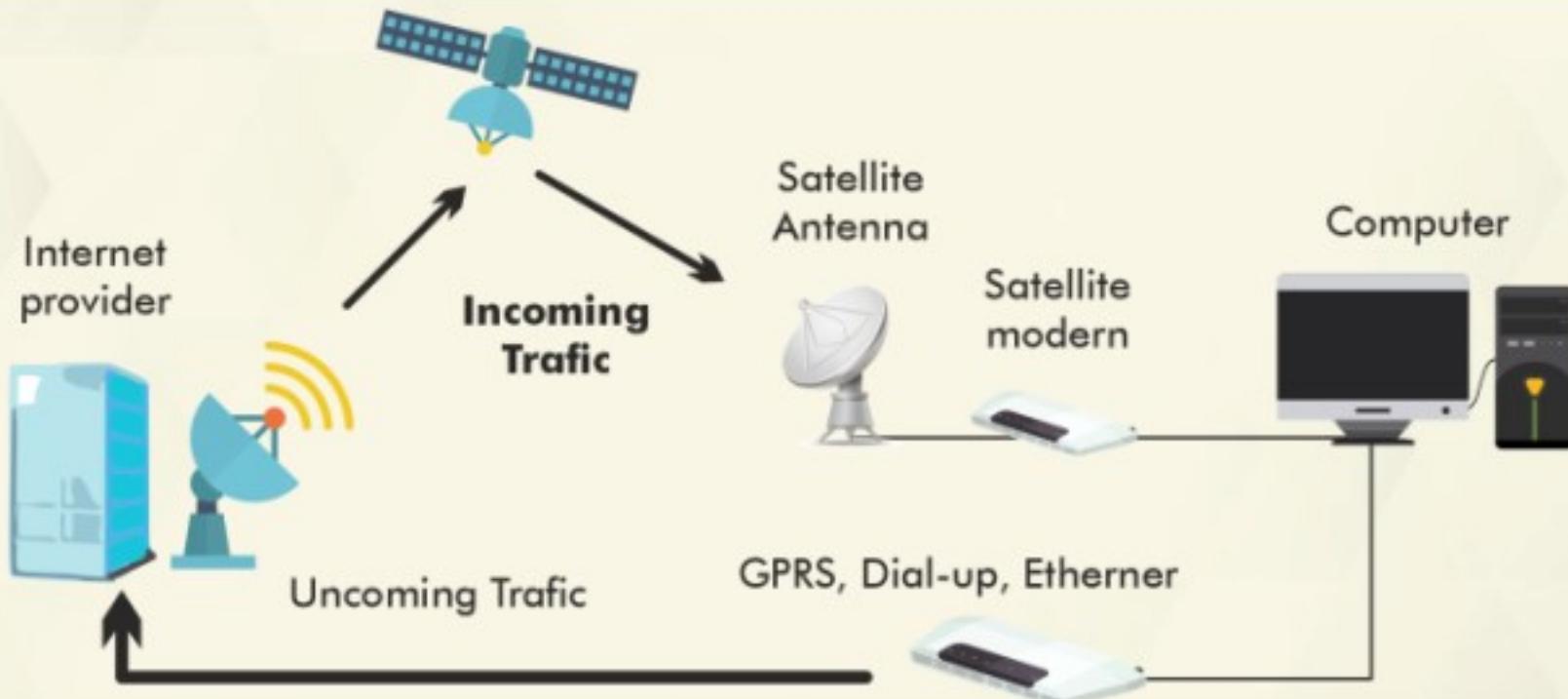


# Internet



# Space Based Internet

## Working of Satellite services



**Q1.** With reference to Visible Light Communication (VLC) technology, which of the following statements are correct?

1. VLC uses electromagnetic spectrum wavelengths 375 to 780 nm
2. VLC is known as long range optical wireless communication.
3. VLC can transmit large amounts of data faster than Bluetooth
4. VLC has no electromagnetic interference.

Select the correct answer using the code given below:

- (a) 1, 2 and 3 only
- (b) 1, 2 and 4 only
- (c) 1, 3 and 4 only
- (d) 2, 3 and 4 only

**Q2.** With reference to communications technologies, what is/are the difference/differences between LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution)?

1. LTE is commonly marketed as 3G and VoLTE is commonly marketed as advanced 3G.
2. LTE is data-only technology and VoLTE is voice-only technology.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

**Q3.** In the context of digital technologies for entertainment, consider the following statements:

1. In Augmented Reality (AR), a simulated environment is created and the physical world is completely shut out.
  2. In Virtual Reality (VR), images generated from a computer are projected onto real-life objects or surroundings.
  3. AR allows individuals to be present in the world and improves the experience using the camera of smartphones or PC.
  4. VR closes the world, and transposes an individual, providing complete immersion experience.
- Which of the statements given above is/are correct?
- (a) 1 and 2 only  
(b) 3 and 4  
(c) 1, 2 and 3  
(d) 4 only

**Q4.** Organic Light Emitting Diodes (OLEDs) are used to create digital display in many devices. What are the advantages of OLED displays over Liquid Crystal displays?

1. OLED displays can be fabricated on flexible plastic substrates.
  2. Roll-up displays embedded in clothing can be made using OLEDs.
  3. Transparent displays are possible using OLEDs.
- Select the correct answer using the code given below:
- (a) 1 and 3 only  
(b) 2 only  
(c) 1, 2 and 3  
(d) None of the above statements is correct

Q5. With reference to 'LiFi', recently in the news, which of the following statements is/are correct?

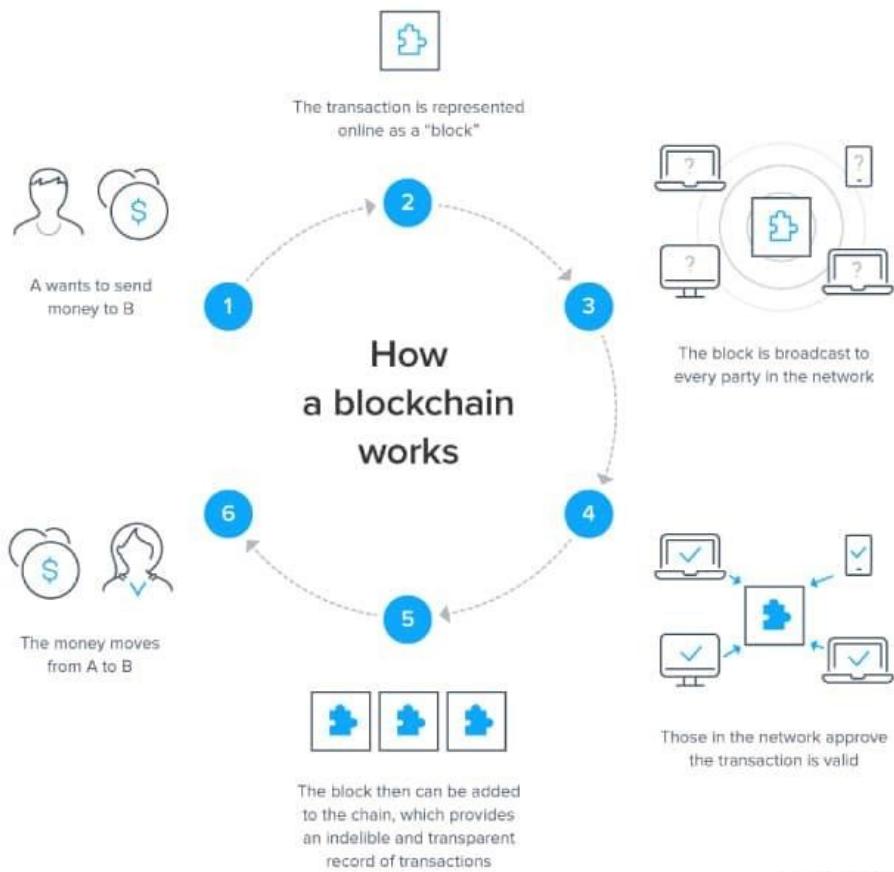
1. It uses light as the medium for high-speed data transmission.
2. It is a wireless technology and is several times faster than 'WiFi'.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

# How a Blockchain Works

F  
M



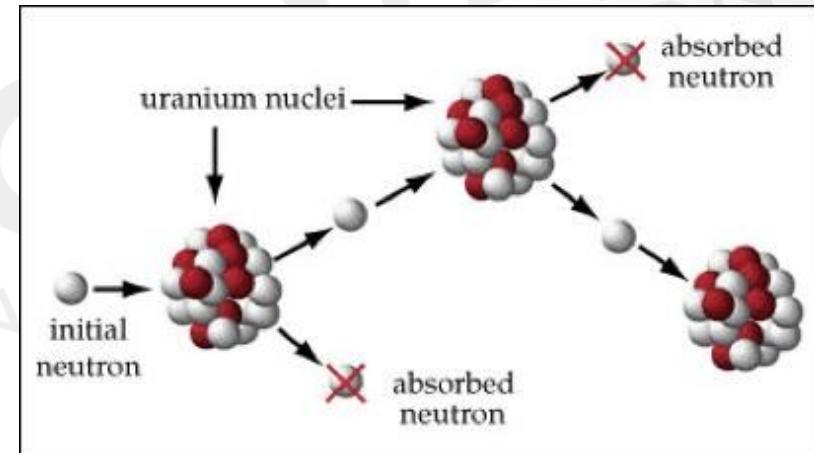
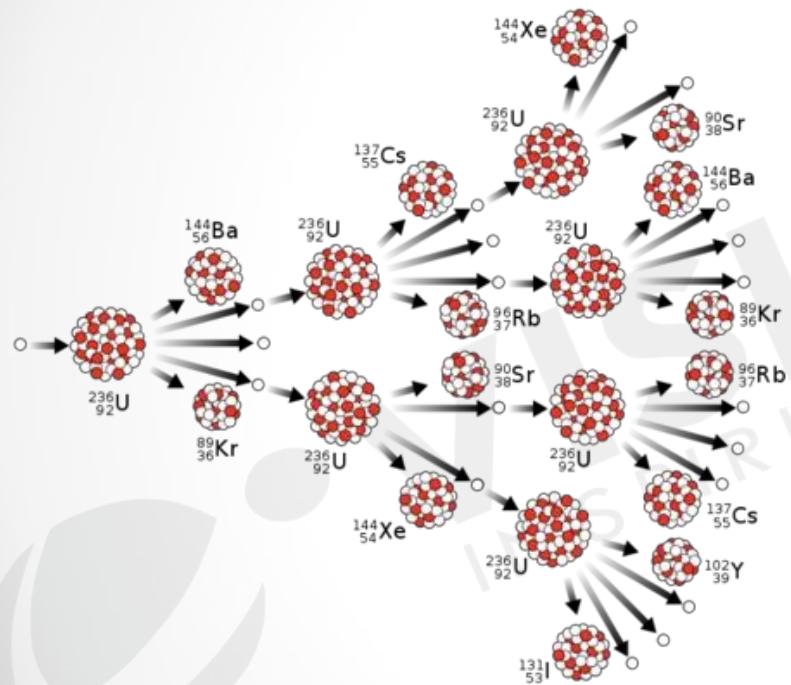
[https://www.youtube.com/watch?v=\\_160oMzblY8](https://www.youtube.com/watch?v=_160oMzblY8)

Source: Lykke

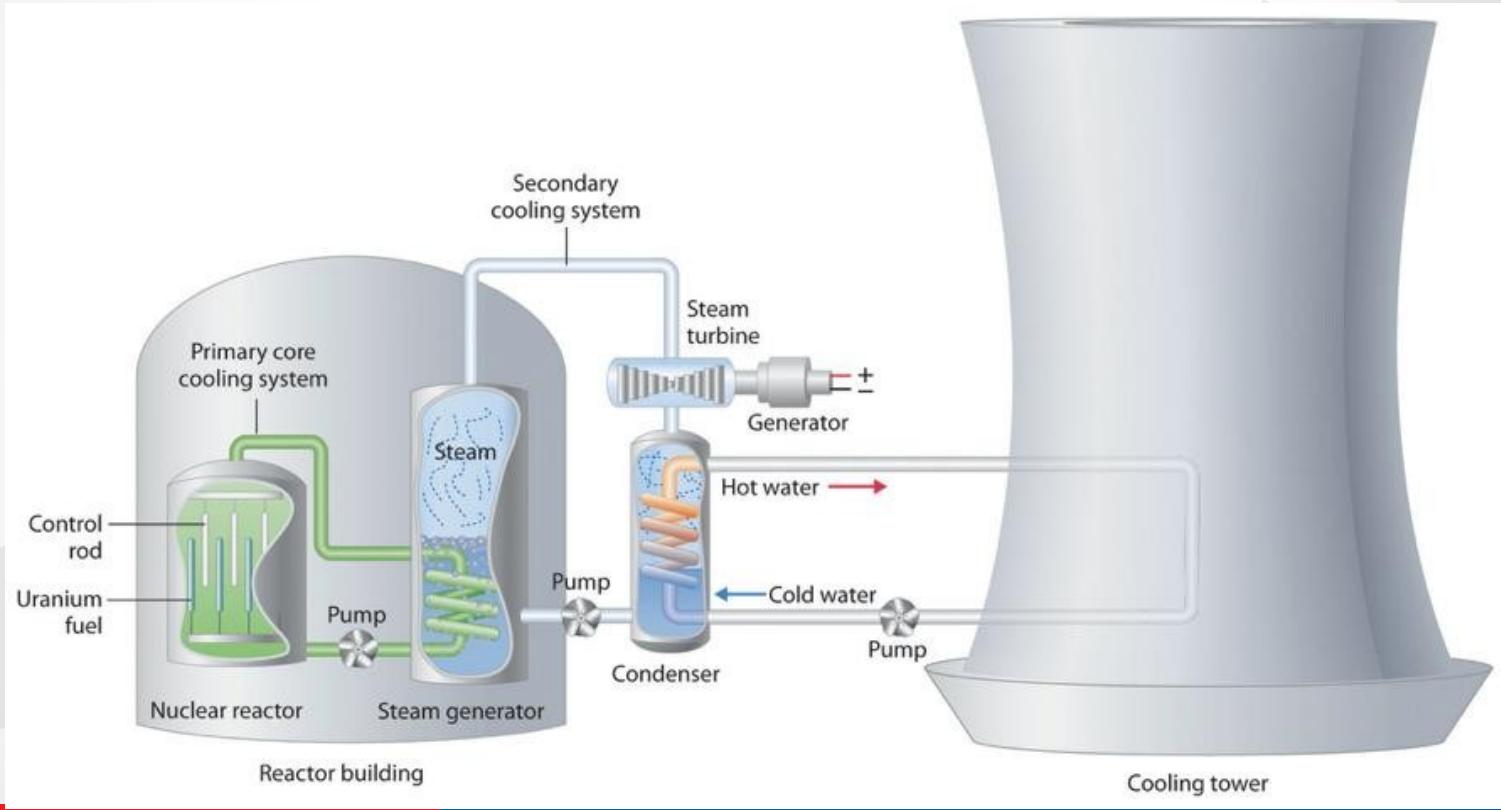
# Nuclear Technology



# Uncontrolled and Controlled Fission



# Nuclear reactor

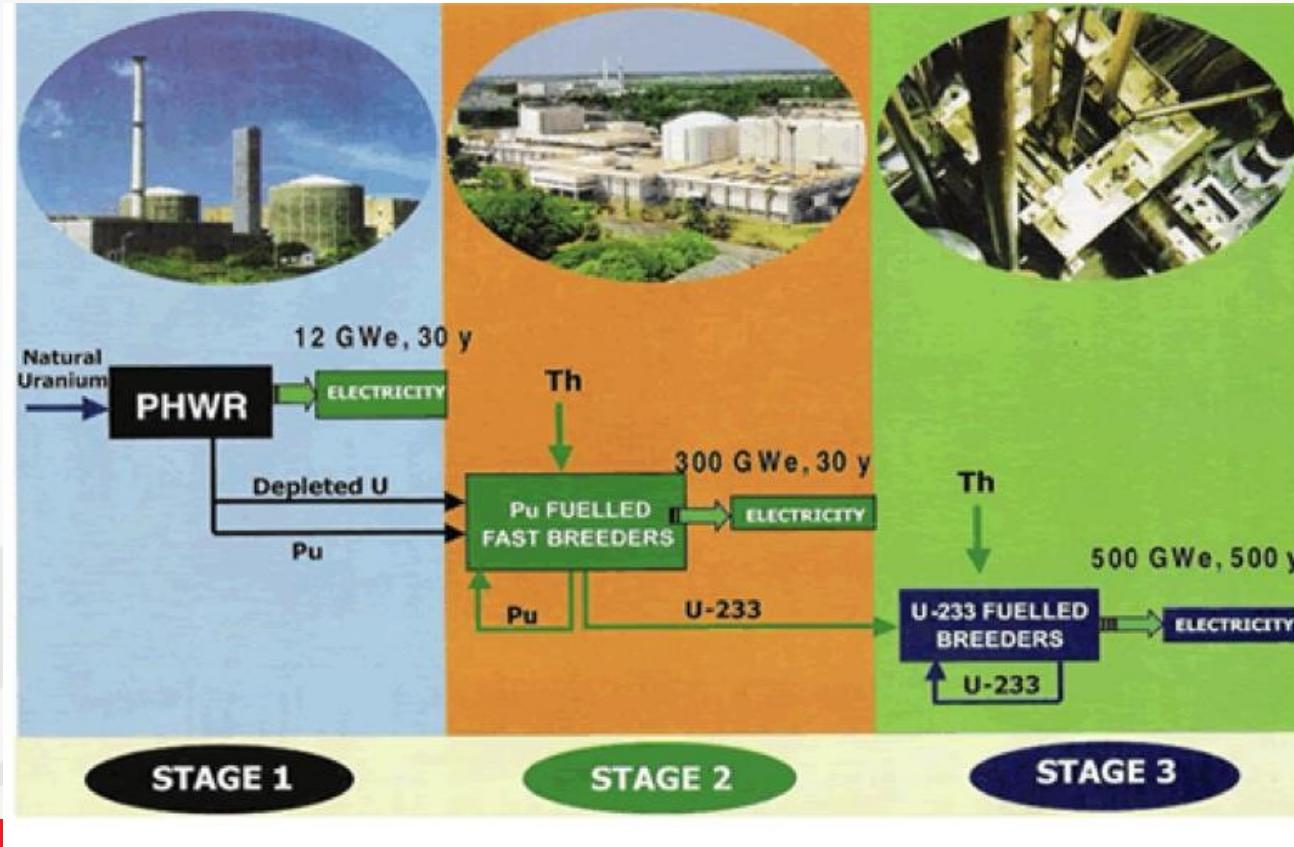


# Major types of Reactor

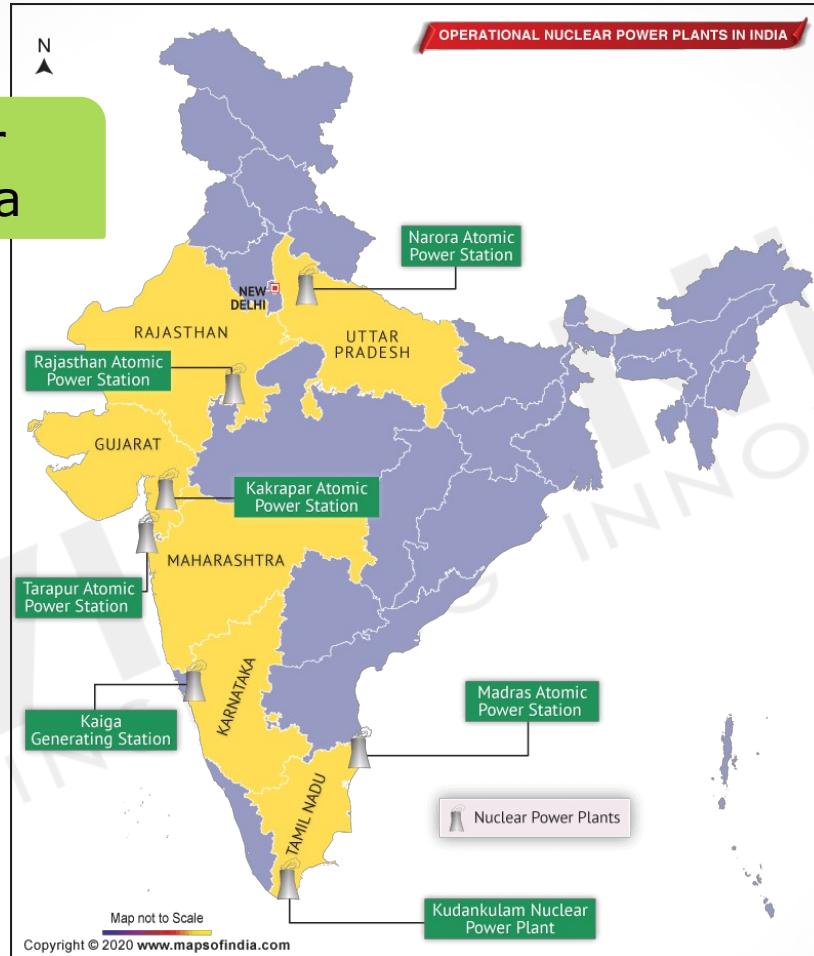
- Pressurized Heavy Water Reactor
- Boiling Water Reactor
- Fast Breeder Reactor



# 3 Staged Nuclear Programme



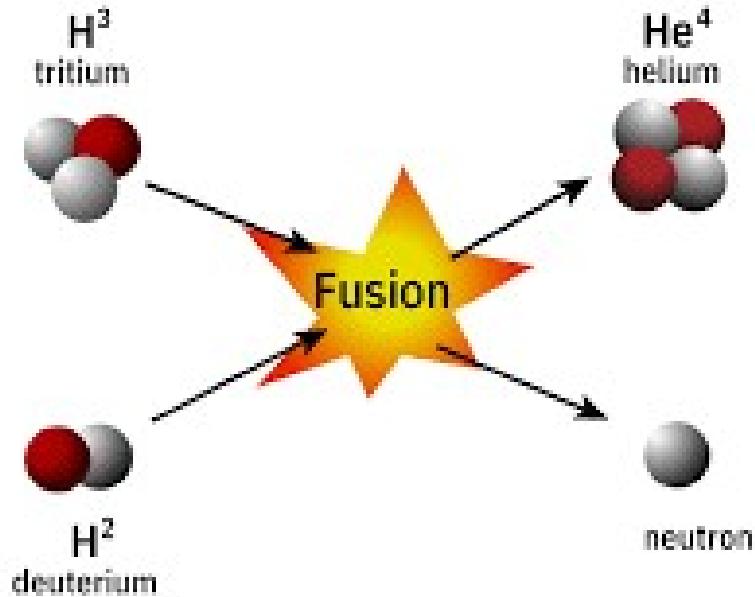
# Operational Nuclear Power Plants of India



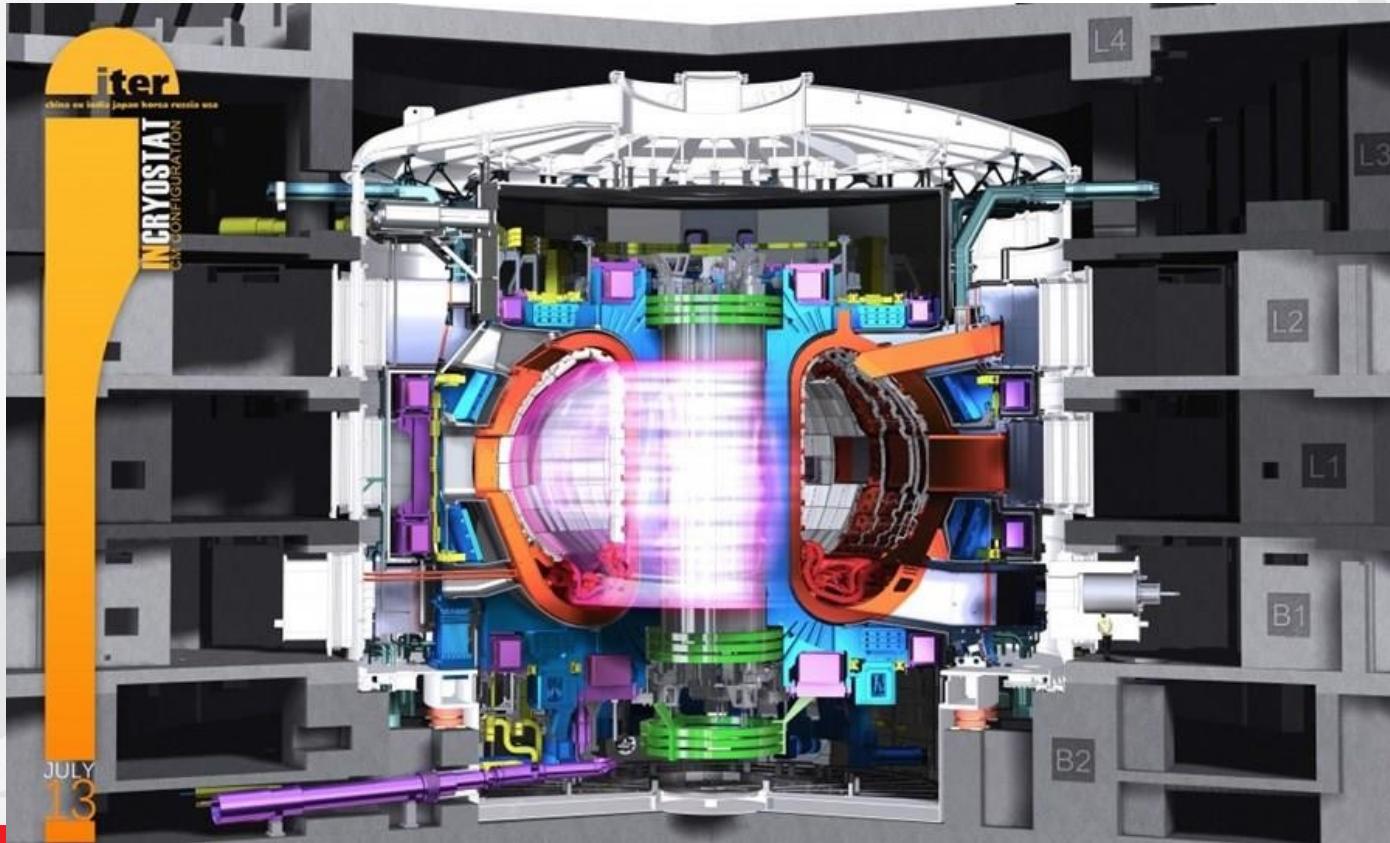
# Radioisotopes

<b>Radioactive Isotope</b>	<b>Applications in Medicine</b>
<b>Cobalt-60</b>	Radiation therapy to prevent cancer
<b>Iodine-131</b>	Locate brain tumors, monitor cardiac, liver and thyroid activity
<b>Carbon-14</b>	Study metabolism changes for patients with diabetes, gout and anemia
<b>Carbon-11</b>	Tagged onto glucose to monitor organs during a PET scan
<b>Sodium-24</b>	Study blood circulation
<b>Thallium-201</b>	Determine damage in heart tissue, detection of tumors
<b>Technetium-99m</b>	Locate brain tumors and damaged heart cells, radiotracer in medical diagnostics (imaging of organs and blood flow studies)

# Nuclear Fusion



# ITER Tokamak



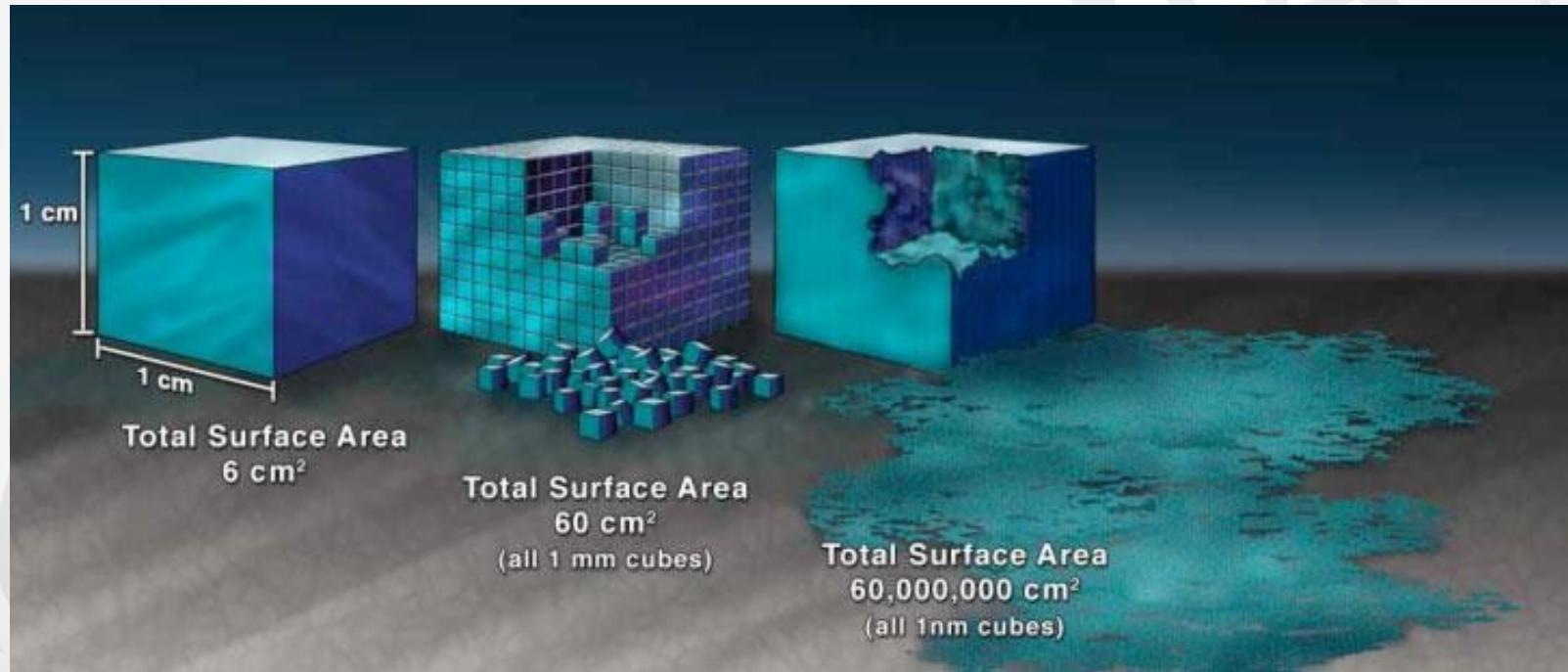
# Nanotechnology



# Nanogold

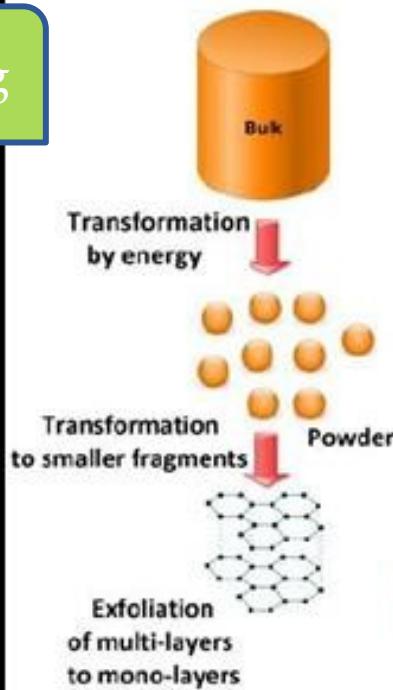


# Increased Surface Area

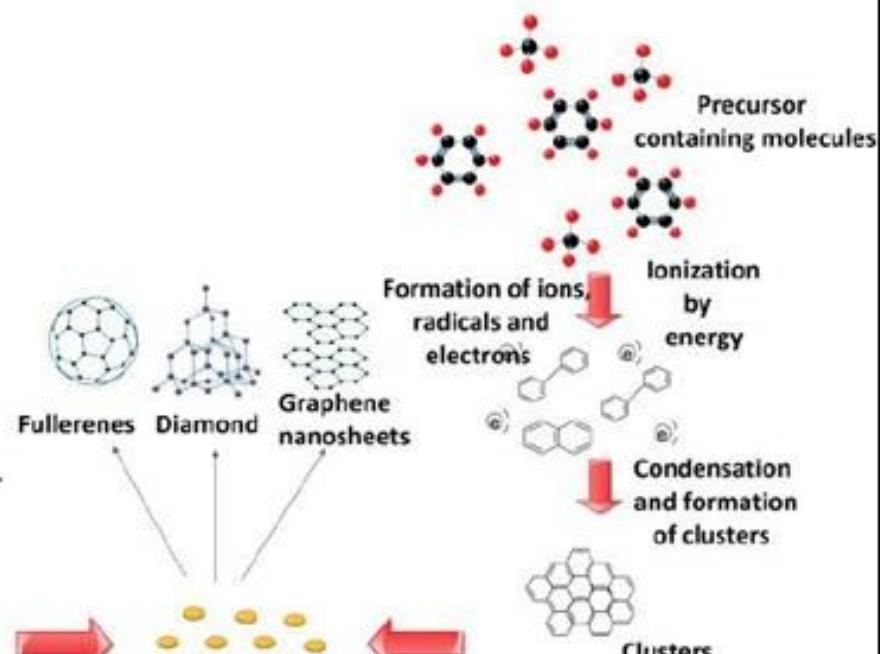


## Nanomanufacturing

### Top- Down Approach



### Bottom-Up Approach

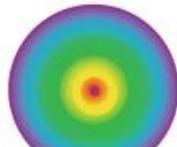


## NMs classification based on dimensionality

### Dimensions of Nanomaterials

**0D**

Nanospheres,  
clusters



Quantum dots



Fullerenes

Au

Gold nanoparticles

**1D**

Nanotubes,  
wires, rods



Metal nanorods,  
Ceramic crystals



Carbon nanotubes,  
Metallic nanotubes



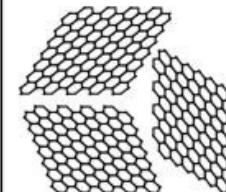
Gold nanowires,  
Polymeric nanofibers,  
Self assembled structures

**2D**

Thin films, plates,  
layered structures



Carbon coated  
nanoplates



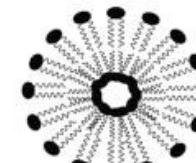
Graphene sheets



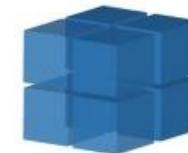
Layered nanomaterials

**3D**

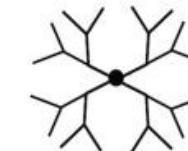
Bulk NMs,  
polycrystals



Liposome

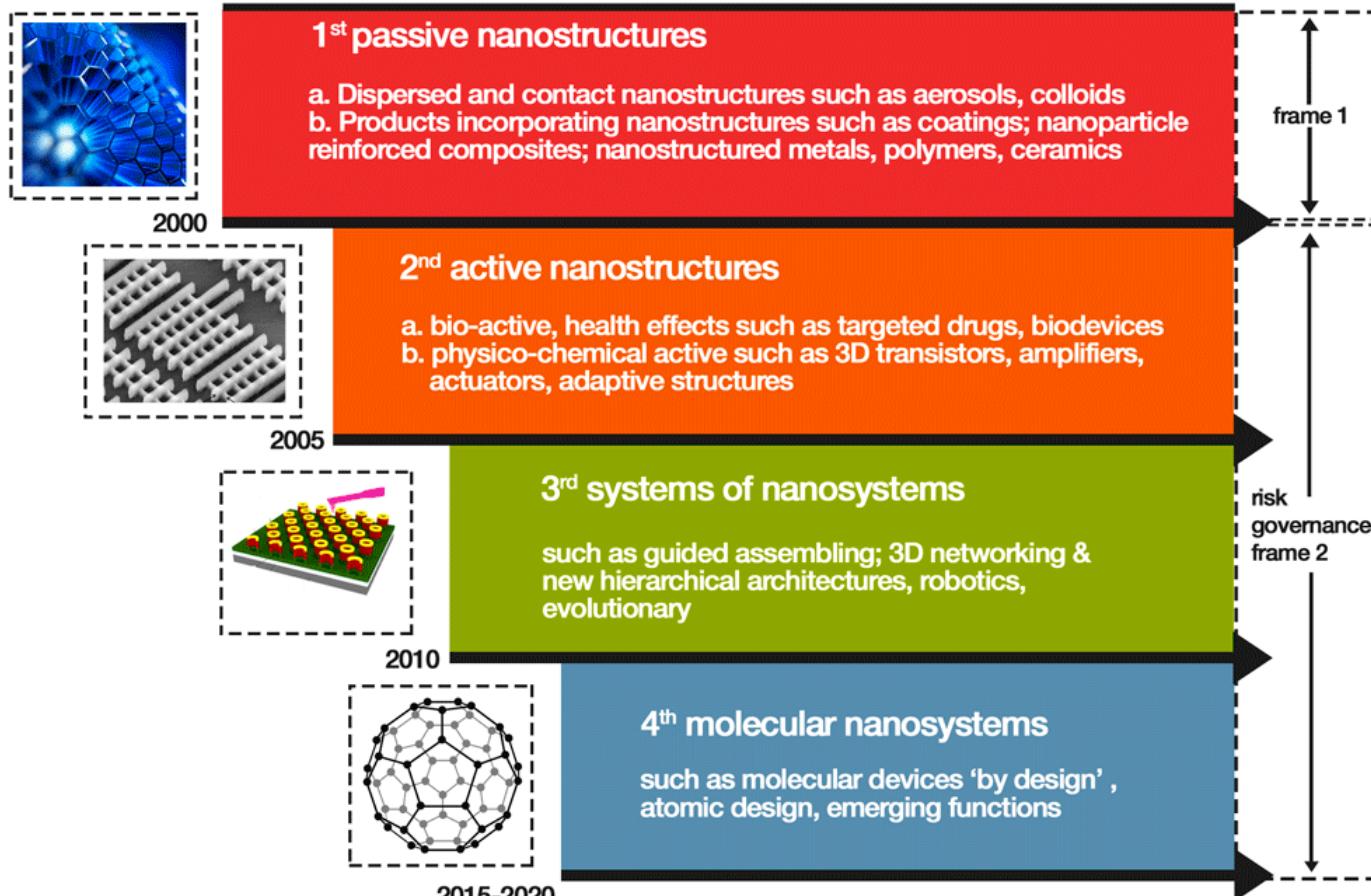


Polycrystalline

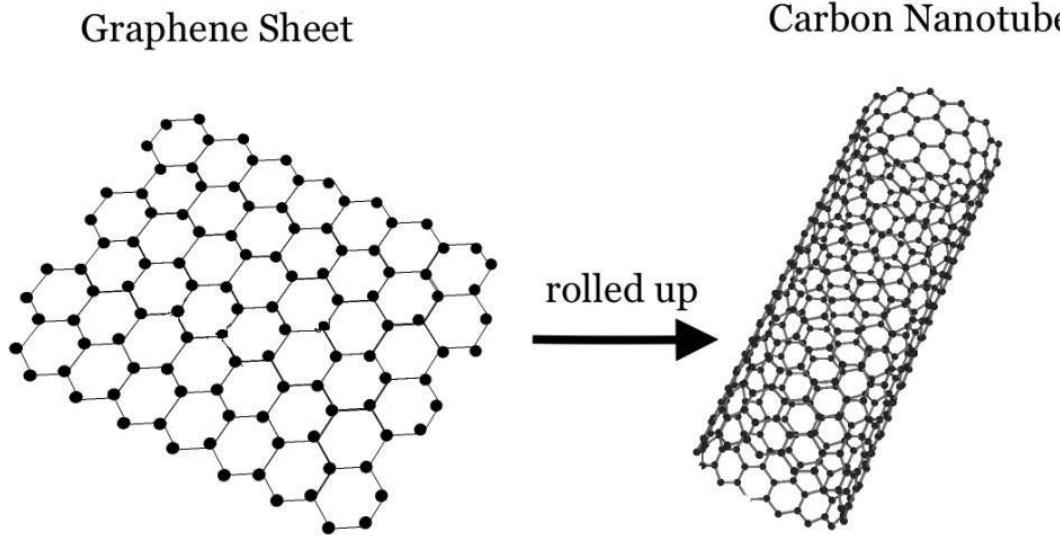


Dendrimer

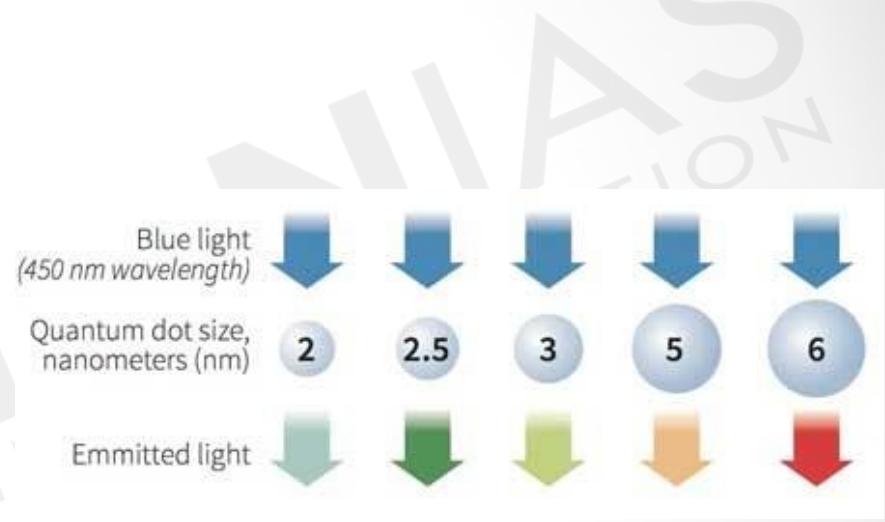
## Timeline of four generations of nano products



# Carbon Nanotubes



# Quantum Dots



## **India's missiles:**

(This is a near exhaustive list of operational missiles of India, however, the focus should be on those missiles which are in news.)

### **Surface-to-Air Missiles**

A surface-to-air missile (SAM), or ground-to-air missile (GTAM) is a weapon designed to be launched from the Earth to destroy enemy aircraft or other missiles and can be considered as an anti-aircraft defence system in modern armed forces.

- **Trishul**
  - Trishul missiles are short-range surface to air missiles with an operational range of 9km.
- **Akash Missile**
  - Presently, there are three variants at different stages of development, Akash-1S, Akash Mark-II, Akash-NG. The Akash -1S can travel up to a distance of 18 to 30 km, while the Akash Mk-II and Akash-NG can travel 35 to 40 km and more than 50 km, respectively.
- **Barak 8**
  - The long-range Indo-Israeli surface to Air Barak 8 Missile can travel up to a distance of 100 km to hit the target with Mach 2 speed.

### **Surface-to-Surface Missiles**

Surface-to-surface missiles are launched from the ground to strike land or sea targets. They may be fired from hand-held or vehicles, from a ship or ground installations. They are often enabled with a rocket engine or sometimes fired by an explosive charge since the launching platform is typically stationary or moving.

- **Agni-I**
  - A medium-range ballistic missile that can travel a distance of 700-1250 km to hit its target. The missile can reach Mach 7.5 speed. It is a single-stage missile that was developed after the Kargil War by the DRDO.
- **Agni-II**
  - It is the second strategic ballistic missile of the Agni family envisaged to be the mainstay of the Indian missile-based strategic nuclear deterrence. An Intermediate-range ballistic missile, Agni-II can reach a distance of 2,000–3,000 km.
- **Agni-III**
  - It is an Intermediate-range ballistic missile that can travel a range of 3,000 km, it was deployed to service in 2011 and can reach targets deep inside neighbouring countries.
- **Agni-IV**
  - Designed by the DRDO and inducted in service in 2013, The Agni-IV is an Intermediate-range ballistic missile that can reach a distance of around 4,000 km at Mach 7 speed.
- **Agni-V**

- The Agni-V missile is an Indian nuclear-capable intercontinental ballistic missile developed by the DRDO.
  - It uses a **three-stage solid fuelled engine**, is capable of striking targets at ranges up to 5,000 kilometres with a very high degree of accuracy.
  - It is a “canisterised” missile.
  - A canister for a missile serves a dual function which provides an environmental container and a launching tube. Cannister can provide both hot and cold launch.
    - A launch system can be either hot launch, where the missile ignites in the cell, or cold launch, where the missile is expelled by gas produced by a gas generator which is not part of the missile itself, and then the missile ignites.
  - A canisterised missile can be stored for a longer period and transported all across the country as per operational requirements.
- **Agni Prime**
    - Agni Prime' is a short-range (surface to a surface) ballistic missile that will have a range of 1000 km to 1500 km and will have advanced features in agility and road mobility. O
    - It can carry a payload of around 1,000 Kg or a nuclear warhead.
    - It is a two-stage canisterised solid propellant ballistic missile.
    - It is predecessor of Agni 1.
  - **Prithvi II**
    - A Short-Range Ballistic Missile, Prithvi II can travel a distance of 350 km. The missile is developed by the DRDO
  - **Shaurya**
    - The Shaurya missile is a canister launched hypersonic surface-to-surface tactical missile developed by the DRDO for use by the Indian Armed Forces. The missile can reach a distance of 750 to 1,900 km to destroy its target.
- Air-to-air Missiles**
- Air to Air Missiles (AAM) is a missile fired from an aircraft with a motive to damage another aircraft or any airborne object. AAM is either solid fuelled or sometimes liquid-fuelled. It evolved from unguided air to air rockets used during World War-I.
- **MICA**
    - MICA is an anti-air multi-target, all-weather, fire-and-forget short and medium-range missile system encompassing a range of 500 m to 80 km reaching Mach 4 during its deployment.
  - **Astra Missile**
    - Developed indigenously by the DRDO, Astra is an all-weather beyond-visual-range active radar homing air-to-air missile encompassing a range of 80-110 km reaching the Mach 4.
  - **Novator K-100**
    - A Russian-made medium-Range air-to-air missile can be deployed to hit targets in the range of 300–400 km with a Mach 3.3 speed.

## **Cruise Missiles**

A cruise missile is guided to its target by an onboard computer. It is a guided missile used against terrestrial targets, that remain in the atmosphere and flies the major portion of its flight path at an approximately constant speed. Cruise missiles are designed to deliver a target warhead over long distances with high precision.

- **BrahMos Supersonic Cruise Missile**
  - BrahMos missiles are designed developed and produced by BrahMos Aerospace, a joint venture company set up by the DRDO and Mashinostroyenia of Russia. It is named after Brahmaputra river and Moskva River of Russia. The BrahMos supersonic cruise missile can cover a range of 290 km reaching the Mach 2.8 to 3 Mach speed.
- **Nirbhay**
  - The Nirbhay subsonic cruise missile can reach a maximum range of 1,000 to 1500 km to destroy its target with a Mach 0.8 speed. The missile can be launched from multiple platforms and is capable of carrying conventional and nuclear warheads.

## **Submarine-launched ballistic missile**

A submarine-launched ballistic missile (SLBM) is a ballistic missile capable of being launched from submarines. Each missile carries a nuclear warhead and allows a single launched missile to strike several targets. Modern submarine-launched ballistic missiles are closely related to intercontinental ballistic missiles which can be deployed to reach a range of over 5,500 km.

- **Sagarika (K-15)**
  - Sagarika (K-15) is an Indian submarine-launched ballistic missile that can reach a range of 750 km that was designed for retaliatory nuclear strikes.
- **K-4 Ballistic Missile**
  - The K-4 Ballistic Missile is a nuclear-capable Intermediate-Range submarine-launched ballistic missile developed by the DRDO to arm the Arihant-class submarines. The missile has a maximum range of 3,500 km.
- **K-5 Missile**
  - The K-5 is a submarine-launched ballistic missile under development by the DRDO. The missile has a planned range of 5,000 km and will be equipped with Arihant-class submarines and is considered to be the fastest missile in its class.

## **Anti-Tank Missile**

An anti-tank guided missile (ATGM) is a guided missile primarily designed to hit and destroy heavily armoured military vehicles, which can be transported by a single soldier, to larger tripod-mounted weapons, which require a team to transport and fire, to vehicle and aircraft mounted missile systems.

- **Amogha-1**
  - The Amogha-1 is an ATGM with a range of up to 2.8km. It is under development by Bharat Dynamics at Hyderabad. It is the maiden missile

designed and tested by Bharat Dynamics and will be produced in two versions. The land version has already been tested.

- **Nag Missile**

- The Nag missile, also known as 'Prospina' for the land-attack version is an Indian third-generation, all-weather, fire and forget, an anti-tank guided missile with an operational range of 500m to 20km and ten-year maintenance-free shelf life.

### **Anti-ballistic missiles**

An Anti-ballistic missile is a surface to air missile designed and manufactured to counter ballistic missiles (Missile defence). Ballistic missiles are used to deliver nuclear, chemical, biological or conventional warheads in a ballistic attack.

- **Prithvi Air Defence (PAD)**

- The Prithvi Air Defence (PAD) is a two-stage liquid and solid-fueled ballistic missile defence high altitude interceptor based on the Prithvi missile. The two-stage interceptor is 10 meters tall and is said to reach a maximum altitude of 80km.

- **Prithvi Defense Vehicle (PDV)**

- The Prithvi Defense Vehicle (PDV) is an exo-atmospheric interceptor missile designed and manufactured to shoot down short-medium, and intermediate-range ballistic missiles in their terminal phase by intercepting with a hit-to-kill approach.

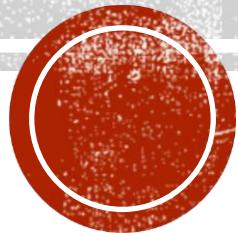
### **Anti-Satellite Missile**

- **A-SAT Missile**

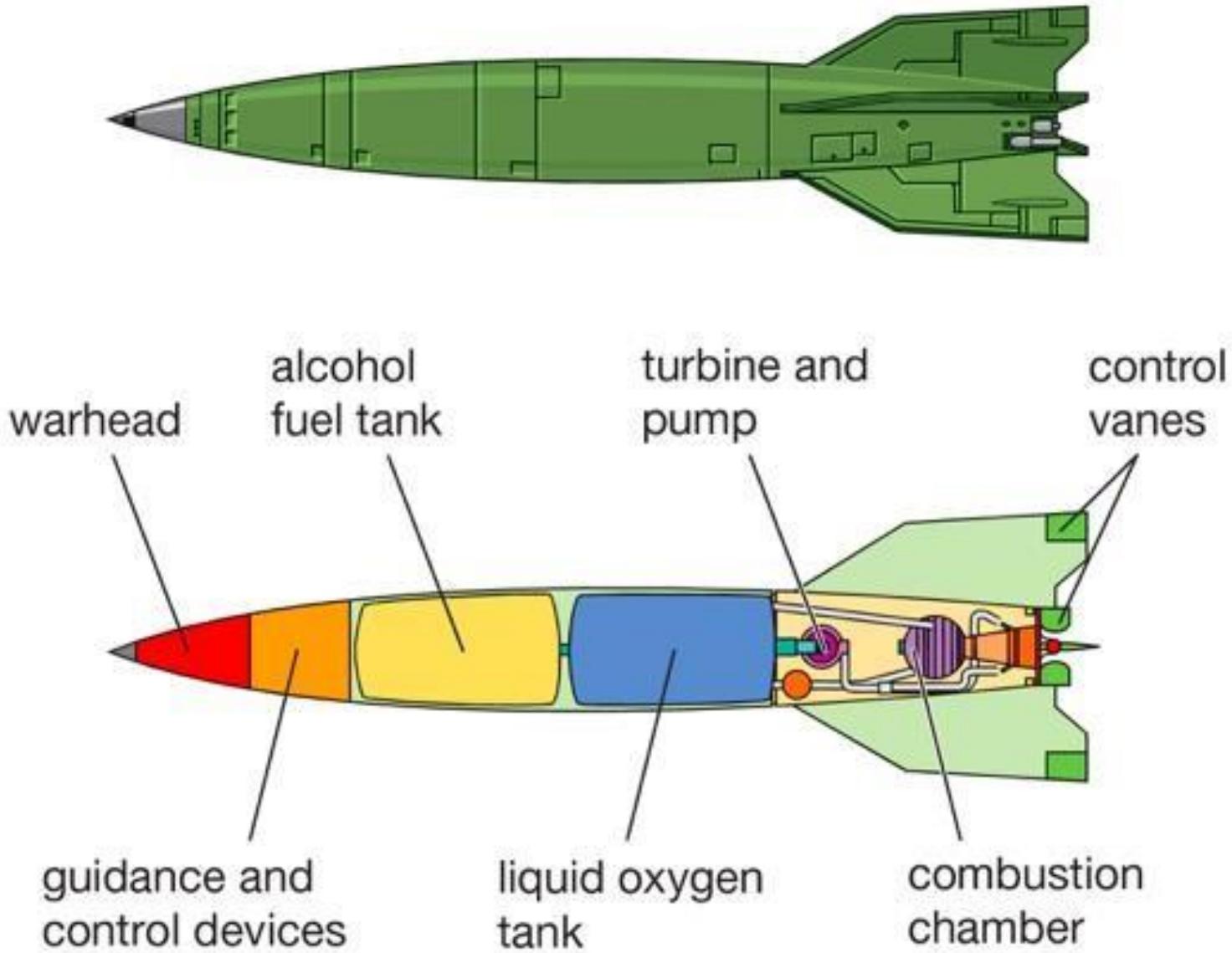
- In March 2019, India joined an exclusive club of countries that has the capability to hit a target in space as it tested the anti-satellite missile via 'Mission Shakti'. This test, which came just months after India completed its fully operational nuclear triad (being able to launch nuclear warheads from air, land and sea), made India just the fourth country, after the US, Russia and China to be able to do so.

**Source:** <https://www.republicworld.com/india-news/general-news/missiles-of-india-a-comprehensive-overview-of-indias-deadly-missile-arsenal.html>

# DEFENSE TECHNOLOGIES



# MISSILE



# PRITHVI AND AKASH



# TRISHUL AND BARAK



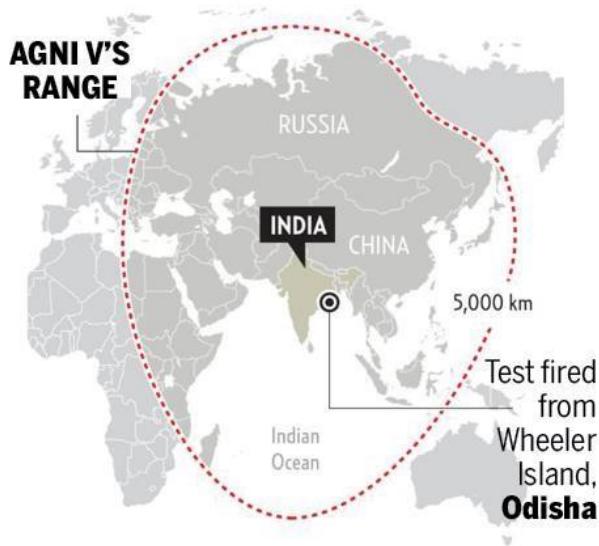
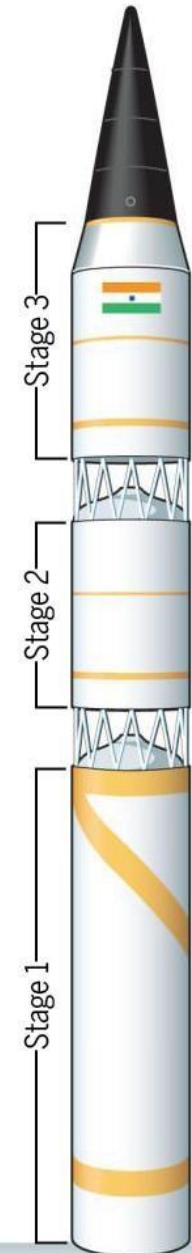
# NAG/HELINA



## AGNI SERIES OF LONG RANGE BALLISTIC MISSILES

### AGNI V

- Operational range: **5,000 km**
- Payload: **1360.78 kg**
- Height **17m**
- Future development possible for variant that could be launched from a submarine



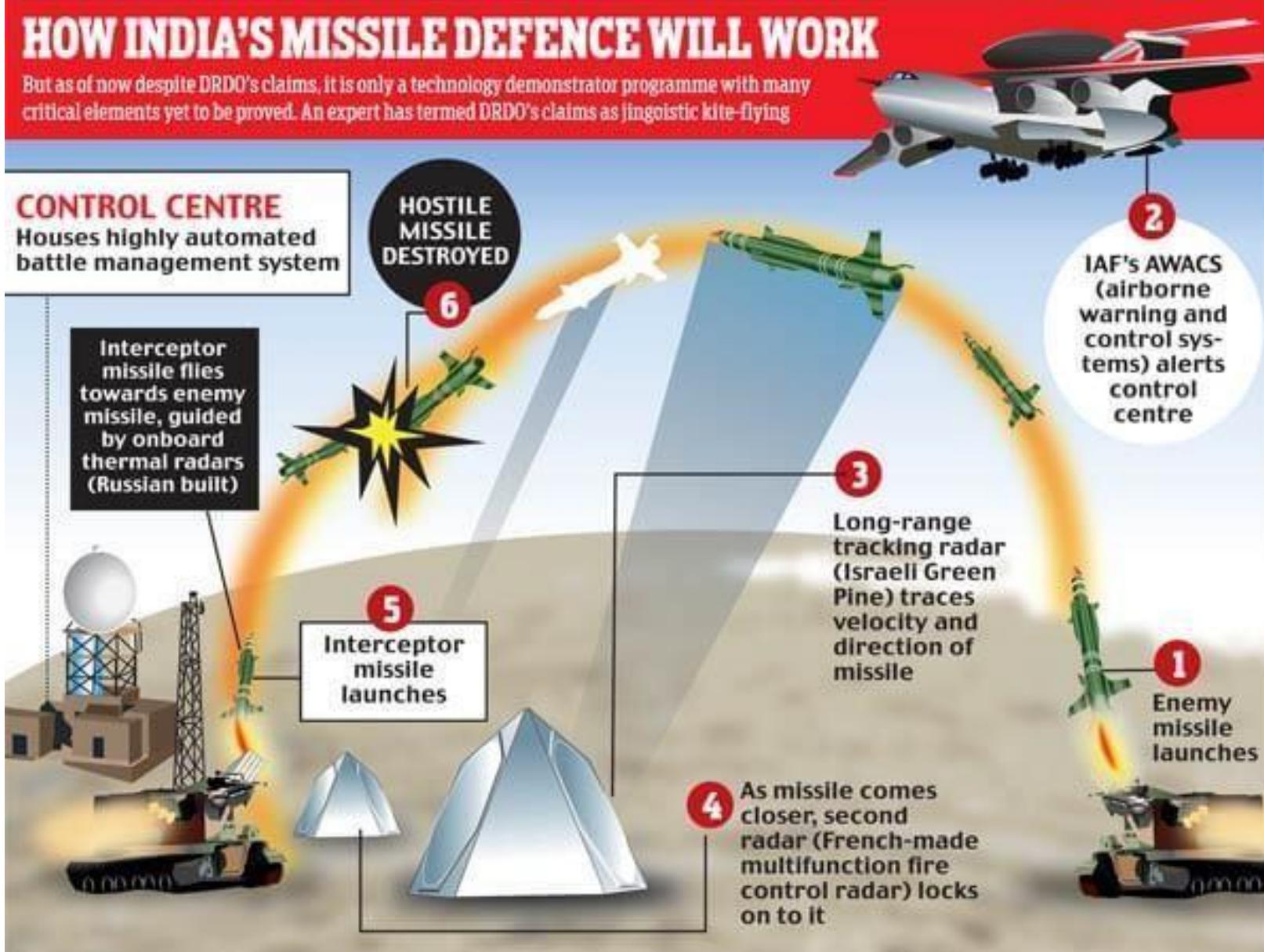
Agni Missile Series	Agni I	Agni II	Agni III	Agni IV
Range (km)	700	2,500	3,000	4,000
Payload (kg)	1,000	1,000	1,500	1,000
Height (m)	15	20	16.3	20

Source: Reuters, PTI

# BALLISTIC MISSILE DEFENSE

## HOW INDIA'S MISSILE DEFENCE WILL WORK

But as of now despite DRDO's claims, it is only a technology demonstrator programme with many critical elements yet to be proved. An expert has termed DRDO's claims as jingoistic kite-flying



# Hypersonic weapons

Considered the next generation of arms with conventional or nuclear warheads that are hard to detect and can travel more than five times the speed of sound

## TRAJECTORY AND DETECTION

### HYPersonic glide vehicle

Speed: at least Mach 5

Launched from a rocket. Hard to detect, track and intercept

Hypersonic cruise missiles are powered by "scramjets", maneuvered at lower altitude toward target

Detected by radar

Atmosphere (100 km)

### CONVENTIONAL BALLISTIC MISSILE

Between Mach 1 and Mach 5

Easier to predict and intercept

Limit of ground-based radar detection at target

Detected by radar

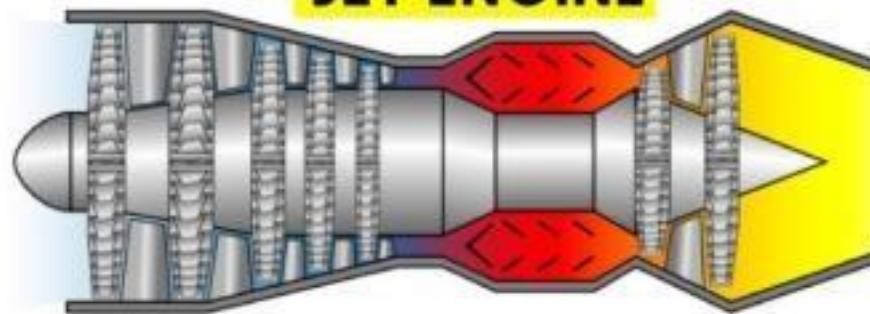
Launch

Target

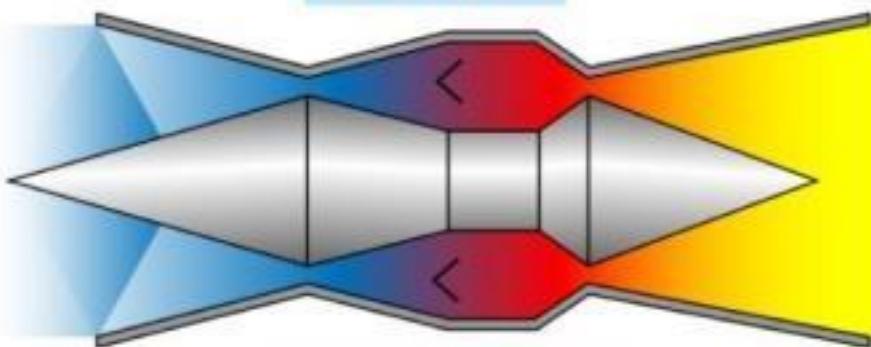


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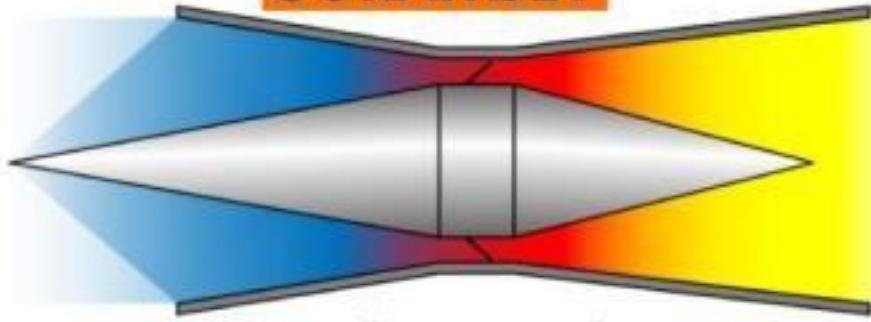
## JET ENGINE



## RAMJET



## SCRAMJET



Compression

Combustion

Expansion



# INS KALVARI



# INS ARIHANT



## Killer K-4

Strike range -  
**3,500 km**

Length - **12 mtr**

Width - **1.3 mtr**

Weight - **17 ton**

Warhead - **2 ton**

Engine -  
**Solid-fueled**

Difficult to be  
tracked and  
destroyed by any  
anti-ballistic  
weapon



# VARUNASTRA



# INS KOLKATA - DESTROYER



# **SAHYADRI – FRIGATES**



# KAMORTA – CORVETTE



# INS VIKRANT



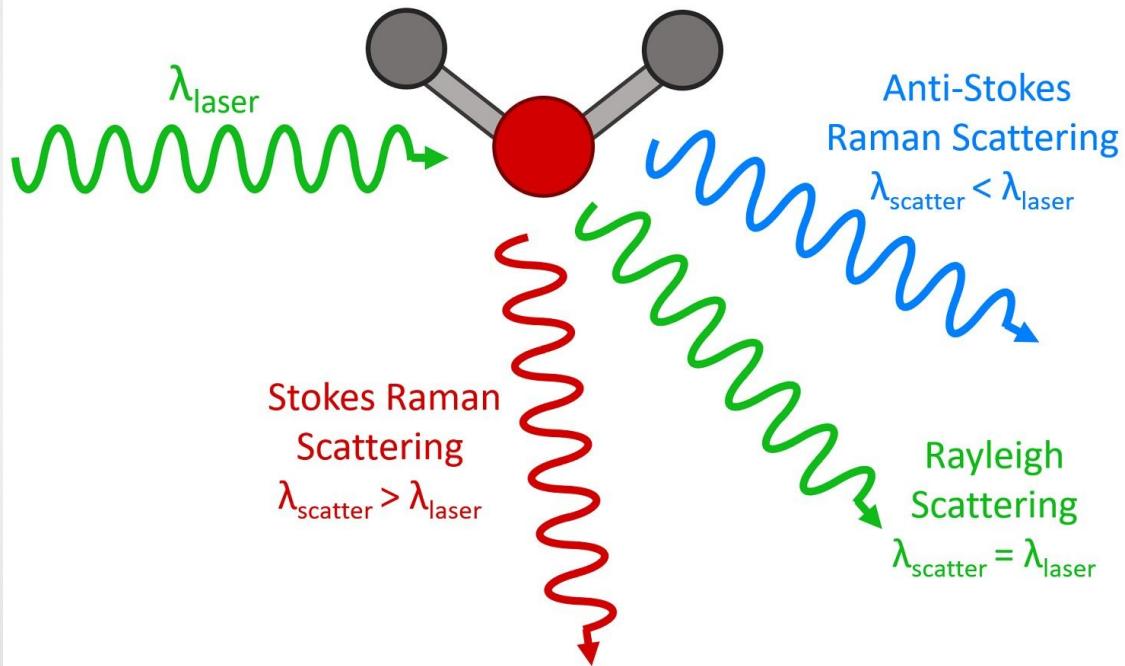
# RAFAEL AND MIRAGE



# Contribution of Indians in SnT

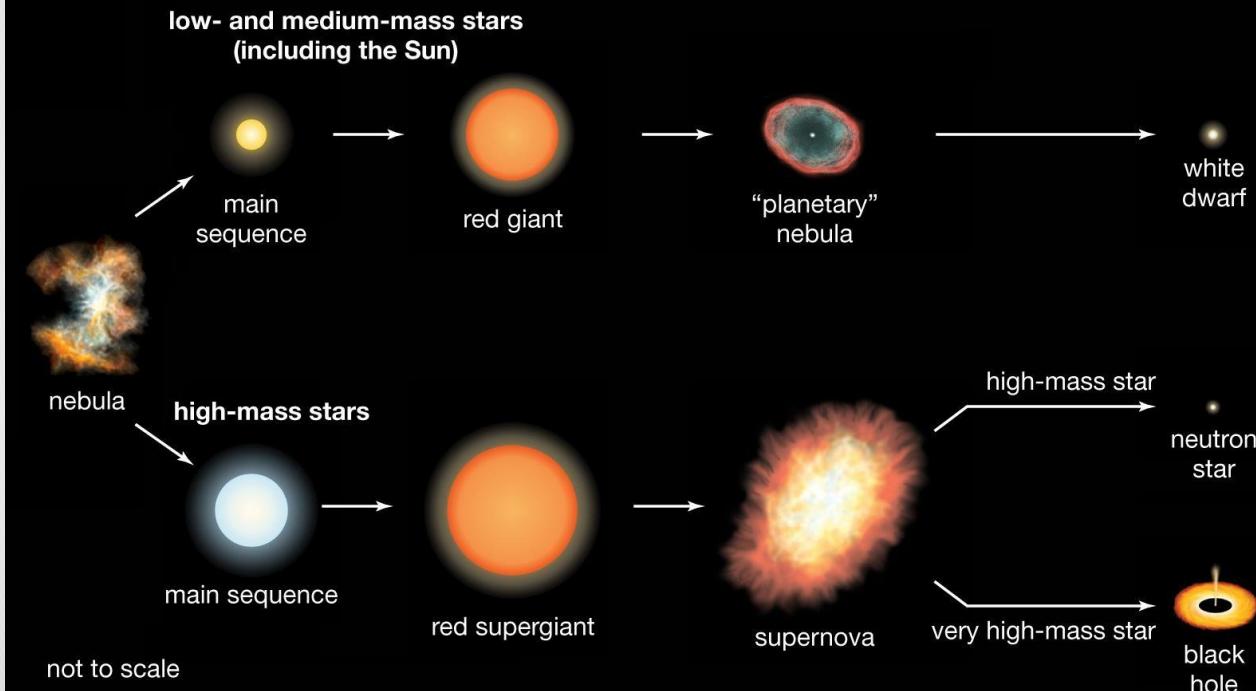
# Dr C V Raman

## Raman Effect

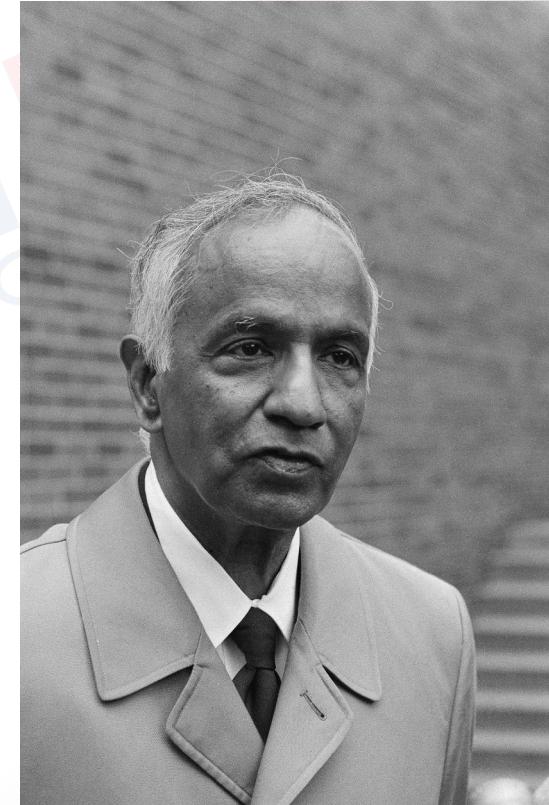


# Dr S Chandrashekhar

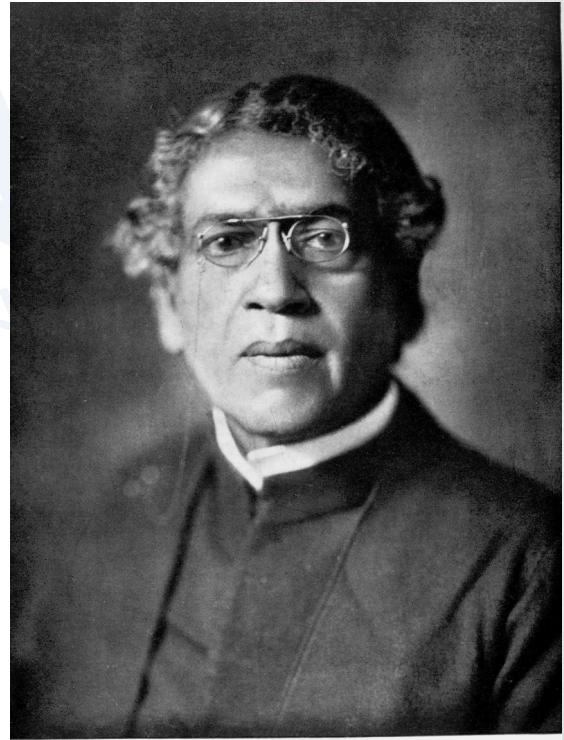
## Stellar evolution



© 2012 Encyclopædia Britannica, Inc.

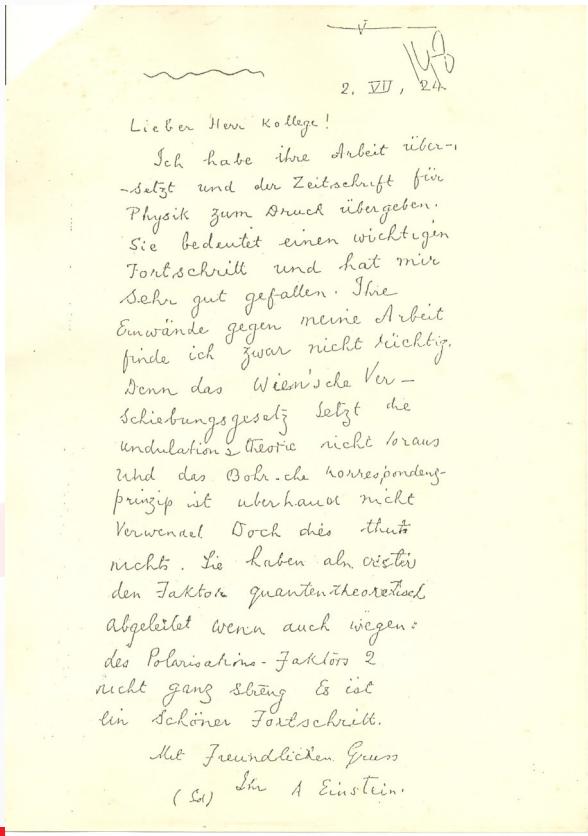


# Dr J C Bose

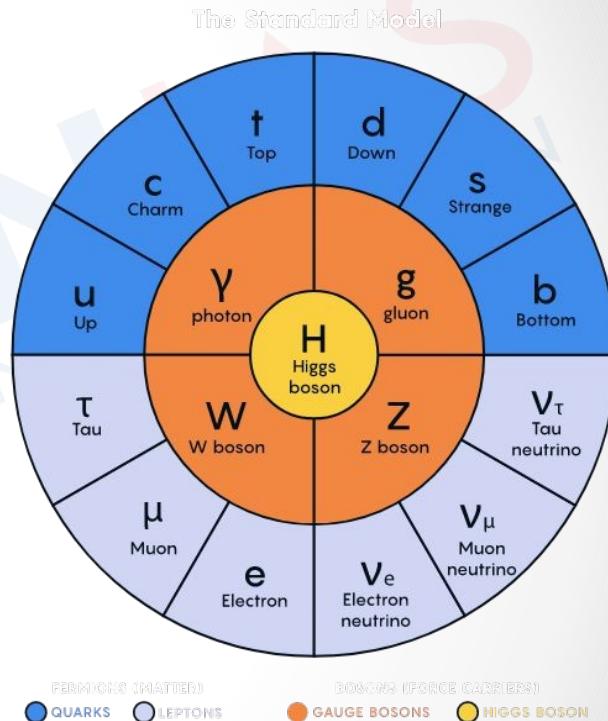


*Yours Sincerely  
J.C. Bose*  
Subject, Topic & Expert

# Dr S N Bose



<b>LEPTONS</b>	mass → $\approx 2.3 \text{ MeV}/c^2$ charge → $2/3$ spin → $1/2$	mass → $\approx 1.275 \text{ GeV}/c^2$ charge → $2/3$ spin → $1/2$	mass → $\approx 173.07 \text{ GeV}/c^2$ charge → $2/3$ spin → $1/2$	mass → $0$ charge → $0$ spin → $1$	mass → $\approx 126 \text{ GeV}/c^2$ charge → $0$ spin → $0$
<b>QUARKS</b>	<b>u</b> up	<b>c</b> charm	<b>t</b> top	<b>g</b> gluon	<b>H</b> Higgs boson
	$\approx 4.8 \text{ MeV}/c^2$ $-1/3$ $1/2$ down	$\approx 95 \text{ MeV}/c^2$ $-1/3$ $1/2$ strange	$\approx 4.18 \text{ GeV}/c^2$ $-1/3$ $1/2$ bottom	$\gamma$ photon	
	$0.511 \text{ MeV}/c^2$ $-1$ $1/2$ electron	$105.7 \text{ MeV}/c^2$ $-1$ $1/2$ muon	$1.777 \text{ GeV}/c^2$ $-1$ $1/2$ tau	$Z$ Z boson	
	$<2.2 \text{ eV}/c^2$ $0$ $1/2$ electron neutrino	$<0.17 \text{ MeV}/c^2$ $0$ $1/2$ muon neutrino	$<15.5 \text{ MeV}/c^2$ $0$ $1/2$ tau neutrino	$W$ W boson	
					<b>GAUGE BOSONS</b>



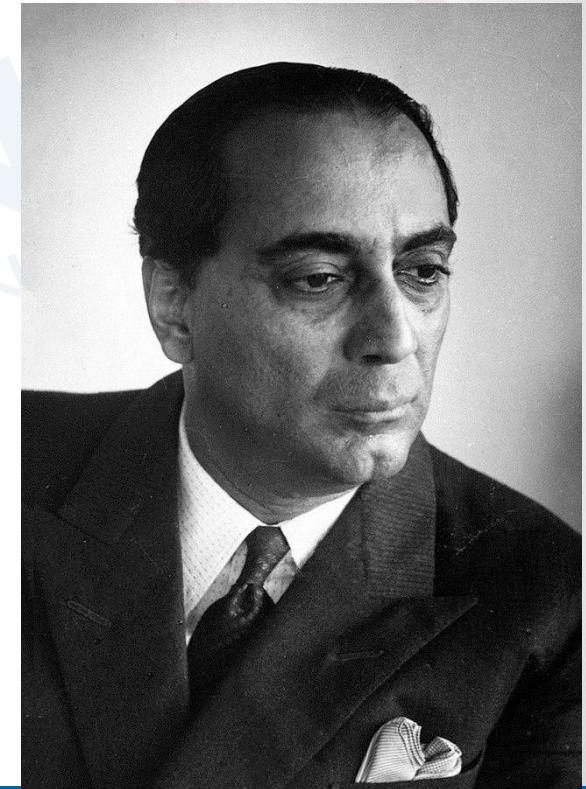
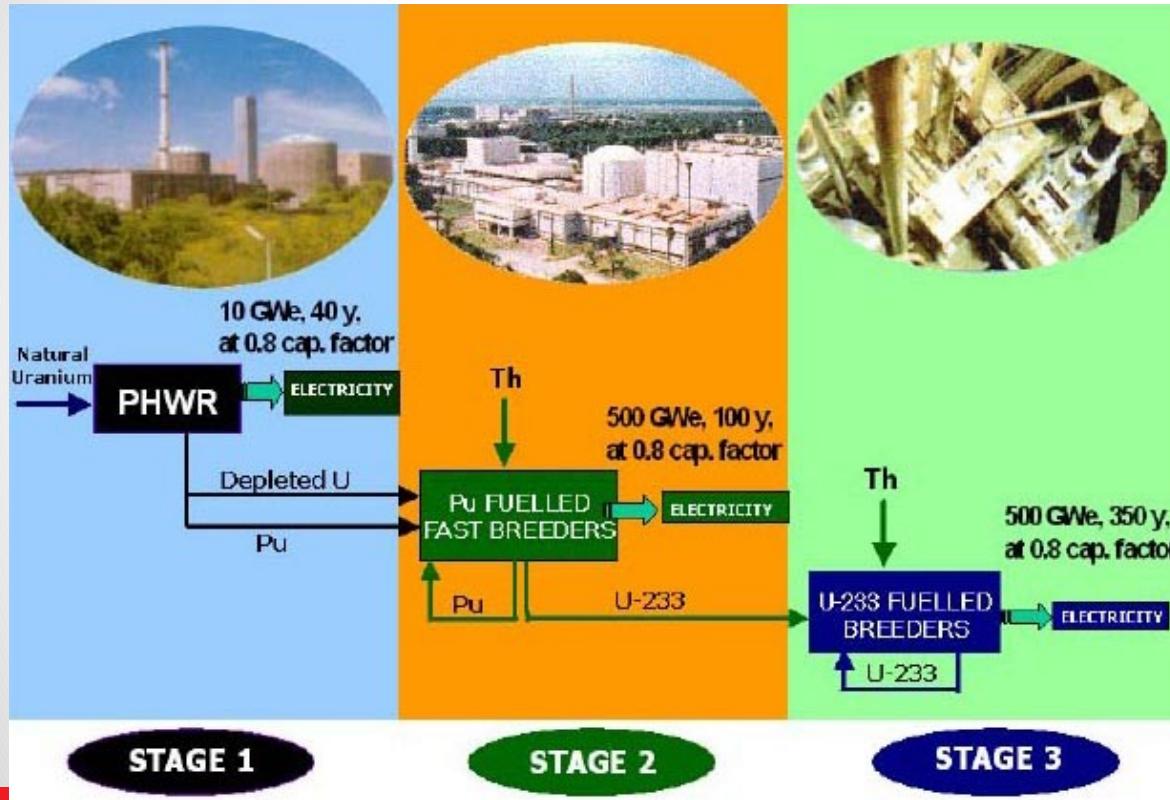
## Fundamental Force Particles

Force	Particles Experiencing	Force Carrier Particle	Range	Relative Strength*
<b>Gravity</b> acts between objects with mass	all particles with mass	graviton (not yet observed)	infinity	much weaker
<b>Weak Force</b> governs particle decay	quarks and leptons	$W^+$ , $W^-$ , $Z^0$ (W and Z)	short range	
<b>Electromagnetism</b> acts between electrically charged particles	electrically charged	$\gamma$ (photon)	infinity	
<b>Strong Force**</b> binds quarks together	quarks and gluons	$g$ (gluon)	short range	much stronger

# Dr Vikram Sarabhai



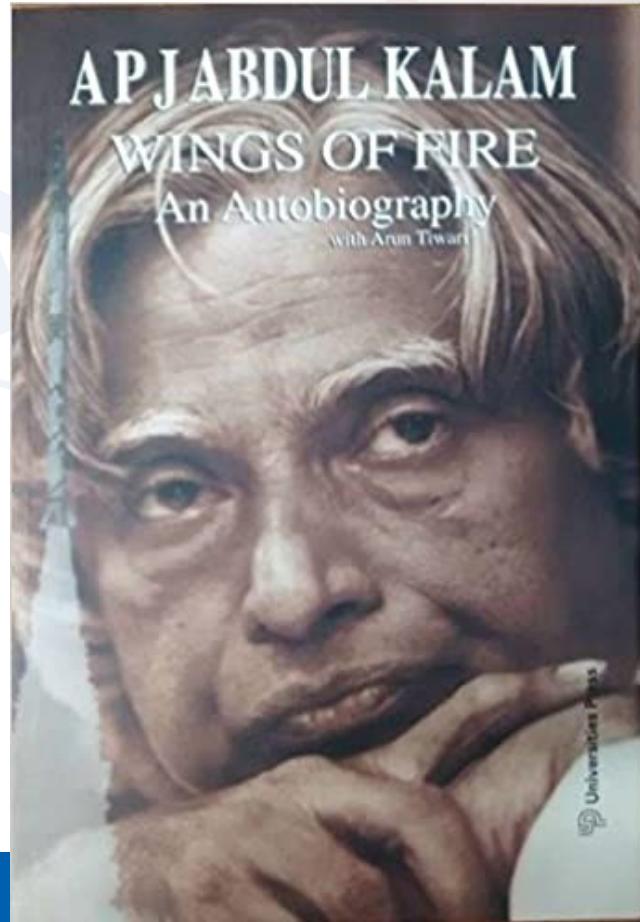
# Dr Bhabha



# Dr Hargobind Khurana



# Dr Kalam



# S Ramanujan

## IV Theorems on summations of series; e.g.

$$(1) \quad \frac{1}{13} \cdot \frac{1}{2} + \frac{1}{23} \cdot \frac{1}{22} + \frac{1}{33} \cdot \frac{1}{23} + \frac{1}{43} \cdot \frac{1}{22} + \&c = \frac{1}{8} (\log 2)^3 - \frac{\pi^2}{12} \log 2 + \left( \frac{1}{13} + \frac{1}{23} + \frac{1}{33} + \dots \right) \&c.$$

$$(2) \quad 1 + 9 \left(\frac{1}{2}\right)^4 + 17 \left(\frac{1}{2}\right)^4 + 25 \left(\frac{1}{2}\right)^4 + \&c = \sqrt{\pi} \left\{ \Gamma(2) \right\}^2$$

$$(3) \quad 1 - 5 \left(\frac{1}{2}\right)^3 + 9 \left(\frac{1}{2}\right)^3 - \&c = \frac{3}{\pi}$$

$$(4) \quad \frac{1^{13}}{e^{2\pi} 1} + \frac{2^{13}}{e^{4\pi} 1} + \frac{3^{13}}{e^{6\pi} 1} + \&c = \frac{1}{24}.$$

$$(5) \quad \frac{\coth \pi}{17} + \frac{\coth 2\pi}{27} + \frac{\coth 3\pi}{37} + \&c = \frac{19\pi^7}{56700}.$$

$$(6) \quad \frac{1}{1^5 \cosh \frac{\pi}{2}} - \frac{1}{3^5 \cosh \frac{3\pi}{2}} + \frac{1}{5^5 \cosh \frac{5\pi}{2}} - \&c = \frac{\pi^5}{768}.$$

$$(7) \quad \frac{1}{(1+2^2)(\sinh 2\pi - \sinh \pi)} + \frac{1}{(3^2+4^2)(\sinh 5\pi - \sinh \pi)} \\ + \frac{1}{(5^2+6^2)(\sinh 7\pi - \sinh \pi)} + \&c \\ = \left( \frac{1}{\pi} + \coth \pi - \frac{\pi}{2} \tanh^2 \frac{\pi}{2} \right) / 2 \sinh \pi.$$

If

$$(i) \quad \frac{1+53x+9x^2}{1-82x-82x^2+x^3} = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \dots \\ \text{or } \frac{a_0}{x} + \frac{a_1}{x^2} + \frac{a_2}{x^3} + \dots$$

$$(ii) \quad \frac{2-26x-12x^2}{1-82x-82x^2+x^3} = b_0 + b_1 x + b_2 x^2 + b_3 x^3 + \dots \\ \text{or } \frac{b_0}{x} + \frac{b_1}{x^2} + \frac{b_2}{x^3} + \dots$$

$$(iii) \quad \frac{2+8x-10x^2}{1-82x-82x^2+x^3} = c_0 + c_1 x + c_2 x^2 + c_3 x^3 + \dots \\ \text{or } \frac{c_0}{x} + \frac{c_1}{x^2} + \frac{c_2}{x^3} + \dots$$

then

$$\begin{aligned} a_n^3 + b_n^3 &= c_n^3 + (-1)^n \\ \text{and } a_n^3 + b_n^3 &= x_n^3 + (-1)^n \end{aligned} \quad \left. \right\}$$

Examples

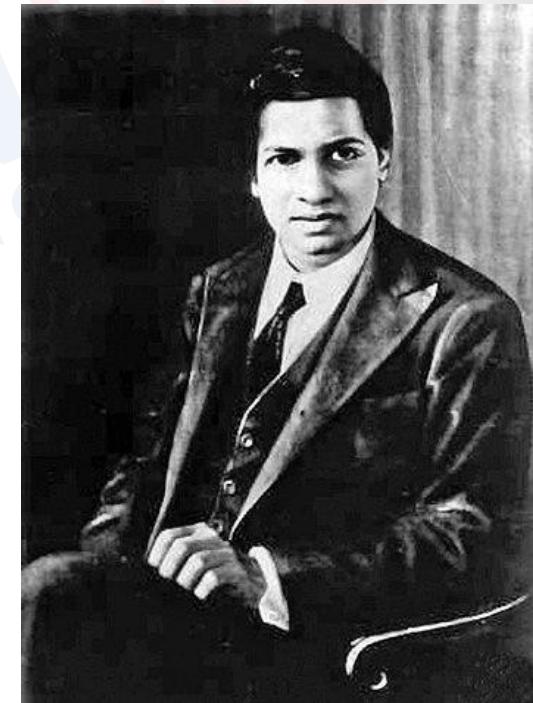
$$135^3 + 138^3 = 172^3 - 1$$

$$11161^3 + 11468^3 = 14258^3 + 1$$

$$791^3 + 819^3 = 1010^3 - 1$$

$$9^3 + 10^3 = 12^3 + 1$$

$$6^3 + 8^3 = 7^3 - 1$$



# Dr Meghnath Saha

## The Saha Equation

In 1920, Meghnad Saha derived an equation for the relative number of atoms in each ionization state. We'll just present the result:

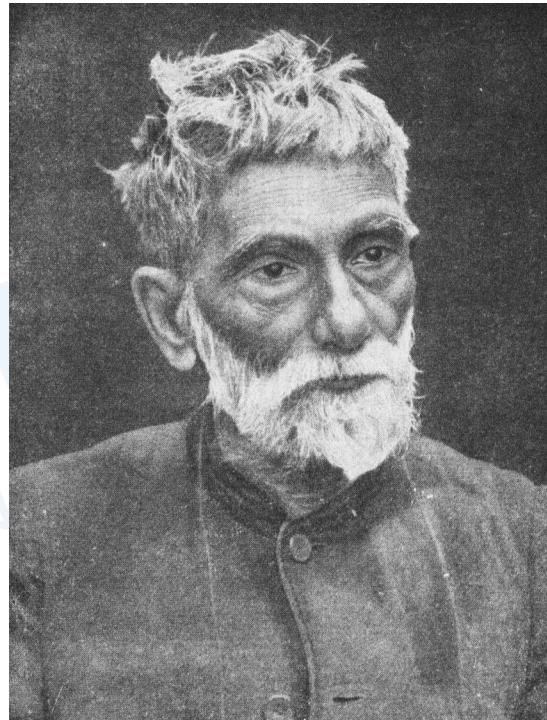
$$\frac{N_{i+1}}{N_i} = \frac{2Z_{i+1}}{n_e Z_i} \left( \frac{2\pi m_e kT}{h^2} \right)^{3/2} e^{-\frac{\chi_i}{kT}}$$

Note:

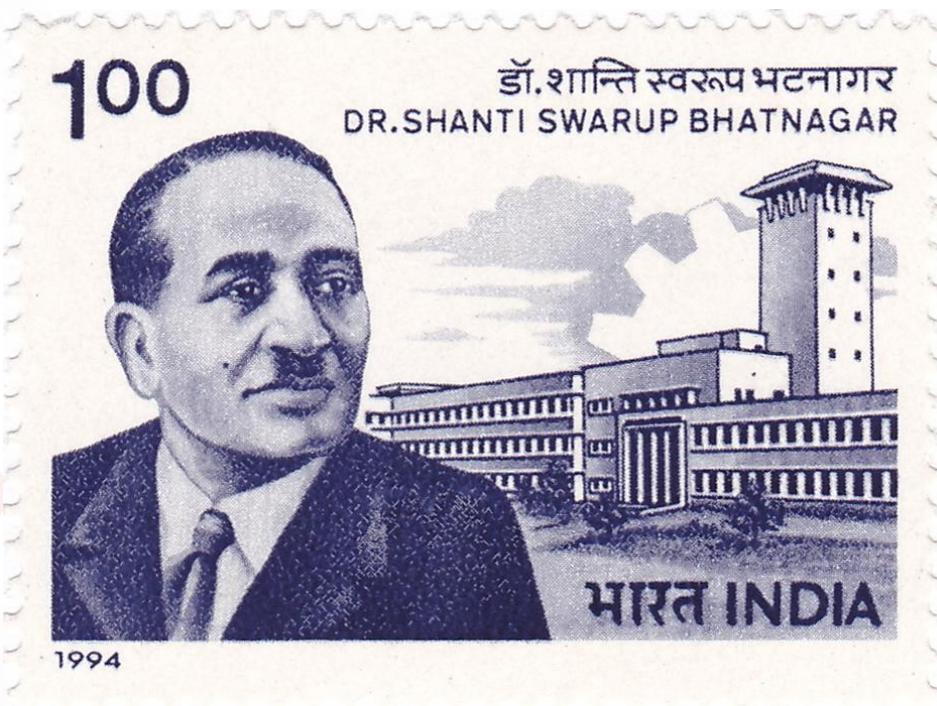
- This depends on the number density of electrons,  $n_e$ . This is because as the number of free electrons increases, it is more likely that they can recombine with an atom and lower the ionization state.
- The Boltzmann factor  $\exp(-\chi_i/kT)$  means it is more difficult to ionize atoms with high ionization potentials



# Dr P C Ray



# Dr Shantiswaroop Bhatnagar



# THE PIONEERS

## Those who treading the unconventional path

**Kadambini Ganguly**  
(1861-1923)

The first Indian woman to get admission to Calcutta Medical College (1884), becomes India's first female doctor & practitioner (1886) of western medicine in the whole South Asia



**Mary Poonen Lukose**  
(1886-1976)

The first female Surgeon General in India, (1938). She became the first woman obstetrician of India



**Bibha Chowdhary**  
(1913-1991)

First woman high energy physicist of India and the first woman scientist at the TIFR (1948). The International Astronomical Union honored her by naming a white yellow dwarf star after her name



**Edavaleth Kakkat Janaki Ammal**  
(1897-1984)

Renowned botanist & plant cytologist, made significant contributions to genetics, evolution, phytogeography and ethnobotany. First Director of the Central Botanical Laboratory at Allahabad, 1952



**Kamala Sohoni**  
(1911-1998)

First Indian woman to receive a PhD in a scientific discipline. She discovered the enzyme 'Cytochrome C' which plays an essential role in the electron transport chain occurring in plants, human and animal cells for energy synthesis



**Asima Chatterjee**  
(1917-2006)

The first woman to be awarded a Doctor of Science by an Indian University (Calcutta) in 1944. She was the first woman to be elected as the General President of the Indian Science Congress



**Iravati Karve**  
(1905-1970)

First Indian female anthropologist. She founded the Department of Anthropology at the University of Pune in 1963. She also held the post of the Vice-Chancellor of SNDT University



**Debala Mitra**  
(1925-2003)

First Indian archaeologist served as Director General of the Archaeological Survey of India, 1981. She explored and excavated several Buddhist sites



**Purnima Sinha**  
(1927-2015)

An Indian physicist who received a doctorate in physics under the guidance of Prof Satyendra Nath Bose. She did tremendous work in the field of x-ray crystallography of clay minerals



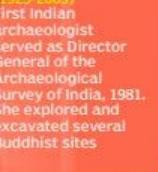
**Rajeshwari Chatterjee**  
(1922-2010)

Woman Engineer who pioneered research in microwave engineering. She is the first woman engineer at IISc who joined the Department of Electrical Communication Engineering (ECE)



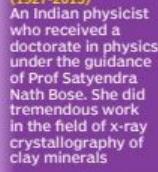
**Anna Mani**  
(1918-2001)

First woman to join the Meteorological department in Pune, 1948. Her major contributions are in the field of solar radiation, ozone and wind energy instrumentation



**Kamal Ranade**  
(1917-2001)

Established India's first tissue culture research laboratory at the Indian Cancer Research Centre in Mumbai, 1960. She was among the first to recognise the connection between cancer susceptibility and the interaction between hormones and tumour virus



**Anandibai Gopalrao Joshi**  
(1865-1887)

First Indian female to study and graduate with a degree in western medicine from the United States (1886). She is believed to be the first woman to set foot on American soil from India

## **Drone Regulation**

Drones or unmanned aerial vehicles (UAVs) are: "Powered, aerial vehicles that do not carry a human operator, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload."



### **Applications of UAVs**

- Damage assessment of property and life in areas affected with natural calamities, surveys, critical infrastructure monitoring.
- Security function: Drones are used by Armed Forces for tactical purposes at border.
- Surveillance and Crowd Management: It is used for effective and smooth conduct of events like Kumbh Mela etc.
- Monitoring of wildlife: UAV are deployed these days for better counting and guarding unreachable region.
- Agriculture: SENSAgRI (SENSor based Smart AGRICulture) is a drone based crop and soil health monitoring system using hyperspectral remote sensing (HRS) sensors.
- Mode of Delivery: Many e-commerce companies are using it for delivering their product like Amazon.
- Other uses: For surveys, infrastructure monitoring, commercial photography, aerial mapping etc.

### **Concerns regarding use of drones**

- Potential threat: Its use poses a security threat, and has the potential for invading privacy.
- The airspace over Indian cities already has a high density of aircraft traffic and unregulated use of drones poses a grave threat for air collisions and accidents.
- Drone traffic management: will require planned research and practical experimentation. Small drones fly at low altitudes and are more susceptible to changing weather conditions. Strong winds and rains can easily knock them off course, out of their designated operating zones.
- Drones as weapons: They are considered a cost effective weapon system with no risk to operators. Thus, they are being portrayed as weapons of future warfare.
- Drones are being used by terrorists, criminals, drug cartels and other antisocial groups for their attacks.

Therefore, government has come up with **Drone rules 2021 under Aircraft Act, 1934 which is** built on a premise of trust, self-certification and non-intrusive monitoring.

### **Salient Features:**

- Classification of Drones: Nano (upto 250gm), Micro (250gm – 2kg), Small (2kg – 25kg), Medium (25kg – 150kg), Large (>150kg)
- Air space has been partitioned into:
  - Red zone denotes “no fly zone” (include airspace around airports; near international border, Vijay Chowk in Delhi; State Secretariat Complex in State Capitals, strategic locations/vital and military installations; etc.)
  - Yellow zone is controlled airspace which signifies airspace requiring Air Defence Clearance or Air Traffic Control clearance.
- Green zone signifies unrestricted airspace zones. However, even for the Green zone, there is a need to get clearance from the Digital Sky Platform.
- Digital Sky Platform (<https://digitalsky.dgca.gov.in/>):
  - It is a software-based self-enforcement unmanned traffic management (UTM) system.
  - It is expected to facilitate registration and licensing of drones.
  - It also provides instant (online) clearances to operators for every flight. Thus India has a ‘No Permission-No Take off’ (NPNT) clause, which implies that a drone cannot be operated in Indian skies unless the regulatory permission is received through the Digital Sky Platform.
  - A process has been prescribed for drone operators to obtain Unique Identification Number (UIN).
- Unmanned Aircraft Operator Permit: It is a permit required by the owners of the drones to fly them which can be obtained from the Director General of Civil Aviation.
- The pilot also needs certification, requiring a remote pilot licence before operating a drone.
- Foreigners are currently not allowed to fly drones in India.
  - For commercial purpose, they need to lease the drone to an Indian entity who in-turn will obtain Unique Identification Number (UIN) and UAOP from DGCA.

# Science and Technology

**Q1.** Recently Radioisotope Thermoelectric Generators (RTG) technology was in the news. Consider the following statements regarding the Radioisotope Thermoelectric Generators (RTG) technology:

1. It can be a steady source of both heat and electric energy for space missions.
2. It will help in launching missions deeper into space.
3. It uses a fission chain reaction to generate energy.
4. Plutonium-238 is used to provide heat and electricity in RTG.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only
- (b) 2, 3 and 4 only
- (c) 1, 3 and 4 only
- (d) 1, 2 and 4 only

**Q2.** With reference to the use of nano technology in health sector, which of the following statements is/are correct?

- 1.Targeted drug delivery is made possible by nanotechnology.
- 2.Nanotechnology can largely contribute to gene therapy.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Q3. With respect to nuclear technology, consider the following statements:

1. The energy released in a nuclear fusion reaction is greater than the energy released by nuclear fission.
2. Nuclear Fusion does not normally occur in nature but fission occurs in stars.
3. At present, nuclear fission reaction is used in nuclear power plants and fusion is still in experimental stage for producing power.

Which of the statements given above is/are correct?

- (a) 3 only
- (b) 1 and 3 only
- (c) 1 and 2 only
- (d) 2 and 3 only

Q4. With reference to the different types of nuclear reactors used in the Indian power plants, consider the following pairs:

<b>Type of Reactor</b>	<b>Power Plant</b>
------------------------	--------------------

- |                                    |             |
|------------------------------------|-------------|
| 1. Pressurised Water Reactor.      | Kudankulam  |
| 2. Pressurized Heavy Water Reactor | Rawatbhatta |
| 3. Fast breeder Reactor            | Tarapore    |

Which of the pairs given above is/are correctly matched?

- (a) 1 only
- (b) 1 and 2 only
- (c) 1, 2 and 3
- (d) 3 only

**Q5. Why are nanomaterials and nanotechnology considered revolutionary for modern scientific and technological development:**

1. Even though the physical properties of nanomaterials don't change, their chemical reactivity enhances significantly.
2. Size of Nanomaterials is directly proportional to its surface area, and decreased surface area is an important requirement for self assembly.
3. They are considered environment friendly because of no negative impact on ecosystems.

Select the correct answer using the code given below.

- (a) 1 and 2 only
- (b) 2 only
- (c) 2 and 3 only
- (d) None

**Q6. Which of the following best describes the rationale for fast breeder reactor (FBR) in India, which is integral to 3 staged Nuclear programme:**

- (a) To convert Natural Uranium in Pu-239, which is a good fissile material.
- (b) To utilize the potential of efficient fission by FBR compared to other reactors
- (c) To use fission base energy and use it for Nuclear fusion
- (d) To use Thorium reserves and convert it into good fissile material

Q7. India is an important member of the 'International Thermonuclear Experimental Reactor'. If this experiment succeeds, what is the immediate advantage for India?

- (a) It can use thorium in place of uranium for power generation
- (b) It attain a global role in satellite-navigation
- (c) It can drastically improve the efficiency of its fission reactors in power generation
- (d) It can build fusion reactors for power generation

Q8. Consider the following statements:

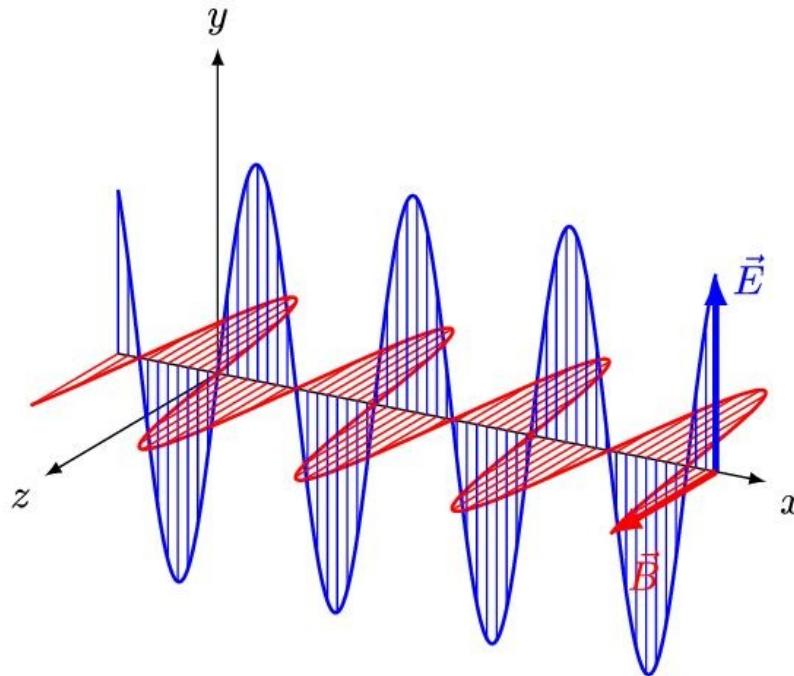
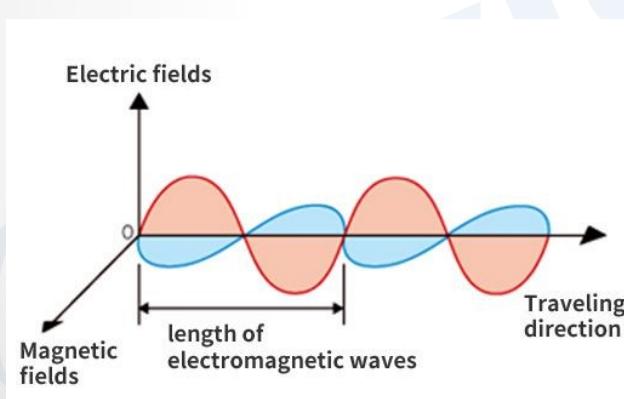
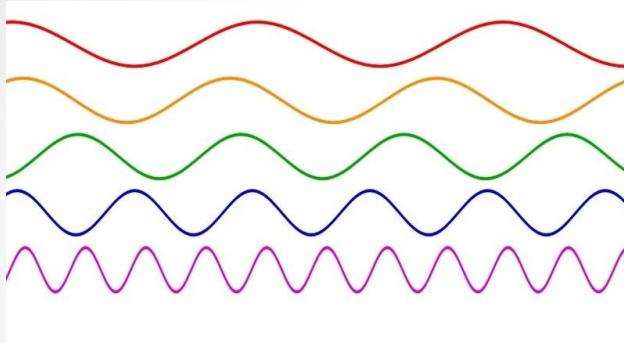
- 1. Other than those made by humans, nanoparticles do not exist in nature.
  - 2. Nanoparticles of some metallic oxides are used in the manufacture of some cosmetics.
  - 3. Nanoparticles of some commercial products which enter the environment are unsafe for humans.
- Which of the statements given above is/are correct?

- (a) 1 only
- (b) 3 only
- (c) 1 and 2
- (d) 2 and 3

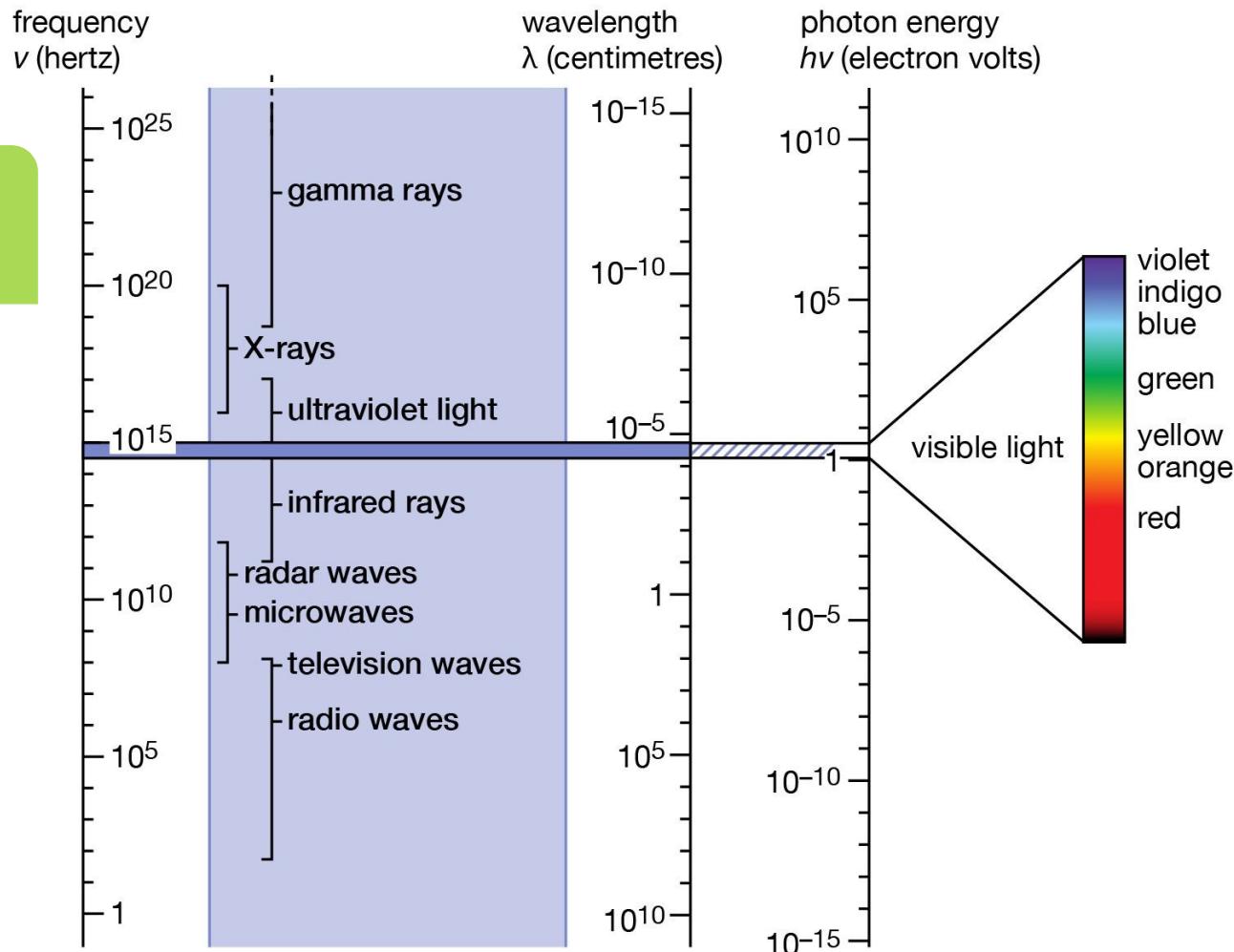
# Topics

- 5G
- Internet – ICANN, Net neutrality, Dark Net, Space Based Internet
- Deep Learning, Machine Learning, AI
- Blockchain Technology and Cryptocurrencies
- Super Computing, Cloud Computing and Edge Computing
- Quantum Technologies
- Data Localization and Data Protection Regime

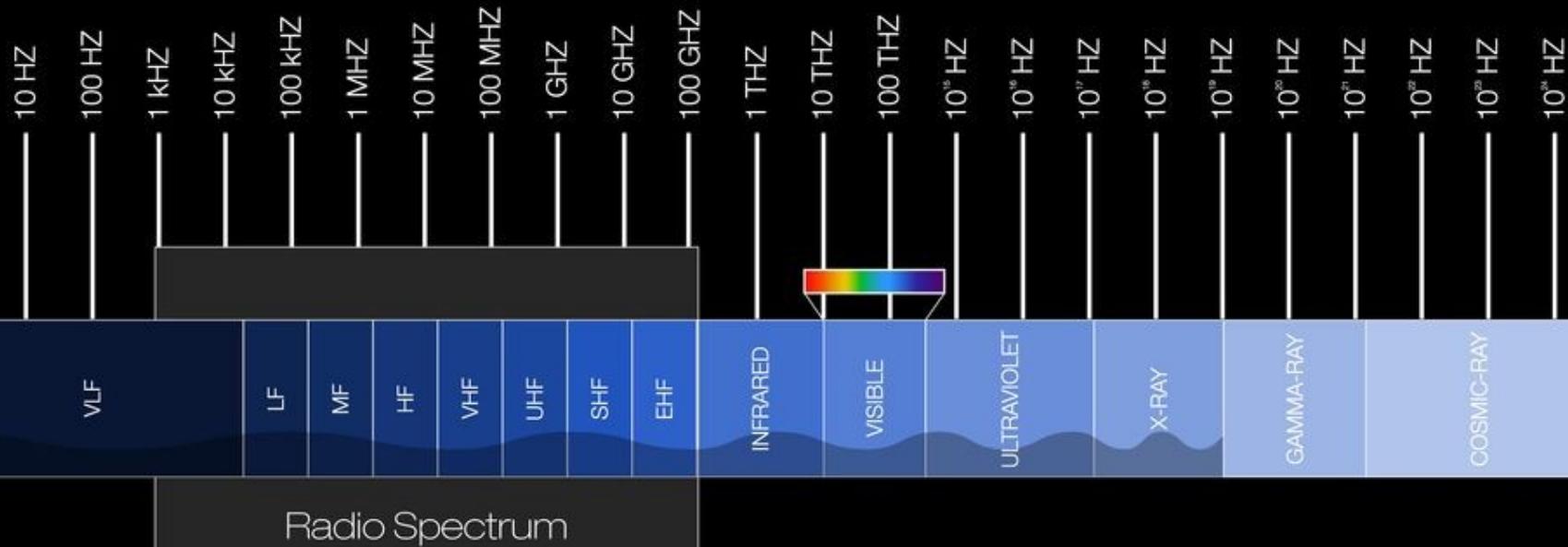
# Electromagnetic Waves



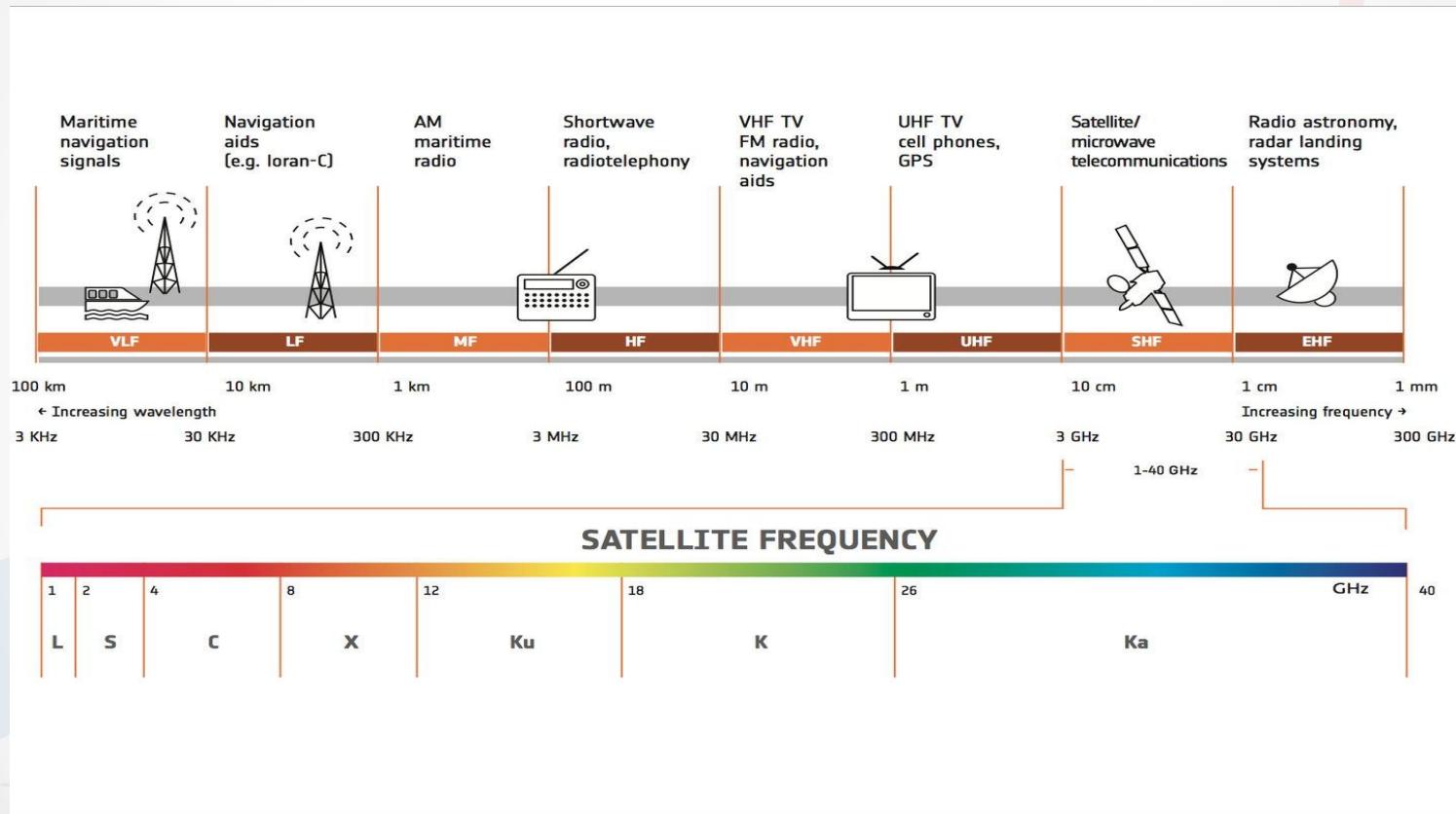
## Electromagnetic Spectrum



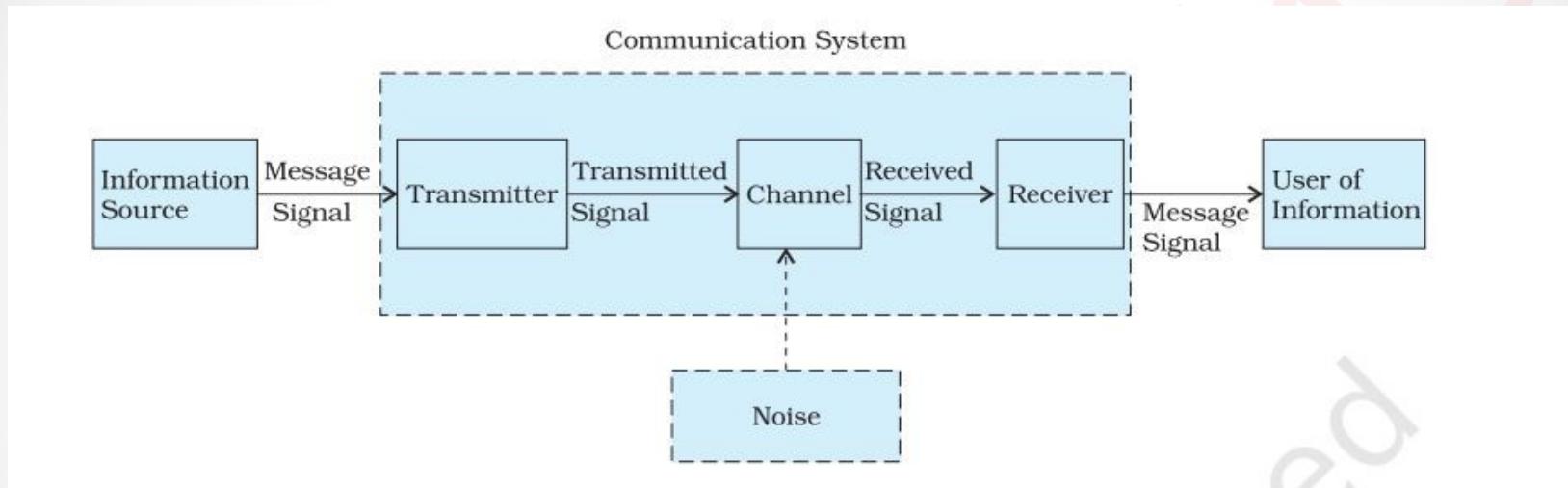
# Electromagnetic Spectrum



# Satellite Frequency



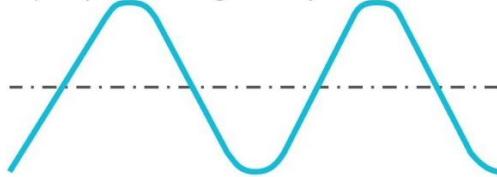
# Generalized Communication System



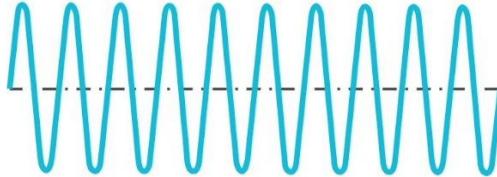
# Modulation

## Amplitude Modulation (AM)

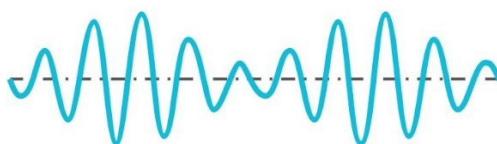
Input (Modulating Wave)



Carrier

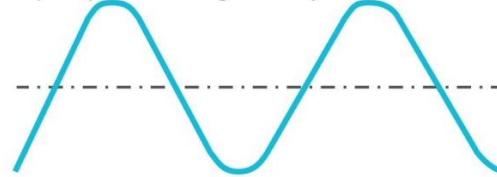


Modulated Result

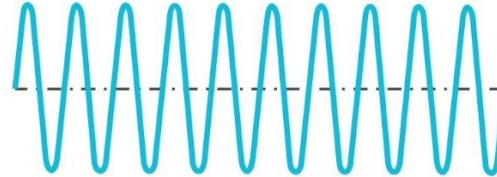


## Frequency Modulation (FM)

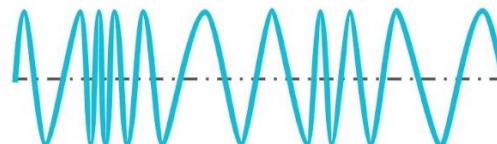
Input (Modulating Wave)



Carrier

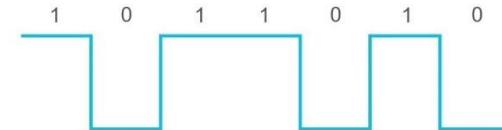


Modulated Result

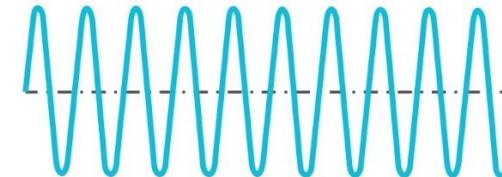


## Digital Modulation

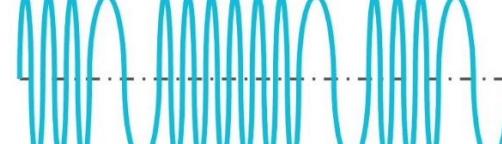
Input (Modulating Wave)



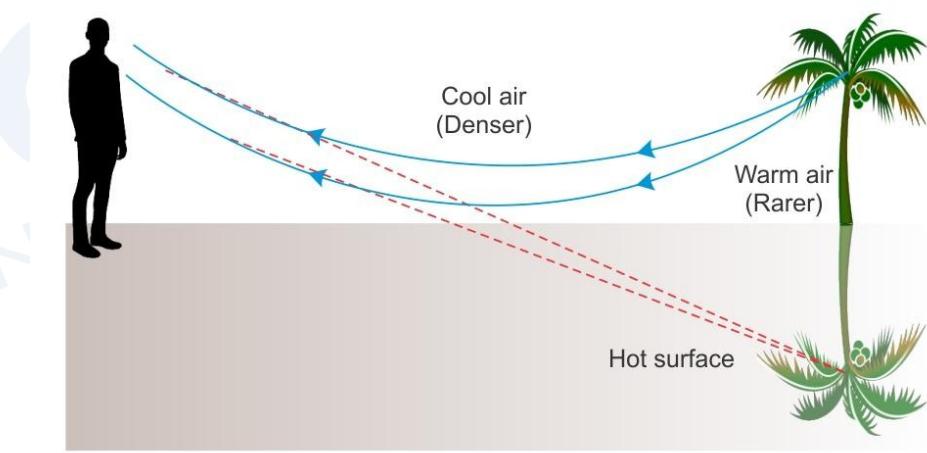
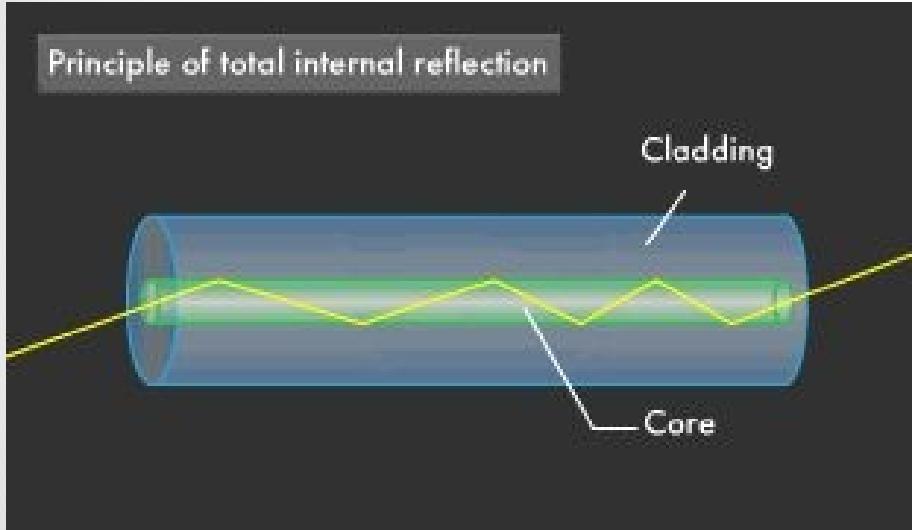
Carrier



Modulated Result



# Optical Fibre Cables



# History of Mobile Technology

SYNOPSYS®

**1G**



Analog  
Technology



**2G**



Digital  
Technology



**3G**



Wireless  
Capability



**4G**



Phones Became  
Computers



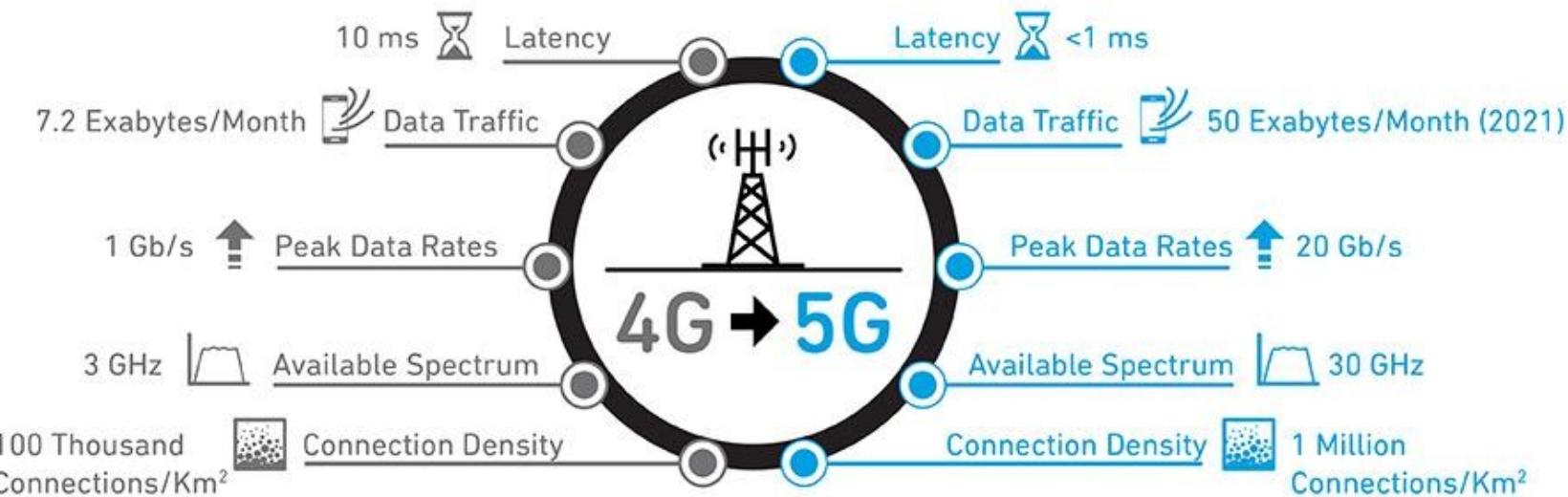
**5G**



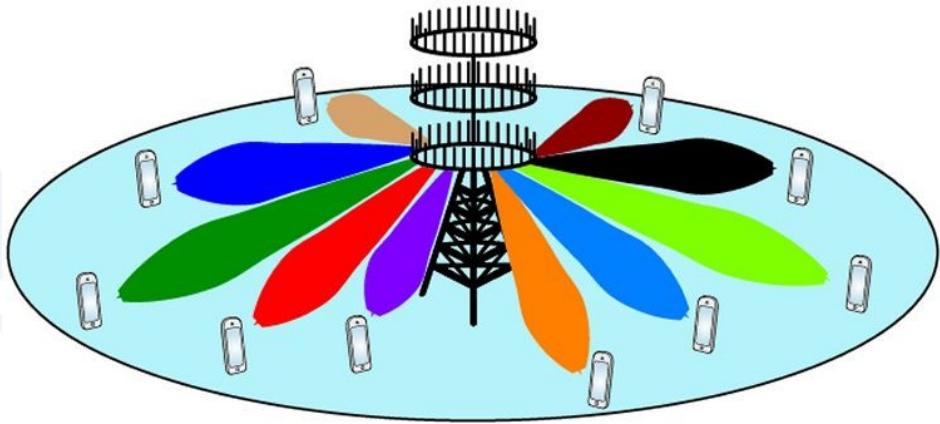
Unparalleled  
Latency



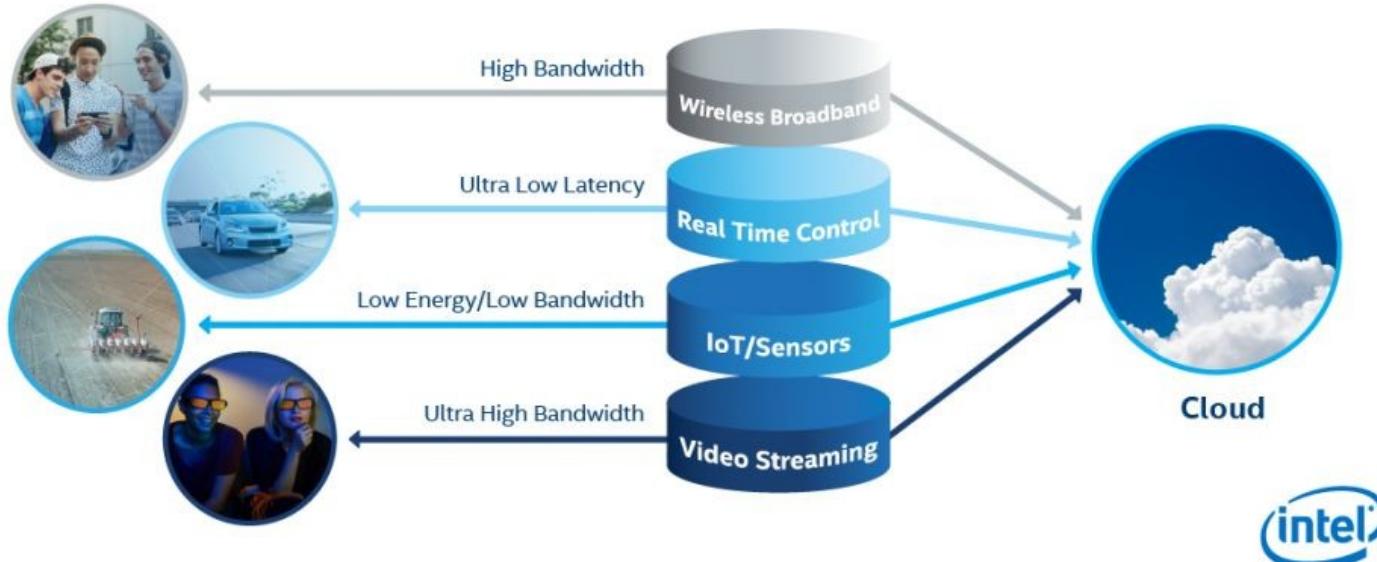
## Comparing 4G and 5G



# 5G Technologies



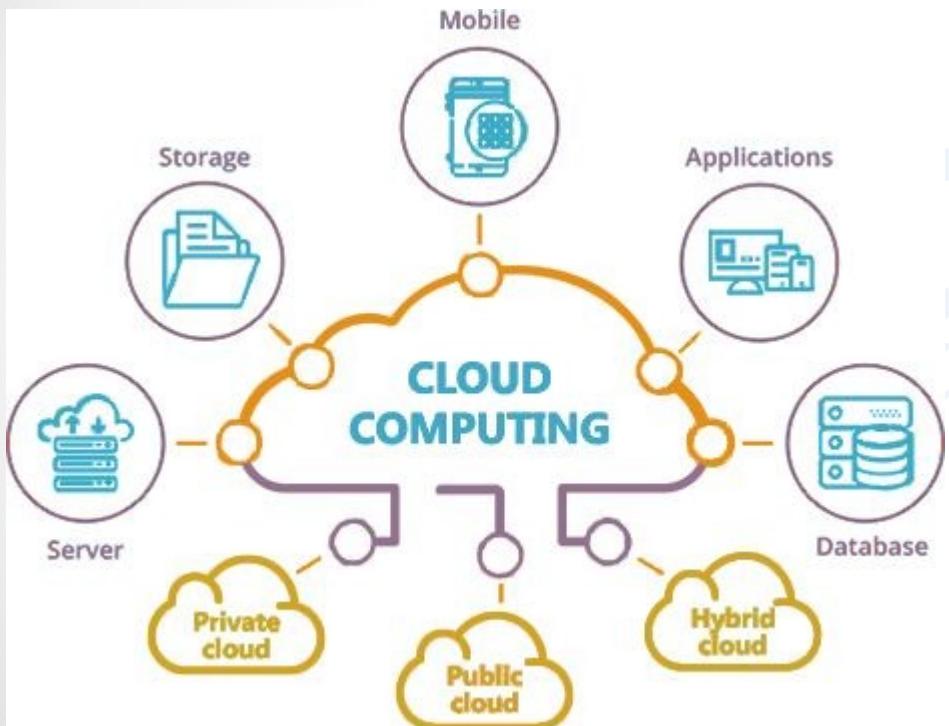
## 5G Network Slices



# Param Siddhi Supercomputer

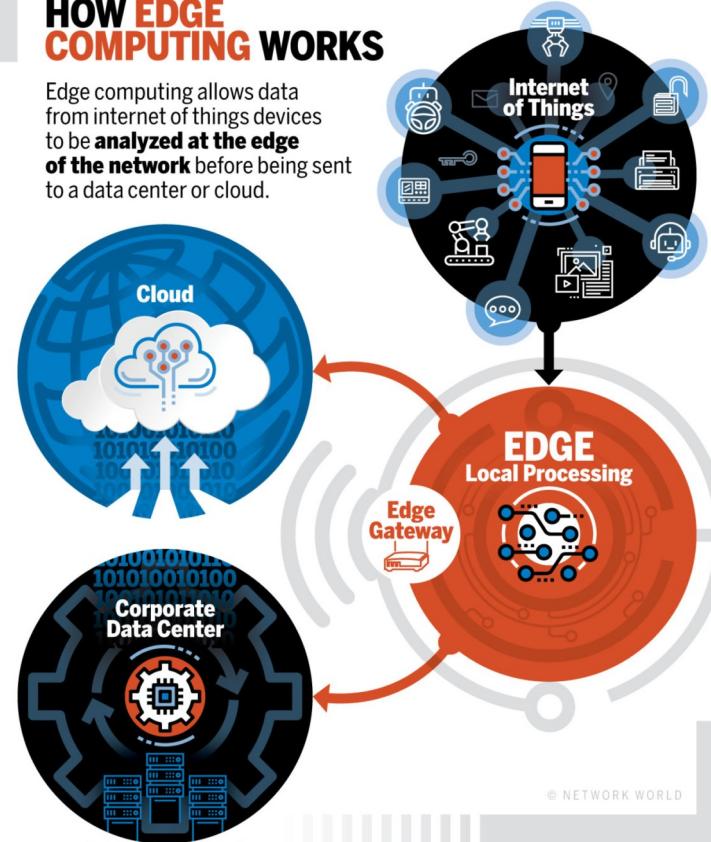


# Cloud and Edge Computing



## HOW EDGE COMPUTING WORKS

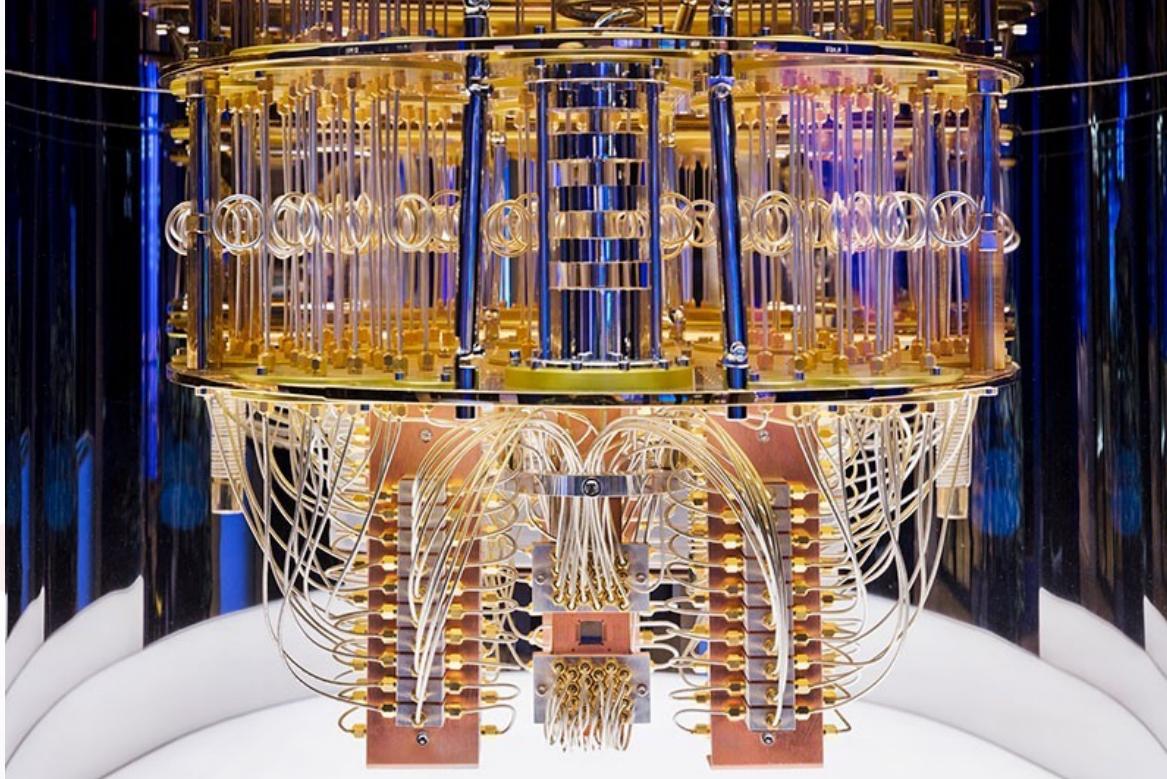
Edge computing allows data from internet of things devices to be **analyzed at the edge of the network** before being sent to a data center or cloud.



# Internet of Things

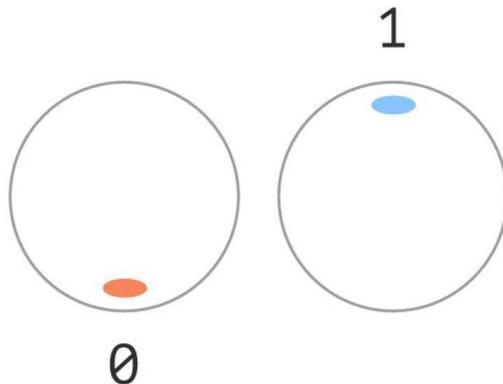


# Quantum Computer

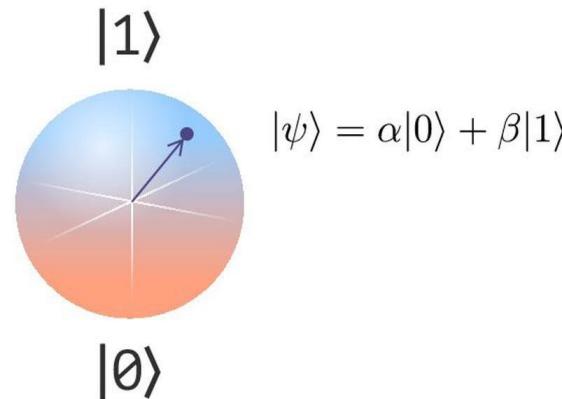


# Qubit

Bit

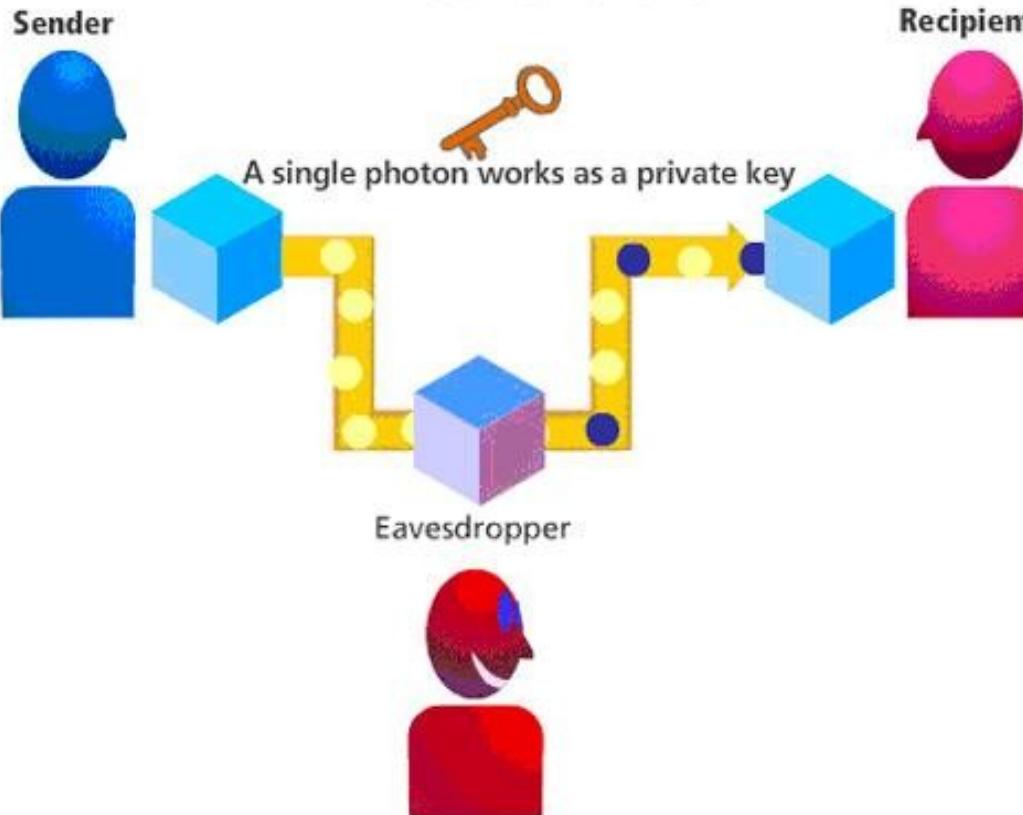


Qubit



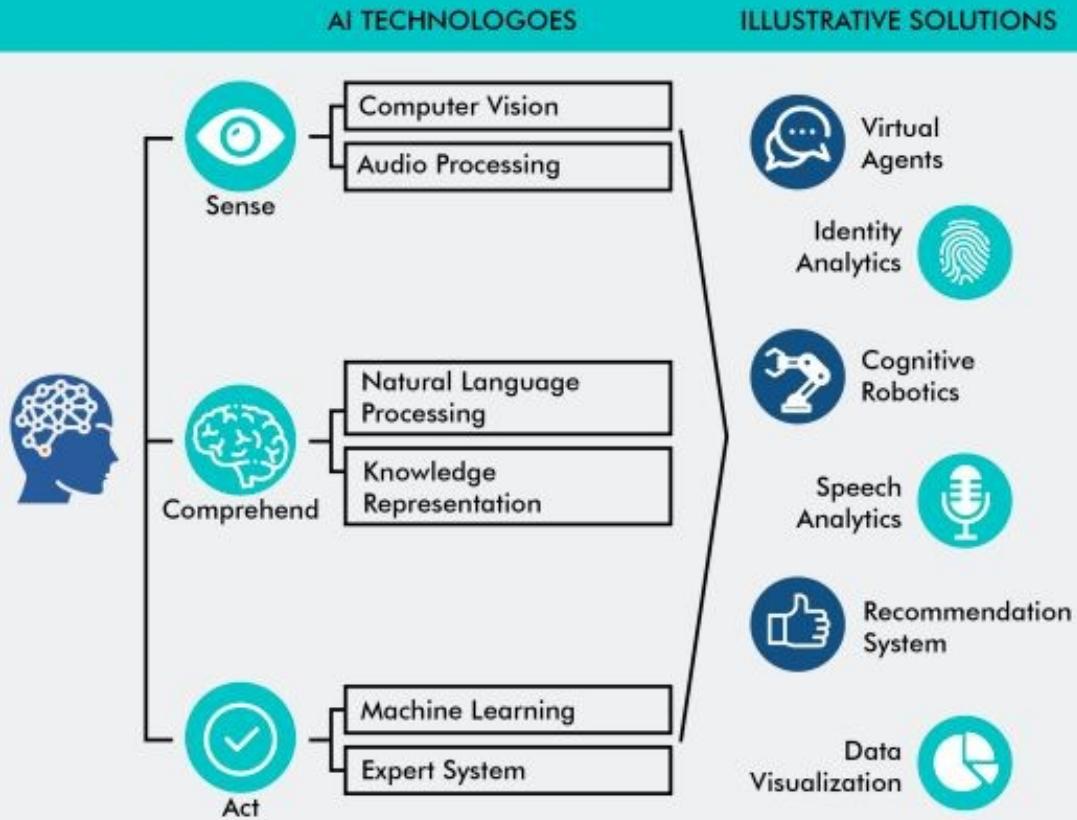
OS  
NZ

## Quantum cryptography system

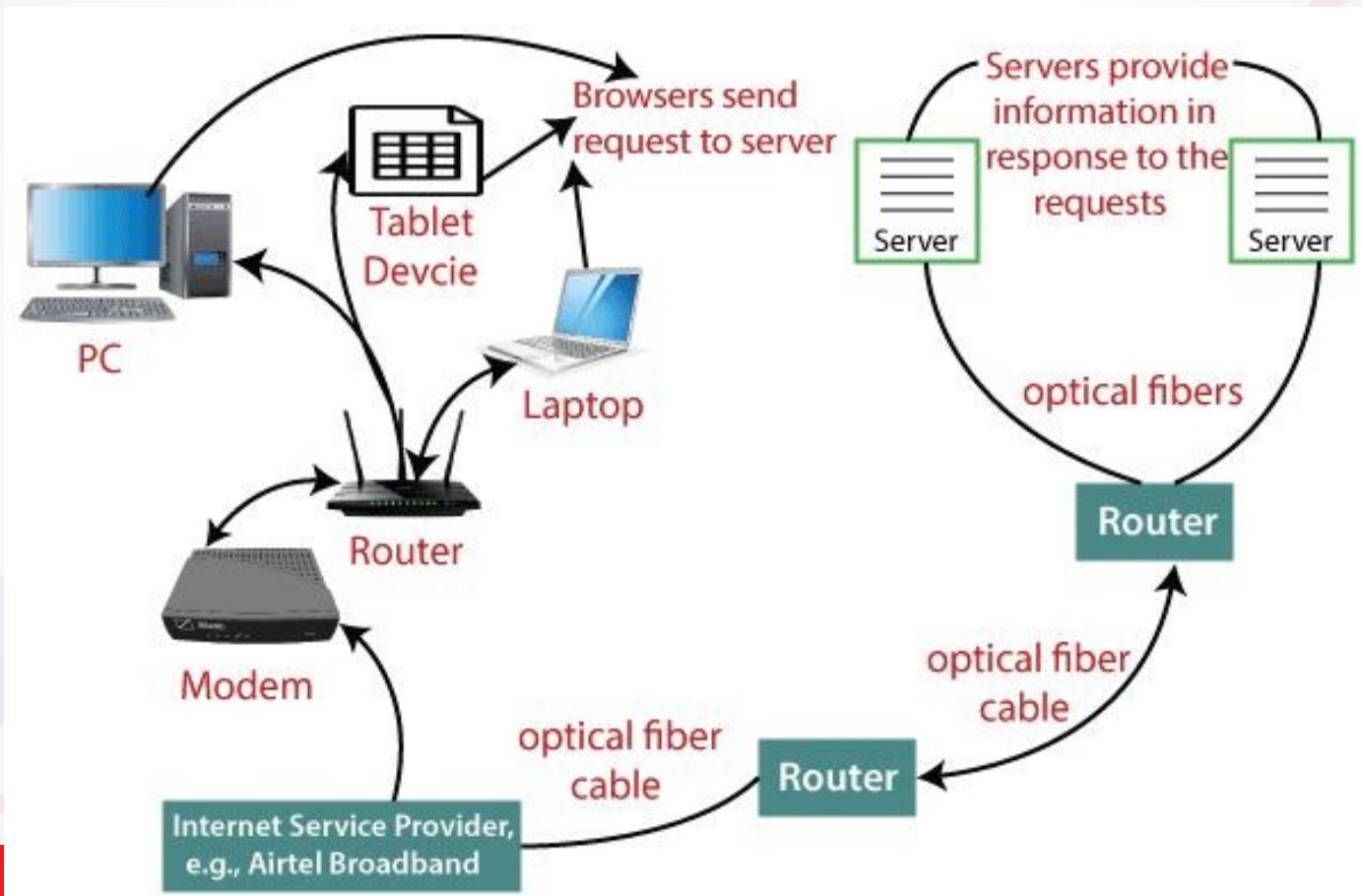


Recipients can discern the presence of eavesdroppers because the quantum state has changed due to observation.

# Artificial Intelligence

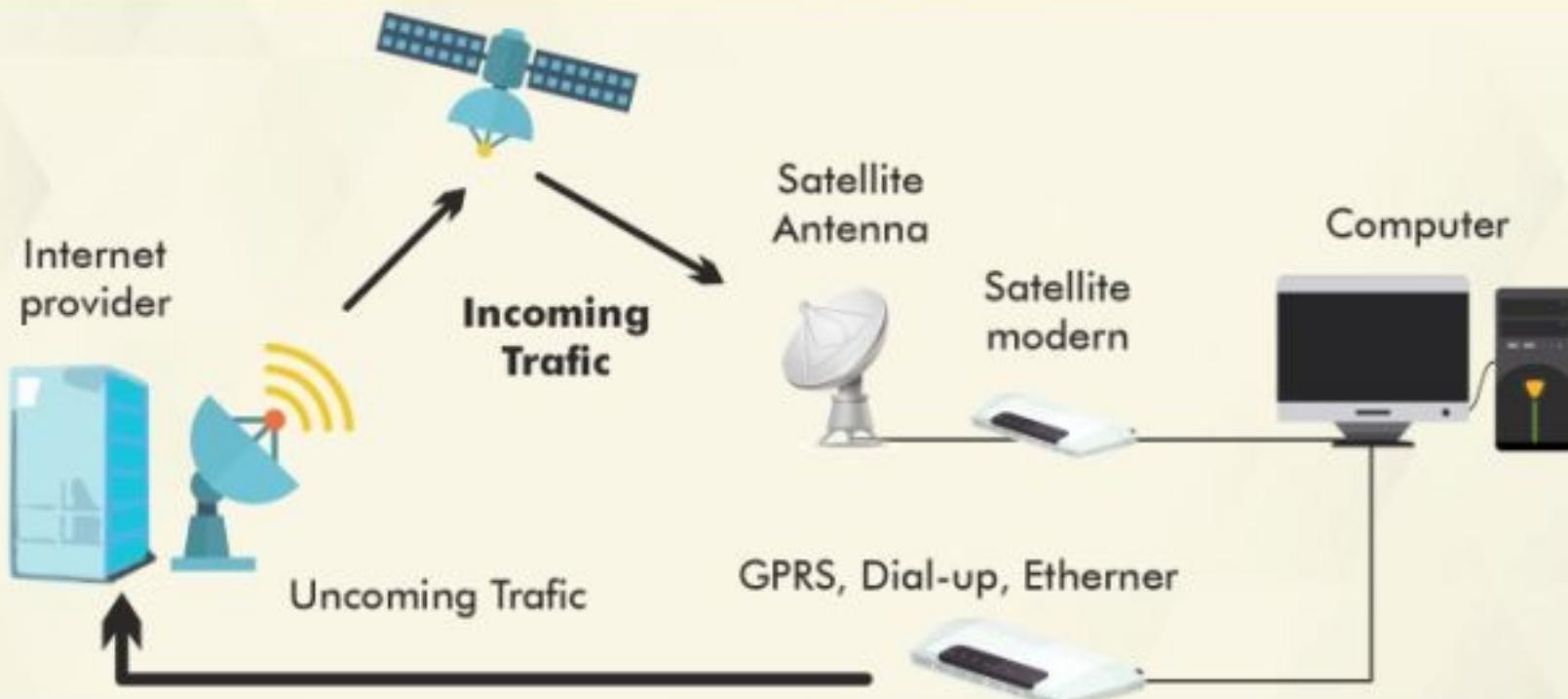


# Internet



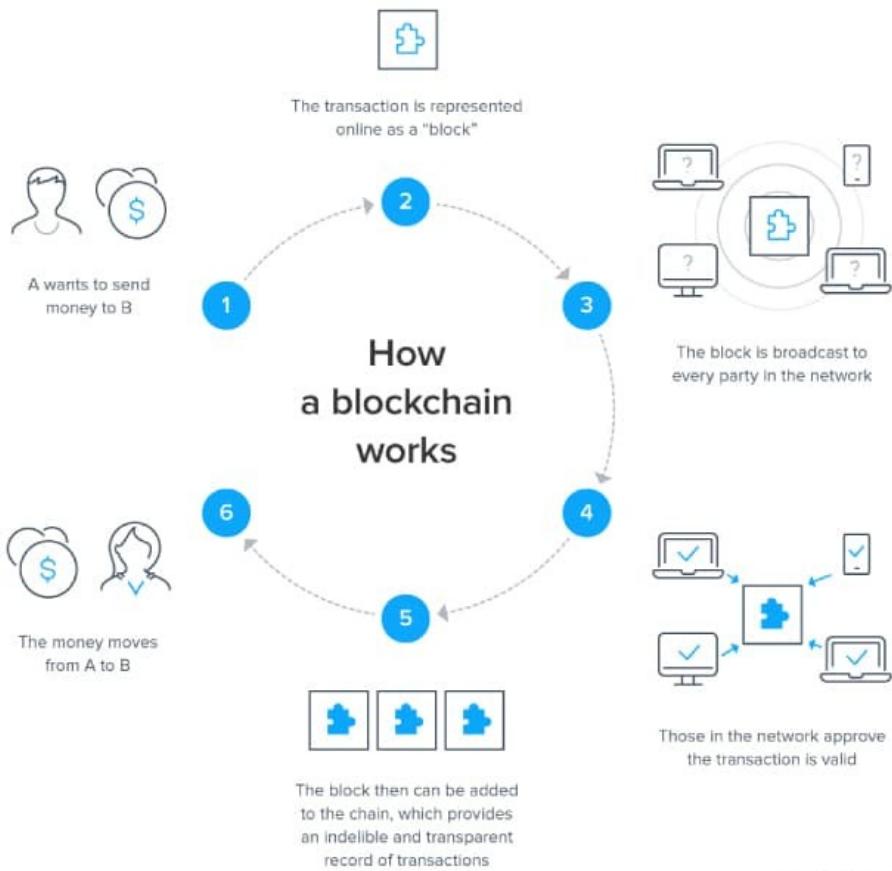
# Space Based Internet

## Working of Satellite services



# How a Blockchain Works

F  
M



[https://www.youtube.com/watch?v=\\_160oMzblY8](https://www.youtube.com/watch?v=_160oMzblY8)

Source: Lykke

Q1. With reference to Visible Light Communication (VLC) technology, which of the following statements are correct?

1. VLC uses electromagnetic spectrum wavelengths 375 to 780 nm
  2. VLC is known as long range optical wireless communication.
  3. VLC can transmit large amounts of data faster than Bluetooth
  4. VLC has no electromagnetic interference.
- Select the correct answer using the code given below:

- (a) 1, 2 and 3 only
- (b) 1, 2 and 4 only
- (c) 1, 3 and 4 only
- (d) 2, 3 and 4 only

Q2. With reference to communications technologies, what is/are the difference/differences between LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution)?

1. LTE is commonly marketed as 3G and VoLTE is commonly marketed as advanced 3G.
2. LTE is data-only technology and VoLTE is voice-only technology.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

**Q3.** In the context of digital technologies for entertainment, consider the following statements:

1. In Augmented Reality (AR), a simulated environment is created and the physical world is completely shut out.
2. In Virtual Reality (VR), images generated from a computer are projected onto real-life objects or surroundings.
3. AR allows individuals to be present in the world and improves the experience using the camera of smartphones or PC.
4. VR closes the world, and transposes an individual, providing complete immersion experience.

Which of the statements given above is/are correct?

- (a) 1 and 2 only
- (b) 3 and 4
- (c) 1, 2 and 3
- (d) 4 only

**Q4:** With reference to Web 3.0, consider the following statements:

1. Web 3.0 technology enables people to control their own data.
2. In Web 3.0 world, there can be blockchain based social networks.
3. Web 3.0 is operated by users collectively rather than a corporation.

Which of the statements given above are correct ?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

**Q5.** With reference to 'LiFi', recently in the news, which of the following statements is/are correct?

1. It uses light as the medium for high-speed data transmission.
2. It is a wireless technology and is several times faster than 'WiFi'.

Select the correct answer using the code given below.

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

**Q6.** Which one of the following-is the context in which the term "qubit" is mentioned ?

- (a) Cloud Services
- (b) Quantum Computing
- (c) Visible Light Communication Technologies
- (d) Wireless Communication Technologies

**Q7.** With reference to "Blockchain Technology" consider the following statements:

1. It is a public ledger that everyone we inspect, but which no single user controls
2. The structure and design of blockchain is such that all the data in it are about crypto currency only.
3. Applications that depend on basic features of blockchain can be developed without anybody's permission.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 1 and 2 only
- (c) 2 only
- (d) 1 and 3 only

**Q8.** With the print state of development, Artificial Intelligence can effectively do which of the following?

1. Bring down electricity consumption in industrial units
2. Create meaningful short stories and songs
3. Disease diagnosis
4. Text-to-Speech Conversion
5. Wireless transmission of electrical energy

Select the correct answer using the code given below:

- (a) 1, 2, 3 and 5 only
- (b) 1, 3 and 4 only
- (c) 2, 4 and 5 only
- (d) 1, 2, 3, 4 and 5

Q9. With reference to Non- Fungible Tokens (NFTs), consider the following statements:

1. They enable the digital representation of physical assets.
2. They are unique cryptographic tokens that exist on a blockchain.
3. They can be traded or exchanged at equivalency and therefore can be used as a medium of commercial transactions.

Which of the statements given above are correct?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

## **Dr Vikram Sarabhai**

- Dr. Vikram Ambalal Sarabhai was an Indian astrophysicist who is considered as the Father of Indian Space Program.
- He worked on cosmic ray studies at the Indian Institute of Science in Bangalore, where he was mentored by Nobel Laureate Dr. C. V. Raman.

### Contributions in the development of space technology in India

- **Establishment of ISRO:** His vision and commitment led to the establishment of Indian National Committee for Space Research (INSCOSPAR), which was later re-christened as the Indian Space Research Organisation (ISRO) in 1969.
- He was appointed as the **Chairman of the Atomic Energy Commission of India** and was largely responsible for the establishment and development of India's nuclear power plants.
- **Physical Research Laboratory (PRL):** In 1947, he returned to India and founded the Physical Research Laboratory (PRL) in Ahmedabad. PRL was one of the first research institutes in India to work in the field of space sciences.
- **India's first rocket launching station:** Along with Dr. Homi Bhabha, Dr. Sarabhai set up India's first rocket-launching station at Thumba near Thiruvananthapuram. It led to the development of present day indigenous rocket launchers like SLV, PSLV, GSLV.
- **Development of Satellite programme:** He started a project for the fabrication and launch of an Indian Satellite. As a result, the first Indian satellite, Aryabhata, was put in orbit in 1975 from a Russian Cosmodrome.
- Further, the **Satellite Instructional Television Experiment (SITE)** was launched in 1976 based on his dialogue with NASA. The project helped India gain technical experience in the field of satellite communications and made available informational television programs to rural India.
- The lander of India's Chandrayaan-2, Vikram, was named after him, and so was the Vikram Sarabhai Space Centre (VSSC), ISRO's facility for rocket development in Thiruvananthapuram.

## **Dr Hargobind Khurana**

- He was born in Raipur village of Multan district, In 1969, he was awarded Padma Vibhushan.
- 1968 Nobel Prize for Physiology or Medicine (shared with Nirenberg and Holley) for interpretation of genetic code and its function in protein synthesis.
- He proved that genetic code consists of 64 different three-letter words, which told the cell where to begin reading the code and where to stop.

- Constructed the **world's first synthetic gene** paving the way for further advancements in the field of genetic engineering and biotechnology.
- He investigated **mutations in rhodopsin** that are associated with retinitis pigmentosa, **which causes night blindness**. Rhodopsin is a light-sensitive protein found in the retina of the vertebrate eye.
- Contributed to the **science of polymerase chain reaction** (PCR) tests, used to detect genetic material from a specific organism, like a virus.
- Discovered structure of **transfer-RNA, or tRNA** (small RNA molecule that participates in protein synthesis)

### **Dr A P J Abdul Kalam**

- He was an Indian scientist who also served as the 11th President of India from July 25, 2002 to July 25, 2007.
- Kalam and his team were successful in developing **India's first indigenous hovercraft which was named Nandi**. A hovercraft is an amphibious craft capable of travelling over land, water, mud, ice and other surfaces.
- The team of rocket engineers of which Kalam was a part, set up the **Thumba Equatorial Rocket Launching Station** (TERLS) in 1963.
- He was project **director of India's first Satellite Launch Vehicle**.
- He was given the responsibility to lead the **Integrated Guided Missile Development Program (IGMDP)**. According to the instructions of then Defence Minister R. Venkataraman, four missiles were to be developed simultaneously as part of the program. After years of consistent hard work and immense dedication, India got her first range of ballistic missiles, the Prithvi, the Agni, the Aakash, and the Nag.
- The **Pokhran-II nuclear** tests were conducted during this period and Kalam played an intensive political and technological role in their success.
- He served as **first principal scientific advisor to government of India**.
- He is author of best selling work Wings of Fire, which has inspired millions.
- He was awarded Bharat Ratna in 1997.

### **Homi Jehangir Bhabha**

- He was the first person to become the Chairman of the Atomic Energy Commission of India.
- Bhabha is acknowledged as the father of Indian nuclear power.
- He envisaged the 3 staged nuclear program to effectively utilize thorium reserve of India.

- Bhabha was also the founding director of the Atomic Energy Establishment, Trombay (AEET) which is now named the Bhabha Atomic Research Centre
- He calculated the **cross section of electron-positron scattering**.
- He also helped in developing the **cosmic radiation's understanding**.
- He was instrumental in establishing the Tata Institute of Fundamental Research in Mumbai.
- Along with Dr. Homi Bhabha, Dr. Sarabhai set up India's first rocket-launching station at Thumba near Thiruvananthapuram.
- He promoted nuclear energy control and also advocated for the prohibition of atomic bombs worldwide.
- He was also nominated for the Nobel Prize for Physics in 1951 and 1953–1956.

## **Visvesvaraya**

- Sir Mokshagundam Visvesvaraya was a civil engineer who also served as Diwan of Mysore (1912 to 1919).
- Sir MV was recognized for engineering the Krishna Raja Sagara Dam located in Mysore.
- Also, he was one of the Chief designing engineers for bringing up a system for flood protection in Hyderabad.
- He is credited for inventing 'automatic sluice gates' and 'block irrigation system' which are still considered to be marvels in engineering.
- He came up with an efficient way of filtering water through 'Collector Wells'
- In 1955, he was honored with Bharat Ratna.
- September 15 is celebrated as Engineers day in India, in his loving memory.

## **Meghnad Saha**

- Meghnad Saha's best-known work concerned the thermal ionisation of elements, and it led him to formulate the Saha Equation.
- This equation is one of the basic tools for interpretation of the spectra of stars in astrophysics.
- By studying the spectra of various stars, one can find their temperature and from that, using Saha's equation, determine the ionisation state of the various elements making up the star.
- He also invented an instrument to measure the weight and pressure of solar rays.
- He was also the chief architect of river planning in India.

## **Praful Chandra Ray**

- He established Bengal Chemical and Pharmaceutical Works Ltd, India's first pharmaceutical company in 1901.
- His research included organic compounds containing sulphur, double salt, homomorphism and fluorination.
- His research included the discovery of the stable compound mercurous nitrite in 1896 while studying nitrite and hyponitrite compounds and their compounds.

### **Shanti Swaroop Bhatnagar**

- He was "father of research laboratories" in India.
- He was also the first Chairman of the University Grants Commission(India)
- In 1958, to honour his name and legacy, the Indian Council of Scientific and Industrial Research (CSIR) instituted the Shanti Swarup Bhatnagar Prize for Science and Technology for scientists who have made significant contributions in various branches of science.
- In 1940, the Board of Scientific and Industrial Research (BSIR) was formed for a period of two years and he was appointed as its Director. In 1941, he persuaded the government to set up an Industrial Research Utilisation Committee (IRUC) for further investment into industrial research.
- In 1942, the Council of Scientific and Industrial Research (CSIR) was formed and the BSIR and IRUC became its advisory bodies. In 1943, CSIR approved his proposal to establish five national laboratories.
- Post-independence, he was made the chairman of the CSIR and he became the first director general of the council. He established many laboratories and mentored many great minds during his tenure as the head of the CSIR.

### **Ramanujan**

- With almost no formal training in pure mathematics, he made extraordinary contributions to mathematical analysis.
- Ramanujan was elected to the London Mathematical Society in 1917 and was elected a Fellow of the Royal Society for his excellent work on Elliptic Functions and the theory of numbers.
- Ramanujan made priceless contributions to several mathematical concepts like infinite series, continued fractions, number theory and mathematical analysis.
- He also made notable contributions like the hypergeometric series, the Riemann series, the elliptic integrals, the theory of divergent series, and the functional equations of the zeta function.
- He introduced a summation in 1918, now known as the Ramanujan sum which is currently used in signal processing, i.e., analysing, modifying and synthesising periodically repetitive signals such as speech, music, DNA sequences etc.
- He introduced the "mock theta functions" which are used today in 'String Theory' in theoretical physics.

- He is also credited for his work in 'Modular functions' which are used to reveal properties of Black Holes by astrophysicists.
- He discovered Hardy Ramanujan number i.e. 1729 which is the smallest number which can be expressed as the sum of two cubes in two different ways-  $1729 = 13 + 123 = 93 + 103$  .
- His birth anniversary 22 December is celebrated as National Mathematics day.

### **Women Scientists of India:**

**Anandibai Gopalrao Joshi** (1865-1887) First Indian female to study and graduate with a degree in western medicine from the United States (1886). She is believed to be the first woman to set foot on American soil from India

**Kadambini Ganguly (1861-1923)** The first Indian woman to get admission to Calcutta Medical College (1884), becomes India's first female doctor & practitioner (1886) of western medicine in the whole South Asia.

**Mary Poonen Lukose** (1886-1976) The first female Surgeon General in India, (1938). She became the first woman obstetrician of India.

**Bibha Chowdhary** (1913-1991) First woman high energy physicist of India and the first woman scientist at the TIFR (1948). The International Astronomical Union honored her by naming a white yellow dwarf star after her name.

**Edavaleth Kakkat Janaki Ammal** (1897-1984) Renowned botanist & plant cytologist, made significant contributions to genetics, evolution, phytogeography and ethnobotany. First Director of the Central Botanical Laboratory at Allahabad, 1952

**Kamala Sohonie** (1911-1998) First Indian woman to receive a PhD in a scientific discipline. She discovered the enzyme 'Cytochrome C' which plays an essential role in the electron transport chain occurring in plants, human and animal cells for energy synthesis.

**Asima Chatterjee** (1917-2006) The first woman to be awarded a Doctor of Science by an Indian University (Calcutta) in 1944. She was the first woman to be elected as the General President of the Indian Science Congress.

**Iravati Karve** (1905-1970) First Indian female anthropologist. She founded the Department of Anthropology at the University of Pune in 1963. She also held the post of the Vice-Chancellor of SNDT University.

**Debala Mitra** (1925-2003) First Indian archaeologist served as Director General of the Archaeological Survey of India, 1981. She explored and excavated several Buddhist sites.

**Purnima Sinha** (1927-2015) An Indian physicist who received a doctorate in physics under the guidance of Prof Satyendra Nath Bose. She did tremendous work in the field of x-ray crystallography of clay minerals.

**Rajeshwari Chatterjee** (1922-2010) Woman Engineer who pioneered research in microwave engineering. She is the first woman engineer at IISc who joined the Department of Electrical Communication Engineering (ECE).

**Anna Mani** (1918-2001) First woman to join the Meteorological department in Pune, 1948. Her major contributions are in the field of solar radiation, ozone and wind energy instrumentation.

**Kamal Ranadive** (1917-2001) Established India's first tissue culture research laboratory at the Indian Cancer Research Centre in Mumbai, 1960. She was among the first to recognise the connection between cancer susceptibility and the interaction between hormones and tumour virus.

#### **Tessy Thomas:**

- known as the 'Missile Woman' of India is the Director General of Aeronautical Systems and the former Project Director for Agni-IV missile in Defence Research and Development Organisation (DRDO).
- She is the first woman scientist to head a missile project in India.
- She has contributed in guidance, trajectory simulation and mission design at the DRDO. She designed the guidance scheme for long-range missile systems, which is used in all Agni missiles.

#### **Ritu Karidhal:**

- As Mission Director of the Chandrayaan-2 mission, Ritu Karidhal was feted for role in helming one of India's most ambitious lunar projects.
- She was responsible for detailing and the execution of the craft's onward autonomy system, that independently operated the satellite's functions in space and responded appropriately to malfunctions.
- Dubbed as the 'Rocket Woman of India' Ritu joined ISRO in 2007 and was also the Deputy Operations Director to India's Mars Orbiter mission, Mangalyaan.

#### **Muthayya Vanitha**

- She is the Project Director of Chandrayaan-2. She is the first woman to lead the interplanetary mission at ISRO.
- She was promoted from Associate Director to Project Director of the mission.
- She has occupied several roles such as leading the Telemetry and Telecommand Divisions in the Digital Systems Group of ISRO Satellite Centre, and has been the Deputy Project Director for several satellites including Cartosat-1, Oceansat-2, and Megha-Tropiques.

#### **Gagandeep Kang,**

- a virologist and scientist, is known for her interdisciplinary research in transmission, development, and prevention of enteric infections and their sequelae in children in India.
- She has been elected as a Fellow of the Royal Society (FRS), the first Indian woman scientist to receive this honour.
- she also national rotavirus and typhoid surveillance networks, established laboratories to support vaccine trials, and conducted phase one-three-

clinical trials of vaccines, a comprehensive approach that has supported two WHO prequalified vaccines made by two Indian companies.

- She is also investigating the complex relationships between infection, gut function, and physical and cognitive development, and seeking to build a stronger human immunology research in India.

### **Mangala Mani**

- The 'polar woman of ISRO', Mangala Mani is ISRO's first woman scientist to spend more than a year in the icy landscape of Antarctica.
- The 56-year-old had never experienced snowfall before she was selected for the mission. In November 2016, she was part of the 23-member team that went on an expedition to Bharati, India's research station in Antarctica.

### **Kamakshi Sivaramakrishnan**

- She is responsible for building the algorithm and the chip that is responsible for bringing information from Pluto as part of New Horizon mission.
- The chip on board the spacecraft collects signals and sends them back to the space station which is three billion miles away.
- Based in San Mateo, California, she has been building a complex algorithm to be more intuitive about how users interact with ads online, as well as across different interfaces – smartphones, tablets, laptops, etc.

### **Chandrima Shah**

- Chandrima is a biologist and the first ever woman president of the Indian National Science Academy (INSA).
- She specialises in cell biology, and has conducted extensive research about the 'Leishmania' parasite which causes Kala Azar.