Topic: Remote Sensing Platforms

Course: Remote Sensing and GIS (CC-11)

M.A. Geography (Sem.-3)

By

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Lecture-2

Concept:

Remote sensing is the acquisition of information about an object without coming in physical contact of that object. And 'sensor' is a device that helps in gathering of information (amount of EMR emitted or reflected by the object). In other words, 'sensor' is the remote sensing device that records wavelengths of energy. Generally, these sensors are mounted or fixed with a 'platform'. Therefore, 'platform' is termed as a vehicle that carries remote sensing device (Fig. 1).

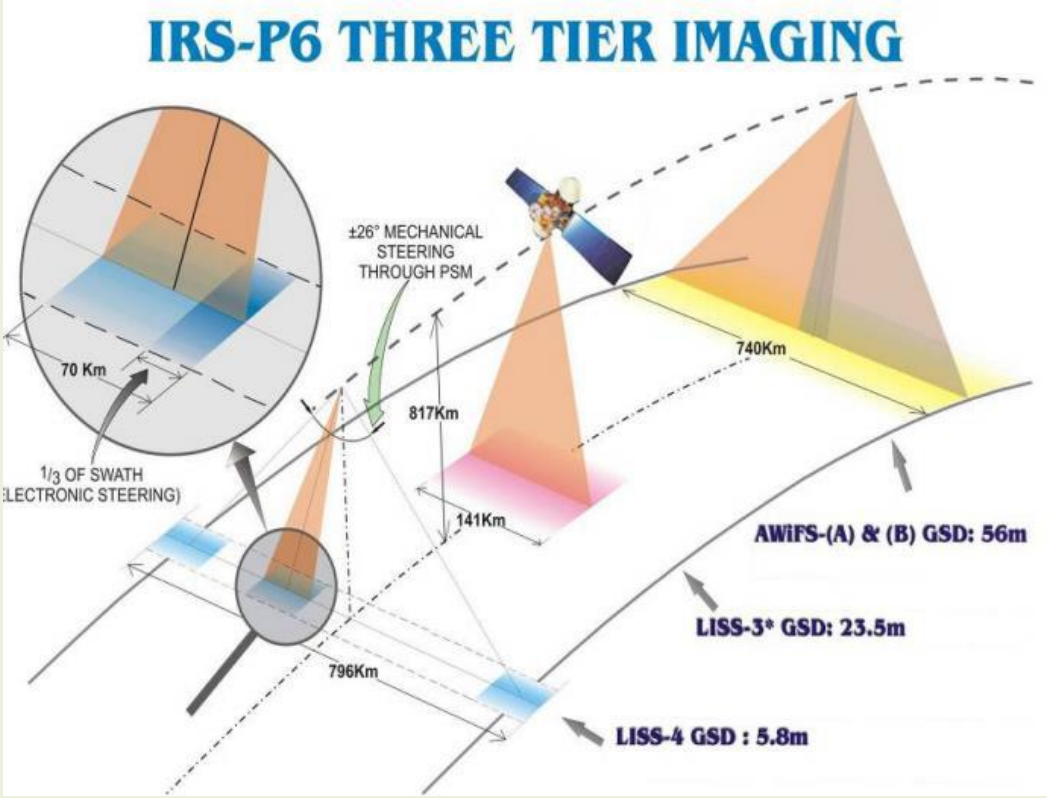


Fig.1: Indian remote sensing platform and sensor.

What is a Platform?

Platform is a stage where sensor or camera is mounted to acquire information about a target under investigation. According to Lillesand and Kiefer (2000), a platform is a vehicle, from which a sensor can be operated. For remote sensing applications, sensors should be mounted on suitable

stable platforms. These platforms can be ground based, air borne or space borne based. As the platform height increases the spatial resolution and observational area increases. Thus, higher the sensor is mounted; larger the spatial resolution and synoptic view is obtained. The types or characteristics of platform depend on the type of sensor to be attached and its application. Depending on task, platform can vary from ladder to satellite. For some task sensors are also placed on ground platforms. Though aircrafts and satellites are commonly used platforms, balloons and rockets are also used.

Type of Platforms:

Platforms can vary from stepladders to satellites. There are different types of platforms and based on its altitude above earth surface. Three types of platforms are used to mount the remote sensors –

1. ***Ground based Platform***
2. ***Air - borne Platform, and***
3. ***Space-borne Platform***

Remote sensing platforms

- There are three main categories of remote sensing platforms

Commonest platforms

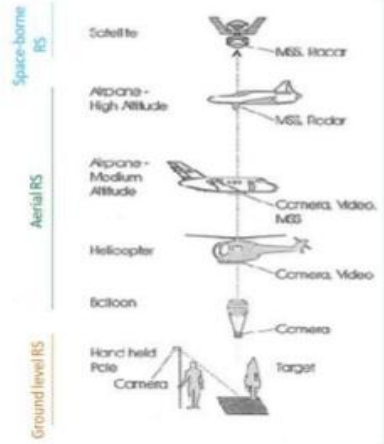
Spaceborne
- Satellite
- Shuttle

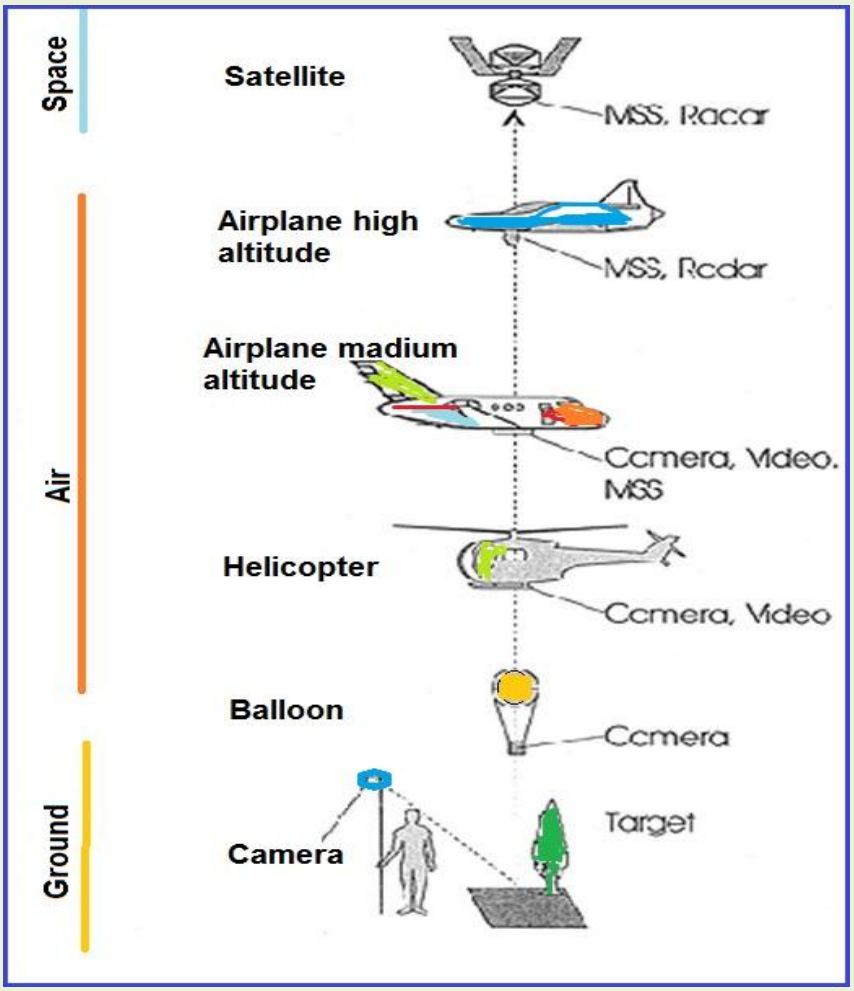
Airborne
- Aeroplane
- Helicopter
- Hot air balloon
- Air ship
- Tethered balloon

Ground-based
- Hand-held
- Raised platform

Remote Sensing Platforms

- Ground level remote sensing
  - Very close to the ground (e.g., Hand held camera)
  - Used to develop and calibrate sensors for different features on the Earth's surface
- Aerial remote sensing
  - Low altitude aerial remote sensing
  - High altitude aerial remote sensing
- Space-borne remote sensing
  - Space shuttles
  - Polar orbiting satellites
  - Geo-stationary satellites





1. Ground based Platforms:

Ground based platforms are used to record detailed information about the objects or features of the earth's surface. These are developed for the scientific understanding on the signal-object and signal-sensor interactions. Ground observation includes both the laboratory and field study, used for both in designing sensors and identification and characterization of land features. Ground observation platforms include – handheld platform, cherry picker, towers, portable masts and vehicles etc. Portable handheld photographic cameras and spectroradiometers are largely used in laboratory and field experiments as a reference data and ground truth verification.

Wide varieties of ground-based platforms are used in remote sensing. Some of the common ones are hand held devices, tripods, towers and cranes. To study properties of a single plant or a small patch of grass, ground based platform is used. Ground based platforms (hand-held or mounted on a tripod) are also used for sensor calibration, quality control and for the development of new sensors. For the field investigations, some of the most popular platforms have been used are 'cherry picker platform, portable masts and towers. The cherry picker platforms can be extended to approx. 15m. They have been used by various laboratories to carry spectral reflectance meters and photographic systems. Portable masts are also available in various forms and can be used to support cameras and sensors for testing. The main problem with these masts is that of stabilizing the platform, particularly in windy conditions. Permanent ground platforms like towers and cranes are used for monitoring atmospheric phenomenon and long-term monitoring of terrestrial features. Towers can be built on site and can be tall enough to project through a forest canopy so that a range of measurements can be taken from the forest floor, through the canopy and from above the canopy (Fig.2)

Fig.2: Crane, Ground based platform.

2. Air- borne/ based Platforms:

Airborne platforms were the sole non-ground-based platforms for early remote sensing work. Aircraft remote sensing system may also be referred to as sub-orbital or airborne, or aerial remote sensing system. At present, airplanes are the most common airborne platform. Other airborne observation platforms include balloons, drones (short sky spy) and high altitude sounding rockets. Helicopters are occasionally used.

Balloons:

Balloons are used for remote sensing observation (aerial photography) and nature conservation studies. The first aerial images were acquired with a camera carried aloft by a balloon in 1859. Balloon floats at a constant height of about 30 km. It consists of a rigid circular base plate for supporting the entire sensor system which is protected by an insulating and shock proof light casing. The payload used for Indian balloon experiment of three Hasselblad cameras with different film filter combinations, to provide PAN, infra red black and white and infra red false color images. Flight altitude being high compared to normal aircraft height used for aerial survey, balloon imagery gives larger synoptic views. The balloon is governed by the wind at the floating altitude. Balloons are rarely used today because they are not very stable and the course of flight is not always predictable, although small balloons carrying expendable probes are still used for some meteorological research.

*Balloons as platforms are not very expensive like aircrafts. They have a great variety of shapes, sizes and performance capabilities. The balloons have low acceleration, require no power and exhibit low vibrations. There are three main types of balloon systems, viz. free balloons, Tethered balloons and Powered Balloons. Free balloons can reach almost top of the atmosphere; hence, they can provide a platform at intermediate altitude between those of aircraft and spacecraft (Fig. 3**).***

Free floating or anchored balloons have altitude range of 22-40 km and can be used to a limited extent as a platform. It is used for probing the atmosphere and also useful to test the instrument under development.

In India, at present, Tata Institute of Fundamental Research, Mumbai, has setup a National balloon facility at Hyderabad. Teethered balloons are connected to the earth station by means of wire shaving high tensional strength nd high flexibility.

Fig. 3: Balloon as platform

Drone:

Drone is a miniature remotely piloted aircraft. It is designed to fulfill requirements for a low cost platform, with long endurance, moderate payload capacity and capability to operate without a runway or small runway. Drone includes equipment of photography, infrared detection, radar observation and TV surveillance. It uses satellite communication link. An onboard computer controls the payload and stores data from different sensors and instruments. The payload computer utilizes a GSM/GPRS

(where available) or independent satellite downlink, and can be monitored its position and payload status from anywhere in the world connected to the internet.

Drone was developed in Britain during World War-II, is the short sky spy which was originally conceived as a military reconnaissance. Now it plays important role in remote sensing. The unique advantage is that it could be accurately located above the area for which data was required and capable to provide both night and day data.

Aircraft Platform:

Aerial platforms are primarily stable wing aircraft. Helicopters are also occasionally used for this purpose. Generally, aircraft are used to collect very detailed images. Helicopters can be for pinpoint locations but it vibrates and lacks stability. Special aircraft with cameras and sensors on vibration less platforms are traditionally used to acquire aerial photographs and images of land surface features. While low altitude aerial photography results in large scale images providing detailed information on the terrain, the high altitude smaller scale images offer advantage to cover a larger study area with low spatial resolution.

The National High Altitude Photography (NHAP) program (1978), coordinated by the US Geological Survey, started to acquire coverage of the United States with a uniform scale and format. Beside aerial photography multi spectral, hyperspectral and microwave imaging is also carried out by aircraft; thereafter multi spectral, hyperspectral and microwave imaging were also initiated.

Aircraft platforms offer an economical method of remote sensing data collection for small to large study areas with cameras, electronic imagers, across- track and along-track scanners, and radar and microwave scanners. AVIRIS hyperspectral imaging is famous aircraft aerial photographic operation of USGS.

Low Altitude Aircraft: *It is most widely used and generally operates below 30,000 ft. They have single engine or light twin engine. It is suitable for obtaining image data for small areas having large scale (Fig. 4).*

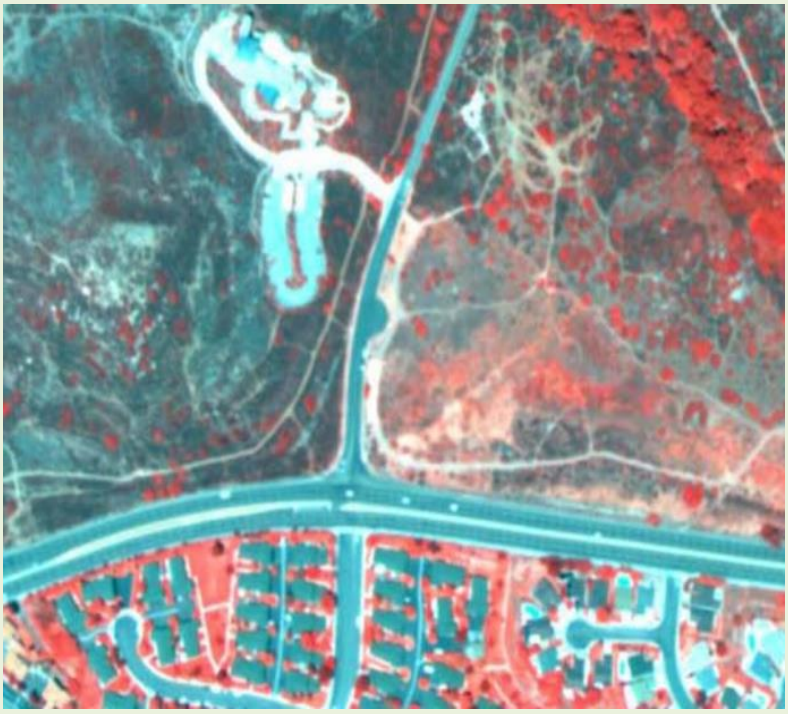


Fig. 4: Low altitude aircraft produced image

It is more stable and operates above 30,000 ft. High altitude aircraft includes jet aircraft with good rate of climb, maximum speed, and high operating ceiling. It acquires imagery for large areas (smaller scale). Examples are NHAP, NAPP, AVIRIS.

Aircraft platform acquire imagery under suitable weather conditions. It controls platform variables such as altitude. Time of coverage can also be controlled. However, it is expensive, less stable than spacecraft and has motion blurring (Fig. 5).

Fig.5: Image by High altitude aircraft.

Rockets as Platforms:

High altitude sounding rocket platforms are useful in assessing the reliability of the remote sensing techniques as regards their dependence on the distance from the target is concerned. Balloons have a maximum altitude of approximately 37 km, while satellites cannot orbit below 120 km. High altitude sounding rockets can be used to a moderate altitude above terrain. Imageries with moderate synoptic view can be obtained from such rockets for areas of some 500,000 square kilometers per frame. The high altitude sounding rocket is fired from a mobile launcher. During the flight its scanning work is done from a stable altitude, the payload and the spent motor are returned to the ground gently by parachute enabling the recovery of the data. One most important limitations of this system is to ensure that the descending rocket not going to cause damage.

Prior to use of airplanes, aerial photographs were obtained by rocketing a camera into the sky and then retrieving the camera and film. Synoptic imagery can be obtained from rockets for areas of some 500,000 square km. The Skylark earth Resource Rocket is fired from a mobile launcher to altitudes between 90 - 400 kms. With the help of a parachute, the payload and the spent motor are returned to the ground gently thereby enabling speedy recovery of the photographic records. This rocket system has been used in surveys over Australia and Argentina. In 1946, V-2 rockets acquired from Germany after World War II were launched to high altitudes from White Sands, New Mexico. These rockets contained automated still or movie cameras that took picture as the vehicle ascended. The main problem with rockets is that they are one-time observations only. Except for one time qualitative or reconnaissance purposes, rocket platforms are not of much use in regular operational systems (Fig. 6).

Fig. 6: Rocket as Platform

3. Space-borne/ based Platforms:

In space- borne remote sensing, sensors are mounted on-board a spacecraft (space shuttle or satellite) orbiting the earth. Space-borne or satellite platform are onetime cost effected but relatively lower cost per unit area of coverage, can acquire imagery of entire earth without taking permission. Space-borne imaging ranges from altitude 250 km to 36000 km.

Space-borne remote sensing provides the following advantages:

- *Large area coverage;*
- *Frequent and repetitive coverage of an area of interest;*
- *Quantitative measurement of ground features using radiometrically calibrated sensors;*
- *Semi-automated computerised processing and analysis;*
- *Relatively lower cost per unit area of coverage.*

Spacecraft as Platform:

- *Remote sensing is also conducted from the space shuttle or artificial satellites. Artificial satellites are manmade objects, which revolve around another object.*
- *The 1960s saw the primary platform used to carry remotely sensed instruments shifted from airplanes to satellite. Satellite can cover much more land space than planes and can monitor areas on a regular basis.*
- *Beginning with the first television and infrared observation Satellite (tiRoS-1) in 1960, early weather satellites returned rather poor views of cloud patterns and almost indistinct images of the earth's surface. Space photography becomes better and was further extended with the Appolo program. Then in 1973 SKYLAB, the first American space workshop was launched and its astronauts took over 35000 images*

of the earth with the earth Resource experiment Package (eReP) on board. Later on with LANDSAT and SPOT satellites program, space photography received a higher impetus (Fig. 7).

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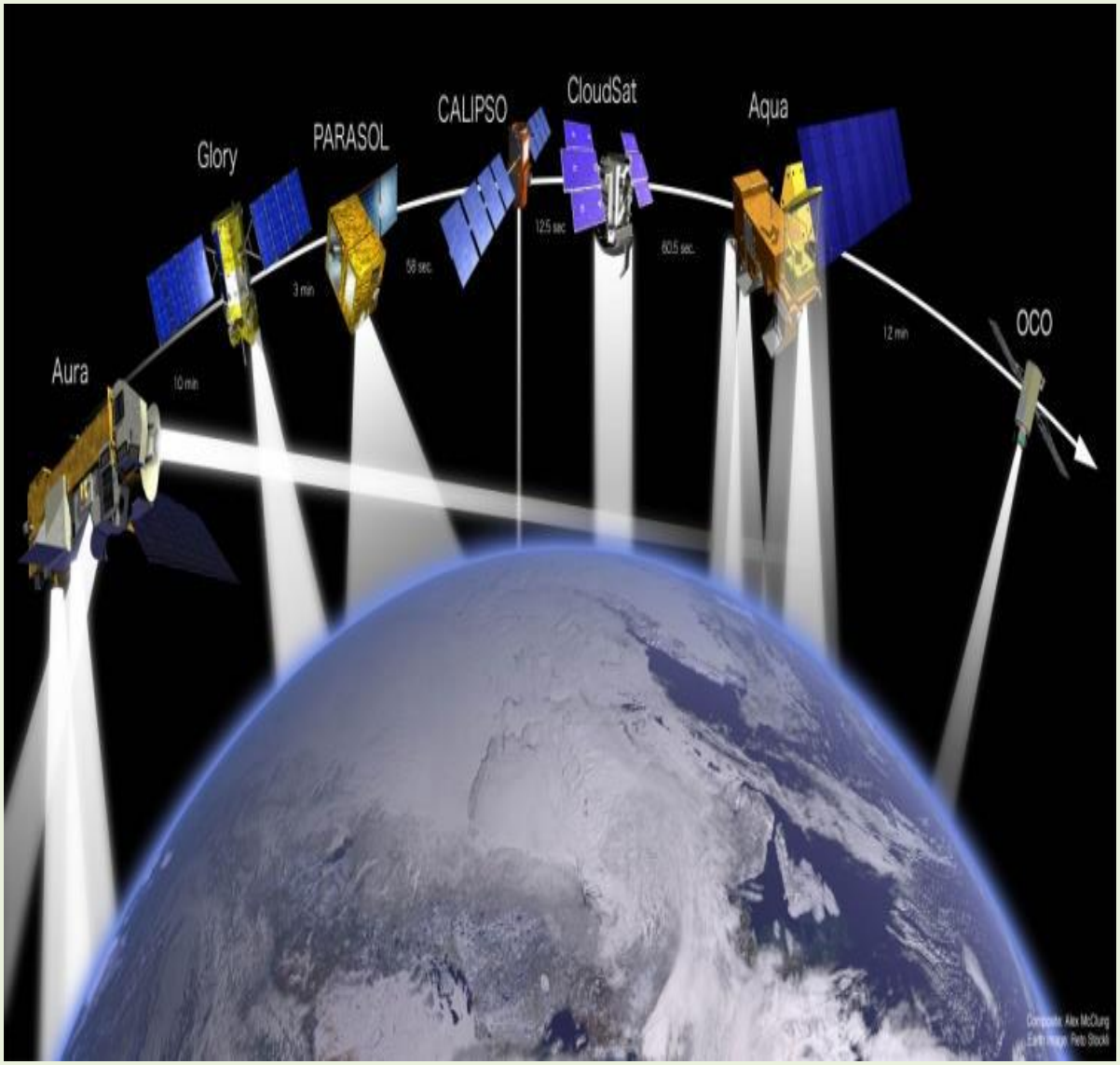

Fig. 7: Spacecraft as platform.

There are two types of well recognized satellite platforms- manned satellite platform and unmanned satellite platform.

Manned Satellite Platforms: *Manned satellite platforms are used as the last step, for rigorous testing of the remote sensors on board so that they can be finally incorporated in the unmanned satellites. This multi- level remote sensing concept is already presented. Crew in the manned satellites operates the sensors as per the program schedule. Information on a series of NASA's manned satellite programs are given in table 6.1.*

Table showing Manned satellite programs of NASA

Program	Year	Crew	Sensors used
Mercury	1962-1963	One	Head-heal Camera
Gemini	1964-1965	Two	Head- held Camera
Apollo	1968-1972	Three	Multispectral Camera
Skylab	1973-1974	Three to Seven	Hand-held Camera
Space Shuttle	1981	Variable	Multispectral Scanner
International Space Station	2000	1st Station Crew Arrived	Head-head Camera, LFC, Sir , MOMS
	Nov 02, 2000	2nd Station Crew Arrived	Multiple sensors for remote sensing and a range of laboratory equipments for conducting physics-chemical and biological experiments. It is planned to serve as the base for launching smaller unmanned satellites into polar orbits from which remote sensing data can be relayed to earth stations. Crew from the Space station can also go to these polar satellites to repair and refuel them. Space Shuttle to provide transportation of Astronauts and necessary cargo between earth and the Space station.
	Mar 10, 2001	3rd Station Crew Arrived	
	Aug 12, 2001	4th Station Crew Arrived	
	Dec 07,2002		
	June 07,		

	2002 *Nov 25, 2002* *Feb 01, 2003* *Apr 18, 2003* *Oct 20, 2003* *Apr 17, 2004*	*5th Station Crew Arrived* *6th Station Crew Arrived* *Space Shuttle Columbia* *Disaster* *7th Station Crew Arrived* *8th Station Crew Arrived* *9th Station Crew Arrived*	

Source: Panda, 2005

Unmanned Satellite Platforms: *Landsat series, SPOT series and IRS series of remote sensing satellite, NOAA series of meteorological satellites, the entire constellation of the GPS satellites and the GOES and INSAT series of geostationary environmental, communication, television broadcast, weather and earth observation satellites etc are examples of unmanned satellite category.*

Keywords: *Platform,Air borne, Space-borne, Manned Satellite, Unmanned Satellite*

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