

SENSORS

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Sensors

- A device
- a device which detects or measures a physical property and records, indicates, or otherwise responds to it.
- Examples: SPOT, Landsat, ASTER, Quickbird, IKONOS etc

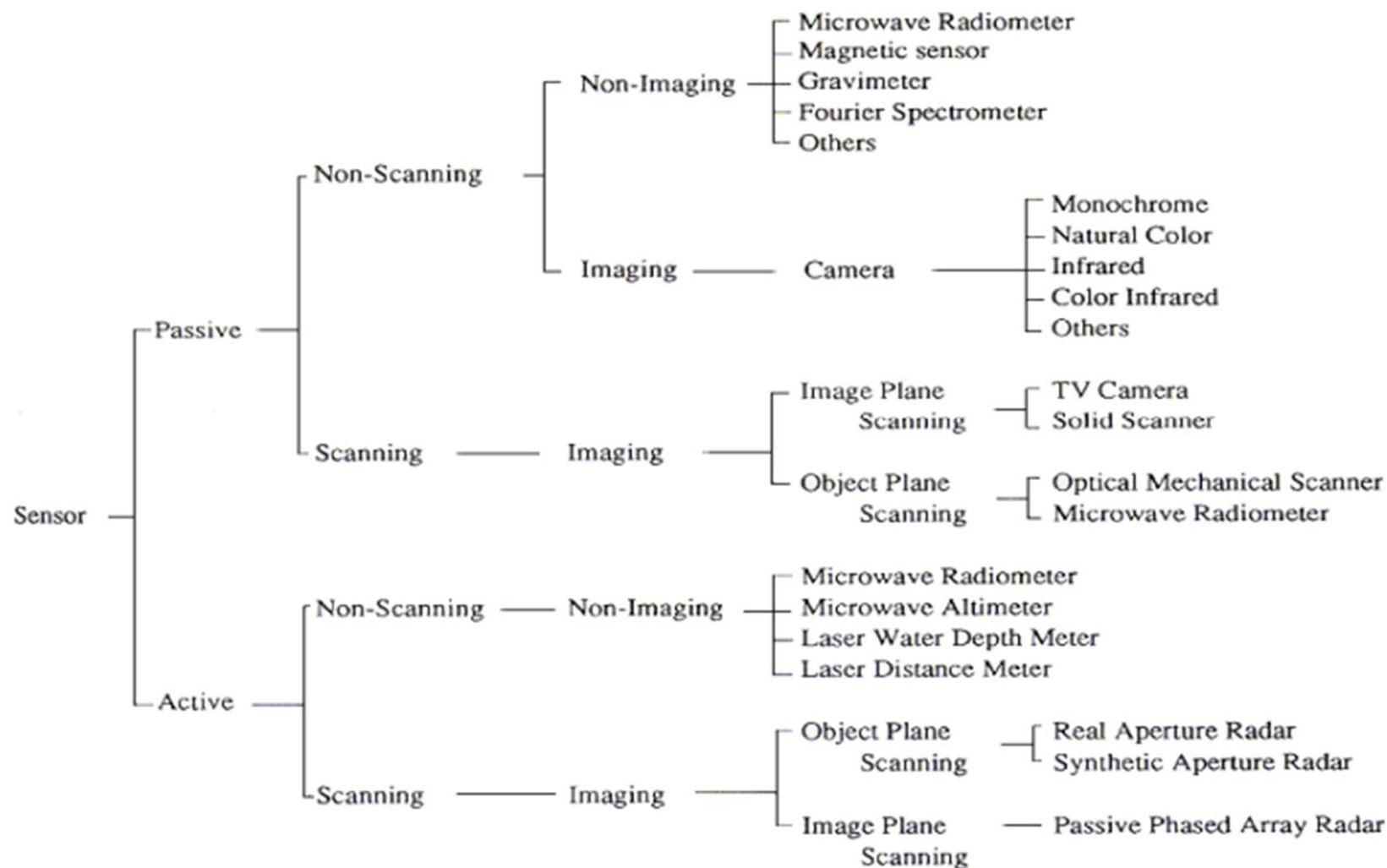
REMOTE SENSING SENSORS

Sensor

Definition in Remote Sensing :

Sensor is a device that gathers energy (EMR) converts into signal and present it in a form (image) suitable for obtaining information about the object under investigation

Types of sensors :

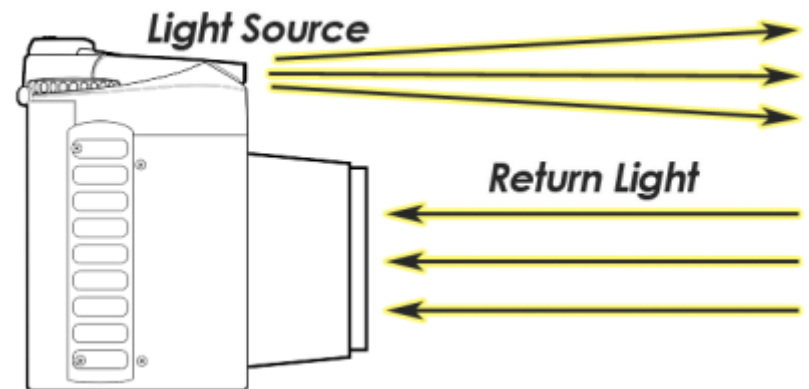
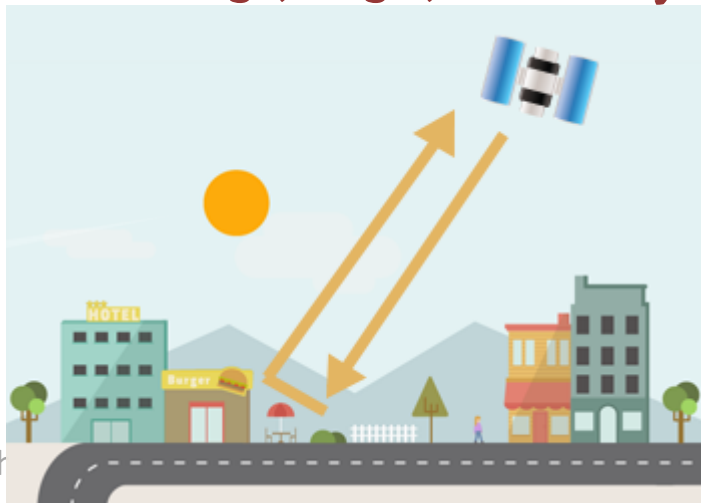


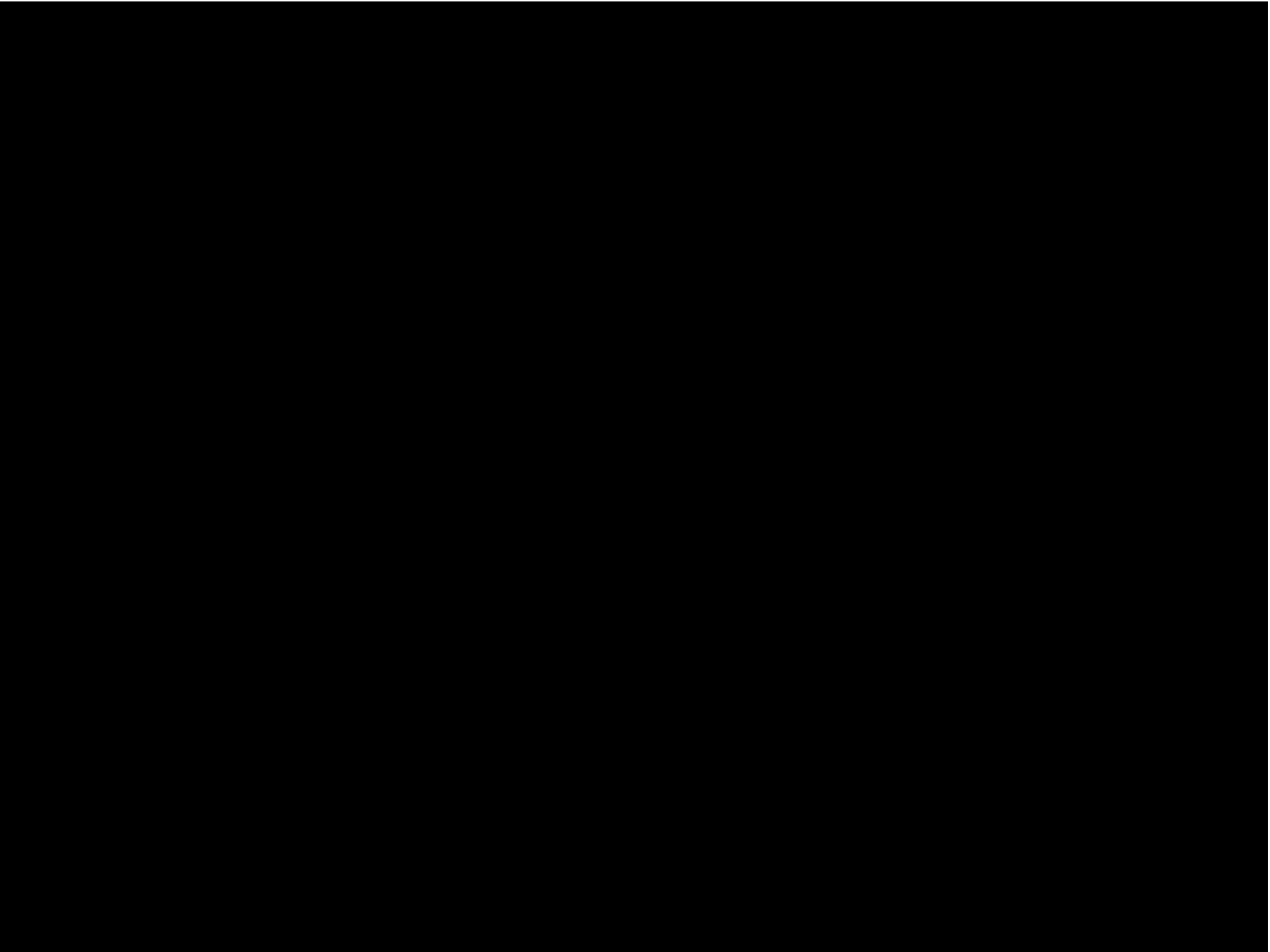
Types of Sensors

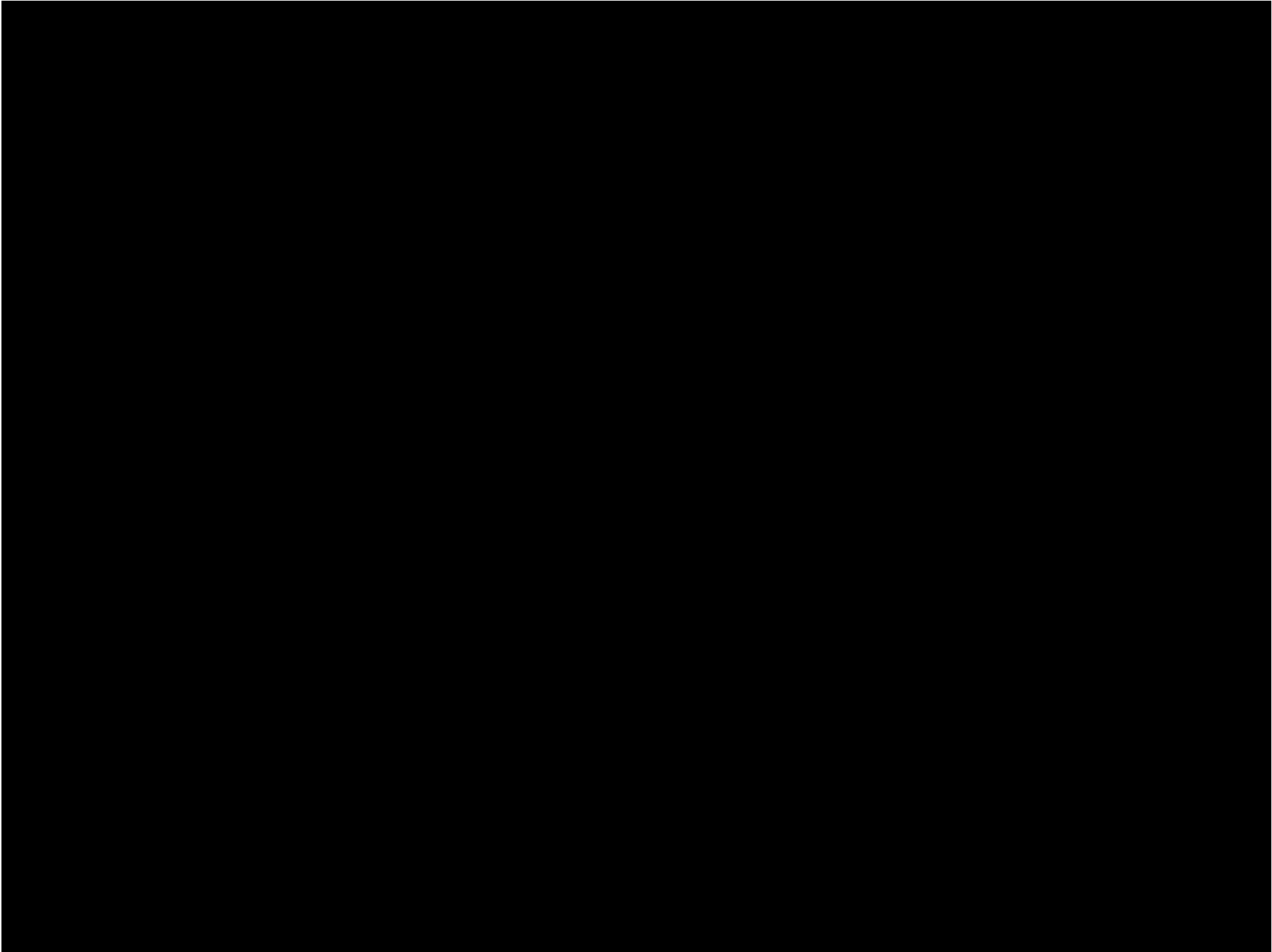
Active Sensors

- Provide own source of energy
- Active sensors emit radiation and measure what is sent back to them
- Example – Lidar and Radars are active sensors.

Radar is an object-detection system that uses radio waves to determine the range, angle, or velocity of objects.

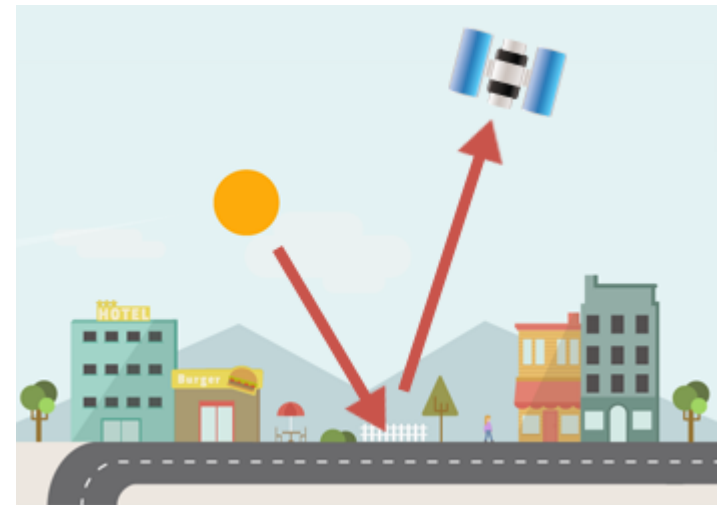
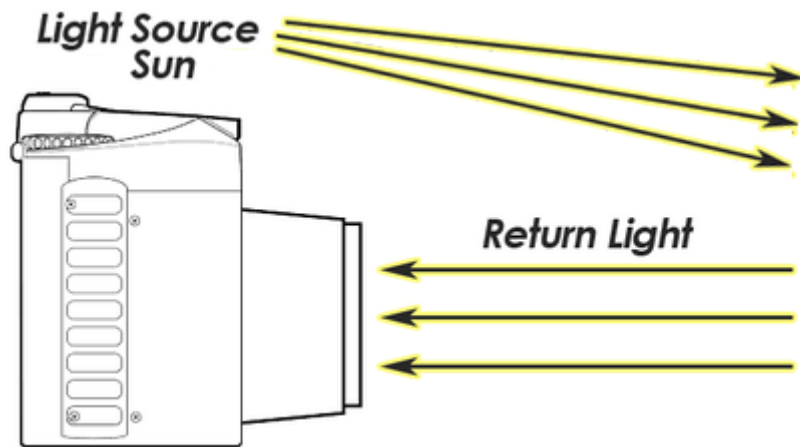






Passive sensors

- Sensor is not carrying it's own source of energy
- Passive sensors detect naturally occurring radiation
- Most satellites are passive sensors.
- Example : Accelerometer, Hyperspectral Radiometer, Imaging Radiometer, Sounder, Spectrometer, Spectroradiometer etc.



Non Scanning or Framing sensors:

Measure the radiation coming from entire scene at once

Ex: Our eyes, Photo cameras

Imaging sensors:

Form image by collected radiation

1. Scanning sensors: The scene is sensed by point by point or measure the radiation coming from point by point (equivalent to small areas within the scene)

Along track Scanners: Image is acquired by line by line

Across track Scanners: Image is acquired by pixel by pixel

2. Non imaging sensors:

- These sensors do not form the image
- These are used to record spectral quantity or parameter as a function of time

Ex: temperature measurement, study of atmosphere

Different Sensors

- **Panchromatic Imaging System**
- **Multispectral Imaging System**
- **Microwave Sensors**
- **Hyperspectral Imaging System**
- **Thermal Sensor**

Panchromatic Imaging System

- A panchromatic image is a single-band grayscale image with a high spatial resolution that “combines” the information from the visible R, G, and B bands.
- A single channel sensor is used to detect radiation. If range of wavelength and the visible range become same then the imagery will appear as a black and white photograph taken from space



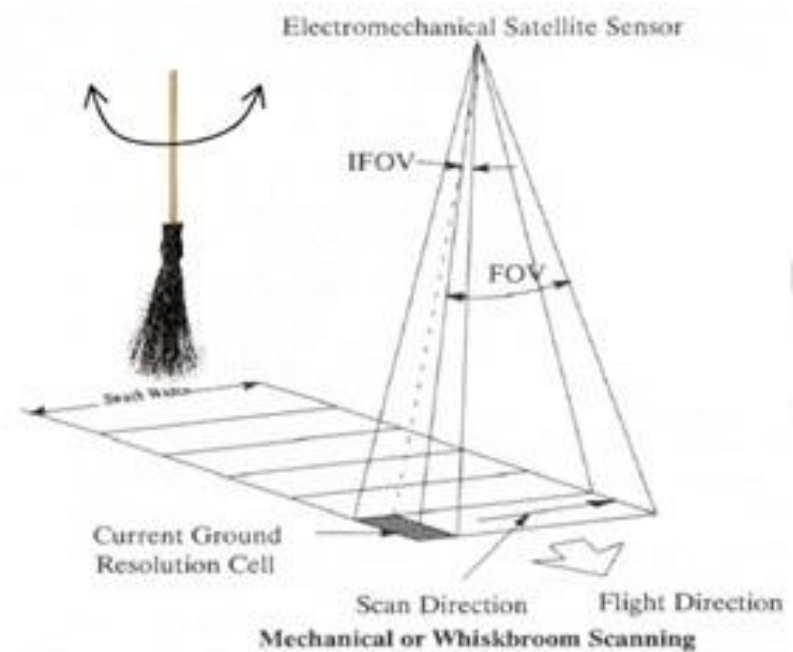
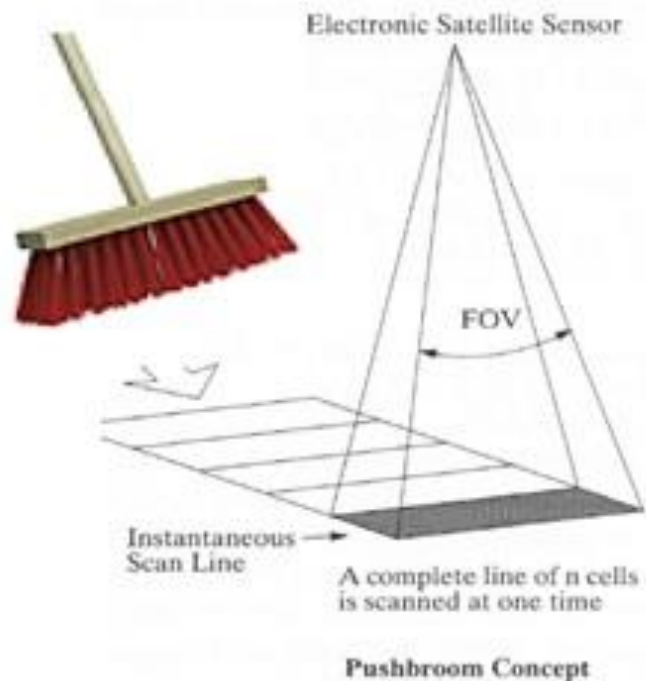
Multispectral Imaging System

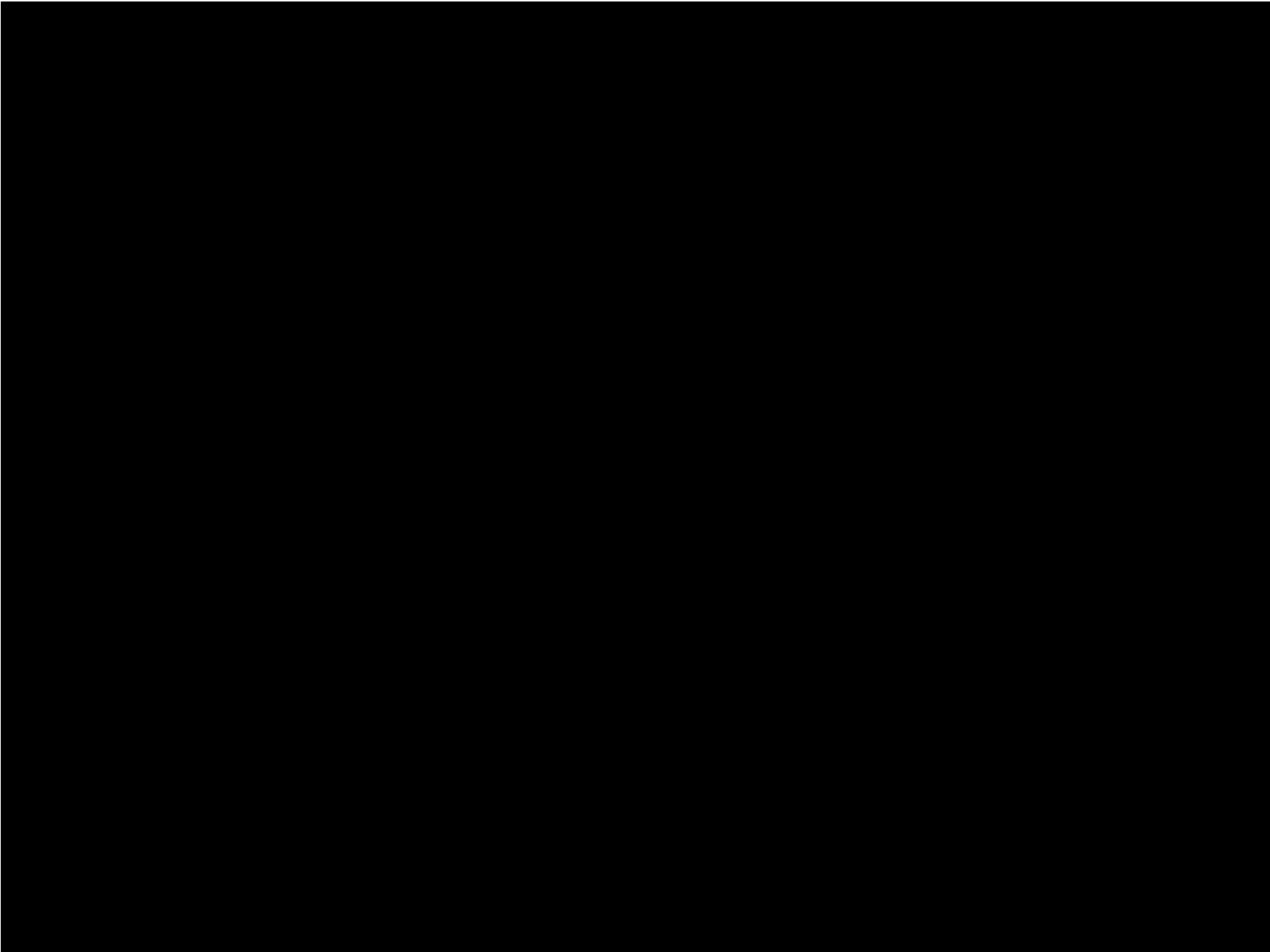
- Uses a multi channel detector and records radiation with a narrow range Brightness and color informatics are available



Scanner Types

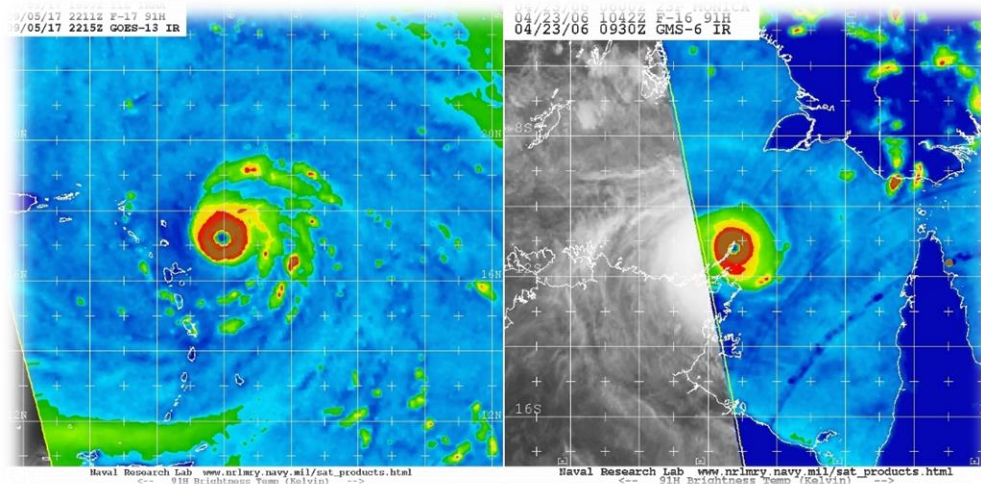
- **Pushbroom (along track)** (series of detector) — SPOT and IKONOS
- **Whiskbroom (across track)** — Landsat





Microwave Sensors

- A Microwave sensor uses high frequency radio waves operating at 360 degrees. They work in a similar way to radar, working on changes in the reflected radio waves. They are especially effective in Large areas such as Warehouses monitoring any changes in the return waves and responding immediately.



CHARACTERISTICS OF SENSORS

- Spatial resolution
- Spectral resolution
- Radiometric resolution
- Temporal resolution

What is Resolution?

- In general, resolution is about capturing or representing information with greater detail, accuracy, or clarity.
- Image resolution can be defined as the level of detail in an image. Raster images are comprised of a series of pixels, where resolution is the total number of pixels along an image's width and height, expressed as pixels per inch (PPI).

CHARACTERISTICS OF SENSORS

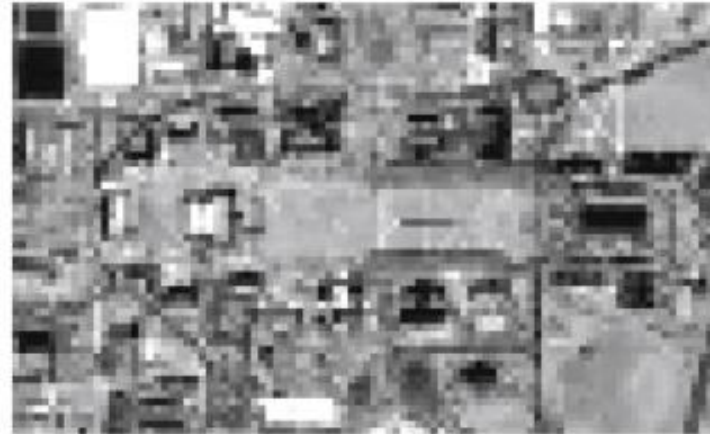
Spatial Resolution

- It refers to the size of the smallest possible object that can be detected
- It tells the pixel size on the ground surface
- In satellite imagery, spatial resolution determines the **level of detail visible in the images**. High-resolution satellites are used for tasks like urban planning, agriculture, and disaster monitoring.

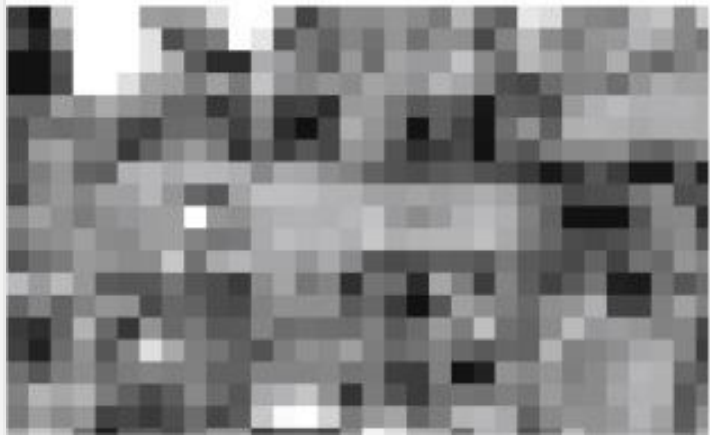
(A) 1 m



(B) 10 m



(C) 30 m

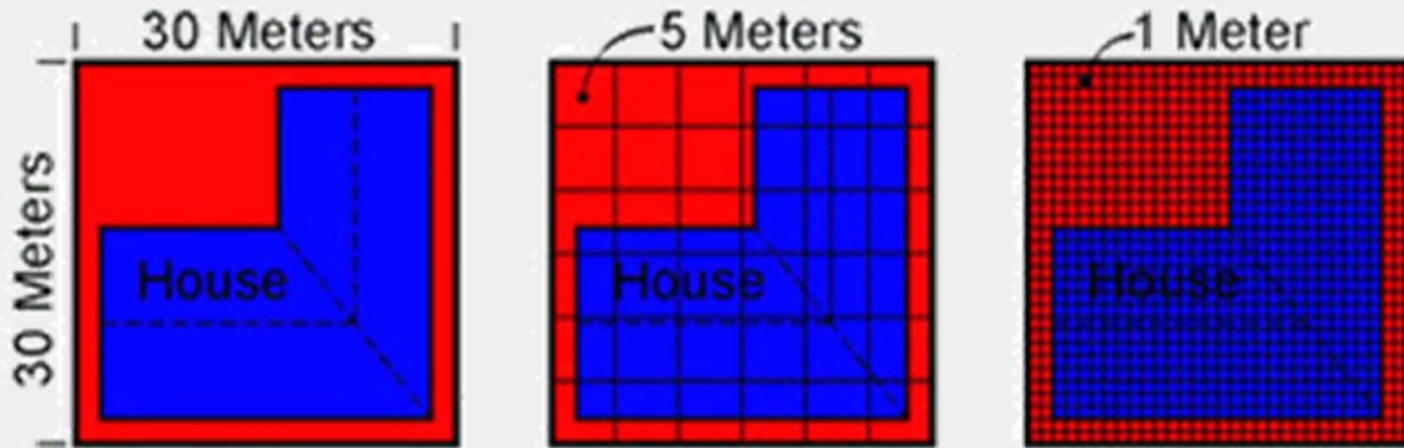


(D) 250 m

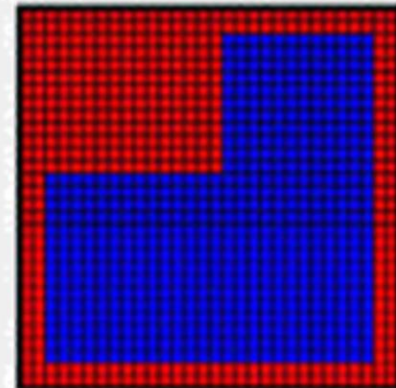
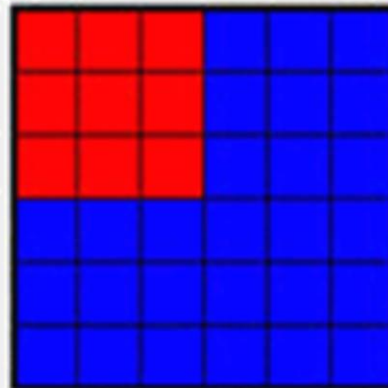


#Spatial resolution refers to the number of pixels in construction of the image

Pixel Size (Resolution)



Pixel Output (Display)



#Images having higher spatial resolution are composed with greater number of pixels than those of lower spatial resolution

The spatial resolution specifies the pixel size of satellite image covering the earth surface.

High spatial resolution – 0.41-4 m

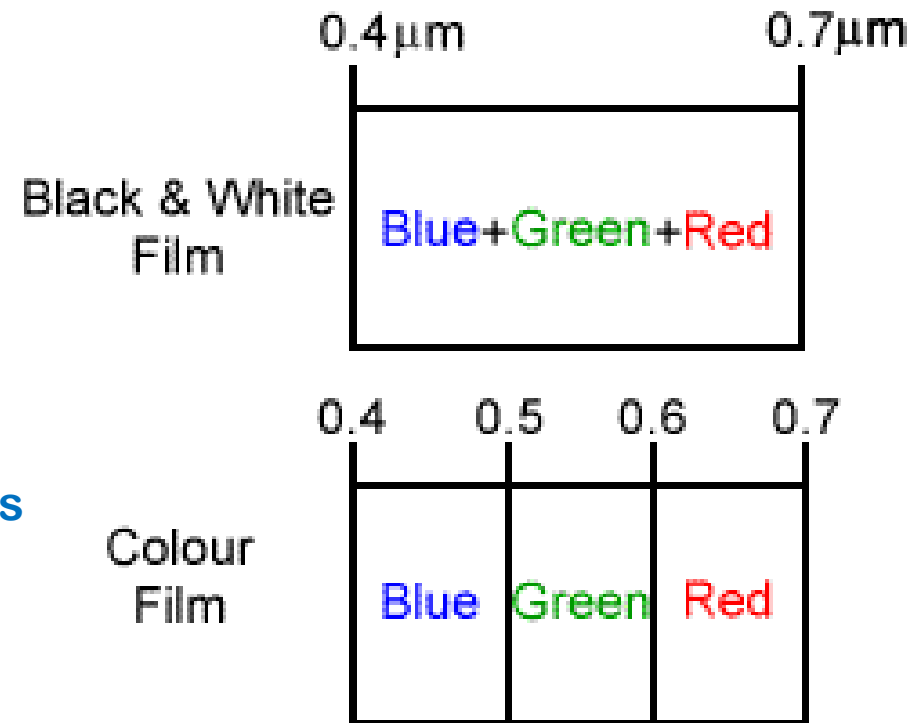
Low spatial resolution – 30 ->1000m

Spectral Resolution

- It describes the ability of a sensor to measure specific wavelength of the electromagnetic spectrum.
- Sand is appear as coarser in finer wavelength bands

#Spectral resolution refers to how many spectral “bands” an instrument records.

- High spectral resolution – 220 bands
- Medium spectral resolution – 3-15 bands
- Low spectral resolution – 3 bands



Radiometric Resolution

- Radiometric resolution refers to the ability of a sensor or imaging system to **distinguish between different levels of brightness** or intensity in an image.
- In remote sensing, for instance, it's essential for distinguishing different land cover types, identifying changes over time, and monitoring environmental conditions.
- In digital imaging, radiometric resolution is often expressed in terms of bit depth. For example, an 8-bit image can represent 256 different levels of intensity, with values ranging from 0 to 255. A 16-bit image can represent 65,536 levels, with values ranging from 0 to 65,535.
- **Landsat 88 have 16-bit data products**

8 bit Resolution

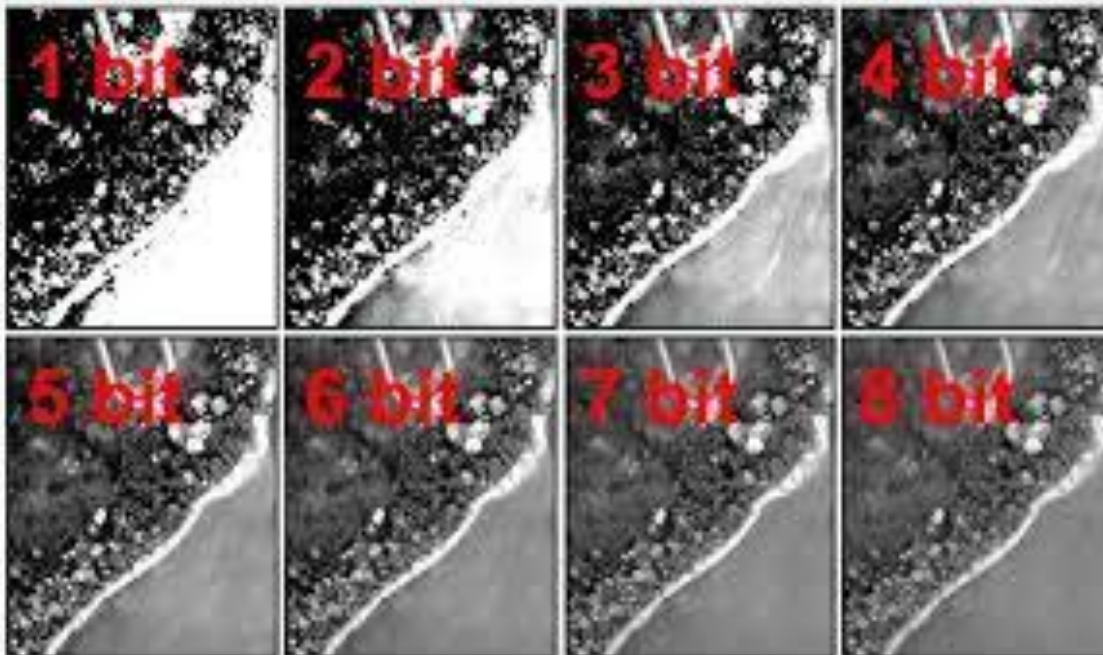
$$2^8 = 256 \text{ levels}$$

2 bit Resolution

$$2^2 = 4 \text{ levels}$$

1 bit Resolution

$$2^1 = 2 \text{ levels}$$



1 bit

2 bit

3 bit

4 bit

5 bit

6 bit

7 bit

8 bit

Temporal Resolution

Temporal resolution is a measure of the repeat cycle or frequency with which a sensor revisits the same part of the Earth's surface.

Temporal resolution of some popular satellites

Mission	Number of satellites	Temporal resolution (single satellite)	Temporal resolution (constellation)
SENTINEL-1	2	12 days	6 days
SENTINEL-2	2	10 days	5 days
LANDSAT 7	1	16 days	16 days
WorldView-3	1	1 day	1 day
Terra	1	16 days	16 days

A satellite with temporal resolution of 1 day is said to have a higher temporal resolution relative to a satellite with temporal resolution of 15 days.

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High temporal resolution - <24 hours -3 days

Medium temporal resolution – 4-16 days

Low temporal resolution - > 16 days

Major Satellite System

Resolution	Sensors
High Spatial Resolution	Quickbird, IKONOS, IRS-P6, OrbView-3, SPOT-5-PAN
Medium Spatial Resolution	Landsat-5-TM, Landsat-7-ETM+, ASTER, SPOT
Low Spatial Resolution	MODIS, ENVISAT, GOES, AVHRR, MSS