ICT in Transport

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Topic: ICT and ITS for all modes of transportation such as roadways, railways, airways, and waterways.

Enabling Technologies

Cloud Computing

Wireless communication technologies (such as smart mobile phones, QR code, RFID and telematics tracking).

Switching from dyadic one-to-one communication to simultaneous one-to-many communication changes the way supply chains are structured and information is shared

“eFreight” Present day problems

Complexity of freight transport information exchange in the context of multimodal transport:

Problems

- lack of interoperability along the supply chain
- operators provide information several times for different purposes
- lack of information on intermodal availabilities

Result

inefficiencies, costs, reduced visibility of freight

administrative costs + perceived complexity for multimodal transport

no full exploitation of multimodal transport / non-optimization of use of existing transport infrastructure

Thus there is need for interoperable interfaces for information on freight in the various transport modes

“eFreight”: The vision of EU

- Interoperability between paperless freight information systems
- Zero paper documents needed for planning, executing and completing any transport operation within the EU
- Reduced waiting time at hubs related to administrative procedures
- Standard framework for intermodal information exchange
- Harmonised border crossings

Intelligent Transport Systems (ITS)

ITS in the field of transport

- **Providing real-time traffic information,**
- **Supporting traffic safety and transport operations etc.**

EXAMPLES of **ITS in the field of transport:**

- Road intelligent transport systems (ITS),
- Air traffic management system (SESAR),
- European rail traffic management system (i.e. ERTMS) and rail information systems (i.e. TAF-TSI),
- Maritime surveillance systems (SafeSeaNet et al.), VTMIS (Vessel Traffic Management and Information System and
- Inland navigation (River Information Services [RIS]).

- Topic: IoT and their application in transportation systems.

- "*Thing*" could be defined as a real/physical or digital/virtual entity that exists and move in space and time and is capable of being identified.

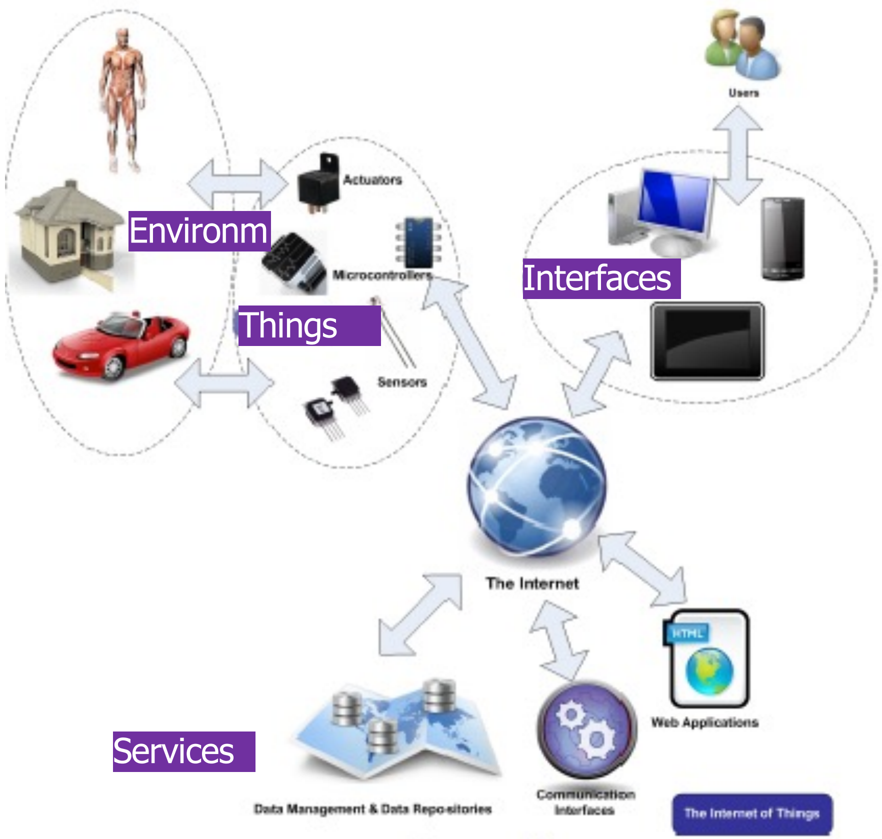
  Things are commonly identified either by assigned identification numbers, names and/or location addresses.

In the IoT, “things” are expected to become active participants in business, information and social processes:

- They are enabled to interact and communicate among themselves and with the environment;
- They exchange data and information “sensed” about the environment;
- They react autonomously to the “real/physical world” events and influencing it by running processes that trigger actions and create services;
- With or without direct human intervention.

Essential Components

- Things: device and everyday objects.
- Environment: Things retrieves information from the environm.
- User Interfaces: users interact with things via some interface;
- Services: applications and services providing funcionality;

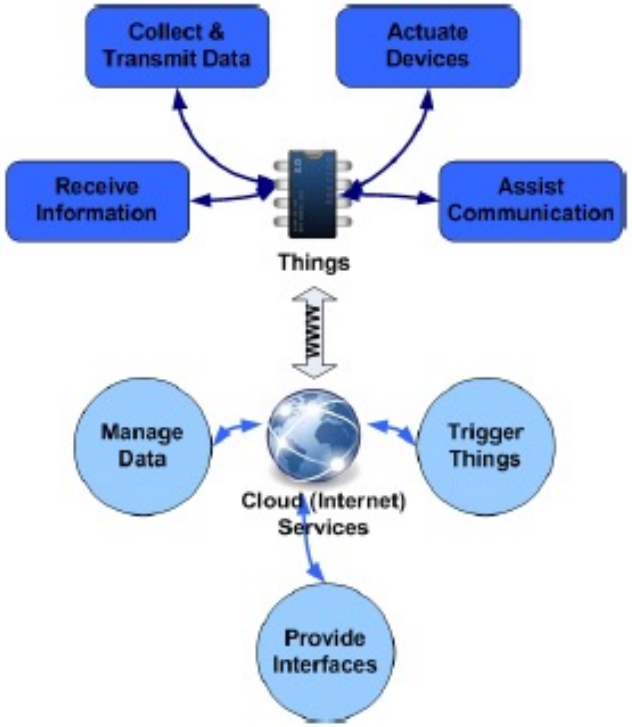


Devices are integrated with the virtual world of the Internet.

Main Features

- Collect and transmit Data: sense the environment, gather data and transmit to another device.
- Actuate based on triggers: Actuate based on conditions set by you.
- Receive information: from other devices or the Internet.
- Communication Assistance: device can also forward data between oth nodes;

Web Platforms can store data - devices usually have limited memory - and also send data back to devices

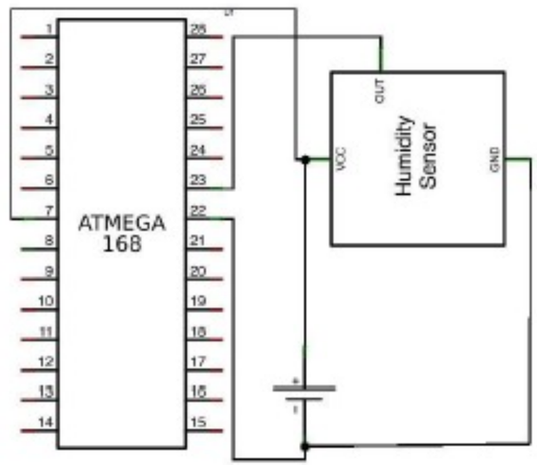


Major Components of IoT Devices (1)

- Control Units: a small computer on a single integrated circuit containing processor core, memory and a programmable I/O peripheral. It is responsible for the main operation.

The Atmega328 chip from Atmel

- Sensor: devices that can measure a physical quantity and convert it into a signal, which can be read and interpreted by the microcontroller unit. Most sensors fall into 2 categories: Digital or analog. An analog data is converted to digital value that can be transmitted to the Internet.

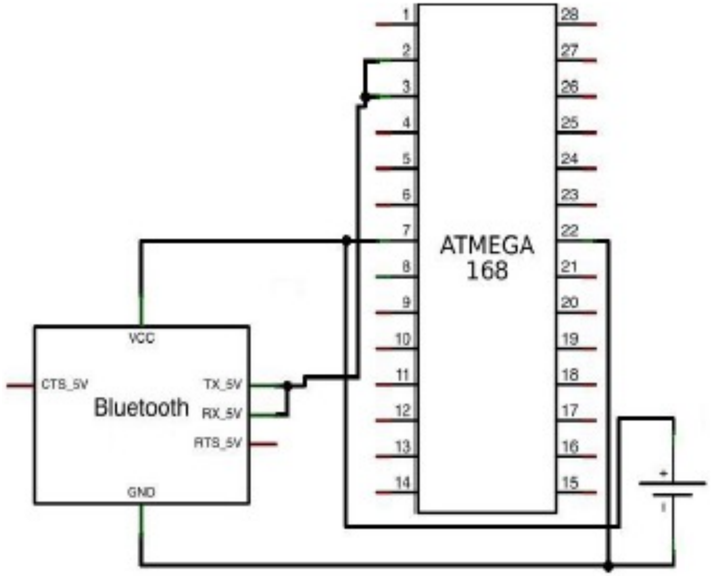


Humidity sensor connected to a microcontroller

Major Components of IoT Devices (2)

- Communication Modules: responsible for the communication with the rest of the IoT platform. The communication between IoT devices and the Internet is performed in two ways:
- A) There is an Internet-enable intermediate node acting as a gateway;
- B) The IoT Device has direct communication with the Internet.

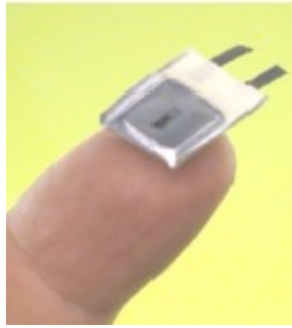
The communication between the main control unit and the communication module uses serial protocol (in most cases). They share a pair or Rx/Tx ports



A Bluetooth module connected to the Atmega168

Major Components of IoT Devices (3)

- Power Sources: In small devices the current is usually produced by sources like batteries, thermocouples and solar cells. Mobile devices are mostly powered by lightweight batteries that can be recharged for longer life duration.



Probably the smallest rechargeable consumer battery.

Topic: Information collection and storage tools.

Database

- A file that stores data in an organized fashion so that information can be retrieved from it.
- Examples:
  - iPod playlist
  - Netflix movie list
  - Contacts in cell phone

Rational Database

Consists of multiple tables of information related through *common fields*

Company | Product

Company Nam	Price level	Product ID
Hawaiian Pools	2	BN-0609-TGOLD
Hawaiian Pools	2	TK-1616-TGOLD
Sahara Pools	1	BN-0609-TPERL
Sahara Pools	1	TK-1212-TPERL
Alure Pools	1	BN-0609-TGOLD
Alure Pools	1	TK-1616-TGOLD
Pete's Pools	3	BN-0609-TGOLD
Pete's Pools	3	TK-1616-TGOLD
Clear Pools	2	BN-0609-TPERL
Clear Pools	2	TK-1616-TGOLD
	0	

Company | Product

Product ID	Product Name	Size	Color	Price
BN-0609-TGOL	Gold Tumbled BN	6"x9"	Gold	$3.49
BN-0609-TPERL	Pearl Tumbled BN	6"x9"	Pearl	$3.75
TK-1212-TPERL	Pearl Tumbled Paver	12"x12"	Pearl	$3.59
TK-1616-TGOL	Gold Tumbled Paver	16"x16"	Gold	$4.29
				$0.00

Database Management Systems

- A program used to store, access and manipulate database information
- Microsoft Access is an end-user DBMS that you can use to create and manipulate fairly small and uncomplicated databases
  - Graphical user interface
  - Wizard
- Oracle, MySQL, IBM's DB2 and Microsoft SQL Server are high-end DBMS programs used to create and manipulate large, complex databases used in large organizations

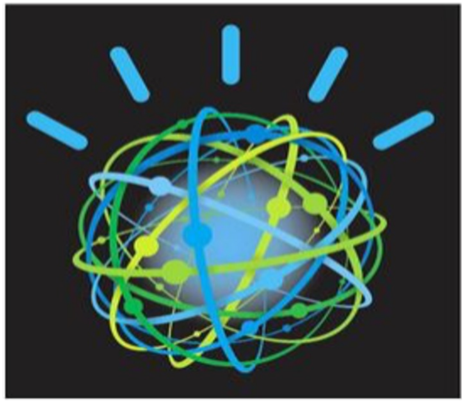
SQL – Structured Query Language

- A sub-language commonly used for developing and managing databases
- SQL pronounced “sequel”
- Used primarily in a database to retrieve, update, insert or remove information
- Sufficiently powerful and can create tables, restructure tables and remove tables, among other very complex tasks

Big Data

A term that describes enormous volumes of data that are too huge for regular database programs

- Unlike data in a database, big data is unstructured and unrelated.
- Analysis of big data requires specialized tools.

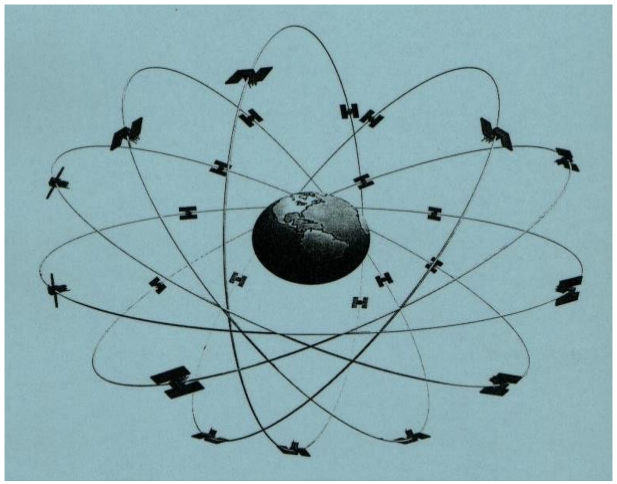


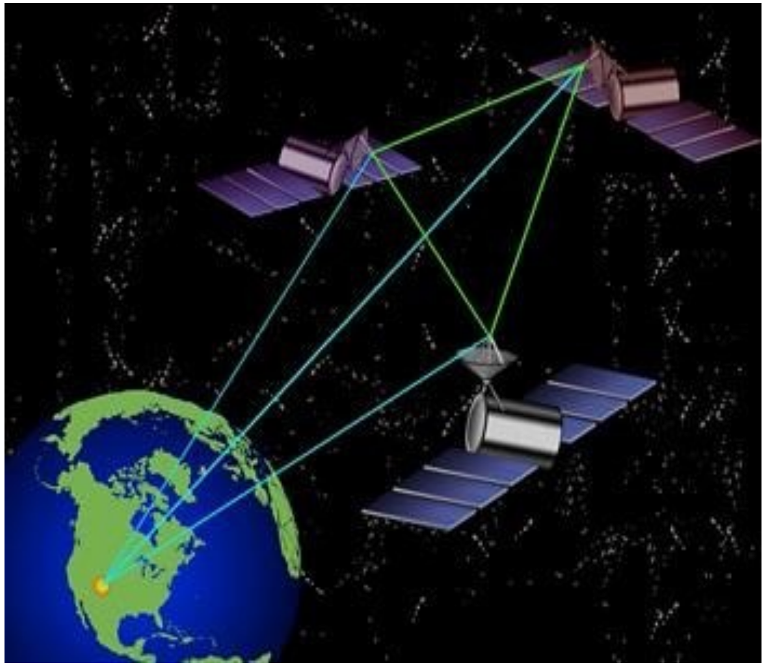
- Topic: Fundamentals of GIS, GPS, and remote sensing.

GLOBAL POSITIONING SYSTEM (GPS)

Global Positioning System

- GPS is a satellite navigation system used to determine the ground position of an object.
- Each GPS satellite broadcasts a message that includes the satellite's current position, orbit, and exact time.



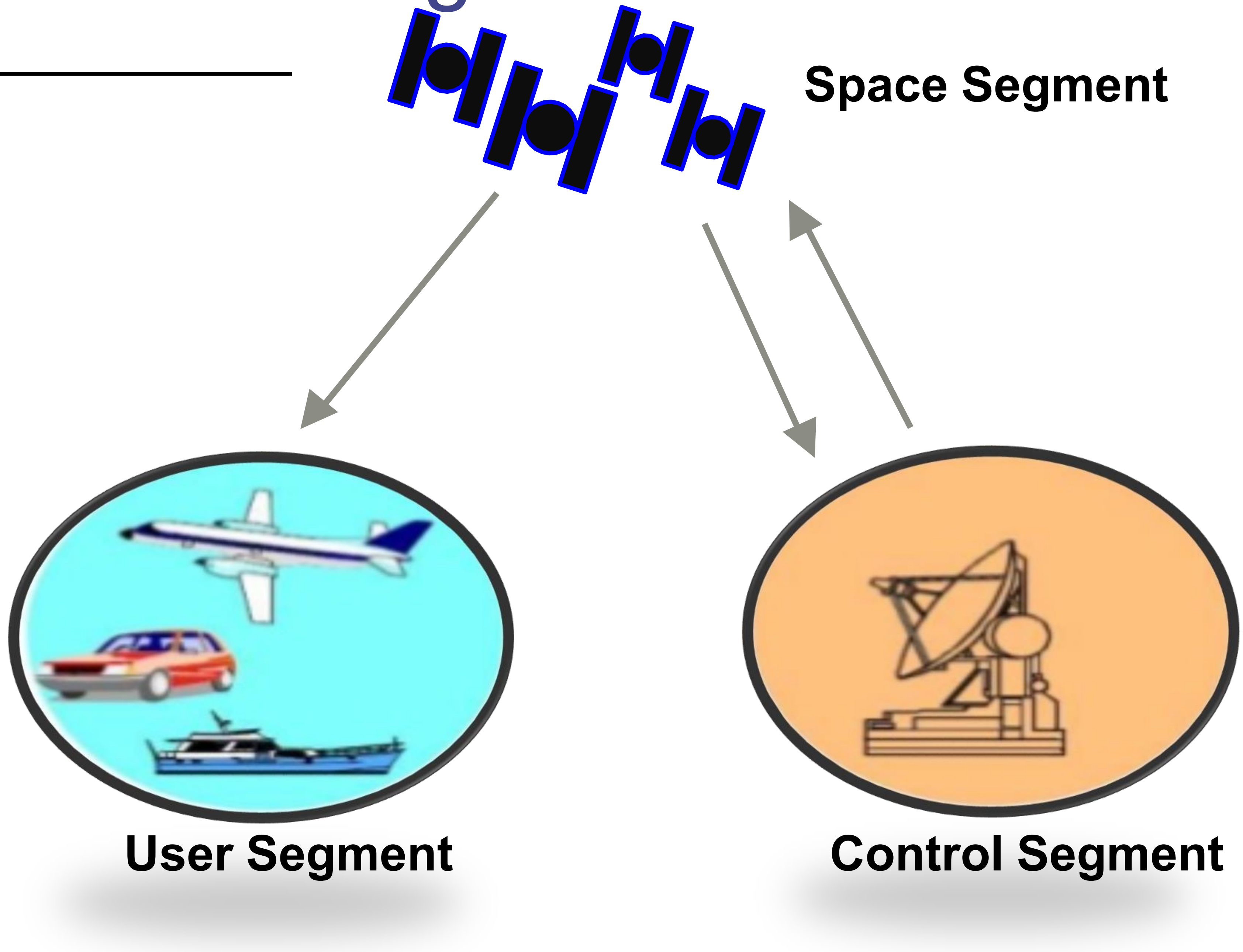


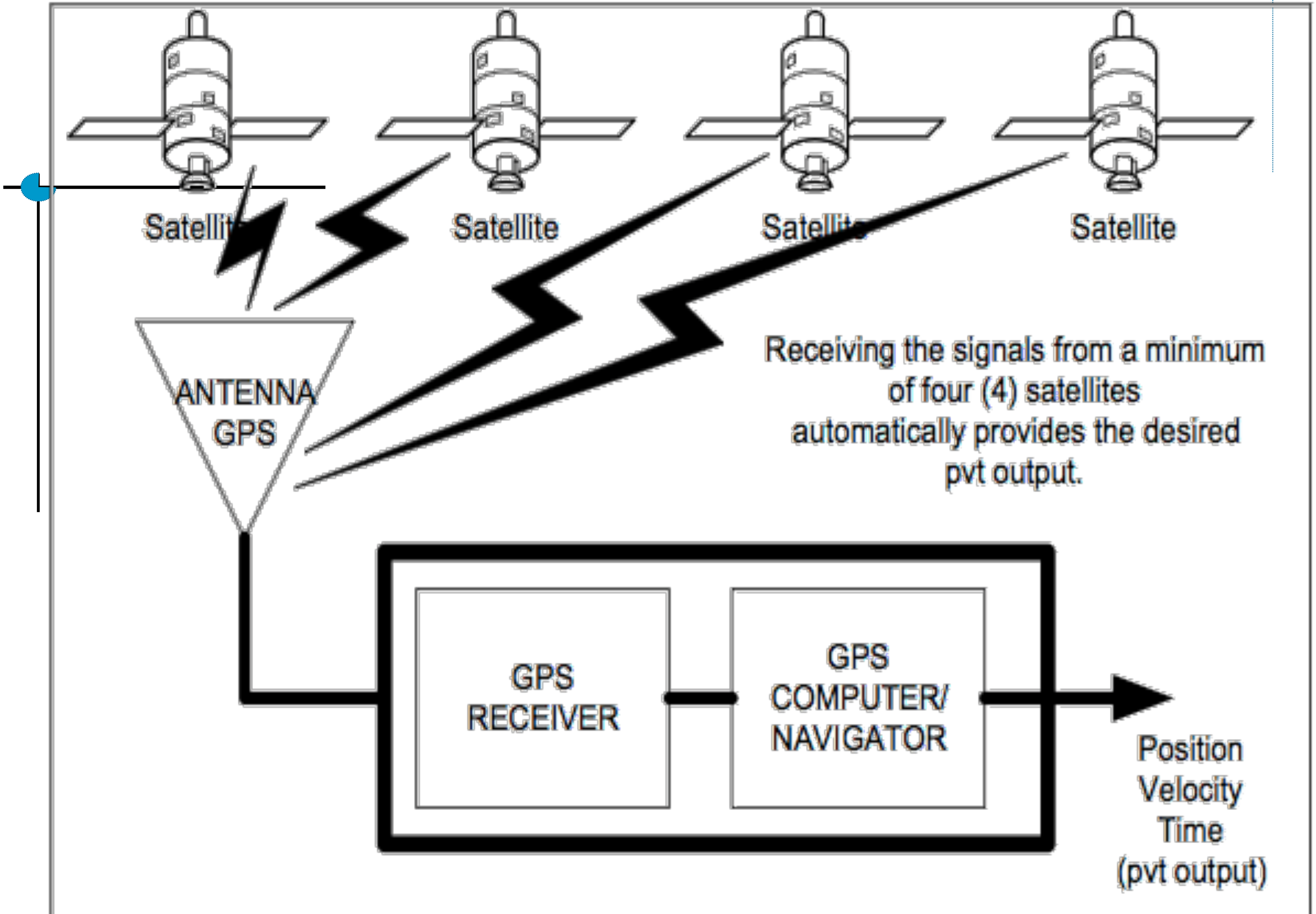
GPS Working

- These satellite, which are equipped with atomic clocks, transmitted radio signals that contain their exact locations, time and other information.

- The radio signals from the satellite, which are monitored and corrected by controlled stations, are picked up by GPS receiver.
- A GPS receiver needs only three satellites to plot a rough, 2D position, which will not be very accurate.
- Ideally, four or more satellites are needed to plot a 3D position which is more accurate.

Three Segments of the GPS





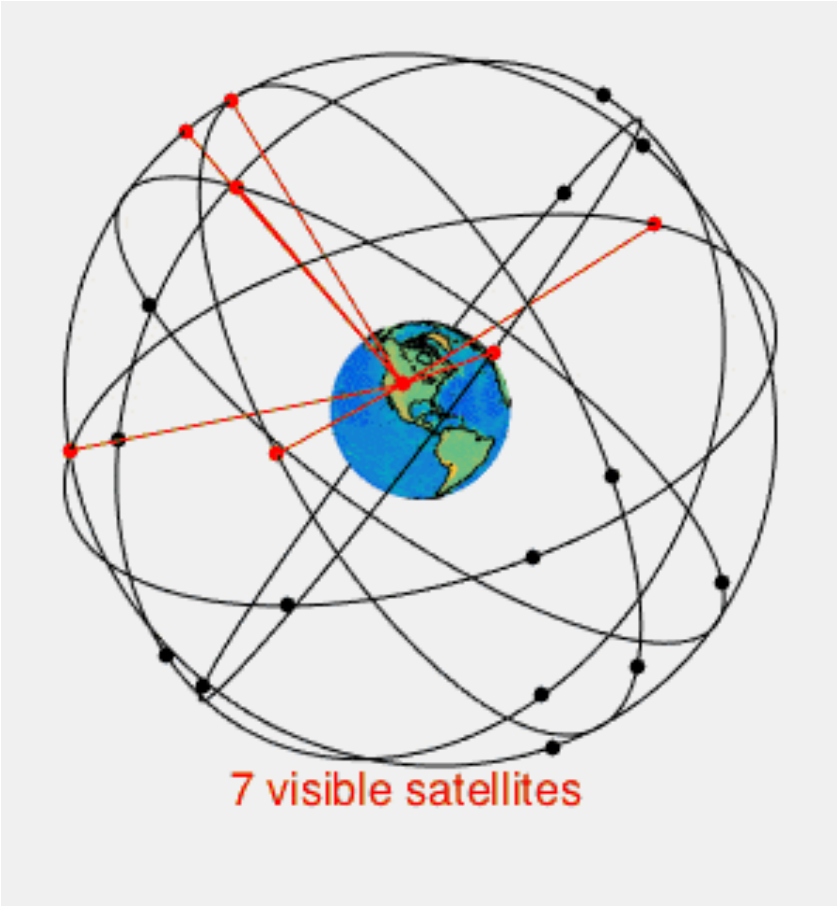
The GPS User Segment - typical

Control Segment

- Control segments track the satellite and then provide them with corrected orbital and time information.
- The control segment consists of five unnamed monitor stations and one Master Control Station.
- The five unnamed stations GPS monitor satellite signals then send that information to Master Control Station where anomalies are corrected and sent back to the GPS satellites through ground antennas.

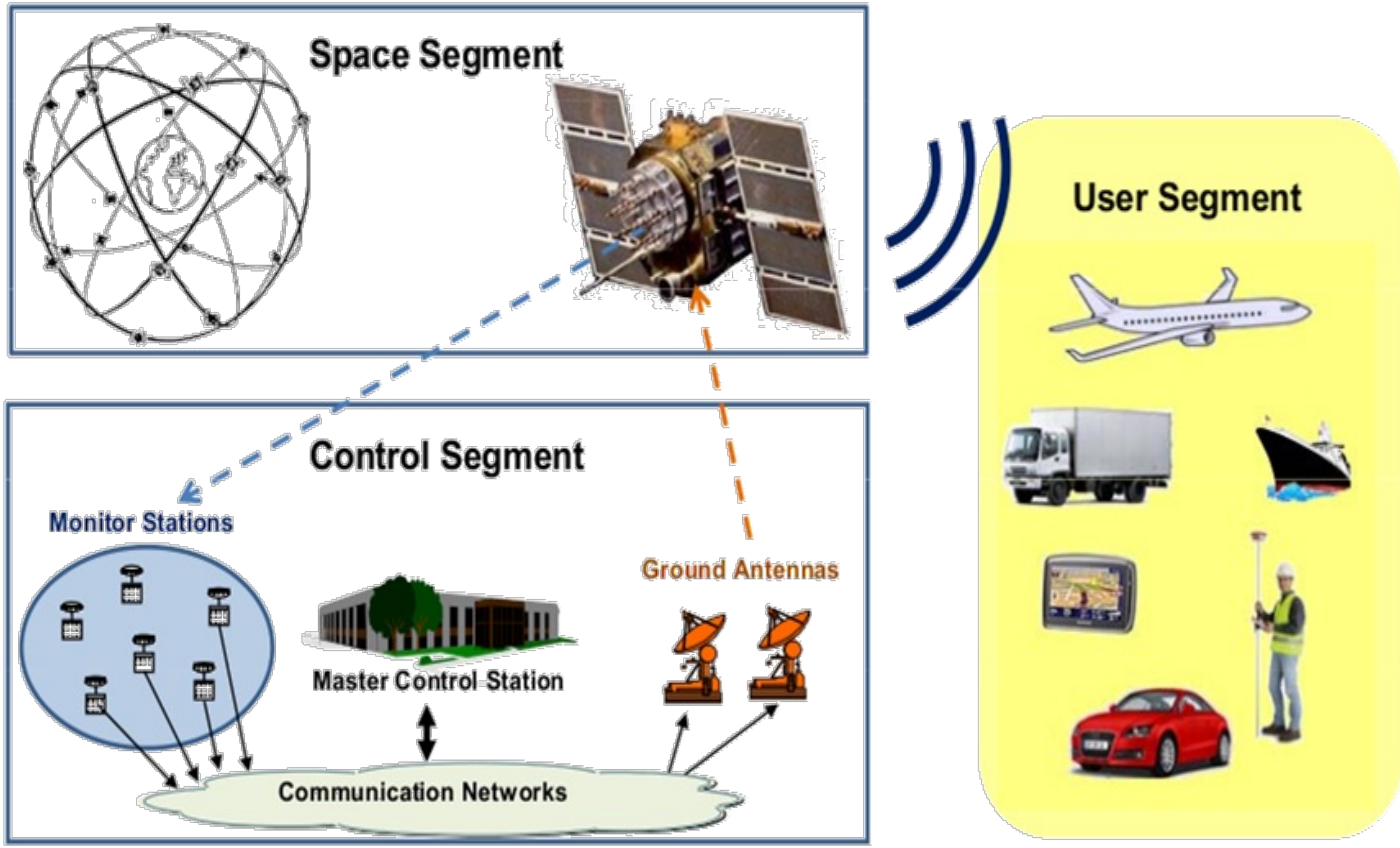
Space Segment

- The space segment (SS) is composed of the orbiting GPS satellite or space vehicles (SV)
- The GPS design originally called for 24 SVs, eight each in three circular orbital plane.
- This was modified to six planes with four satellite each.

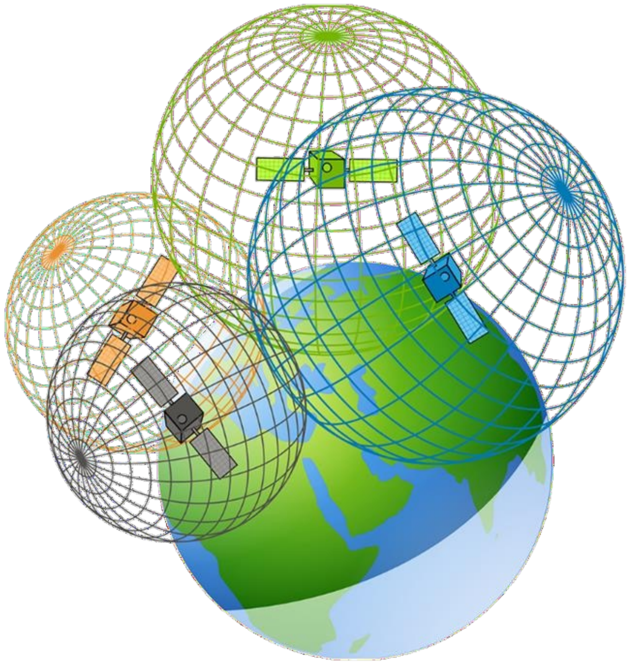


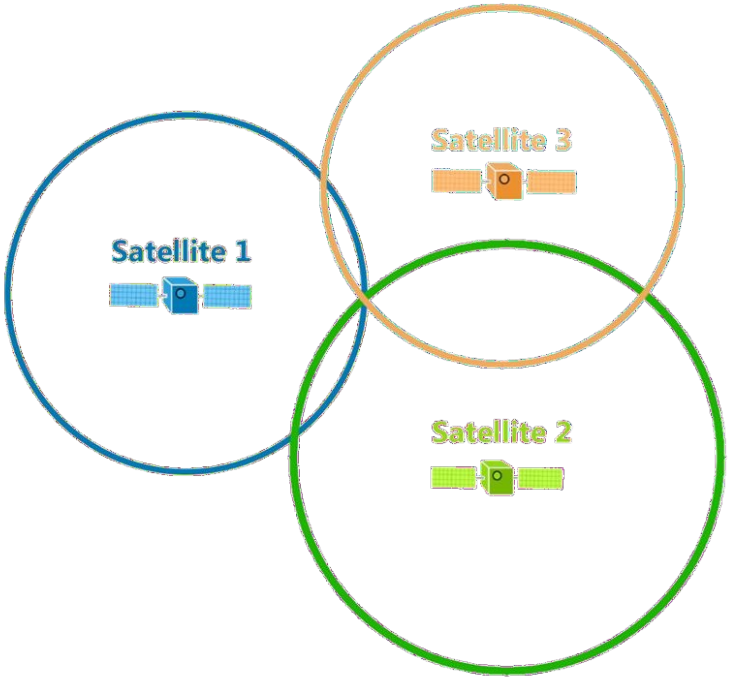
User Segment

- It consist of GPS receiver equipments, which receives the signals from the GPS satellite and uses the three dimensional position and time.
- It decodes the timing signals from the “visible” satellite calculating their distances, latitude, longitude, elevation and time.
- Commercial application;
  - Military.
  - Search and rescue.
  - Transportation modes.
  - Surveying.
  - Marine, aeronautical and terrestrial navigation.
  - Remote controlled vehicle and robot guidance.
  - Satellite positioning and tracking.
  - Geographic Information Systems (GIS).


Space Segment
User Segment
Control Segment
Monitor Stations
Ground Antennas
Master Control Station
Communication Networks

How GPS Determines Position ?





How GPS Determines Position ?

The GPS receiver uses the following information to determine a position.

1. Precise location of satellites

- when GPS receiver is first turned on, it downloads orbit information from all the satellites called almanac.
- This process, the first time, can take as long as 12 minutes; but once this information downloaded, it is stored in the receiver's memory for future use.

How GPS Determines Position ?

2. Distance from each satellite

- The GPs receiver calculates the distance from each satellite to the receiver by using the distance formula

Distance = velocity x time

- The receiver already knows the velocity, which is speed of the radio wave or 186,000 miles per second (the speed of light).
- To determine the time part of the formula, the receiver times how long it takes for a signal from the satellite to arrive at the receiver.
- The GPS receiver multiples the velocity of the transmitted signal by the time it takes the signal to reach the receiver to determine the distance.

How GPS Determines Position ?

3. Triangulation to determine position

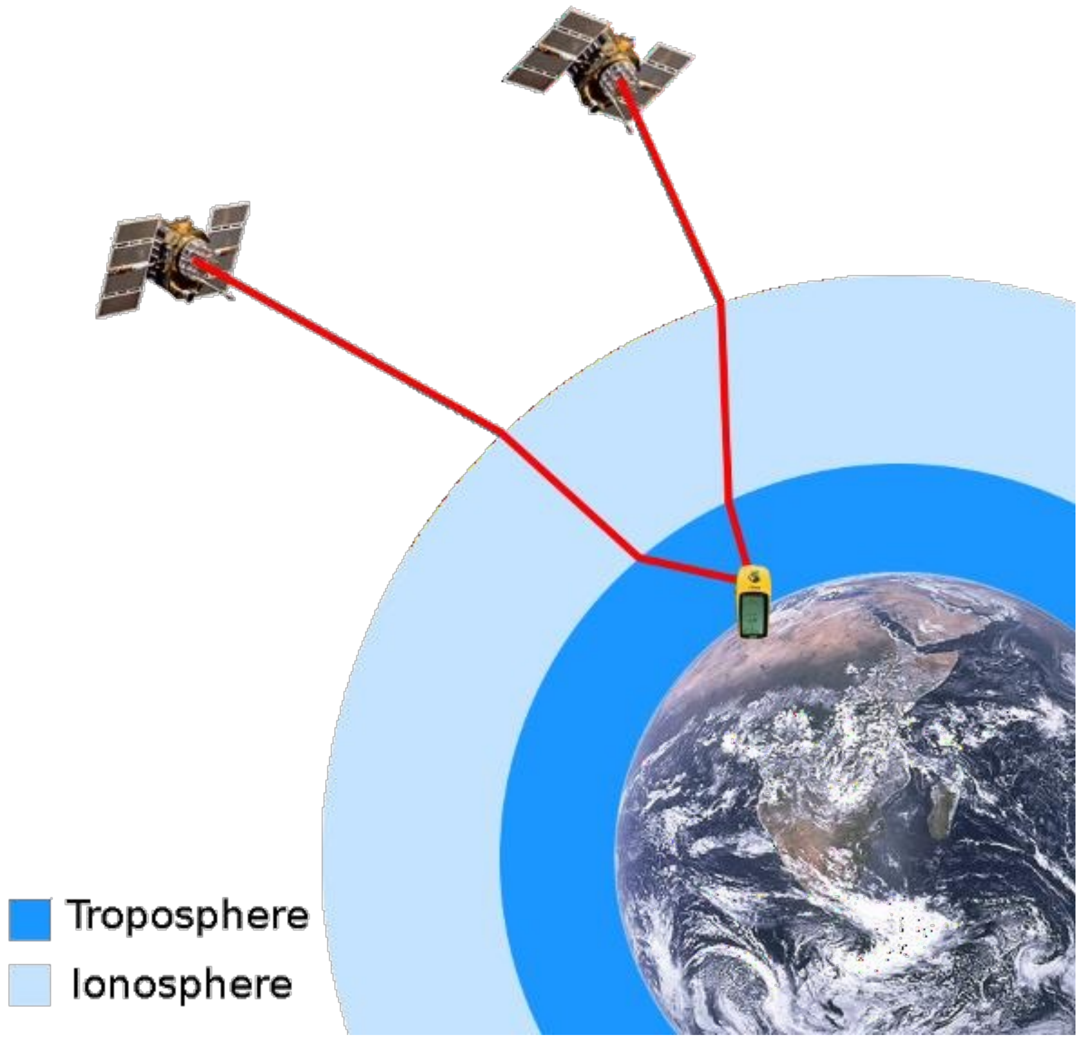
- The receiver determines location by using triangulation.
- When it receives signals from at least three Satellite the receiver should be able to calculate its approximate position (a 2D position)
- The receiver needs at least four or more satellite to calculate a more accurate 3D position.
- The position can be reported in latitude/longitude, UTM (Universal Transverse Mercator), or other coordinate system.

Basic Functions of GPS

GPS have following four basic functions;

- Position and coordinates (latitude, longitude, altitude).
- Direction of travel between any two points.
- Travel velocity.
- Accurate time of the day.

Sources of Error



Error on GPS Signal

Receiver Clock Error

■ Differences between satellite clock and receiver clock.

■A receiver's built-in clock may have slight timing errors because it is less accurate than the atomic clocks on GPS satellites.

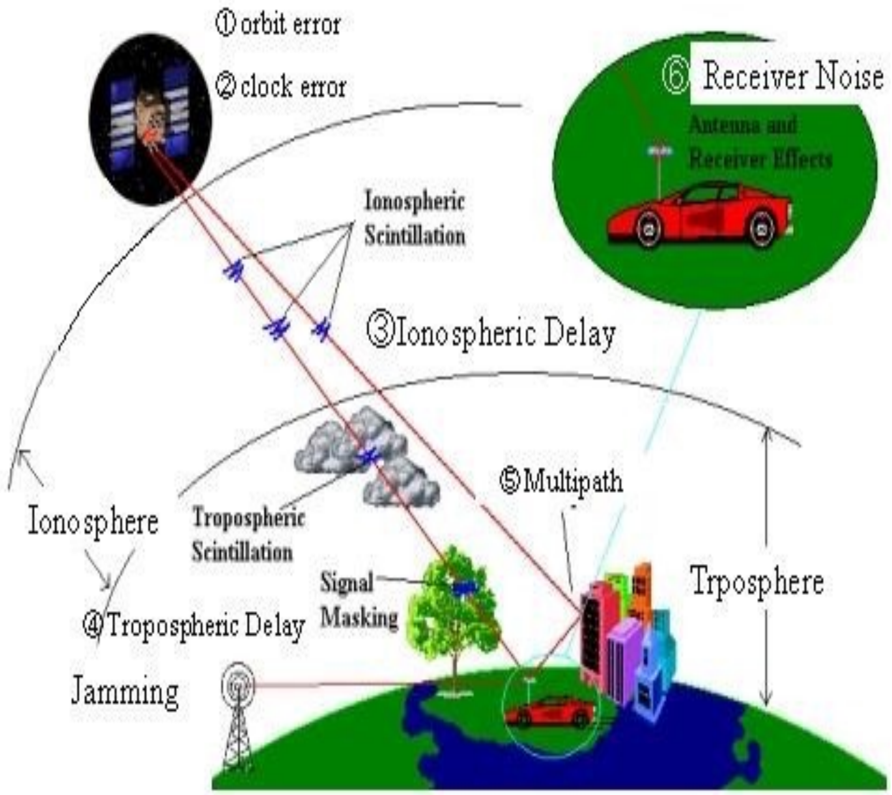
Ionosphere Delays

■Satellite signals slow as they pass through the atmosphere.

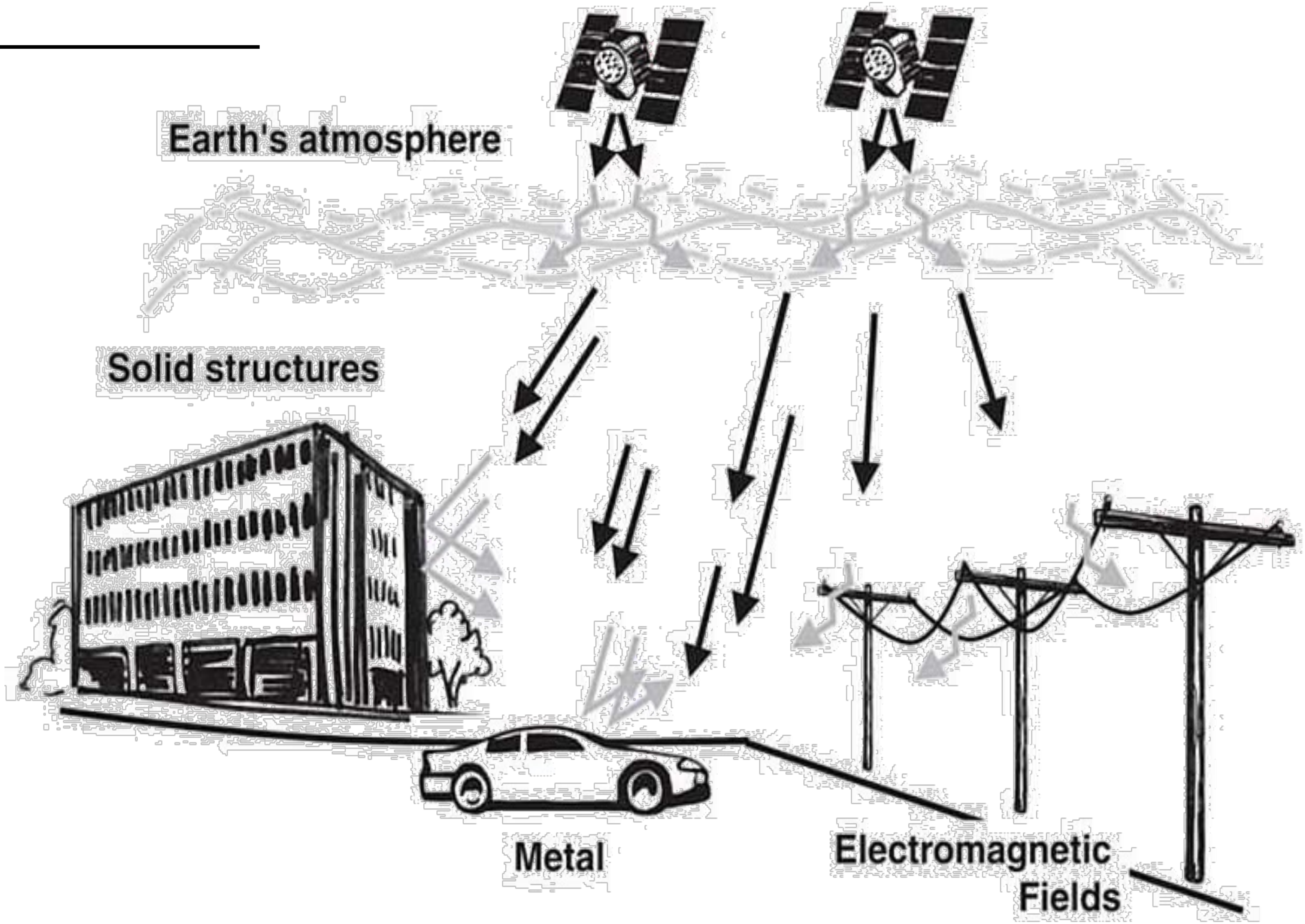
■ The GPS system uses a built-in model to partially correct for this type of error.

Signal Multipath Error

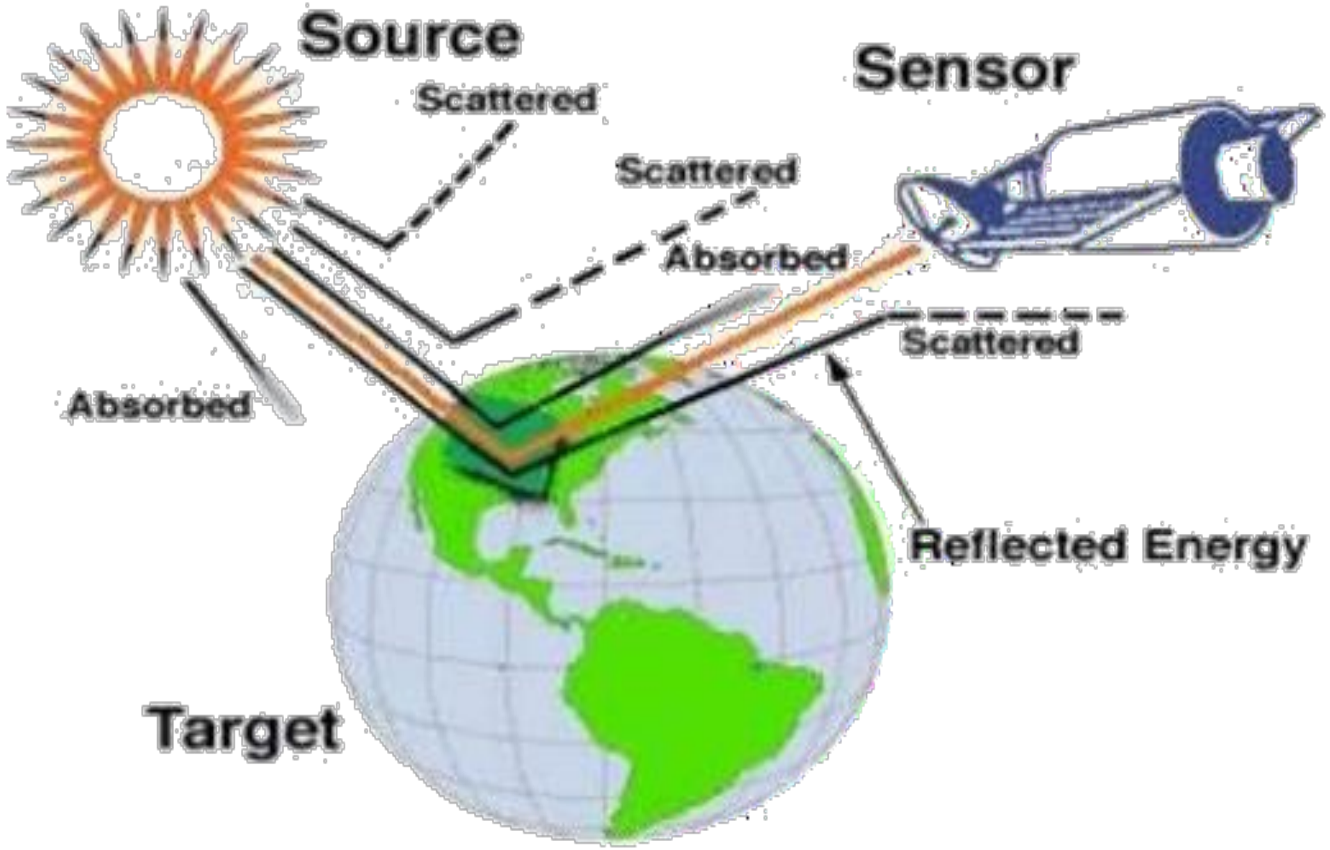
The GPS signal may reflect off objects such as tall buildings or large rock surfaces before it reaches the receiver, which will increase the travel time of the signal and cause errors.



Sources of Signal Interference



Remote Sensing



Remote Sensing

- Technique of obtaining information about objects through analysis of data collected by special instruments that are not in physical contact with the object of investigation.

- It is science of acquiring information about the earth's surface without actually being in contact with it.

- This is done by sensing and recording reflected or emitted energy and processing, analyzing and applying that information.

Remote Sensing

- The electromagnetic radiation is normally used as an information carrier in remote sensing.
- The output of a remote sensing is usually an image representing the sense being observed.
- The information need a physical carrier to travel from the object/events to the sensor through prevailing medium.

Need for Remote Sensing

- Systematic data collection.
- Repeatability.
- Global coverage.
- Multipurpose information.

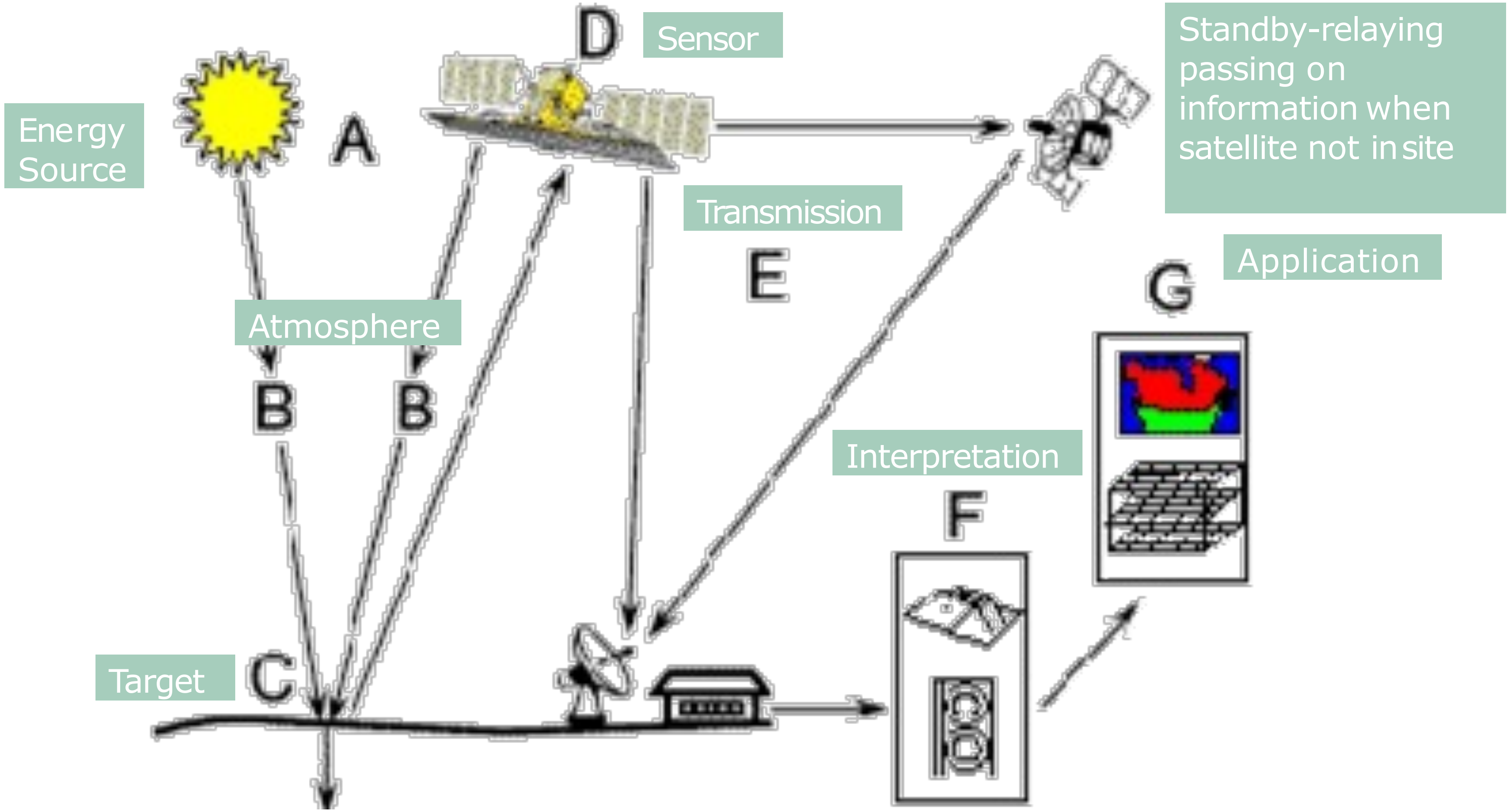
Who Uses Remote Sensing and Why?

- The geographer, who looks for change on Earth's surface that need to be mapped.
- The forester, who needs information about what types of trees are growing and if they have being affected by disease or fire.
- The environmentalist, who wants to detect, identify and follow the movements of pollutants such as oil slicks on the ocean.
- The geologist, who is interested in finding valuable minerals.

Who Uses Remote Sensing and Why?

- The farmer, who wants to keep an eye on how his crops are growing and if they have being affected by disease, pests, floods etc.
- The ship captain, who needs to find the best route through the northern ice packs.
- The Military, who sends out his crew based on information about the size and movement of forest.
- The urban planner, who wants to map and monitor land cover, land use, morphology etc.

Remote Sensing Process



Remote Sensing Process

1. Energy source or Illumination (A)

The first requirement of remote sensing is to have and energy source which illuminates or provides electromagnetic energy to the target of interest.

2. Radiation or Atmosphere (B)

- As energy travels from its source to the target, it will come in contact with and interact with atmosphere it passes through.
- This interaction may take place a second time as the energy travels from the target to the sensor.

3. Interaction with the Target (C)

Once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.

Remote Sensing Process

4. Recording of Energy by the Sensor (D)

After the energy has been scattered by, or emitted from the target, we require a sensor to collect and record the electromagnetic radiations.

5. Transmitting, Reception and Processing (E)

The energy recorded by the sensor has to be transmitted. Often in electronic form, to receiving and processing station where the data are processed into an image (hardcopy or digital)

6. Interpretation and Analysis (F)

The processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.

7. Application (G)

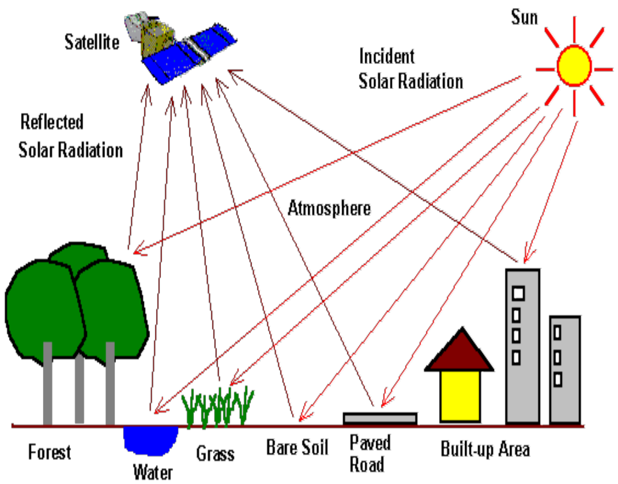
The final element of remote sensing process is to achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem .

Principal behind Remote Sensing

- Electromagnetic energy reaching the earth's surface from the sun is reflected, transmitted or absorbed.

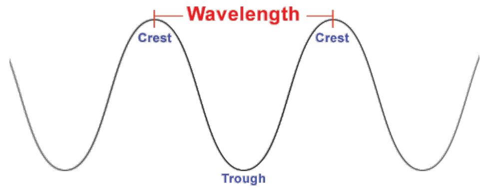
- Specific target have an individual and characteristic manner of interacting with incident radiation that is describe by the spectral response of that target.

- A projected coordinate system based on a map projection such as transverse Mercator, Albers equal area, or Robinson, all of which (along with numerous other map projection models) provide various mechanisms to project maps of the earth's spherical surface onto a two dimensional Cartesian coordinate plane. Projected coordinate systems are sometimes referred to as map projections.



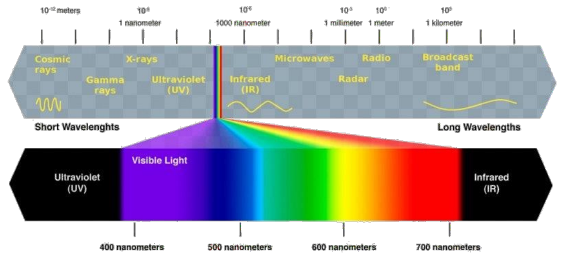
Principal behind Remote Sensing

- Electromagnetic radiation (EMR) like radio- waves, infrared (heat) waves make characteristic pattern as they travel through space.



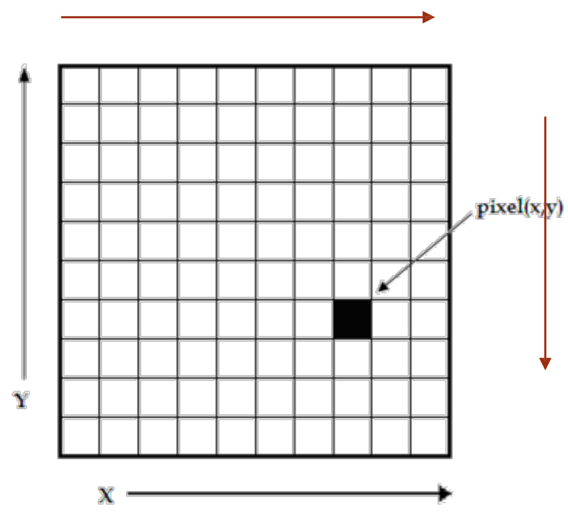
- Each wave has a certain wavelength
- The light which our eyes, remote sensors can detect is part of the visible spectrum.

- The visible wavelengths covers a range from approximately 0.4 to 0.7µm (1µm = 1x 10 -6 of a meter).



Data Recording

- An image is a two-dimensional representation of an objects in a real scene.
- Remote sensing images are the representation of parts of the earth surface as seen from the space.
- A digital image comprises of a two dimensional array of a picture elements called **pixels** arranged in column ad row.
- Each pixel represents an area on the earth's surface.
- A pixel has an **intensity** value and **location address** in the two dimensional image.



Platform and Sensors

Sensor:

A device that records electromagnetic Energy for example, camera, scanner.

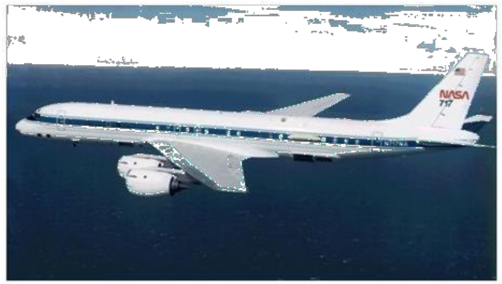
Platform:

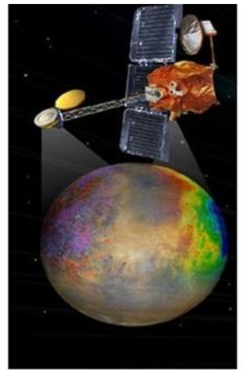
Carrier bed used to carry a sensor for example, airborne, space borne, ground etc.

Platform

- Platform are used to house the sensors which obtain data for remote sensing purpose.

- The distance between the target being imaged and the platform, plays a large role in determining the detail of information obtained and the total area imaged by the sensor.





- Platform are;

✓ Ground based

✓ Airborne eg. Aircarft, Drone.

✓ Space borne e.g. setellite

Advantages and Disadvantages of Platforms

Platform	Advantages	Disadvantages
Ground-based	• Can be used to identify the reflectance characteristics of an individual leaf, plant or area. • Flexible availability. • Useful for real-time spraying applications.	Collect the reflectance characteristic from a single point, not creating image.
Aircraft	• Relatively flexible availability. • Relatively high spatial resolution. • Changeable sensors.	• High cost. • Availability depends on weather condition.
Satellite	• Some free images. • Clear and stable images. • Large area within each image. • Good historical data.	• High cost high spatial resolution images. • Clouds may hide ground features. • Fixed schedule. • Data may not be collected at critical times. • May need to sort through many images to obtain useful information.

Types of Sensors

Passive Sensors:

- Passive system record energy reflected or emitted by target illuminated by sun.
- Examples; normal photography, most optical satellite sensors.

Active Sensors:

- Active system illuminates target with energy and measures reflection.
- Example; Radar sensors, Laser altimeter.
- RADAR (Radio Detection and Ranging), LIDAR (Light Detection and Ranging)