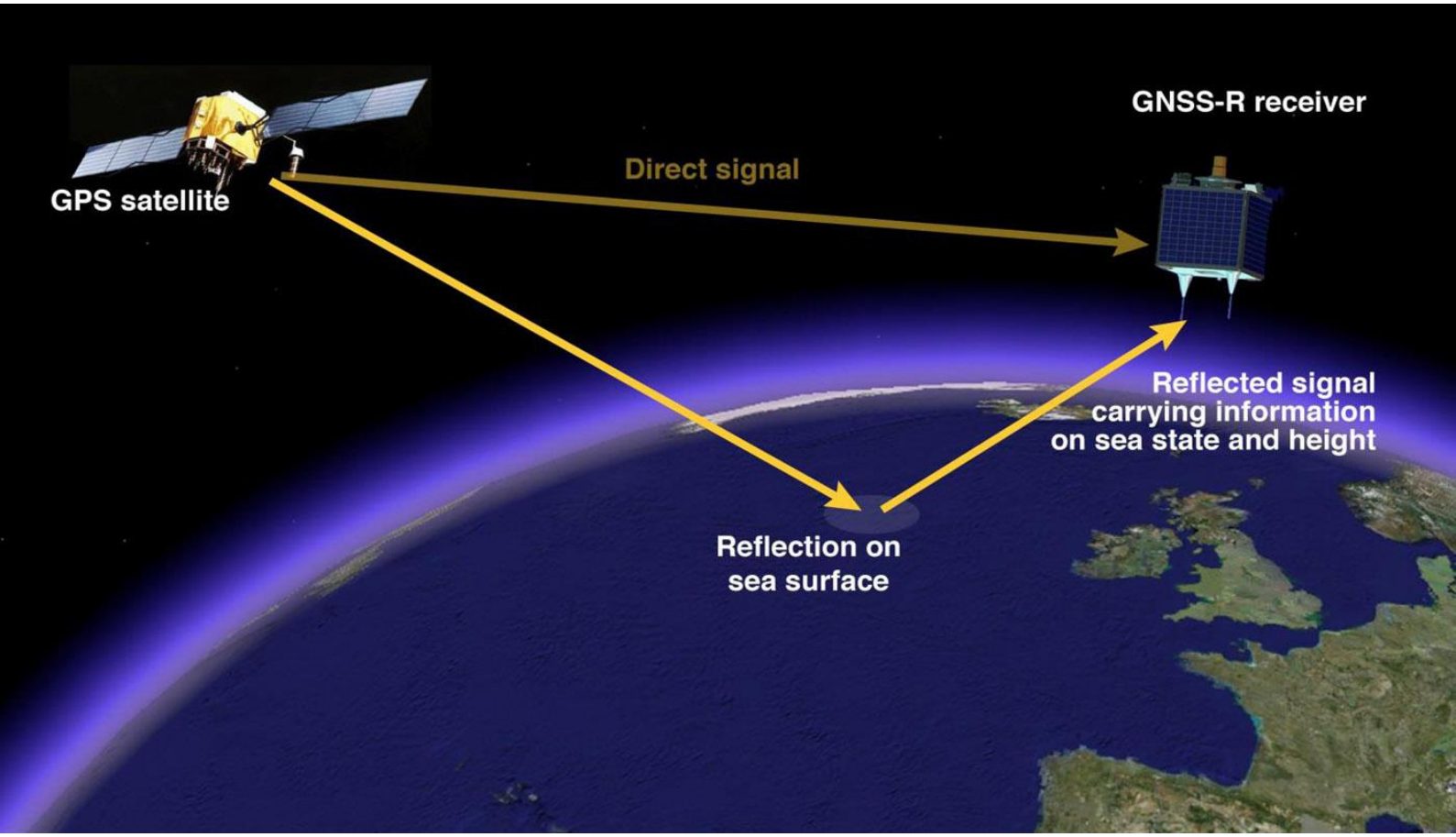
ARUL IAS ACADEMY

COMBINED CIVIL SERVICES EXAMINATION- I

Group - I Services (Main Examination)

(Degree Standard)



PAPER – III - General Studies

UNIT-I: GEOGRAPHY OF INDIA WITH SPECIAL REFERENCE TO TAMILNADU

CONTACT :

ARUL IAS ACADEMY

246, ALLWIN COMPLEX, JAWAHAR BAZAAR, KARUR-1

CONTACT : 9597234 231, 79044 52287

WHATSAPP : 9597234 231

Geographic Information System (GIS)

Introduction

- The full form of GIS is the Geographic Information System. It is a system designed to capture, evaluate, manipulate, handle, and view all forms of geographical & spatial information and data. It helps you to conduct spatial analysis and manage large data and view the data in maps or graphical form for presentation and analysis. Such advantages make GIS a useful tool for visualizing spatial data or building management information systems for an organization.

The Features of GIS

- These characteristics are recognized as representations of points, lines, regions, or rasters. Road records can be processed as lines, for example, in the map of a city, and borders could be documented as zones, and aerial photos can be saved as raster data.
- GIS stores data using spatial indices that enable the characteristics of any arbitrary area on a map to be defined.
- For instance, within a specified radius of a point, or all the roads or routes which pass via a territory, a GIS can easily identify and quantify all of the areas.
- Some information, combined with tabular data, may be spatial. In specific, attribute information about extra information about each of the spatial features.
- For instance, spatial data is the actual location of the hospitals in a geographical area. The attribute data is additional information such as hospital name, quality of care, and bed size.
- GIS is a fusion of these different types of information that, through spatial analysis, allows it a powerful problem-solving device.

History of GIS

- One of the most famous early examples of spatial analysis can be traced back to London in the year 1854 when Dr. John Snow was able to predict the occurrence of cholera outbreak (More: John Snow's Cholera Map using GIS

Data). Thanks to the study that Snow released, officials from the government were able to determine the cause of the disease; which was contaminated water from one of the major pumps.

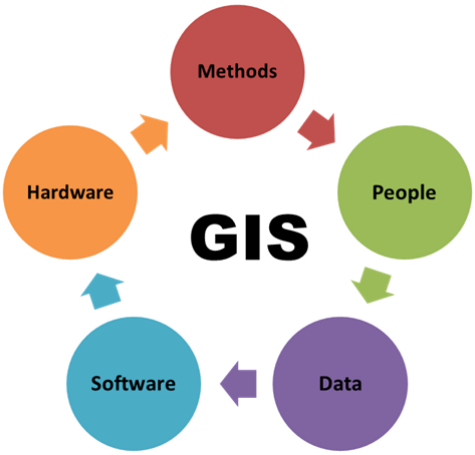
- The map that Snow came up with was very interesting in that it had the capability of analysing the phenomena relating to their geographical positions and this was the first time the world was witnessing this.
- Photo zincography was developed in the earlier years of the 1900s and this enabled the maps to be divided into various layers as required. In the initial stages, the process of drawing these maps was lengthy since it involved free hand but this changed later on with the introduction of the computer.
- The first GIS was created by Dr. Roger Tomlinson and then introduced in the early 1960s in Canada. During its inception, this system was mainly meant for collecting, storing and then analysing the capability & potential which the land in the rural areas had.
- Prior to this, mapping by the use of computers was being used for such cases but this is a method that had numerous limitations associated to it.
- By the end of the 80s period, the use of GIS had already become popular in other related fields which is why it led to a spur in the growth of the industrial sector. Recently, designers came up with open source software for GIS so that the brilliant technology can be enhanced in a much simpler manner while being made available to all.

Techniques of GIS

- GIS can be used as tool in both problem solving and decision making processes, as well as for visualization of data in a spatial environment. Geospatial data can be analyzed to determine
- The location of features and relationships to other features.
- Where the most and/or least of some feature exists.
- The density of features in a given space.
- What is happening inside an area of interest (AOI).
- What is happening nearby some feature or phenomenon.
- And how a specific area has changed over time (and in what way).

Components of GIS

- Hardware
- Software
- Methods
- People
- Data



Hardware

- Hardware is the computer on which a GIS operates. Today, GIS runs on a wide range of hardware types, from centralized computer servers to desktop computers used in standalone or networked configurations.

Software

- GIS software provides the functions and tools needed to store, analyze, and display geographic information.

Key software components

- A database management system (DBMS)
- Tools for the input and manipulation of geographic information
- Tools that support geographic query, analysis, and visualization
- A graphical user interface (GUI) for easy access to tools

People

- GIS technology is of limited value without the people who manage the system and to develop plans for applying it. GIS users range from technical specialists who design and maintain the system, to those who use it to help them do their everyday work.

Methods

- A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

Data

- Maybe the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or bought from a

commercial data provider. Most GIS employ a DBMS to create and maintain a database to help organize and manage data.

- The data that a GIS operates on consists of any data bearing a definable relationship to space, including any data about things and events that occur in nature. At one time this consisted of hard-copy data, like traditional cartographic maps, surveyor's logs, demographic statistics, geographic reports, and descriptions from the field. Advances in spatial data collection, classification, and accuracy have allowed more and more standard digital base-maps to become available at different scales.

The Types of GIS Data

- Spatial
- Attribute
- Metadata

Remote Sensing (RS)

- GIS includes maps, vector information, and imagery. The collection of imagery is commonly achieved through remote sensing. Remote sensing started with aerial photography in the late 1800's onboard a balloon. Air-planes were used to collect information from above in the early 1900s, and the first image taken from space was aboard the Apollo spacecraft in 1969.
- In the early 1970s the first imaging satellite (ERTS-1) collected imagery of the Earth. Images continue to be collected from both space and aircraft, and are available for commercial and personal use on the Internet.
- The term "remote sensing," first used in the United States in the 1950s by Ms. Evelyn Pruitt of the US Office of Naval Research, is now commonly used to describe the science—and art—of identifying, observing, and measuring an object without coming into direct contact with it.
- This process involves the detection and measurement of radiation of different wavelengths reflected or emitted from distant objects or materials, by which they may be identified and categorized by class/type, substance, and spatial distribution.
- Remote sensing, the science of obtaining information about objects or areas from a distance, is typically done from aircraft or satellites. Remote sensors collect data by detecting the energy that is reflected from Earth.
- These remote sensors can be either passive or active. Passive sensors respond to external stimuli. They record radiation that is reflected from Earth's surface, usually from the sun. Because of this, passive sensors can only be used to collect data during daylight hours.
- In contrast, active sensors use internal stimuli to collect data about Earth. For example, a laser-beam remote sensing system projects a laser onto the surface

of Earth and measures the time that it takes for the laser to reflect back to its sensor.

Uses of GIS

- Emergency response teams normally use GIS when they want to collect logistics with regards to how they will move in times of natural disasters (see: Predicting Natural Disasters and Humanitarian Crises through GIS).
- The system also comes in handy when authorities want to discover any potential wetlands that need to be protected from the harmful effects brought about by pollution.
- Companies also take advantage of the GIS so that they may be able to choose a strategic market location that has not yet been saturated by other competitors in the particular niche industry.
- Management personnel use this system also so that they can be able to locate areas that are bound to suffer from catastrophes with regards to the infrastructure that is in place there.
- Any potential spread of diseases & other such like pandemic are usually limited by the use of the GIS since the patterns of their occurrence is predicted in sufficient time.

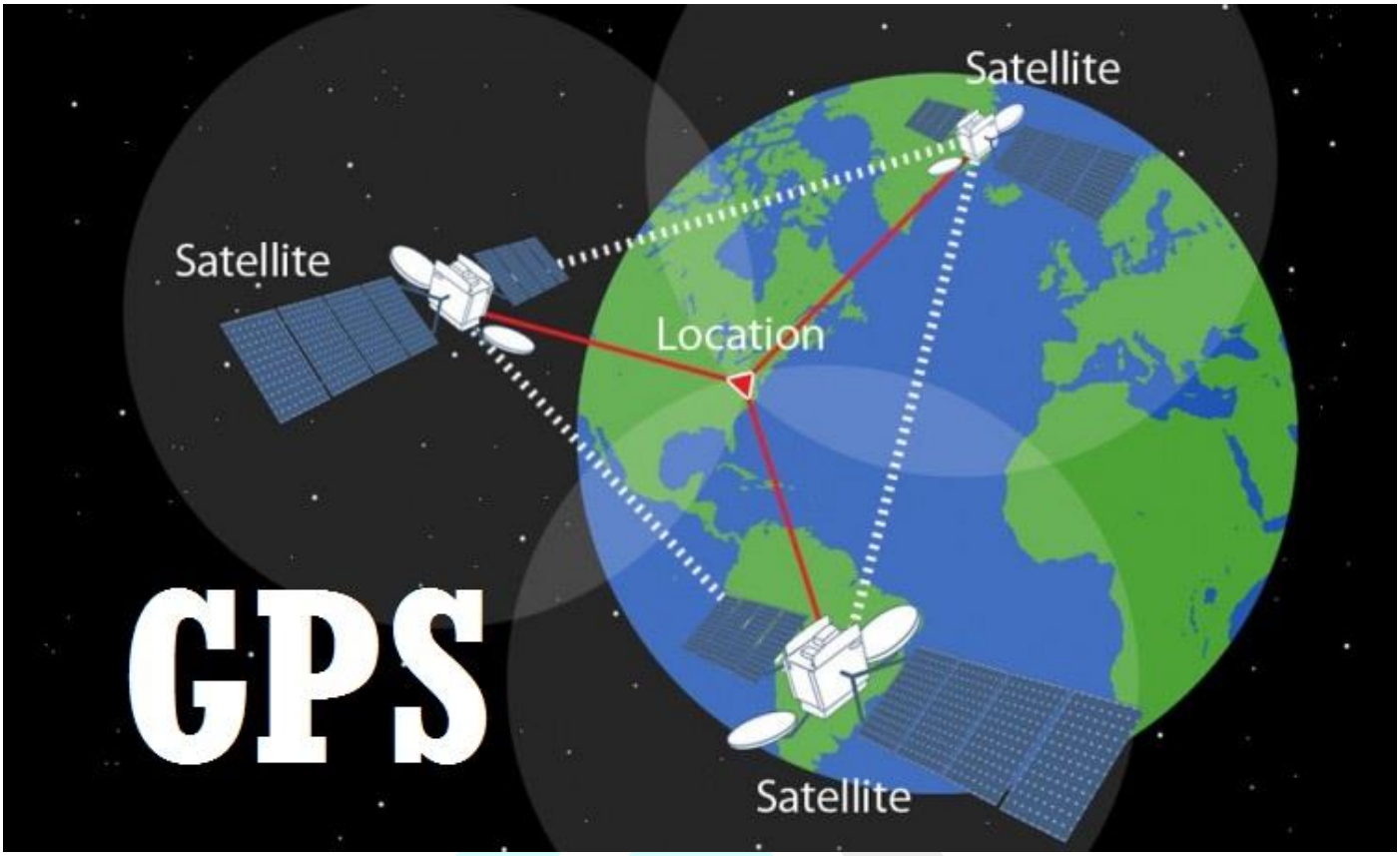
The Benefits of GIS

- Cost savings resulting from greater efficiency.
- Better decision making.
- Improved communication.
- Better geographic information recordkeeping.
- Managing geographically.

Application of GIS

- Mapping.
- Telecom and Network Services.
- Accident Analysis and Hot Spot Analysis.
- Transportation Planning.
- Environmental Impact Analysis.
- Disaster Management and Mitigation.

Global Positioning System (GPS)



Introduction

- Over the years, people have been using different techniques to navigate across the world. Traditionally, people used to depend on landmarks and stars to travel between different locations, while compasses and maps helped them from getting lost. The discovery of the Global Positioning System (GPS) made people no longer have to rely on these traditional positioning techniques to find their way around.

History of GPS

- GPS also is known as the Navstar project started in the year 1973 and became fully operational in 1994. This system is funded and run by the United States Department of Defence. Originally, this system was intended for military purposes only but was made available to public use on completion of the project.

Basic Principles of GPS

- The basic principle inherent in GPS is to determine with the best possible accuracy a point in space, as defined by three coordinates, here geographical latitude and longitude, as well as elevation above sea level.

Components of a GPS system

- GPS is a system and it is made up of three parts: satellites, ground stations, and receivers. Following are the functionalities of each of these parts:
- Satellites act like the stars in constellations, and we know where they are because they invariably send out signals.
- The ground stations make use of the radar to make sure the satellites are actually where we think they are.
- A receiver is a device that you might find in your phone or in your car and it constantly seeks for the signals from the satellites. The receiver figures out how far away they are from some of them. Once the receiver calculates its distance from four or more satellites, it knows exactly where you are.

Process of GPS

- There are at least 4 GPS satellites in the line of sight of a receiver on the earth. The transmitter GPS sends information about the position and time to the receiver GPS at fixed intervals of time.
- The signals that are sent to the receiver devices are radio waves. By finding the difference in time between the signal that was sent from the GPS satellite to the time the GPS receivers, the distance between the GPS receiver and the satellite can be calculated.
- Using the trilateration process, the receiver locates its position as the signals are received from at least 3 satellites.
- For a GPS to calculate a 2-D position which includes the latitude and longitude, a minimum of 3 satellites are required and for a 3-D position which includes latitude, longitude, and an altitude, minimum of 4 satellites are required.

Trilateration

- Trilateration is defined as the process of determining the location based on the intersections of the spheres. The distance between the satellite and the receiver is calculated by considering a 3-D sphere such that the satellite is located at the center of the sphere.
- Using the same method, the distance for all the 3 GPS satellites from the receiver is calculated.

The Parameters of After Trilateration:

- Time of sunrise and the sunset
- Speed
- Distance between the GPS receiver to the destination
- GPS systems are remarkably versatile and can be found in almost any industry sector. They can be used to map forests, help farmers harvest their fields and navigate airplanes on the ground or in the air.

Space Segment:

- GPS consists of a network of 24 active satellites located nearly 20000 kilometers above the Earth's surface. Each satellite broadcasts different signals which can be tracked by a GPS receiver on earth, which are then analyzed by the GPS receiver to determine its precise location.
- The signals operate in all weather conditions but can't penetrate through solid objects, so GPS receivers perform best when they have a clear view of the sky.

Control Segment:

- GPS contains a control segment that has a system of tracking stations located around the world.
- The master control facility is located at Schriever Air Force Base in Colorado.
- Its receivers come in all different shapes and sizes, are widespread, and are affordable. Today, GPS receivers can be found in watches, phones, tablets, computers, cars, and a wide variety of other devices.
- A master control station
- An alternate master control station
- Six dedicated monitor stations
- Four dedicated ground stations

User Segment:

- The GPS user segment has a user segment and GPS receivers. These receivers transform SV signals into velocity, position, and time estimates.
- It needs four satellites to measure the Four dimensions of X, Y, Z, and time. GPS receivers are helpful in navigation, time dissemination, positioning, and some other research.
- Navigation is the key function of GPS. It is useful for ships, aircraft, and even ground vehicles.

Recent GPS Technology

- GPS III will have a 15-year design life, twice as long as some of the current GPS satellites. It will have three times better accuracy, which means the 5 to 10-meter accuracy of existing GPS technology will be slashed to 1 to 3 meters. The signal will also be more powerful, allowing it to overcome interference.

Global Navigation Satellite System (GNSS)

INTRODUCTION

- GNSS refers to the collection of the world's global satellite based positioning systems. GNSS are recognized to be the systems of choice in outdoor environments and, to a great extent, one of the most accurate source of position (and precise timing) information when it is available.
- The first satellite navigation system was Transit, a system deployed by the US military in 1960's. Transit's operations were based on the Doppler Effect: the satellites travelled on well-known paths and broadcast their signals on well-known radio frequency. The received frequency will differ slightly from the broadcast frequency because of the movement of the satellite with respect to the receiver.
- The satellite broad cast signals that contains orbital data (from which the position of the satellite can be calculated) and the precise time, the signals is transmitted. There are multiple constellations of GNSS satellites orbiting the earth. GNSS satellites' orbit situated about 20,000 km above the earth's surface. They are moving very fast, several kilometres per second. The latest generation of GNSS satellites (Block IIF) weight over 1,400 kg.

Components of a GNSS system

- The GNSS consist of three main satellite technologies: GPS, Glonass and Galileo. Each of them consists mainly of three segments: (a) space segment, (b) control segment and (c) user segment.
- These segments are almost similar in the three satellite technologies, which are all together make up the GNSS. As of today, the complete satellite technology is the GPS technology and most of the existing worldwide applications related to the GPS technology.
- The GNSS technology will become clearer after the operation of Galileo and the reconstruction of Glonass in the next few years.

GNSS SIGNAL

- The overall of mentioned signals (Modernized GPS, Galileo and Glonass signals), make up the GNSS signals.
- Each satellite system has specific signal characteristics, but each system attempts
- to be compatible with the others in order to prevent the interferences and attenuation between the signals. It is important to consider that the processing of all signals should be performed using the same receiver, thus a complex receiver design is supposed to be designed and built.
- As mentioned above, The GNSS frequency plan shall respect the radio-regulations as they are discussed and agreed on at ITU forums. The available spectrum which can be used for the development of Radio-Navigation Satellite Systems (RNSS)

Various Countries GNSS Systems

Global Positioning System (United States)

- GPS is the oldest GNSS system. It initiated its operations in 1978 and was available for global use from 1994.
- The need to have an independent military navigation capability drove its innovation. And, US military was first to realize this. And thus, in 1964 the Transit system was deployed for the purpose. Transit, which was also known as NAVSAT, worked on the Doppler Effect and use to provide location information and navigation to missile submarines, surface ship and also to hydrographic survey and geodetic surveying to the US army.
- With time, GPS was opened up for public use. Currently, GPS has a 33 satellite constellation, out of which 31 are in orbit and operational. It is maintained by the US Air Force and is committed to maintaining the availability of at least 24 operational GPS satellites. Till date, GPS has launched 72 satellites.

GLONASS (Russia)

- Global Navigation Satellite System or GLONASS is global navigation system of Russia. GLONASS became operational in year 1993 with 12 satellites in 2 orbits at the height of 19,130 km. At present, there are total 27 satellites in orbit and all are operational. GLONASS is operated by Russian Aerospace Defence Forces and is the Second alternative navigational system in operation.

Galileo (EU)

- Galileo is European Union's GNSS constellation, which is being put together by the European Space Agency, and the European GNSS Agency will operate it. Galileo is global navigation system available for civilian and commercial use. The fully deployed Galileo system will consist of 30 operational satellites and 6 in-orbit spares. As of now 22 out of 30 satellites are in orbit.
- Galileo started offering Early Operational Capability from 2016 and is expected to reach full operational capability by 2020.

BeiDou (China)

- BeiDou is Satellite Navigation System of China. It has total 22 Operational satellites in orbit and the full constellation is scheduled to comprise 35 satellites. BeiDou has two separate constellations, BeiDou-1 and BeiDou-2.
- BeiDou-1 also known as first generation was a constellation of three satellites. It became operational in year 2000 and offered limited coverage and navigation services, mainly for users in China and neighboring regions. Beidou-1 was decommissioned at the end of 2012.

QZSS (Japan)

- The Quasi-Zenith Satellite System is the regional satellite navigation system from Japan which is still under construction by the Satellite Positioning Research and Application Center, Japan. As per plans, the QZSS constellation will have 7 satellites, out of which 4 are already in orbit.
- QZSS is expected to be operational by the end of 2018, where it will provide highly precise and stable positioning services in the Asia-Oceania region. QZSS will be compatible with GPS.

IRNSS — NAVIC (India)

- The Indian Regional Navigation Satellite System (IRNSS), which was later given the operational name of NAVIC or Navigation with Indian Constellation, is the regional satellite navigation system of India. Launched and operated by the Indian Space Research Organisation (ISRO), IRNSS covers India and nearby regions extending up to 1,500 km.

- All the seven satellites are in orbit, but the first satellite – IRNSS A – is not functioning now since some time last year ISRO reported that all three atomic clocks on it have failed.
- ISRO's bid to launch a replacement satellite failed in August 2017 when in a rare occurrence the heat shield of the launch vehicle failed to separate to release the satellite. Currently, three IRNSS satellites of it are in the geostationary orbit and other 4 are in geosynchronous orbits. There is still some time before India starts getting its services.

Aim of IRNSS

- Standard Positioning Service (SPS) for civilian, research & commercial use.
- Restricted Service (RS) for authorized users. For example in defence, IRNSS is used for ground, aerial and marine navigation, disaster management, mobile phone integration, mapping and visual & voice navigation for drivers, among others.

Applications of GNSS

- GNSS applications are widely used to get the quick information about a particular field.
- Consumers,
- Transportation, GIS, Machine Control Port
- Automation, Precision Agriculture, Construction,
- Marine Mining, Unmanned Vehicles Surveying,
- Defence, and Aerial Photogrammetry,