Unit V

Satellite Services : VSAT and DTH systems, GPS and navigation systems, Satellite Internet and mobile satellite services, Remote sensing and weather monitoring, Case study on ISRO missions: Chandrayan, MOM

Satellite Mobile Services

- Once satellites are deployed in orbit, they can provide wide area service for telephone, facsimile, and Internet, on an as-needed basis, without the need for extensive ground facilities.
- Most of the systems that offer telephone services provide the users with dual-mode phones that operate to GSM standards.
- GSM stands for *global system for mobile communications* (originally Groupe Spe'cial Mobile); it is the most widely used standard for cellular and personal communications.
- The user frequencies are in the *L* (1 to 2 GHz) and *S* (2 to 4 GHz) bands, and where geostationary satellites are employed these require large on-board antennas in the range 100 to 200 m2.

Services

- Some of the services provided by satellites are,
  - Fixed satellite service (FSS)
  - Broadcasting satellite service (BSS)
  - Mobile satellite services
  - Navigational satellite services
  - Meteorological satellite services
- The fixed satellite service provides links for existing telephone networks as well as for transmitting television signals to cable companies for distribution over cable systems.
- Broadcasting satellite services are intended mainly for direct broadcast to the home, sometimes referred to as *direct broadcast satellite* (DBS) service in Europe it may be known as *direct-to-home* (DTH) service.

- Mobile satellite services would include land mobile, maritime mobile, and aeronautical mobile.
- Navigational satellite services include global positioning systems, and satellites intended for the meteorological services often provide a search and rescue service.
- The Ku band is the one used at present for direct broadcast satellites, and it is also used for certain fixed satellite services.
- The C band is used for fixed satellite services.
- The VHF band is used for certain mobile and navigational services and for data transfer from weather satellites.
- The L band is used for mobile satellite services and navigation systems.

- Direct-to-home broadcasting, referred to as direct broadcast satellite (DBS) service in the United States, represents one major development in the field of geostationary satellites.
- Another is the use of very small aperture terminals (VSATs) for business applications.
- A third geostationary development is mobile satellite service (MSAT), which extends geostationary satellites services into mobile communications for vehicles, ships, and aircraft.

2. DTH (Direct-To-Home) Satellite TV

DTH refers to the direct reception of **digital television** services by users using a small dish antenna.

Key Features

- **One-way communication** (downlink only)
- Uses **Ku-band** mainly
- Antenna size: **45–90 cm**
- Requires a **Set-Top Box (STB)** or DVB-S/S2 receiver
- Broadcasts TV channels directly from satellite to home

Components

- Broadcast center / uplink center
- Satellite (geostationary)
- User dish antenna
- Set-top box (with conditional access)

Advantages

- High-quality digital video and audio
- Large number of channels
- Works in remote rural areas
- Minimal infrastructure required

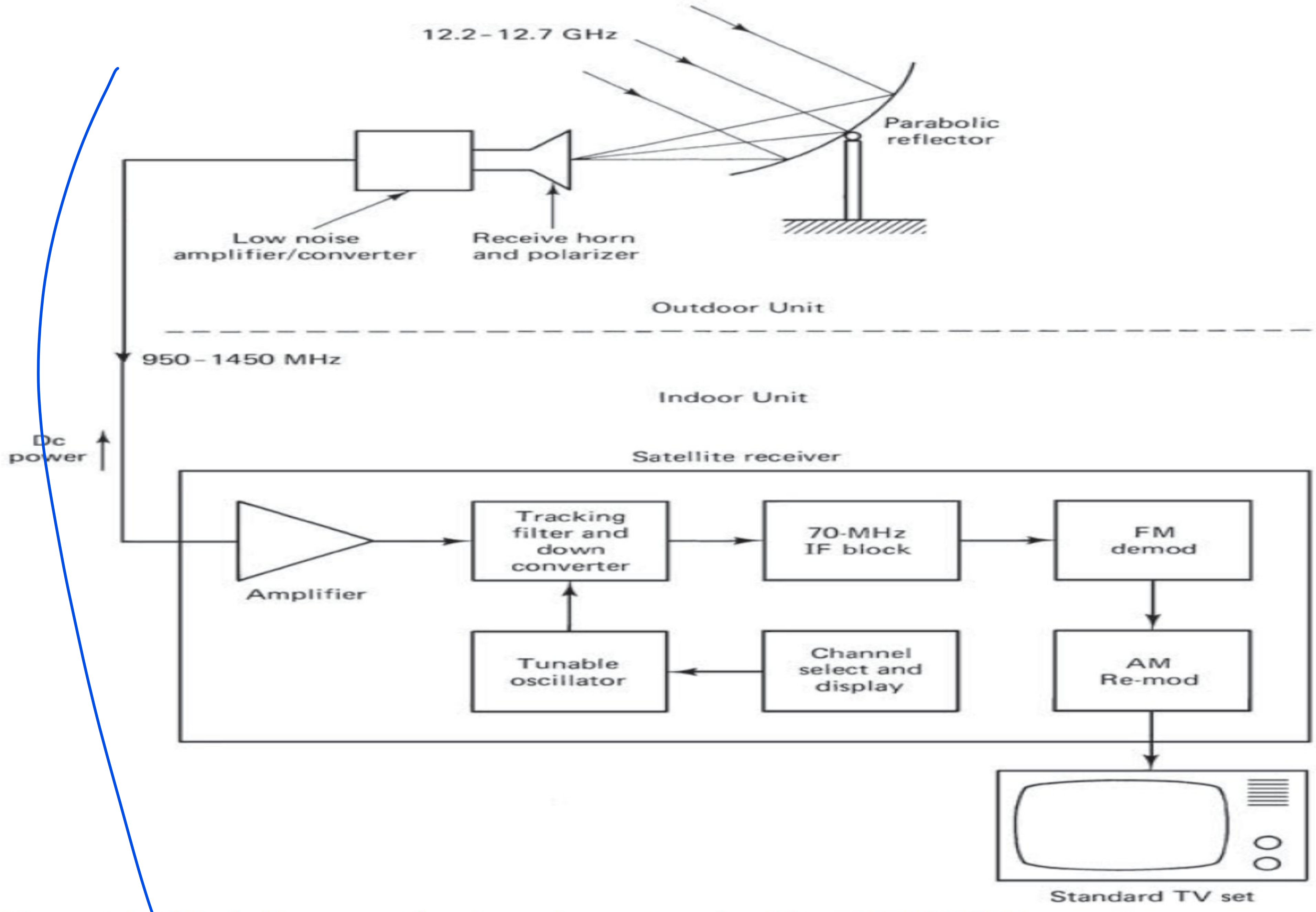


Figure 8.1 Block diagram showing a home terminal for DBS TV/FM reception.

8.2.1 The outdoor unit

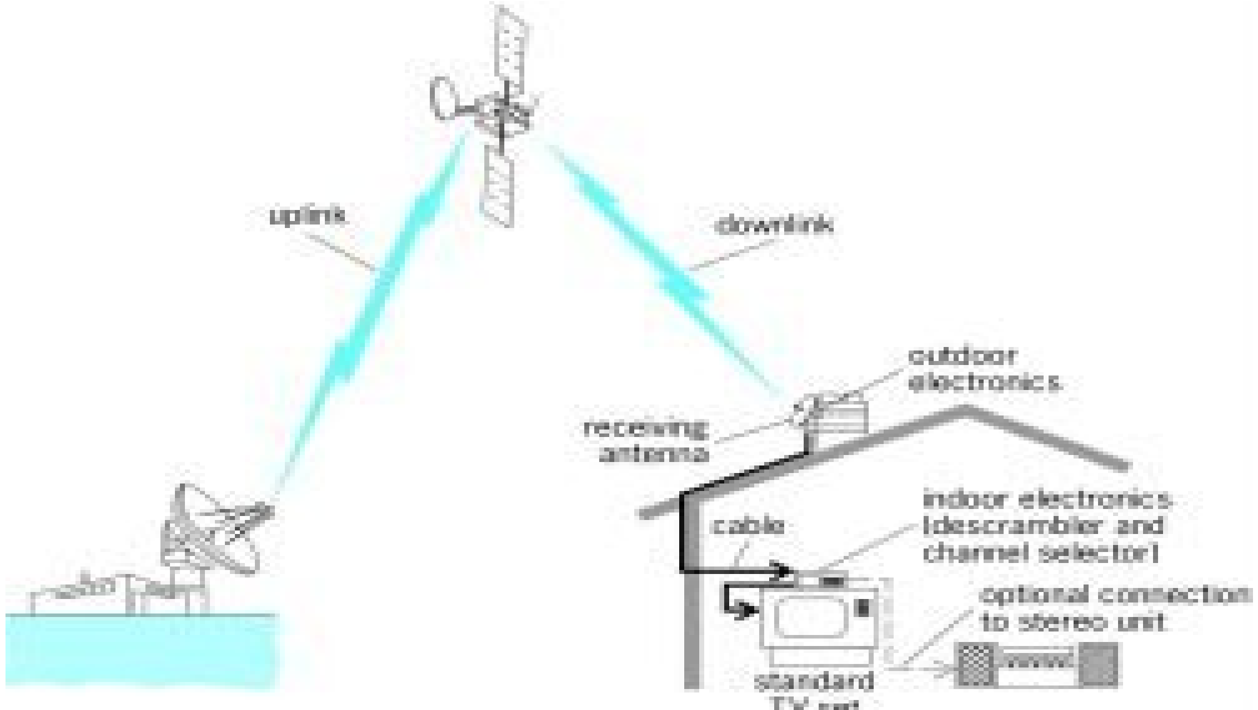
This consists of a receiving antenna feeding directly into a low-noise amplifier/converter combination. A parabolic reflector is generally used, with the receiving horn mounted at the focus. A common design is to have the focus directly in front of the reflector, but for better interference rejection, an offset feed may be used as shown.

The receiving horn feeds into a *low-noise converter* (LNC) or possibly a combination unit consisting of a *low-noise amplifier* (LNA) followed by a converter. The combination is referred to as an LNB, for *low-noise block*. The LNB provides gain for the broadband 12-GHz signal and then converts the signal to a lower frequency range so that a low-cost coaxial cable can be used as feeder to the indoor unit. The standard frequency range of this downconverted signal is 950 to 1450 MHz, as shown

The indoor unit for analog (FM) TV

The signal fed to the indoor unit is normally a wideband signal covering the range 950 to 1450 MHz. This is amplified and passed to a tracking filter which selects the desired channel, as shown in Fig. 8.1.

The selected channel is again downconverted, this time from the 950- to 1450-MHz range to a fixed intermediate frequency, usually 70 MHz although other values in the *very high frequency* (VHF) range are also used. The 70-MHz amplifier amplifies the signal up to the levels required for demodulation. A major difference between DBS TV and conventional TV is that with DBS, frequency modulation is used, whereas with conventional TV, amplitude modulation in the form of *vestigial single sideband* (VSSB) is used. The 70-MHz, FM *intermediate frequency* (IF) carrier therefore must be demodulated, and the baseband information used to generate a VSSB signal which is fed into one of the VHF/UHF channels of a standard TV set.



1. VSAT (Very Small Aperture Terminal)

A **VSAT** is a small, two-way satellite communication system used for **data, voice, and video** communication.

Key Features

- **Two-way communication** (uplink and downlink)
- Antenna size: **0.75 m to 2.4 m**
- Uses **Ku-band** and **Ka-band** mainly
- Connects users to a central **hub station**
- Supports **point-to-point**, **point-to-multipoint**, and **mesh networks**

Applications

- Banking & ATMs (secure data)
- Telemetry & SCADA (oil, gas, utilities)
- Remote office connectivity
- Defense networks

- Disaster management communication
- Enterprise private networks

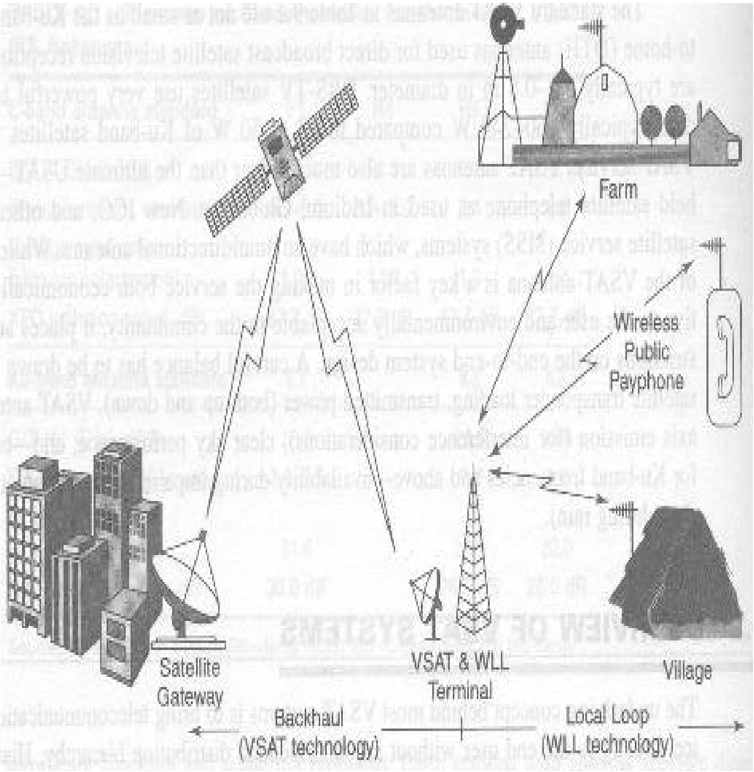
Advantages

- Works in remote areas with no terrestrial network
- Reliable and secure
- Easy to deploy
- Supports broadband data

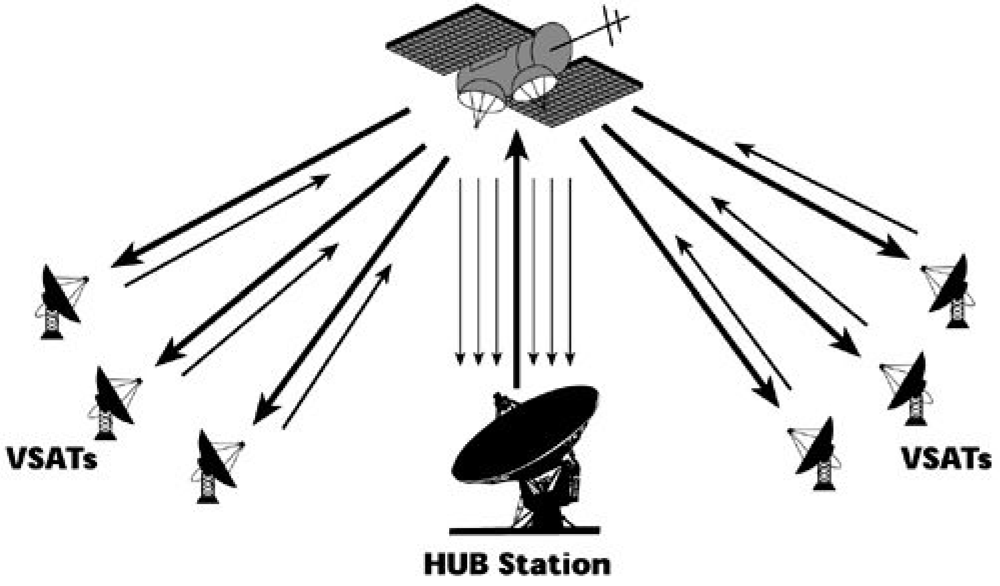
VSATs

- VSAT stands for *very small aperture terminal* system.
- This is the distinguishing feature of a VSAT system, the earth-station antennas being typically less than 2.4 m in diameter.

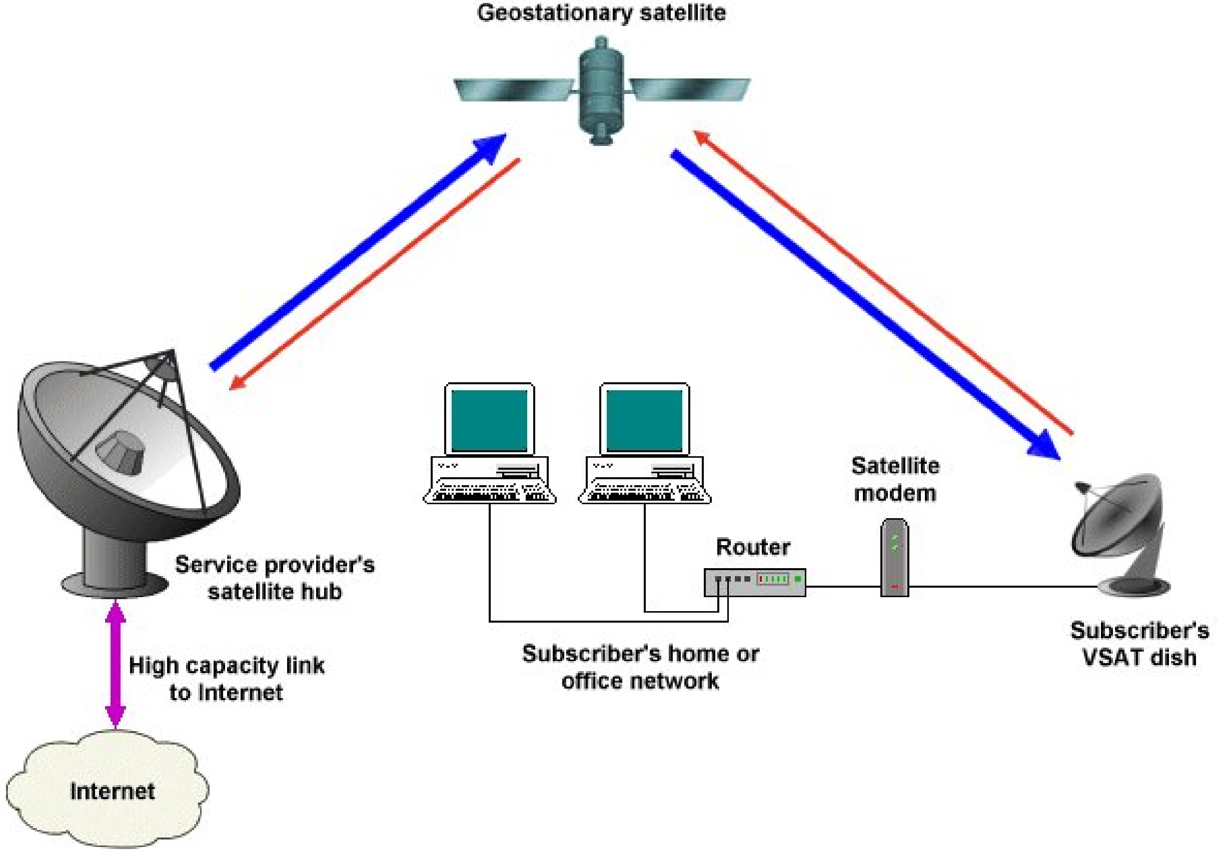
- VSATs are reserved for private networks, mostly providing two-way communications facilities.
- Typical user groups include banking and financial institutions, airline and hotel booking agencies, and large retail stores with geographically dispersed outlets.



<u>Specifications of VSAT systems:</u>
They operate in Ku band.
Earth station diameters range from 1-2 m.
Transmitter power: 1-2 W.
Data rate: Few thousand bps to 256 kbps.



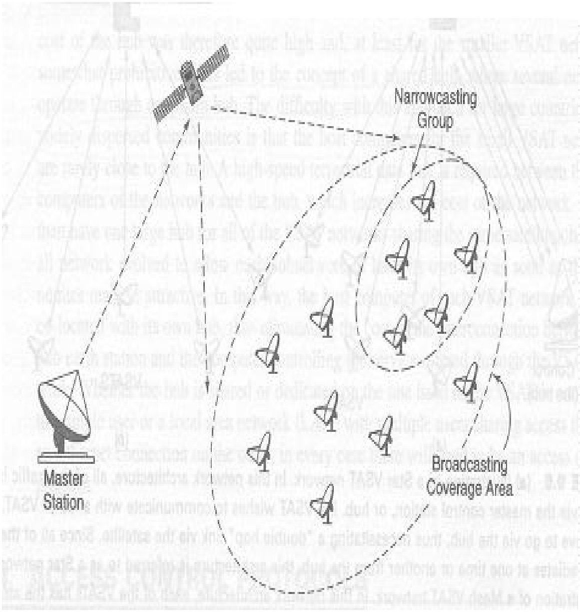
VSATs
VSATs
HUB Station

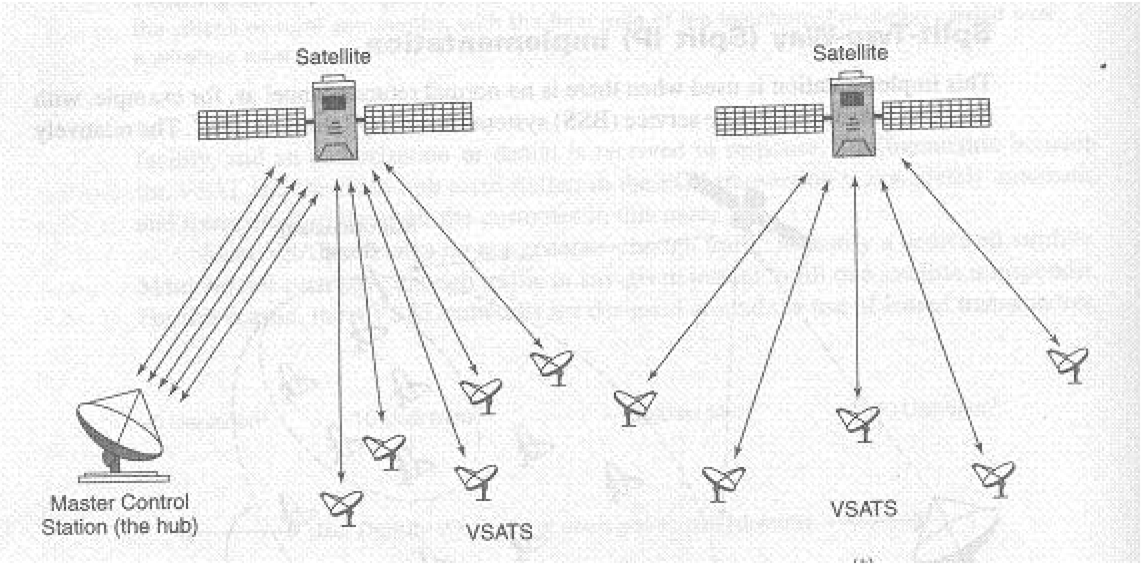


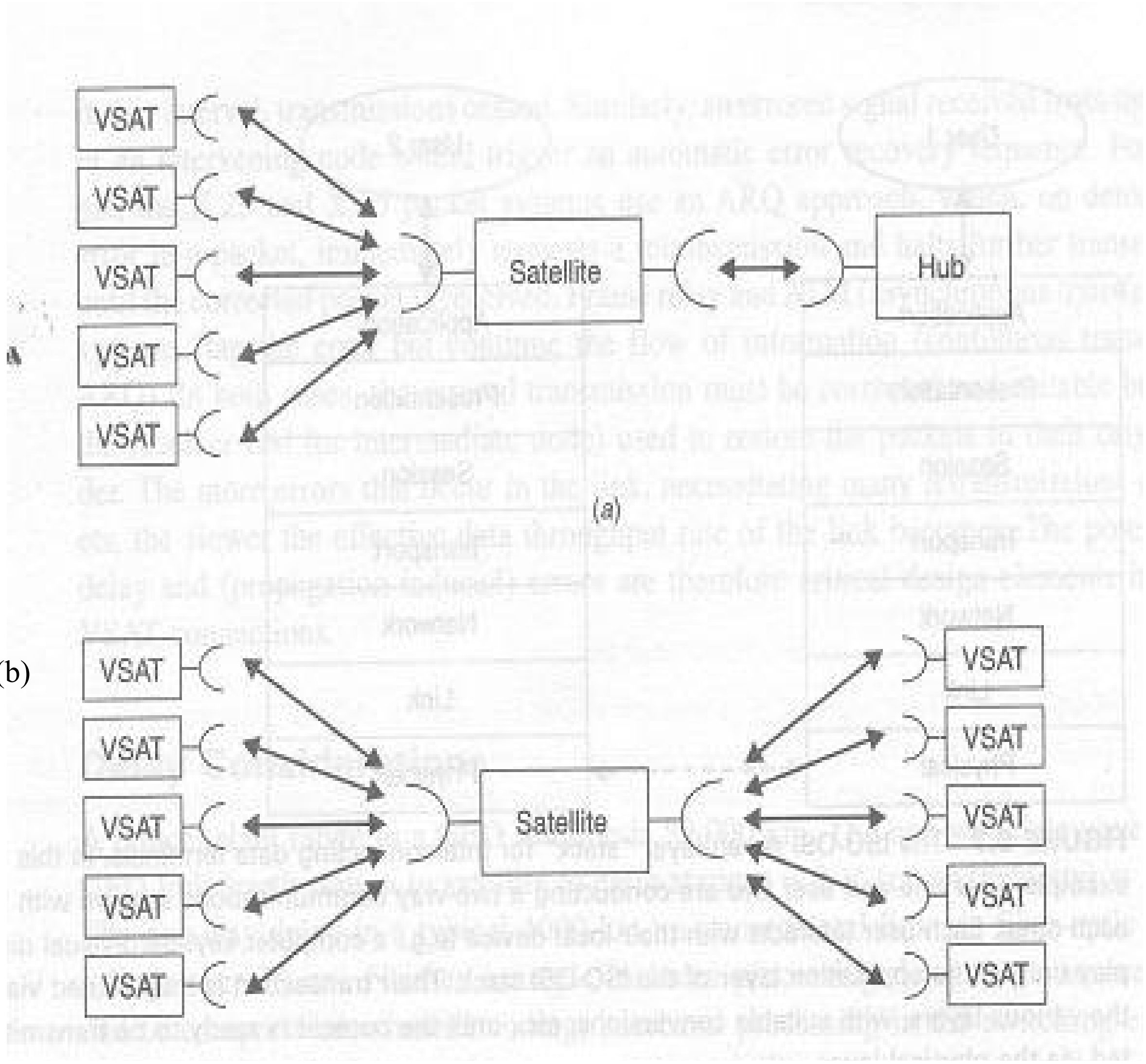
Geostationary satellite
Satellite modem
Router
Service provider's satellite hub
High capacity link to Internet
Internet
Subscriber's home or office network
Subscriber's VSAT dish

- The basic structure of a VSAT network consists of a hub station which provides a broadcast facility to all the VSATs in the network and the VSATs themselves which access the satellite in some form of multipleaccess mode.
- The hub station is operated by the service provider, and it may be shared among a number of users, but of course, each user organization has exclusive access to its own VSAT network.
- Time division multiplex is the normal downlink mode of transmission from hub to the
- VSATs, and the transmission can be broadcast for reception by all the VSATs in a network, or address coding can be used to direct messages to selected VSATs.

- Access the other way, from the VSATs to the hub, is more complicated, and a number of different methods are in use







(b)

fig a : Star topology
fig.b: Mesh topology.

- The most popular access method is FDMA, which allows the use of comparatively low-power VSAT terminals
- TDMA also can be used but is not efficient for low-density uplink traffic from the VSAT

- The traffic in a VSAT network is mostly data transfer of a bursty nature,examples being inventory control, credit verification, and reservation requests occurring at random and possibly infrequent intervals, so allocation of time slots in the normal TDMA mode can lead to low channel occupancy.
- A form of demand assigned multiple access (DAMA) is employed in some systems in which channel capacity is assigned in response to the fluctuating demands of the VSATs in the network. DAMA can be used with FDMA as well as TDMA, but the disadvantage of the method is that a reserve channel must be instituted through which the VSATs can make requests for channel allocation.
- Abramson (1990), presents a method of code-division multiple access (CDMA) using spread spectrum techniques, coupled with the Aloha protocol.
- The basic Aloha method is a random-access method in which packets are transmitted at random in defined time slots.
- The system is used where the packet time is small compared with the slot time, and provision is made for dealing with packet collisions which can occur with packets sent up from different VSATs
- This method provides the highest throughput for small earth stations.

Applications of VSAT systems

- *Telecommunication service to the end user*

An application of a VSAT in a remote area is the VSAT-WLL concept.Wireless Local Loop (WLL)/ fixed Wireless: *Fixed wireless* refers to wireless devices or systems that are situated in fixed locations, such as an office or home, as opposed to devices that are mobile, such as cell phones. Fixed wireless devices normally derive their electrical power from utility mains, as opposed to portable wireless devices that normally derive their power from batteries.

The advantages of fixed wireless include the ability to connect with users in remote areas without the need for laying new cables and the capacity for broad bandwidth that is not impeded by fiber or cable capacities.

- *Multimedia Applications*

A VSAT network allows multimedia traffic to be brought directly to the end user. E.g. Video-conferencing.

- *Point of sale*

An example for a Point of sale VSAT system that is used to transmit credit card information, the information about the sale & customer credit facility can be done using VSAT terminal.

- Other applications of VSAT systems include Internet access, file distribution, database access, environmental monitoring, police, customs and excise offices.

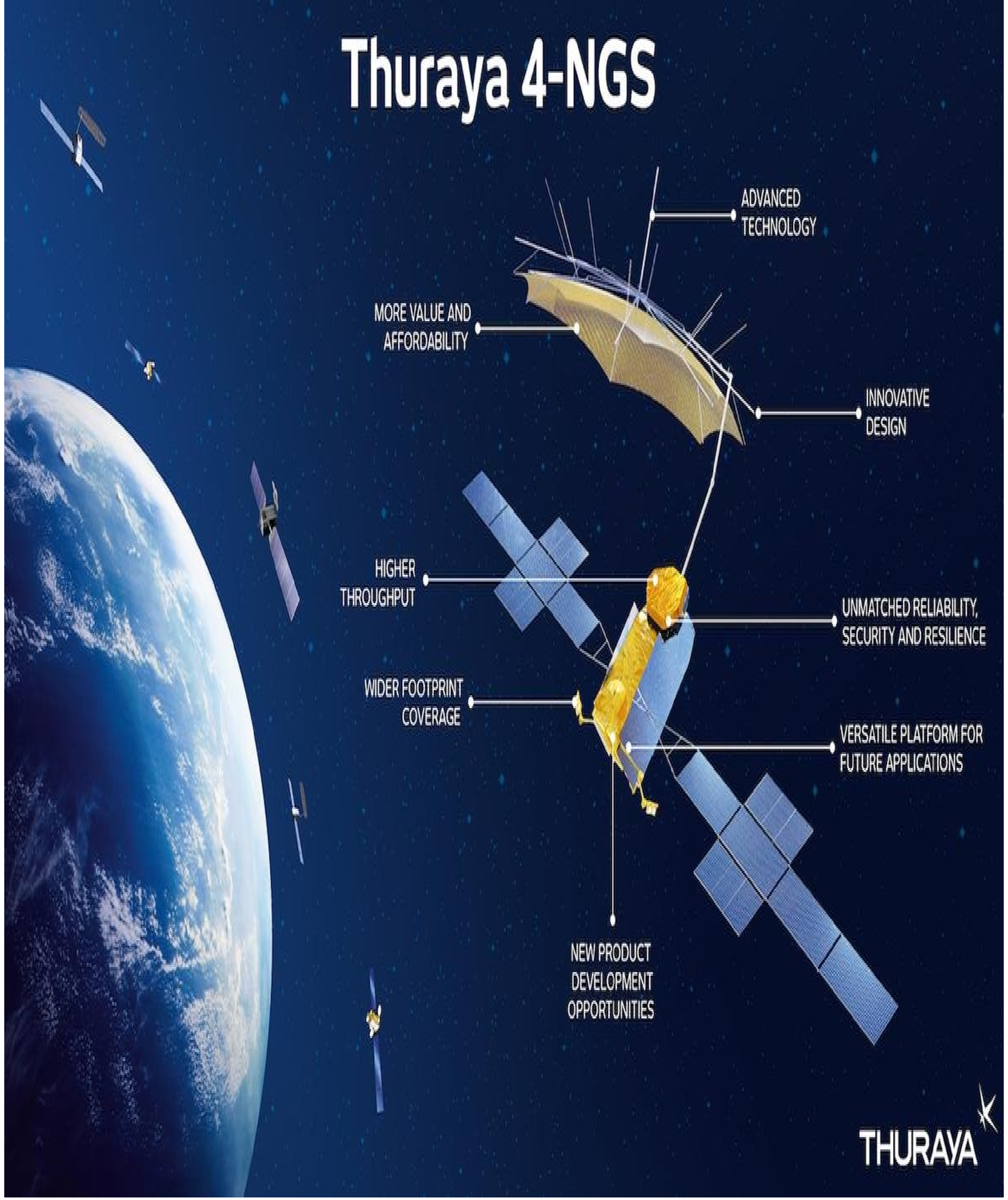
ACeS Network

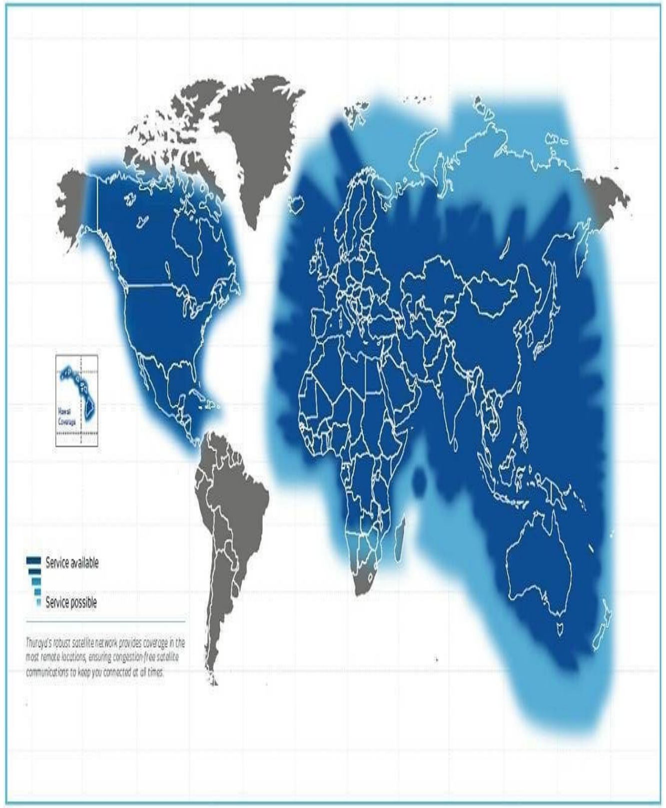
Asian Cellular System

- The Asian Cellular System, or AceS, utilizes one Garuda geosynchronous satellite covering the Asia Pacific area, an area of over 11 million square miles.
- The footprint ranges from China in the north to Indonesia in the south, and the Philippines and Papua New Guinea in the east to India and Pakistan in the west.
- The satellite is positioned at 123°E longitude with a variation of plus or minus 3°N and S.

- The population of the regions serviced totals over 3.5 billion
- The Garuda satellite has capacity for at least 11,000 simultaneous telephone channels, servicing up to 2 million subscribers.
- The satellites utilize two 12 meter, L-band antennas (large umbrella like structures) that generate 140 spot beams.

- On-board digital switching is provided which routes calls between beams.
- Subscribers are provided with a dual-mode phone that can be switched between satellite and the GSM modes of operation.
- Services include voice telephony, Internet connectivity, data,and alerting and paging.
- The mobile links operate at frequencies in the L-band (uplink 1625.5–1660.5 MHz; downlink 1525–1559 MHz), and the gateway frequencies are in the C-band (uplink 6.425–6.725 GHz; downlink 3.400–3.700 GHz).
- The gateway terminals provide access to the national telephone networks.
- A second satellite will be employed to expand the service into western and central Asia, Europe, and northern Africa.


Thuraya 4-NGS
ADVANCED TECHNOLOGY
MORE VALUE AND AFFORDABILITY
INNOVATIVE DESIGN
HIGHER THROUGHPUT
UNMATCHED RELIABILITY, SECURITY AND RESILIENCE
WIDER FOOTPRINT COVERAGE
VERSATILE PLATFORM FOR FUTURE APPLICATIONS
NEW PRODUCT DEVELOPMENT OPPORTUNITIES
THURAYA

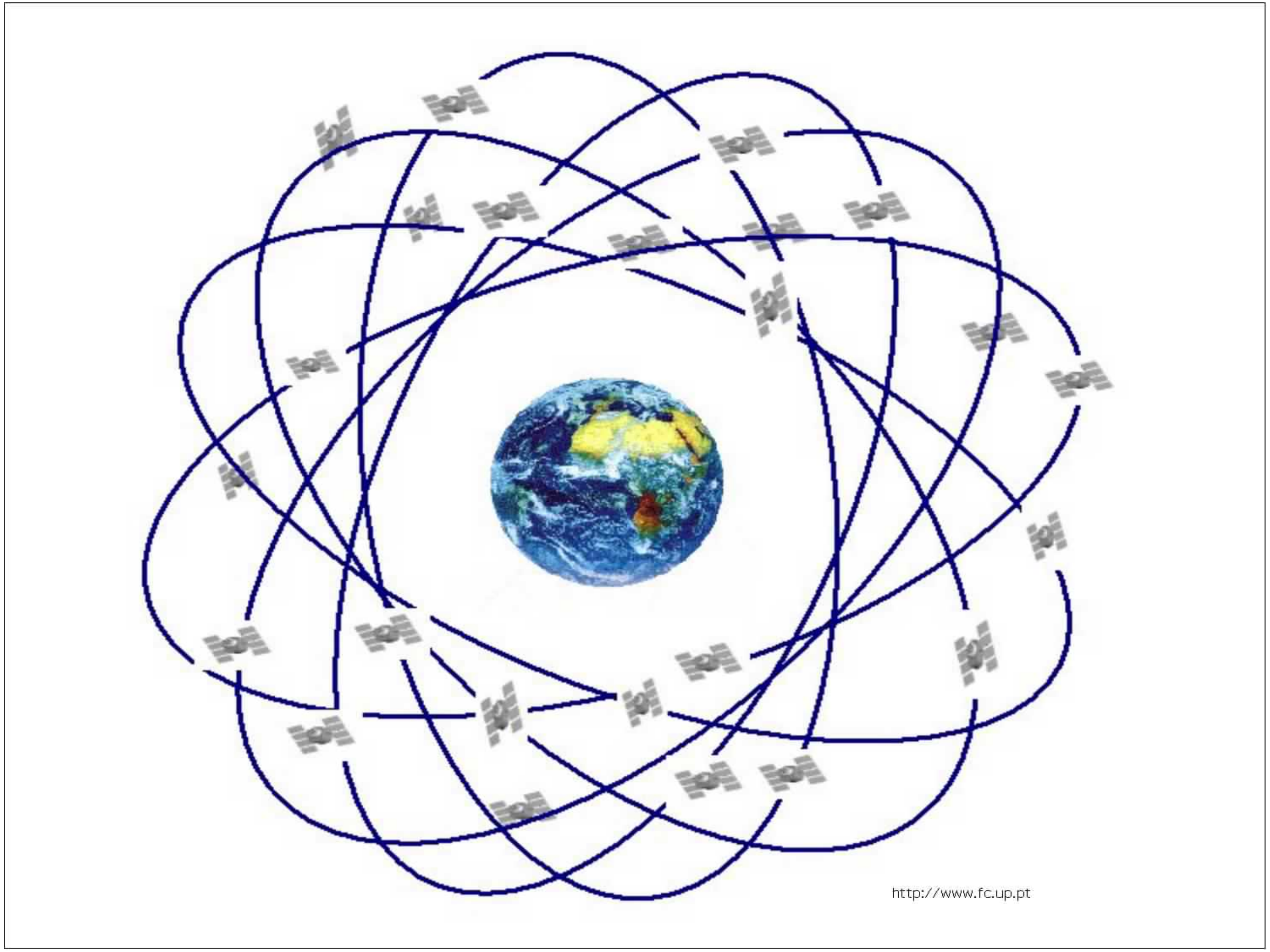

Hawaii Coverage
Service available
Service possible
Thuraya's robust satellite network provides coverage in the most remote locations, ensuring congestion-free satellite communications to keep you connected at all times.

Thuraya

- The Thuraya satellite system has geosynchronous satellites located at 44° and 28.5°E longitude, at an inclination of 6.3°

- The first Thuraya satellite was launched on October 21, 2000,and the second on June 10, 2003. A third satellite is being built to increasethe system capacity.
- The Thuraya satellite system serves an area between about 20°W to 100°E longitude and 60°N to 2°S latitude, covering more than 110 countries with a combined population of 2.3 billion. The footprint spans Europe, North, Central Africa, and large parts of Southern Africa.
- A 16 m elliptical antenna is employed providing 250 to 300 spot beams, with onboard beam-switching.
- An uplink beacon signal provides beam adjustment to compensate for the non geostationary path of the satellites.
- The network capacity is about 13,750 telephone channels.
- Quaternary phase-shift keying modulation is used, with *frequency-division multiple access* (FDMA)/*time-division multiple access* (TDMA).
- Dual-mode handsets are used that can be switched between GSM mode and satellite mode. Service features include voice telephony, fax, data, short messaging, location determination, emergency services, and high-power alerting.
- The mobile links operate at frequencies in the L-band (uplink 1625.5–1660.5 MHz; downlink 1525–1559 MHz), and the gateway frequencies are in the C band (uplink 6.425–6.725 GHz; downlink 3.400–3.700 GHz).

Global Positioning System (GPS)

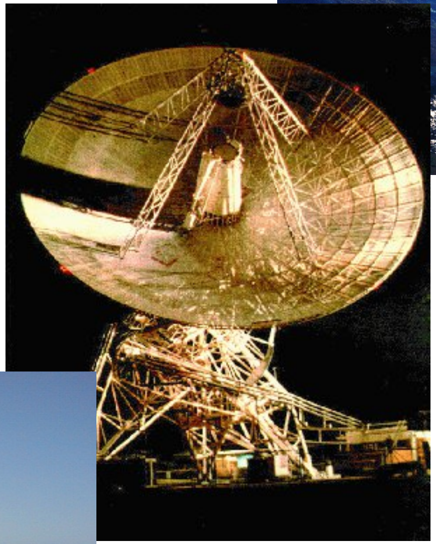


Introduction--cont.

- GPS provides specially coded satellite signals that can be processed with a GPS receiver, enabling the receiver to compute position, velocity and time.
- A minimum of four GPS satellite signals are required to compute positions in three dimensions and the time offset in the receiver clock.
- Accuracy and precision of data increases with more satellites.

Three Parts

- Space segment
- Control segment
- User segment



Space Segment

Space Segment--Information

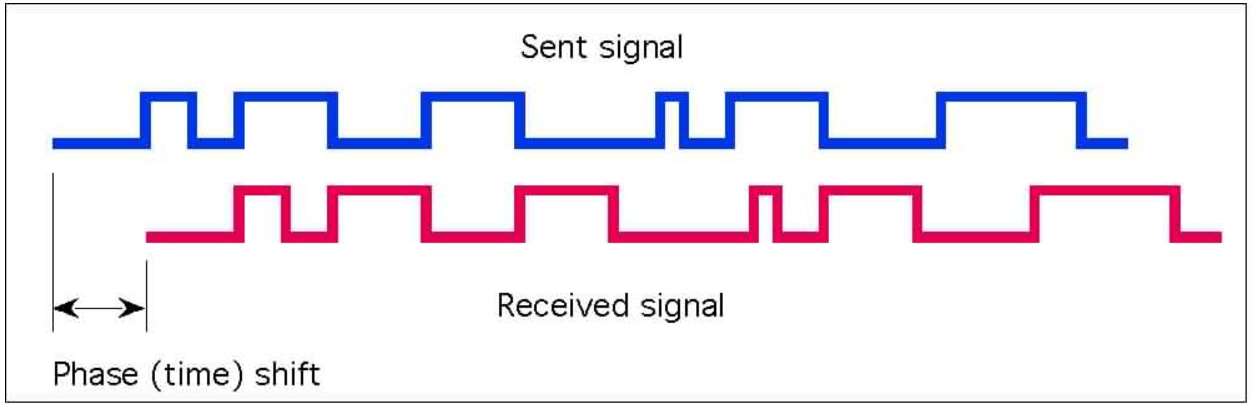
- The GPS uses a constellation of 24 satellites that orbit the earth at about 11,000 nautical miles, once every 12 hours.
- The orbital position is constantly monitored and updated by the ground stations.
- Each satellite is identified by number and broadcasts a unique signal.
- The signal travels at the speed of light.
- Each satellite has a very accurate clock, 0.000000003 seconds

Space Segment--Satellite Signals

- Because the GPS receiver calculates its location by trilateration, the task of the receiver is to determine its distance from multiple satellites.
- The GPS system uses two types of signals to calculate distance.
  - Code-phase ranging
  - Carrier-phase ranging

Space Segment--Satellite Signals--Code-Phasing Ranging

- Each satellite has a unique signal.
- It continuously broadcasts its signal and also sends out a time stamp every time it starts.
- The receiver has a copy of each satellite signal and determines the distance by recording the time between when the satellite says it starts its signal and when the signal reaches the receiver.



Space Segment--Satellite Signals--Code-Phasing Ranging – cont.

- Distance is calculated using the velocity equation.

$$\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$$

- Rearranging the equation for distance:

$$\text{Distance} = \text{Velocity x Time}$$

- If the system knows the velocity of a signal and the time it takes for the signal to travel from the sender to the receiver, the distance between the sender and the receiver can be determined.

Distance Example—Code Phase Ranging

- The signals from the GPS satellites travel at the speed of light--186,000 miles/second.
- How far apart are the sender and the receiver if the signal travel time was 0.23 seconds?

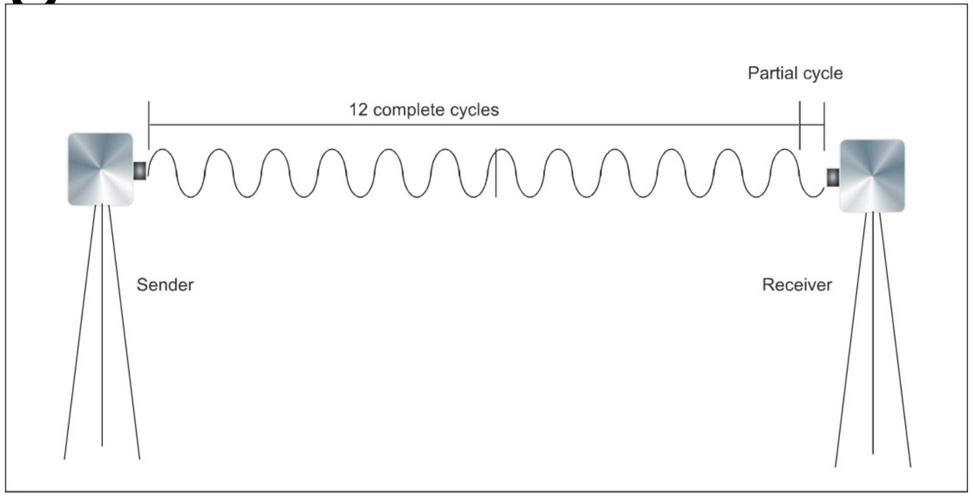
$$\text{Distance (ft)} = \text{Velocity (mi/sec)} \times \text{Time (sec)}$$

$$= 186{,}000 \ \frac{\text{mi}}{\text{sec}} \ \times 5208 \frac{\text{ft}}{\text{mi}} \ 0.23 \text{ sec} = 2{,}257{,}8400 \text{ ft}$$

- It should be clear that this system requires very accurate measurement of time and synchronization of clocks.
- These time errors limit the precision of this system.

Space Segment—Carrier-Phase Ranging

- Surveying quality receivers use the underlying carrier frequency.
- Easy to determine number of cycles.



- The proportion of a partial cycle is difficult to determine.
- This is called phase ambiguity.
- Phase ambiguity error is resolved by comparing multiple signals from multiple receivers.
- More precise system.

Receiver Segment

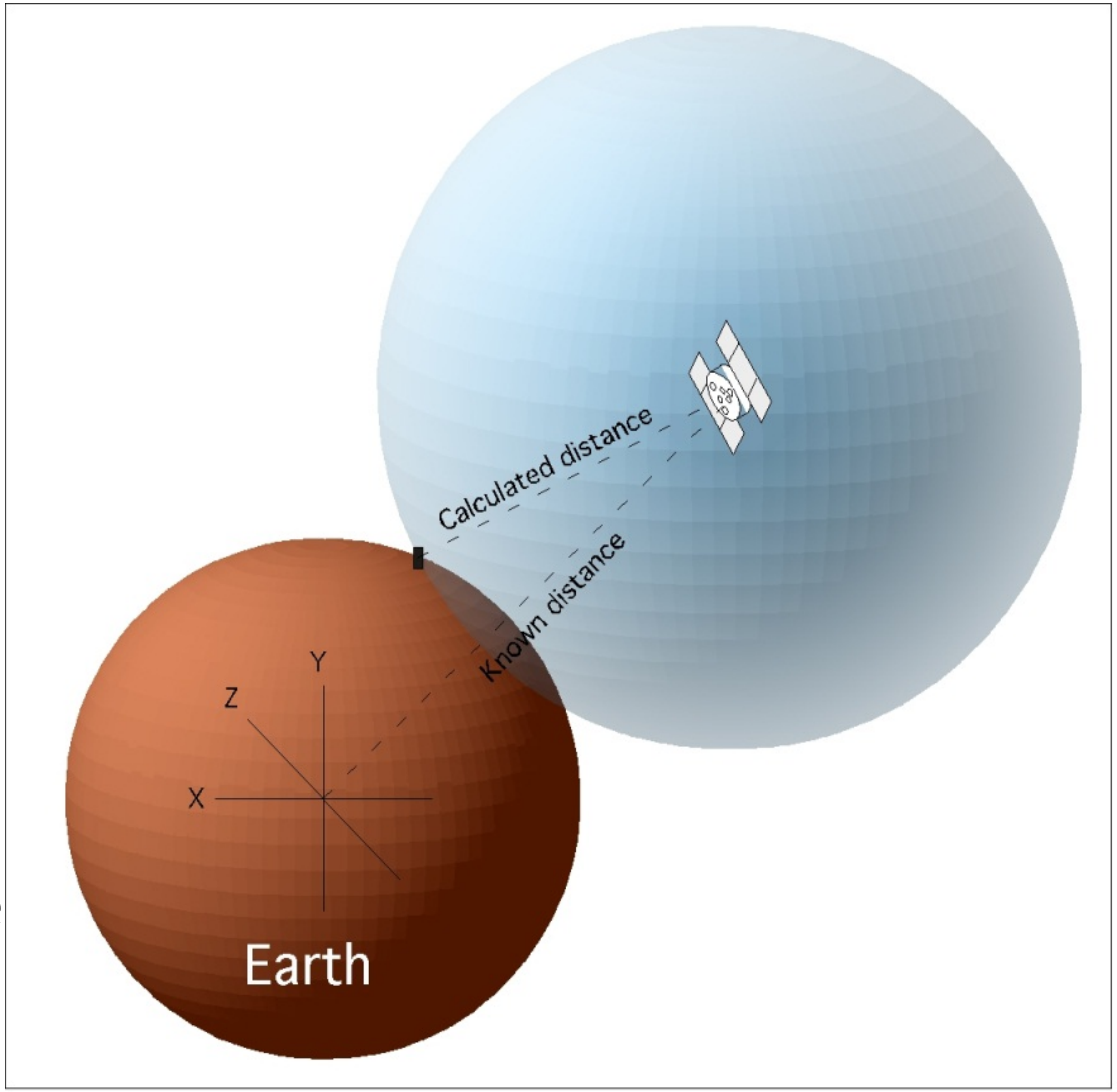
Receiver

- The receiver collects, decodes and processes the satellite signals.
- The basic receiver does not include a transmitter.
- Different levels of precision are available.
- The receiver determines its location by trilateration.

GPS Trilateration

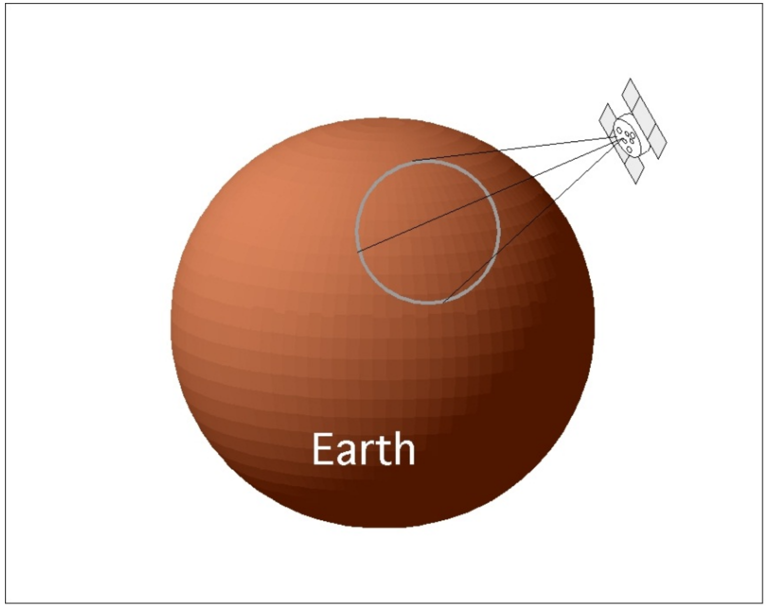
- Each satellite knows its position and its distance from the center of the earth.
- Each satellite constantly broadcasts this information.
- With this information and the calculated distance, the receiver calculates its position.
- Just knowing the distance to one satellite doesn't provide enough information.

Trilateration is a **position-finding method** where the location of a point is determined using the **known locations of three reference points and the distances to each of them**.



GPS Trilateration--cont.

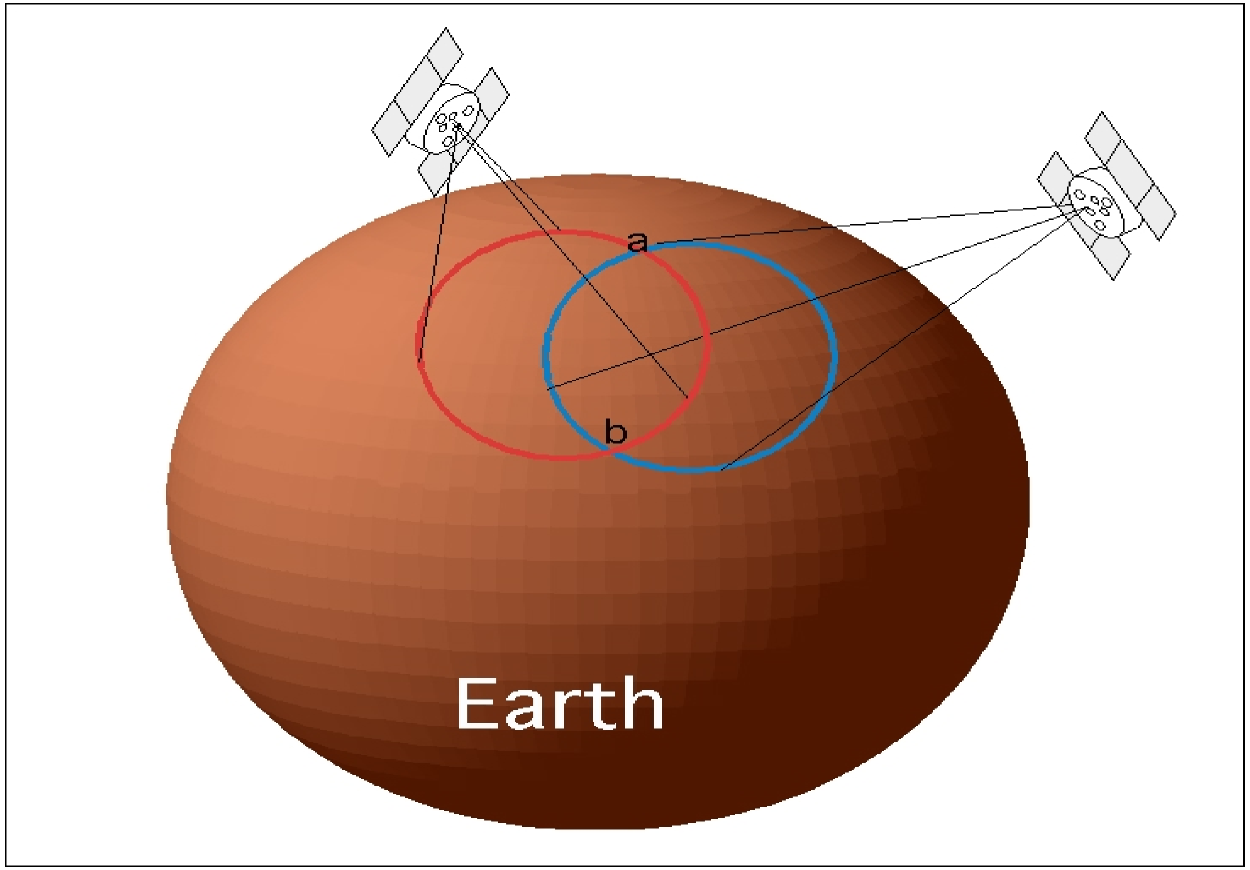
- When the receiver knows its distance from only one satellite, its location could be anywhere on the earths surface that is an equal distance from the satellite.
- Represented by the circle in the illustration.
- The receiver must have additional information.

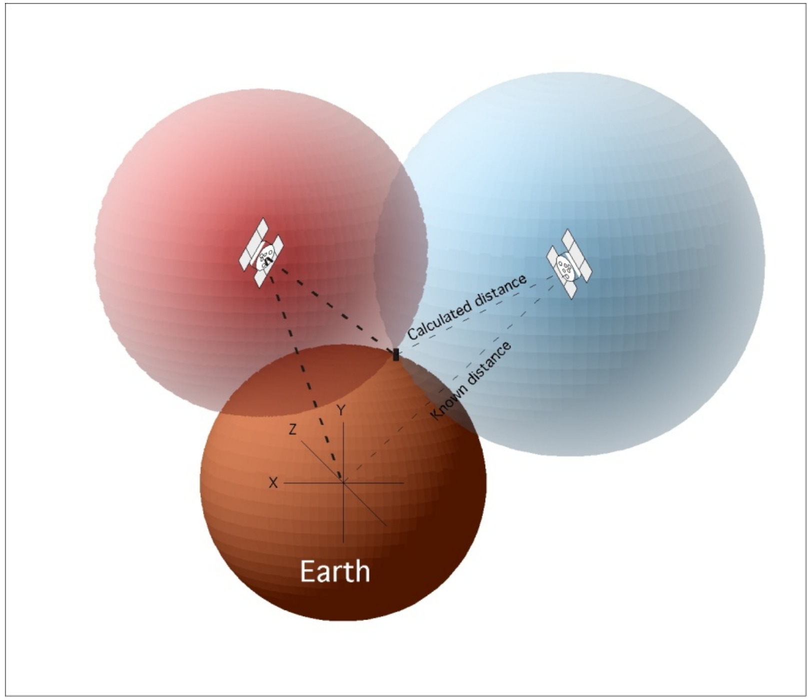


GPS Trilateration--cont.

With signals from two satellites, the receiver can narrow down its location to just two points on the earths surface.

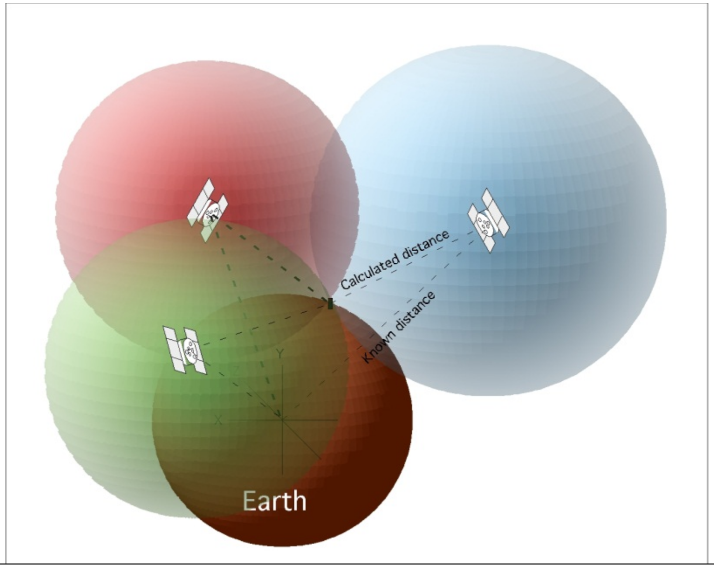
Were the two circles intersect.

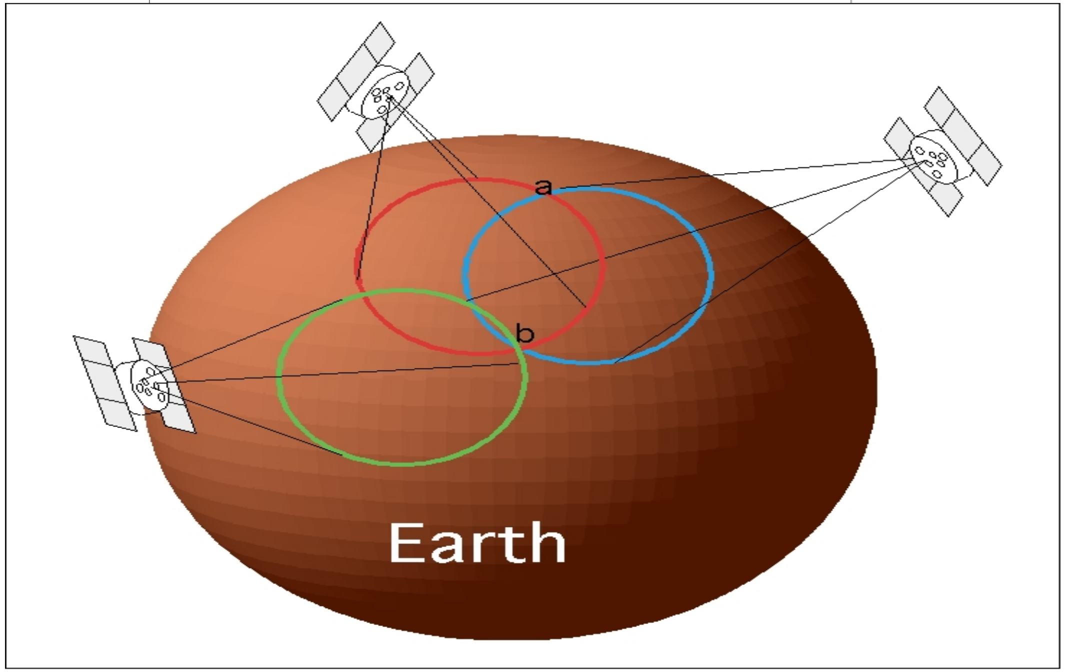




GPS Trilateration--cont.

- Knowing its distance from three satellites, the receiver can determine its location because there is only two possible combinations and one of them is out in space.
- In this example, the receiver is located at b.
- The more satellite that are used, the greater the potential accuracy of the position location.





Global Positioning Satellite System (GPS)

In the GPS system, a constellation of 24 satellites circles the earth in near-circular inclined orbits. By receiving signals from at least four of these satellites, the receiver position (latitude, longitude, and altitude) can be determined

- The GPS system uses one-way transmissions, from satellites to users, so that the user does not require a transmitter, only a GPS receiver.
- The only quantity the receiver has to be able to measure is time, from which
- propagation delay, and hence the range to each satellite, can be determined.
- Knowing the range to three of the satellites and their positions, it is possible to compute the position of the observer (user).
- The geocentric-equatorial coordinate system is used with the GPS system, where it is called the earth-centered, earth-fixed (ECEF)coordinate system. Denoting the coordinates for satellite n by (xn, yn, zn) and those for the observer by (x0, y0, z0) the range from observer to satellite

$$\rho_{0n}^2 = (x_n - x_0)^2 + (y_n - y_0)^2 + (z_n - z_0)^2$$

The range measurements made to three reference points clustered together will yield nearly equal values.

Position calculations involve range differences, and where the ranges are nearly equal, any error is greatly magnified in the difference.

This effect, brought about as a result of the satellite geometry, is known as dilution of precision (DOP).

This means that range errors occurring from other causes, such as timing errors, are magnified by the geometric effect.

With the GPS system, dilution of position is taken into account through a factor known as the position dilution of precision(PDOP) factor. This is the factor by which the range errors are multiplied to get the position error.

As it is there will be some unknown difference in the start times. Let t_n be the true propagation time from satellite n to the observer, and let t_{dn} be the delay time as measured by the correlator. Let Δt be the unknown difference between the clock start times then $t_n = t_{\mathrm{dn}} - \Delta t$ (Δt can be + or –). The satellite clocks are synchronized to the master atomic clock, so Δt will be the same for all satellites. The range to the satellite n is therefore

$$\rho_{On} = ct_n = c(t_{\mathrm{dn}} - \Delta t) \qquad (17.2)$$

where c is the speed of light. Substituting this in Eq. (17.1) gives:

$$O = (x_n - x_0)^2 + (y_n - y_0)^2 + (z_n - z_0)^2 - c^2(t_{dn} - \Delta t)^2 \quad (17.3)$$

The unknowns here are the location (x_0, y_0, z_0) and the timing difference Δt. For satellite n the position (x_n, y_n, z_n) is known and delay time t_{dn} is measured by the receiver. Since there are four unknowns, the receiver must be capable of measuring t_{dn} for four satellites simultaneously ($n = 1, 2, 3, 4$) to yield four simultaneous equations of the form (17.3). These can be solved to find the unknowns Δt and (x_0, y_0, z_0). The latter, of course, are the required position coordinates for the receiver, and these would be converted into local coordinates (latitude, longitude, and altitude). All this requires quite sophisticated microprocessing in the receiver. Also, the composition of the GPS signal is much more complex than indicated here, utilizing spread-spectrum techniques.

2. Calculating position using trilateration

This is a more complex problem that involves solving a system of equations to find the receiver's x, y, z coordinates and the receiver's time offset.

- **Principle:** GPS uses at least four satellites. The distance to each satellite (d_1, d_2, d_3, d_4) is used to create four spheres. The intersection of these spheres is the location of the receiver.
- **Formula:**
  - $(x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2 = (c(t_1 - t_0))^2$
  - $(x - x_2)^2 + (y - y_2)^2 + (z - z_2)^2 = (c(t_2 - t_0))^2$
  - $(x - x_3)^2 + (y - y_3)^2 + (z - z_3)^2 = (c(t_3 - t_0))^2$
  - $(x - x_4)^2 + (y - y_4)^2 + (z - z_4)^2 = (c(t_4 - t_0))^2$

- **Explanation:**
  - (x, y, z) are the unknown coordinates of the receiver.
  - (x_n, y_n, z_n) are the known coordinates of the nth satellite.
  - c is the speed of light.
  - t_n is the time the signal was sent from the nth satellite.
  - t_0 is the unknown time offset of the receiver's clock.
- **Note:** This system of four non-linear equations is solved simultaneously to find the four unknowns (x, y, z, and t_0).

A GPS receiver receives a signal 0.07 seconds after transmission.
Speed of light $c = 3 \times 10^8$ m/s.
Find the pseudorange.

Solution:

$$R = c \times t = (3 \times 10^8)(0.07) = 2.1 \times 10^7 \text{ m}$$

A GPS receiver calculates the following ranges:

Satellite	**True Range (**
S1	21,000
S2	20,900
S3	20,800
S4	21,200

But measured pseudoranges are **200 m larger** than expected.

Find the **receiver clock bias.**

olution:

$$\Delta t = \frac{200}{3 \times 10^8} = 6.67 \times 10^{-7}\ \text{sec}$$

Given PDOP = 2.5 and range error = 3 m.

Calculate position error.

$$\text{Position Error} = PDOP \times \sigma = 2.5 \times 3 = 7.5\ \text{m}$$

1. Satellite Internet

Satellite Internet provides broadband connectivity using communication satellites instead of terrestrial networks. It is especially useful in remote or rural areas where fiber or mobile networks are unavailable.

Key Features

- Uses **geostationary (GEO)**, **medium-earth orbit (MEO)**, or **low-earth orbit (LEO)** satellites.
- Provides **global coverage**, including oceans, deserts, and mountains.
- Supports broadband services such as web browsing, VoIP, video streaming, etc.
- New LEO constellations (e.g., Starlink, OneWeb) offer **high speed** and **low latency**.

Advantages

- Widely available even in remote locations.
- Quick deployment—no need for ground infrastructure.
- Useful for disaster recovery when terrestrial networks fail.

🛰️ RADARSAT – Overview

RADARSAT is a **Canadian Earth-observation satellite series** that uses **Synthetic Aperture Radar (SAR)** to capture high-resolution images of the Earth **day or night**, in **all weather conditions** (rain, clouds, fog, snow).

It includes:

- **RADARSAT-1** → launched 1995
- **RADARSAT-2** → launched 2007
- **RADARSAT Constellation Mission (RCM)** → launched 2019 (RADARSAT-A, B, C)

Works through **cloud cover**

Works **at night** (active microwave system)

Monitors **large areas quickly**

Very useful for **disaster management**, **ice monitoring**, **agriculture** and **ocean studies**

RADARSAT-1

- Band: **C-band (5.3 GHz)**
- Modes: Standard, Fine, Wide, ScanSAR
- Resolution: **10–100 m**
- Swath width: **50–500 km**

RADARSAT-2

- C-band (5.4 GHz)
- Fully **polarimetric** (HH, HV, VV, VH)
- Resolution: **3 m** (spotlight mode)
- Applications: agriculture, disaster mapping, ice mapping

RADARSAT Constellation Mission (RCM)

- Three satellites working together
- Daily coverage
- Higher revisit time
- Better maritime tracking and ecosystem monitoring

🌍 Applications of RADARSAT

1. Agriculture

- Crop monitoring
- Soil moisture
- Yield estimation

2. Disaster Management

- Flood mapping
- Landslides
- Earthquake damage
- Forest fires

3. Ocean and Coastal Monitoring

- Oil spill detection
- Ship detection
- Wave height and wind mapping

4. Ice Monitoring (major use in Canada)

- Sea-ice type
- Ice movement
- Safe navigation for ships

5. Environmental and Land Use

- Deforestation
- Urban growth
- Wetland monitoring

🛰 Advantages of RADARSAT

- Operates in all weather
- Operates day/night
- High resolution
- Large area coverage
- Multi-polarization (RADARSAT-2)
- Frequent revisit (RCM)

Mangalyaan

- The Mars Orbiter Mission (MOM), informally called *Mangalyaan* (Sanskrit for "Mars-Craft"), is a Mars orbiter launched into Earth orbit on 5 November 2013 by the Indian Space Research Organisation (ISRO).
- Spacecraft Successfully enters Martian Orbit on 24-09-2014

Objectives of the mission:

- **Technological Objectives:**

1. Design and realisation of a Mars orbiter with a capability to survive and perform Earth bound manoeuvres, cruise phase of 300 days, Mars orbit insertion / capture, and on-orbit phase around Mars.
2. Deep space communication, navigation, mission planning and management.
3. Incorporate autonomous features to handle contingency situations.

- **B. Scientific Objectives:**

1. Exploration of Mars surface features, morphology, mineralogy and Martian atmosphere.

What Mangalyaan actually going to do???

1. To find methane.
2. To find the availability of water in MARS.
3. To find temperature and climatic condition in mars.
4. To find the chemical components present.

SHORT DESCRIPTION ABOUT MANGALAAN

Name meaning : Mars-Craft (from sanskrit mangala)

Duration:15 months.

Budget:450 crores.

Purpose: To analyse MARS.

Specification

❖MASS

The lift-off mass was 1,350 kg , including 852 kg of propellant mass.

❖DIMENSIONS

Cuboid in shape of approximately 1.5 m .

❖POWER

Electric power is generated by three solar array panels of 1.8 × 1.4 m each. Electricity is stored in a 36 Ah Li-ion battery.

Conti…

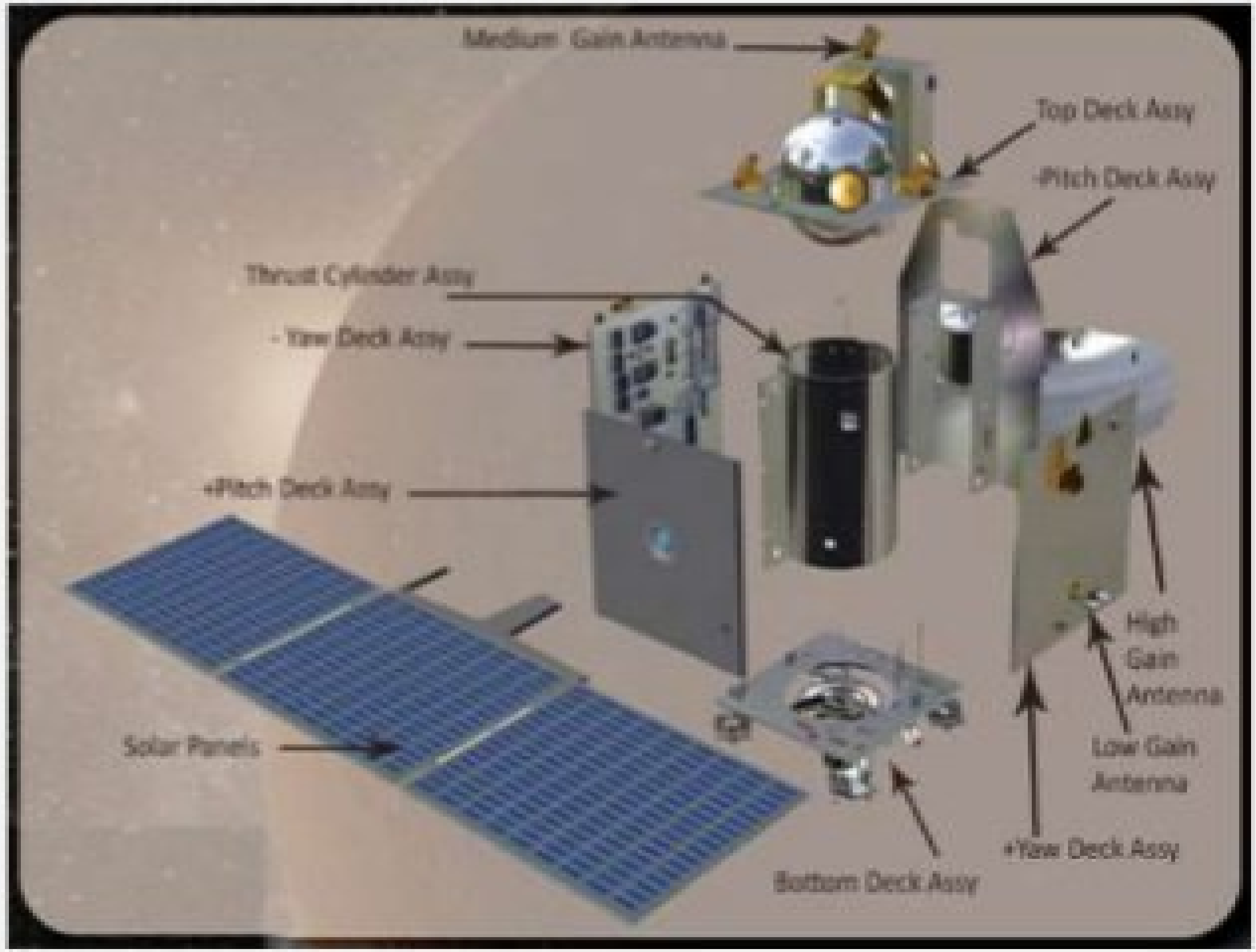
❖PROPULSION

Liquid fuel engine of 440 N thrust is used for orbit raising and insertion in Martian orbit, and 8 numbers of 22 N thrusters are used for attitude control .

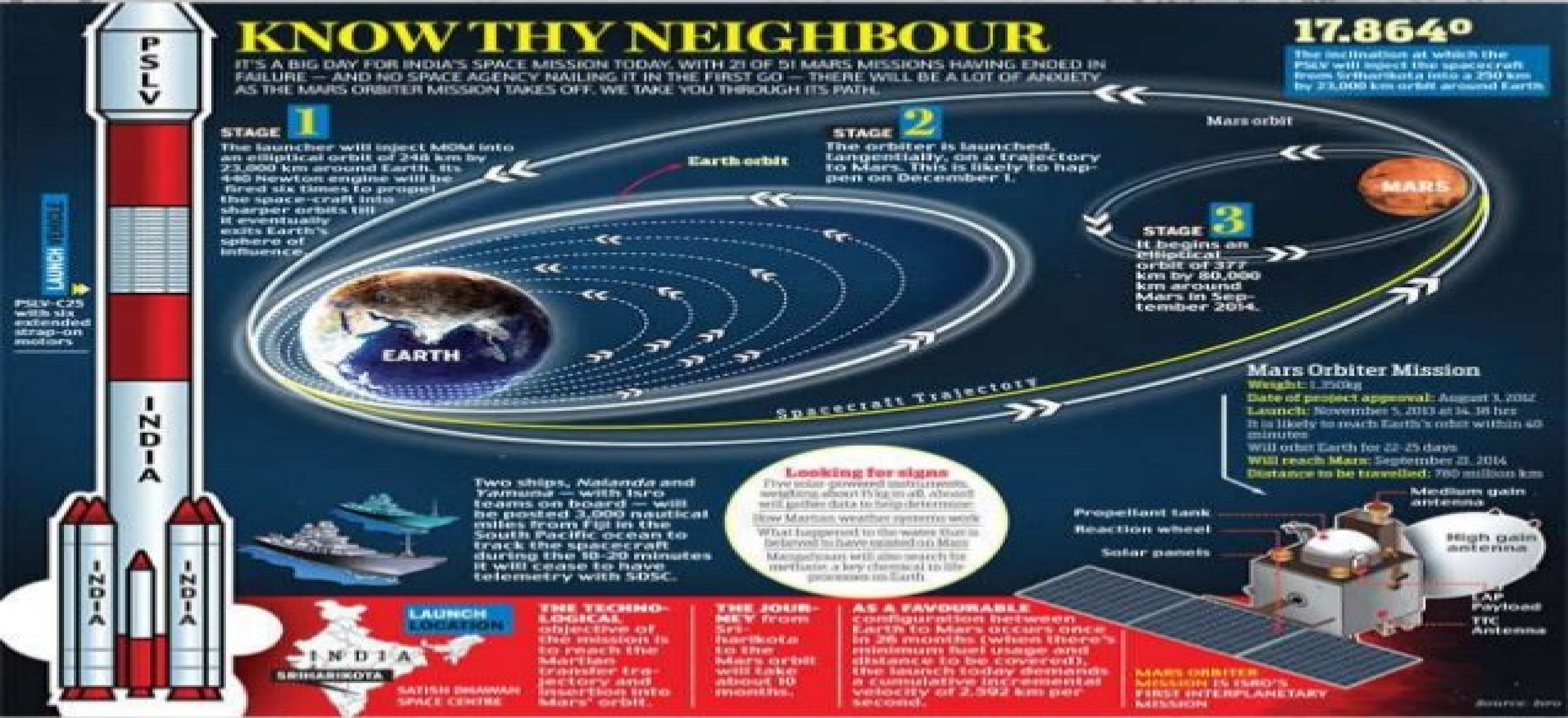
❖COMMUNICATIONS

Two 230 W TWTAs and two coherent transponders. The antenna array consists of a low-gain antenna, a medium-gain antenna and a high-gain antenna.

Image of Mangalyaan



Trajectory path



payload

Mars Orbiter Mission carries five scientific payload

1.Lyman Alpha Photometer (LAP)
2.Methane Sensor for Mars (MSM)
3. Mars Exospheric Neutral Composition Analyser .
4. Mars Color Camera (MCC)
5. Thermal Infrared Imaging Spectrometer (TIS)

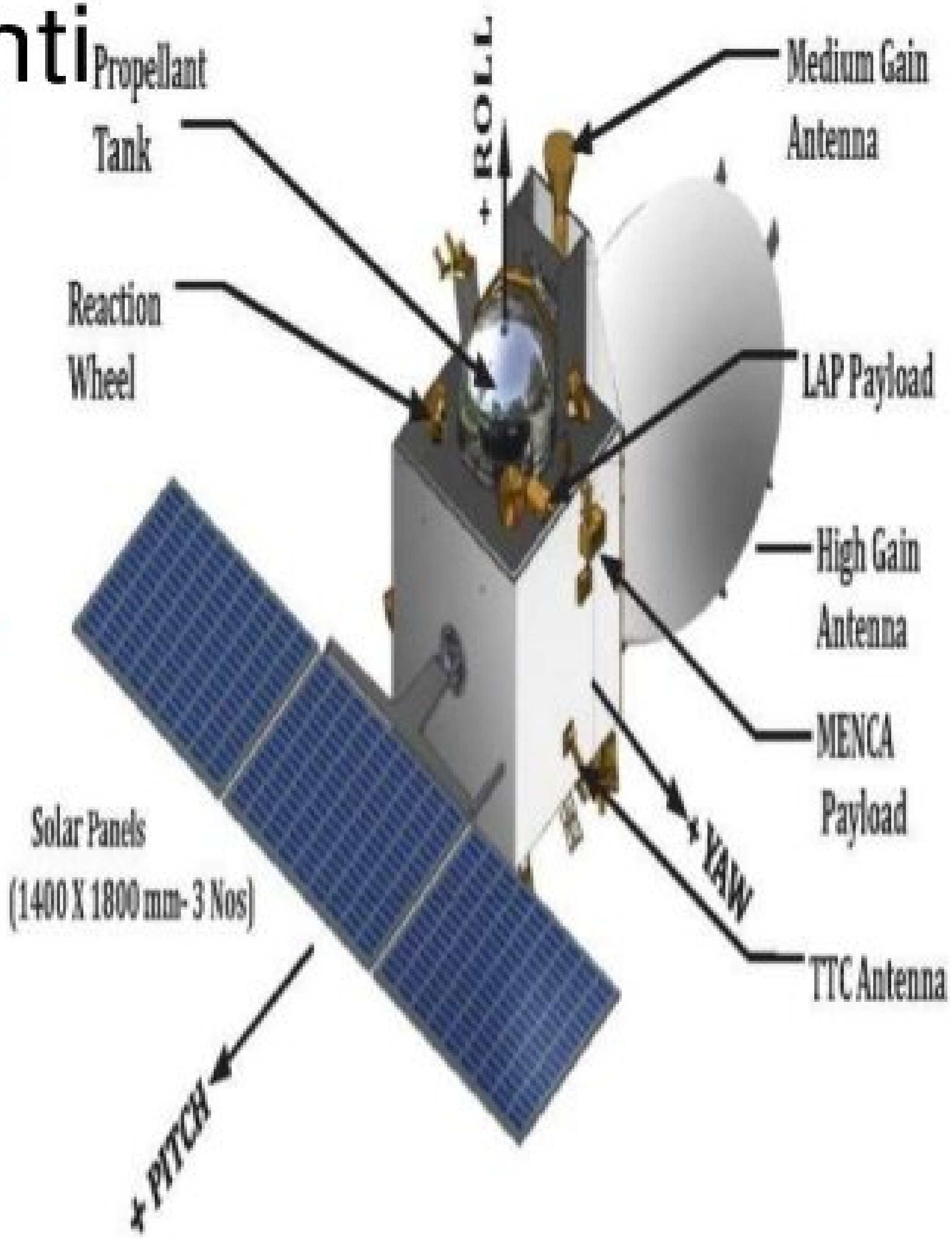
- MOM will search for methane, a key target for researchers hunting for signs of life on Mars.
- Living things produce more than 90 percent of the methane in Earth's atmosphere. And the gas is thought to disappear relatively quickly from Mars' air, meaning that any methane spotted there would have been produced recently.

Mangalyaan carries five scientific instruments

- ✓The **Mars Color Camera (MCC)** will provide high-quality images of the planet, as well as its moons, Phobos and Deimos.
- ✓The **Thermal Infrared Imaging Spectrometer (TIS)** will measure the temperature and emissivity of the planet's surface as it varies from day to night, making it possible to identify minerals and soil types.
- ✓The **Mars Exospheric Neutral Composition Analyzer (MENCA)** is a mass spectrometer, which can identify chemical compounds in the planet's outer atmosphere.

Conti

- ✓The **Lyman Alpha Photometer (LAP)** will measure the ratio of deuterium to hydrogen, which will help to explain how Mars has lost its water over time.
- ✓The **Methane Sensor for Mars (MSM)** is intended to help answer one of the biggest mysteries about the red planet.



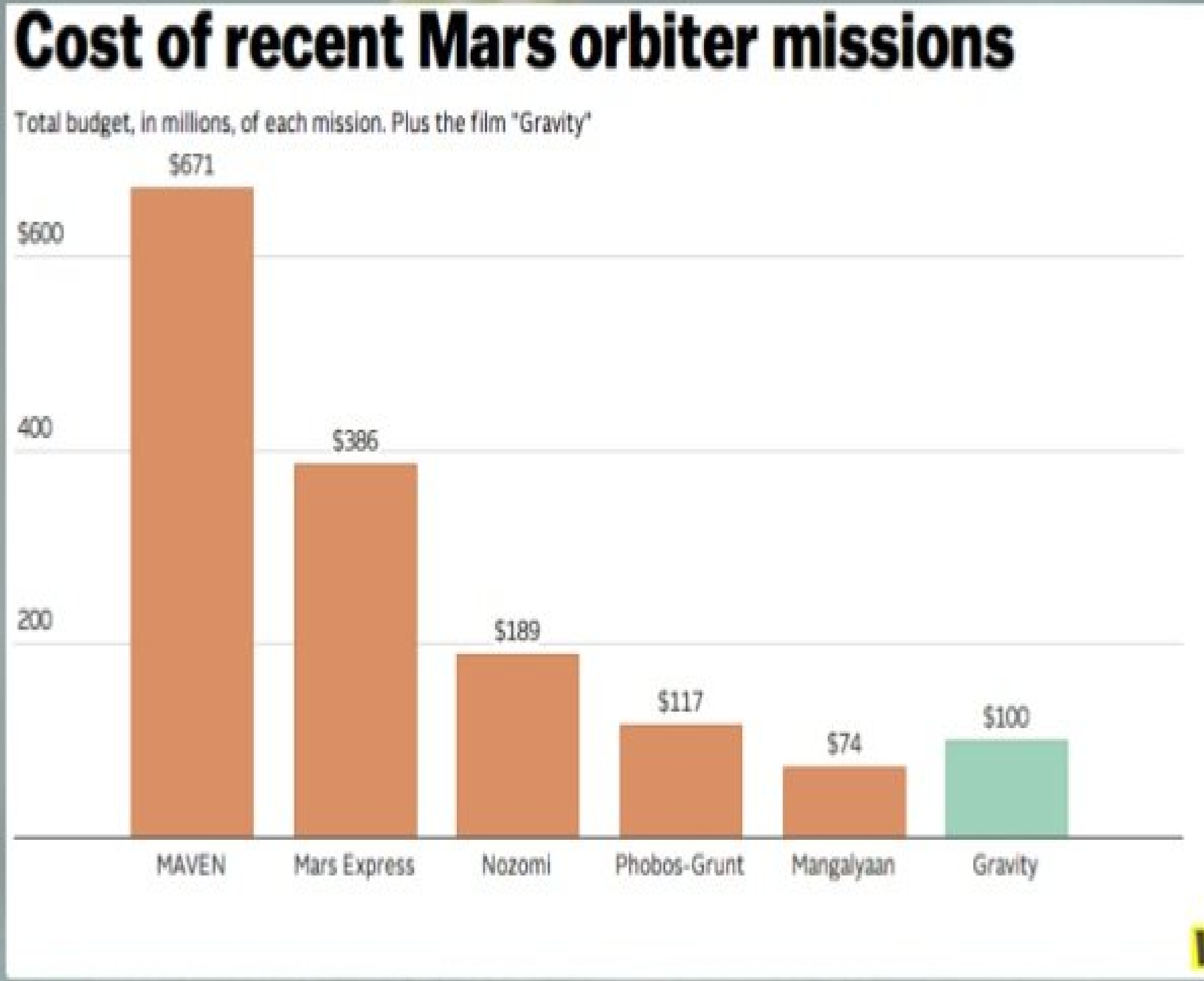
Launch Vehicle - PSLV-C25

- The Mars Orbiter Mission probe lifted-off from the First Launch Pad at Satish Dhawan Space Centre SHAR, Sriharikota, Andhra Pradesh, using a Polar Satellite Launch Vehicle (PSLV) rocket C25 at 09:08 UTC (14:38 IST) on 5 November 2013.

Budget for MOM

- The total cost of the project is 450 corers or 71 dollars.
- Its is one of very cheapest and worthy mission launched by ISRO.

Comparison of MOM with other mission's



Ground Segment


- ISRO Telemetry Tracking and Command Network (ISTRAC) will be providing support of the TTC ground stations, communications network between ground stations and control center, Control center including computers, storage, data network and control room facilities, and the support of Indian Space Science Data Center (ISSDC) for the mission.
- The ground segment systems form an integrated system supporting both launch phase, and orbital phase of the mission.

ISRO's Mars Orbiter Mission captures its first image of Mars. Taken from a height of 7300 km; with 376 m spatial resolution.

Conti..

- Mangalyaan is the first spacecraft to be launched outside the Earth's sphere of influence by ISRO in its entire history of 44 years.

- Considering that Mars is about 670 million kilometers from the Earth, the cost of the ride works out to about Rs.6.7 per kilometre - cheaper than what even autorickshaws charge anywhere in India!

- The orbiter weighs 1,350-kg, which is even less than the weight of an average sports utility vehicle.

- The manufacturing of Mangalyaan took 15 months while NASA took five years to complete MAVEN.

- If MOM found the presence of methane then INDIA will be first country to achieve it.

CHANDRAYAAN-2

Objective

- Chandrayaan-2, India's 2nd moon mission (after Chandrayaan-1, 2008) was successfully launched on 22^{nd} July at 2.43 pm by GSLV-MkIII-M1 (Geosynchronous Satellite Launch Vehicle Mark III) from Second Launch Pad at Satish Dhawan Space Center Sriharikota (Andhra Pradesh).

- Main aim is to improve our understanding about the Moon discoveries, latest inventions that will benefit India.

- It will also provide detailed information of moon's topography and atmosphere leading to a better understanding of Moon.

Basic Information

- With a total mission mass of 3.8 tonnes, the entire project is set to cost Rs 978 crore.
- Rs 603 crore for the spacecraft and Rs 375 crore for the GSLV Mk-III.
- Chandrayaan-2 consists of an orbiter, a lander (Vikram), and a rover (Pragyan).

Mission Details.....

Operator - Indian Space Research Organization
Type of Mission - Lunar orbiter, Lander and Rover
Duration of Mission - Orbiter: 1 year
Lander: >15 Days
Rover: >15 Days
Launch Mass - Aprox. 3850 Kg
Mass of Payload - Orbiter: approx 2,379 Kg
Lander: approx. 1,471 Kg
Rover: approx. 27 Kg
Date of Launch - 22nd July 2019.
Rocket - GSLV Mk III
Launch Site - Satish Dhawan Space Centre Sriharikota

Mission Details.....

- Chandrayaan-2 begin its journey to Moon on 22 July, 2019.
- The Lander-Orbiter pair will go into an initial elliptical (180 X 24000 km altitude) Earth orbit, followed by a trans-lunar injection.
- Both will go into an initial elliptical lunar orbit.
- After orbit insertion, the Lander and the Orbiter separate.
- The Orbiter evolves into a 100 km circular polar orbit and the Lander breaks from orbit and lands on the surface in the high latitude areas near the South Pole.

- The Orbiter portion of the mission is planned to last 1 year.
- The rover will be deployed using a ramp shortly after the landing and is planned for 14-15 days that is one period of lunar daylight.
- The rover and the lander of the mission will have a life of one lunar day, which is equal to 14 earth days, though the orbiter has a life of one year.
- The landing window is likely to be between September 6 and 7 because that is the beginning of a lunar day and scientific experiments will be conducted during this period.
- It will be a long journey to the moon for the Chandrayaan-2 spacecraft carrying a lander called Vikram and a rover known as Pragyan.
- The journey is quite a long one as the distance between the Earth and the moon is about 3.844 lakh km.

Rover

- **Rover** also known as *Pragyan* will have two instruments on board.
- On the surface of the Moon the instrument will test the mineral and chemical compositions and also about soil and rocks formation.
- Data on and around the South Pole will be collected and sent.
- That is it will send information from the moon to Vikram Lander.

- Lander will send data to Orbiter.
- Then the Orbiter will send it to the ISRO centre. This whole process will take about 15 minutes.
- So, it can be said that information sent from Pragyan Robot will take about 15 minutes to reach the **ISRO** centre in India.

- Dimensions: 0.9 × 0.75 × 0.85 m
- Power: 50 W
- Travel speed: 1 cm/sec.

- One of the instruments on Pragyan is a Laser Induced Breakdown Spectroscope (LIBS).
- Coming from the Laboratory for Electro Optic Systems (LEOS) in Bengaluru, LIBS' main objective is to identify the elements that are present near the landing site.
- To do this, laser pulses are fired at various locations and the radiation from the decayed plasma is analyzed.

Lander

- **Lander** also known as *Vikram.*
- ISRO has named Lander after the founder of ISRO and the father of Indian Space Program Vikram Sarabhai.
- The five-legged lander will have three instruments onboard.
- They are the Radio Anatomy of Moon-Bound Hypersensitive Ionosphere and an Atmosphere Probe (Rambha) that will measure the density of the lunar sub surface and changes around it.

And thirdly, is the instrument for Lunar Seismic Activity (ILSA) which will measure the seismicity or quake or tremor-potential of the region.

Orbiter

- **Orbiter** of Chandrayaan-2 will be installed at 100 km above the moon and consists of eight instruments.
- Specifications of these instruments are not provided that will be loaded on to the rocket.
- But there will be an Imaging Infra-red Spectometer (IIRS) which will try to identify minerals and indicators of hydroxyl and water molecules.
- It will operate on **solar power.**


CHANDRAYAAN-1
INDIA'S FIRST SCIENTIFIC MISSION TO MOON

Introduction:

- CHANDRAYAAN LITEARLLY MEANS MOON VECHILE .
- INDIA'S FIRST UNMANNED MISSION TO MOON DEVOLPED BY ISRO.
- WAS LAUNCHED ON 22 OCTOBER 2008 FROM SATISH DHAWAN SPACE CENTRE SRIHARIKOTA, ANDHRA PRADESH .
- ESTIMATED COST - RS 386 CRORE

Objectives of the Chandrayaan-1

- SIMULTANEOUS MINERALOGICAL, CHEMICAL & PHOTO-GEOLOGICAL MAPPING .
- HIGH RESOLUTION MAPPING OF THE LUNAR SURFACE TO IDENTIFY MINERAL .
- 3D MAPPING OF LUNAR SURFACE AT VERY HIGH SPATIAL RESOLUTION.
- TO MOTIVATE THE YOUNG MINDS IN SPACE AND PLANETARY SCIENCE.

SPECIFICATIONS:

- MASS: 1380 KG AT LAUNCH.
- SHAPE: CUBOID
- POWER: SOLAR PANEL GENERATING 700 W OF POWER, STORED IN A 36 A-H LITHIUM-ION BATTERY.
- HAS THREE SOLID STATE RECORDERS (SSRS).
- Liquid Engine used to travel towards moon.
- Dual gimballed antenna to transfer scientific data.

- PAYLOADS: Collection of instrument embedded on chandrayaan.

INDIAN PAYLOADS

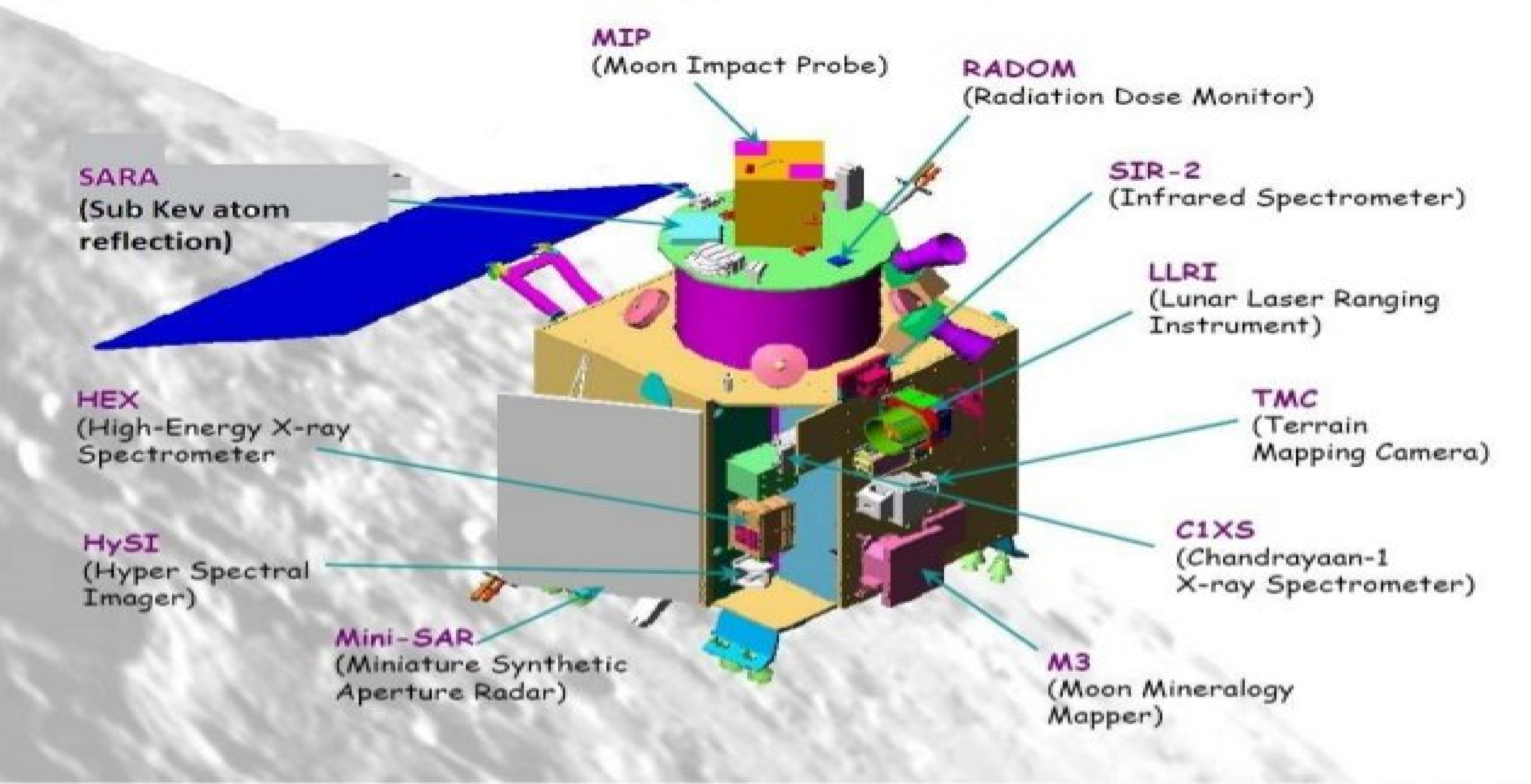
1. TERRAIN MAPPING CAMERA
2. HYPER SPECTRAL IMAGER
3. LUNAR LASER RANGING INSTRUMENT
4. HIGH ENERGY X-RAY SPECTROMETER
5. MOON IMPACT PROBE

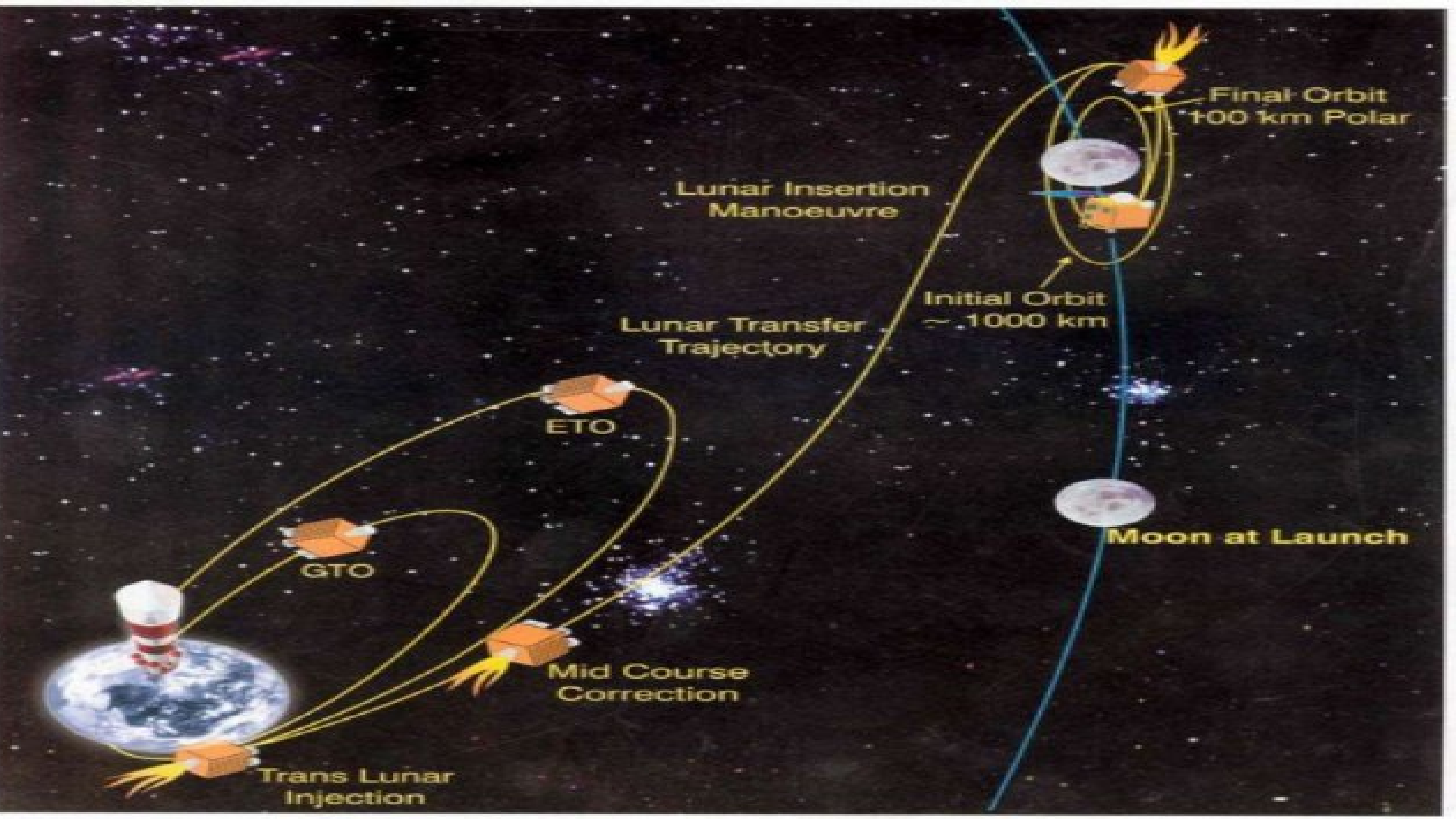
- **FOREIGN PAYLOADS**

1. CHANDRAYAAN X RAY SPECTROMETER
2. MINI SAR
3. SIR- SMART INFRARED SPECTROMETER
4. RADIATION DOSE MONITOR-
5. MOON MINERALOGY MAPPER
6. SARA

SUB ATOM REFLECTING ANALYSER

The Chandrayaan-1 Spacecraft




Final Orbit
100 km Polar
Lunar Insertion
Manoeuvre
Initial Orbit
~ 1000 km
Lunar Transfer
Trajectory
ETO
GTO
Moon at Launch
Mid Course
Correction
Trans Lunar
Injection

https://youtu.be/BEFMHOS2Em0

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