Ecol – 501 Remote Sensing and GIS

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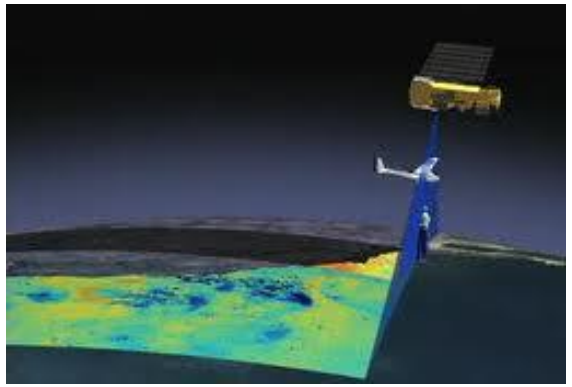

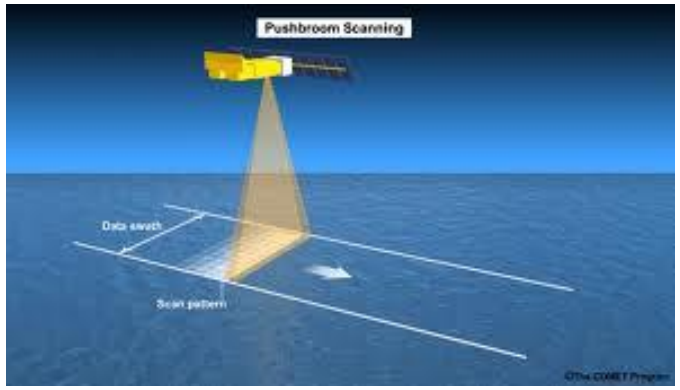

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Puducherry

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Content

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1. General Information

Course Code	:	ECOL - 501
Course Title	:	Remote Sensing and Geographical Information System
Number of Credits	:	4.5 ECTS
Course duration	:	18 Weeks
Level	:	Postgraduate
Course Teacher	:	Prof. S. Jayakumar
Prerequisite	:	Basic understanding on Mathematics (school higher level), English language skill, computer operation (Windows/Mac).

2. Course description

This 3 ECTS course provides the students the fundamentals of remote sensing and Geographical information system. It teaches the characteristics of different frequencies of electromagnetic radiation and its interaction with atmosphere and earth's surface. This course introduces the reflective, thermal and microwave remote sensing to students. It also makes the students understand the aerial photography, photogrammetry and global positioning system. It introduces the concept of image interpretation and various sensor characteristics. It makes the students understand the concept of data structures and basic spatial modelling concepts.

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3. Course goals

The main course objective is to make the students understand the fundamentals and applications of remote sensing and Geographical information system in natural resources management. To enable the students understand the different types of remote sensing, sensor characteristics, payload. To make the students understand how EMR interacts with earth's surface. To give students fundamental and applications of GPS. To introduce the students to the theory of spatial data structure, projections and coordinate systems. To make them understand the thematic maps, weightage and spatial modeling.

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4. Course outcome

By the end of the course, successful students will:

1. Know the principles of remote sensing, GIS and GPS
2. Understand the interactions of EMR with earth's materials.
3. Be able to distinguish the significance between reflective, thermal and microwave remote sensing
4. Understand the payload characteristics and how to determine different resolutions
5. Know the basics of coordinate system and projections
6. Know the concept of digitalization, and thematic map preparation.
7. Know the basic data structure in GIS and their significance.
8. Be familiar with the data integration and weightages used in spatial modeling.
9. Know the basic concept of modeling and how to conceptualize a model.
10. Understand the applications of RS and GIS in various fields.

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5. Course structure

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5.a. Course Content

Week -1	**Fundamentals of remote sensing**
	Components of RS
Week -2	Electromagnetic radiation
	Atmospheric window and effects of atmosphere
	Principles of Scanner and CCD array
Week -3	Types of Sensor and bands
	The pixel
	Spectral reflectance of soil, water and vegetation
Week - 4	Thermal Remote Sensing
	Microwave Remote Sensing
Week - 5	Satellite and Sensors
	Satellite orbits and for different resolution
Week - 6	Digital image processing-mosaicing, histogram equalization
	Image Classification
Week - 7	Air borne and space borne data: Fundamentals of photogrammetry, aerial cameras, planning of aerial photography
Week - 8	Planning of aerial photos and characters of aerial photo
	Types of Aerial photos, Photogrammetry
Week - 9	Elements of aerial photo interpretation
Week - 10	Satellite data availability - Indian space agency - data centre and USGS Earth Explorer

5. Course structure

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5.a. Course Content

Week - 11	**GIS terms and terminologies**
Week - 12	GIS components
	How to create a thematic map from satellite image
	Raster and Vector data structure
Week - 13	Map Projection and coordinate system
	Digital Cartography and elements of map
Week - 14	Overlay analysis
	Weighted overlay analysis
Week - 15	Fundamentals and applications of Navigation system
	Classification Methods and RS in forestry
Week - 16	RS in forestry and water
Week - 17	RS in LULC Mineral Disaster
	RS in Forest fire
	RS in Agriculture

5. Course structure

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5.b. Mode of delivery

In-Class teaching

Google Classroom

On-line teaching

Students will get enrolled in Google classroom
And online classes will be conducted if covid -19 conditions do not permit to conduct off-line classes

5. Course structure

5.c. In-class discussion

The discussion will focus on how to map natural resources using the relevant satellite data, classification technique and selecting appropriate scale.

5.d. In-class assignments & field assignment

Understanding satellites and sensors available and preparedness for field study, data collection, and data quality standards and ground truth verification.

5.d. Reading and discussion of assigned papers for seminars

Understanding the level of RS and GIS technique integrated in the study, debate the novel approach in the methodology, need for such studies, data and tools utilized.

5.e. Group project presentation

Students will conduct group project and make a presentation in the class.

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6. Course Assessment

Type of assessment	Percentage of Marks
In-class discussion	5
Assignment	5
Seminars	10
Group projects	10
Internal assessment test (MCQ types)	10
Final assessment	60
Total	**100**

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7. References

1. Emery W. and Camps A., (2017) Introduction to Satellite Remote Sensing 1st Edition Atmosphere, Ocean, Land and Cryosphere Applications, Elsevier Publications
2. Rees W.G (2013) Physical Principles of Remote sensing (3rd edition), Scott polar,
3. Research Institute, University of Cambridge, New York.
4. George Joseph (2008) Fundamentals of Remote Sensing (2nd edition), Universities press, Hyderabad.
5. Lillies T. M. and Kiefer R.W (2003) Remote Sensing and Image Interpretation, John Wiley and Sons.
6. Raizer, V (2017) Advances in Passive Microwave Remote Sensing of Oceans 1st Edition CRC Press
7. Solimini, D., (2016) Understanding Earth Observation: The Electromagnetic Foundation of Remote Sensing (Remote Sensing and Digital Image Processing) 1st Edition, Springer;
8. Estes J. E., and Senger, L.W. (1973), Remote Sensing Techniques for Environmental Analysis, John Wiley and Sons New York.
9. Fischer, and Nijkamp, P (1993). Geographic Information Systems – Spatial Modeling and Policy Evaluation, Springer – Verlag.

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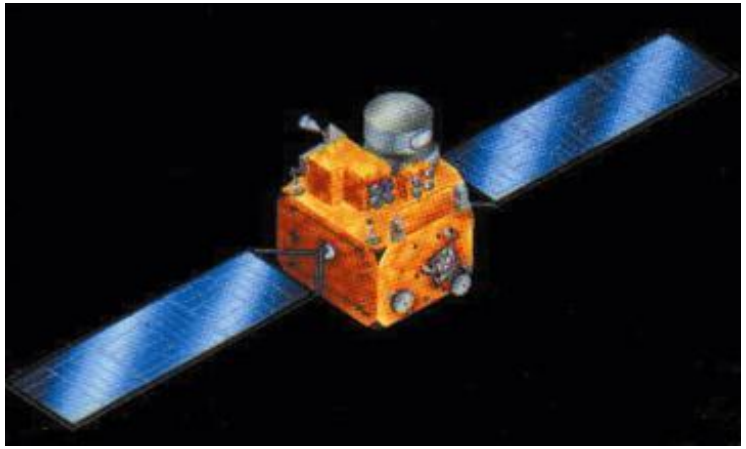
Introduction to Remote Sensing

1. Remote Sensing is the acquisition of physical data of an object without touch or contact (Fintz and Simonett, 1976)

2. Remote Sensing is the acquisition of data about an object or scene by a sensor that is far from the object (Colwell, 1983)

3. Information about the earth's land and water areas from the images/data acquired at a distance (Campbell, 1987)



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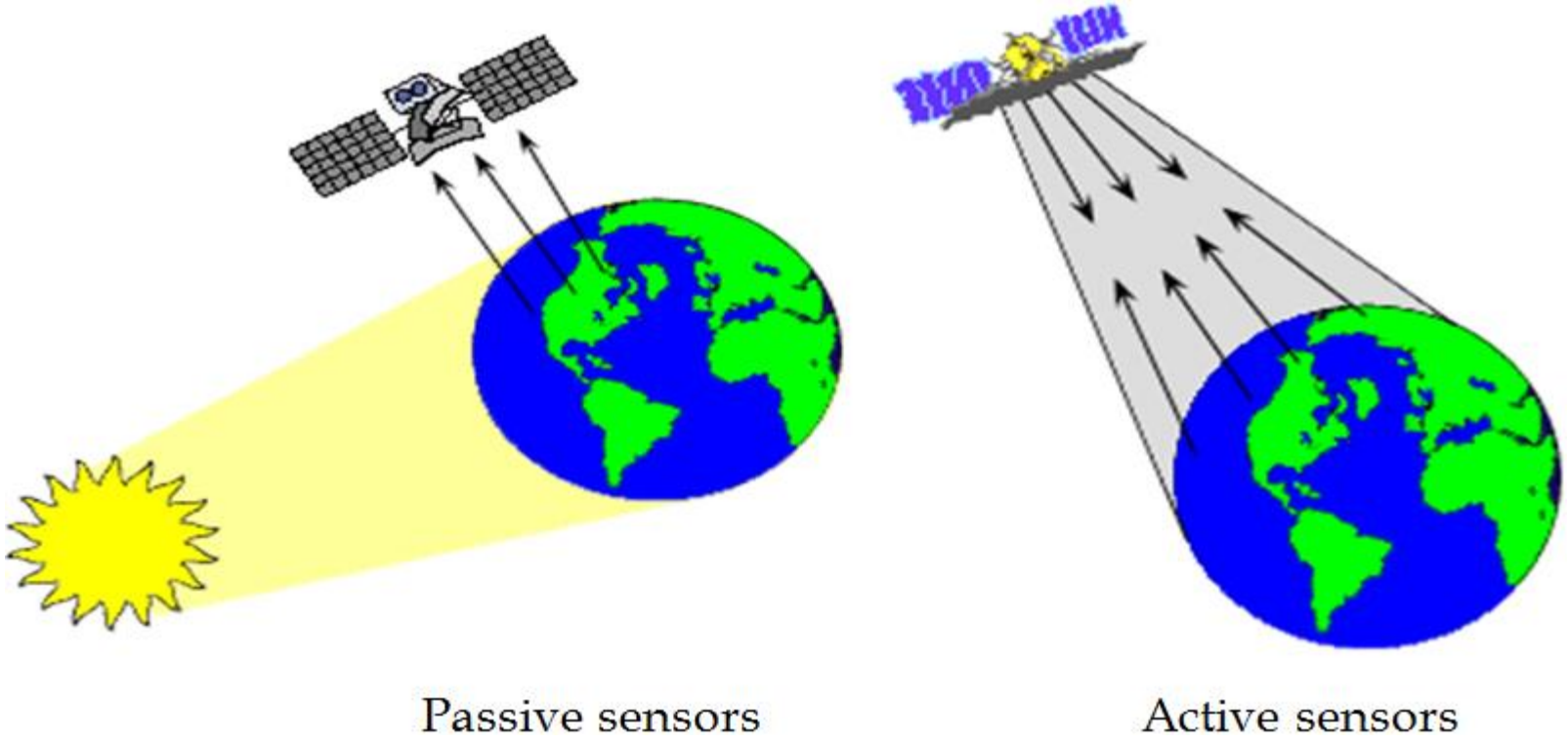
Types of Remote Sensing

- **Active**
- **Passive**



Electromagnetic Spectrum

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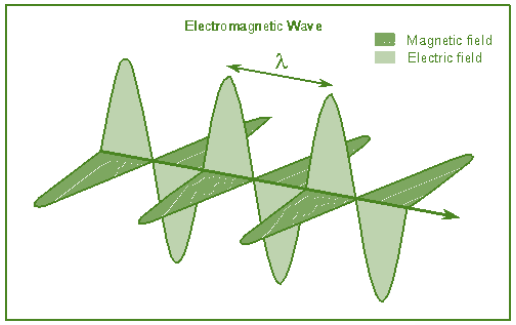
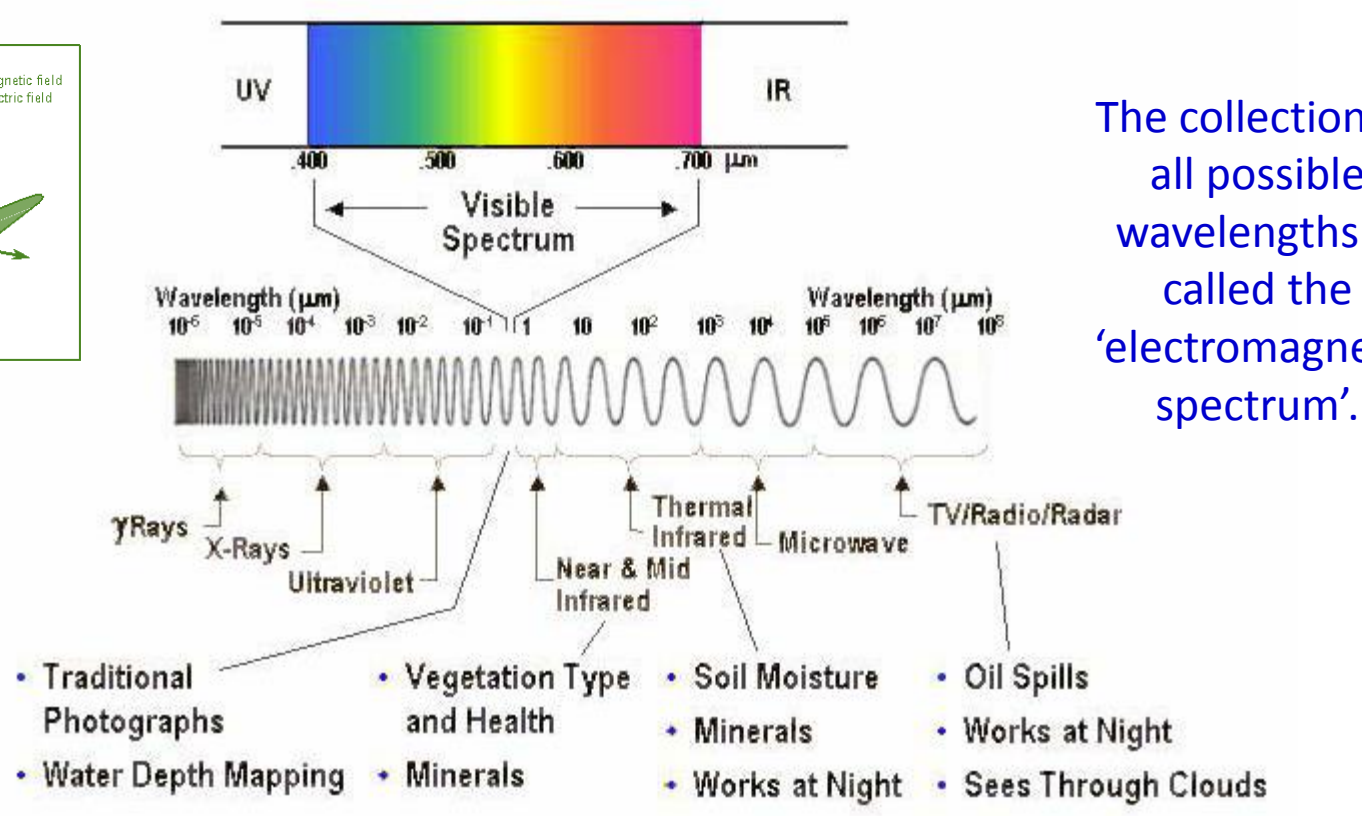
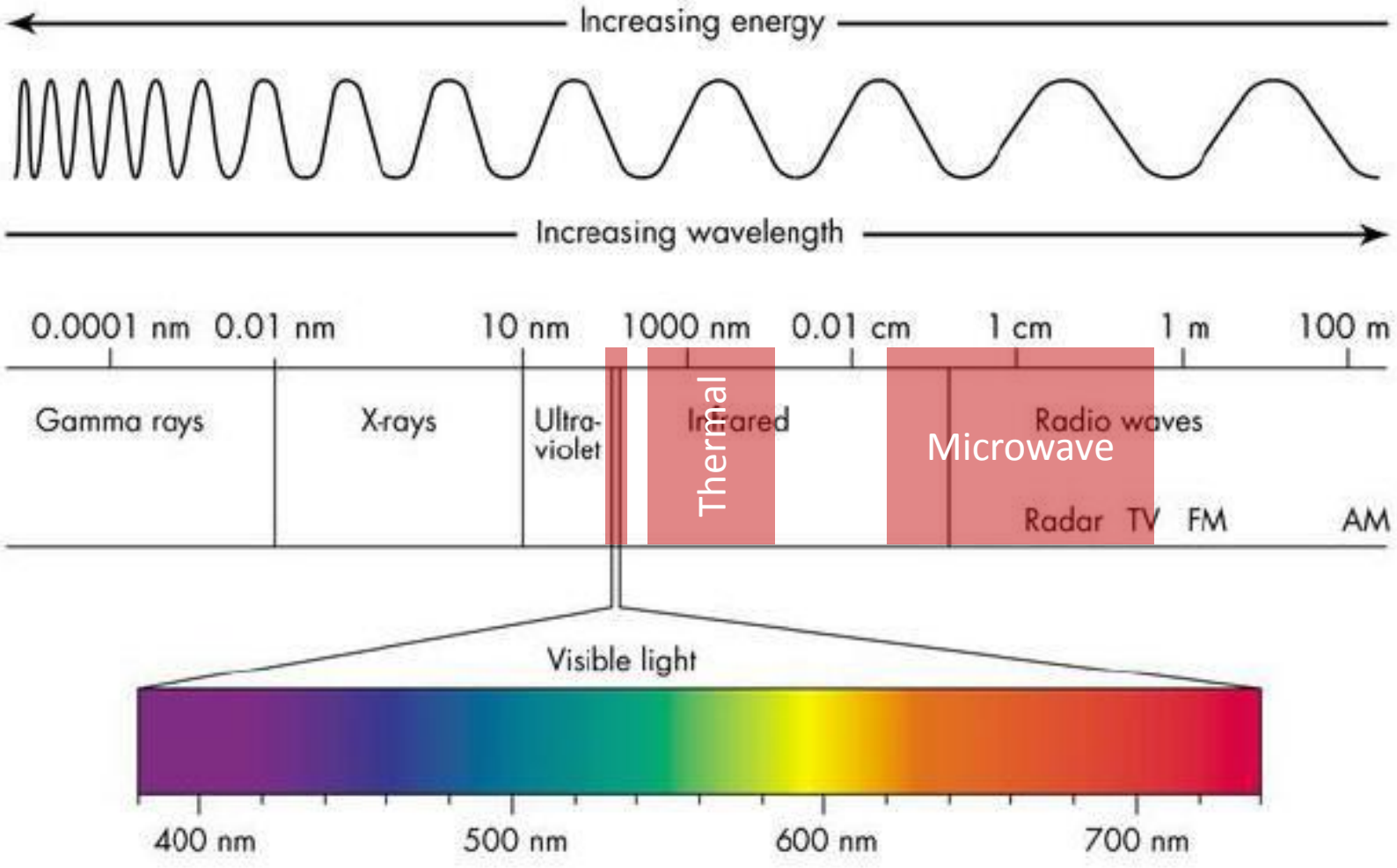
Electromagnetic radiation is, the energy propagated through space between electric and magnetic fields. The electromagnetic spectrum is, the extent of that energy ranging from cosmic rays, gamma rays, X-rays to ultraviolet, visible and infrared radiation including microwave energy and television & radio waves.





The collection of all possible wavelengths is called the 'electromagnetic spectrum'.

EMR – Remote sensing



EMR – Remote sensing

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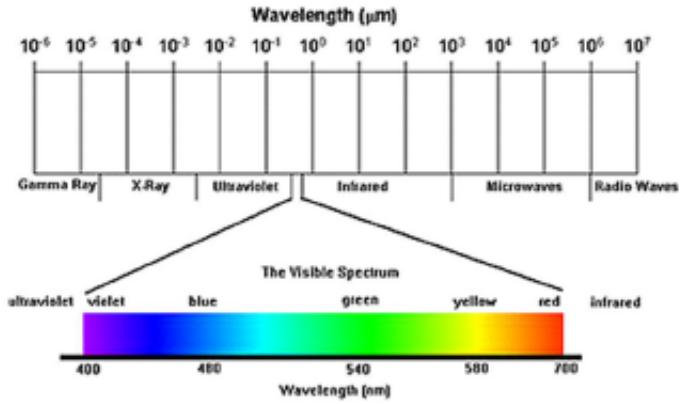
The Electromagnetic Spectrum



Infrared: 0.7 to 300 μm wavelength.

Near Infrared (NIR): 0.7 to 1.5 μm.
Short Wavelength Infrared (SWIR): 1.5 to 3 μm.
Mid Wavelength Infrared (MWIR): 3 to 8 μm.
Long Wanelength Infrared (LWIR): 8 to 15 μm.
Far Infrared (FIR): longer than 15 μm.

The NIR and SWIR - **Reflected Infrared**
The MWIR and LWIR are the **Thermal Infrared**.

Wavelength units: 1 mm = 1000 μm;
1 μm = 1000 nm.

X-Rays and Gamma Rays
Ultraviolet: 3 to 400 nm

Visible Light: 400 nm (violet) to about 700 nm (red) – fall roughly within the following wavelength regions:

Red: 610 - 700 nm
Orange: 590 - 610 nm
Yellow: 570 - 590 nm
Green: 500 - 570 nm
Blue: 450 - 500 nm
Indigo: 430 - 450 nm
Violet: 400 - 430 nm

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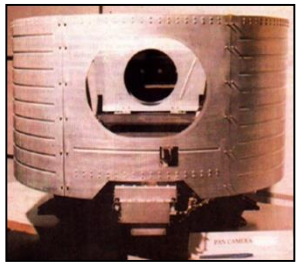
Principles of Scanner and CCD arrays

The sensor is a device used to acquire a photograph or an image.

- Sensors will sense and measure the amount of radiated energy reflected from an object and record it.

- The word ‘Sensor’ is normally used for the device used to acquire images in remote sensing
- The amount and range of the radiation that the sensor is capable of sensing, is specific to each type of sensor.



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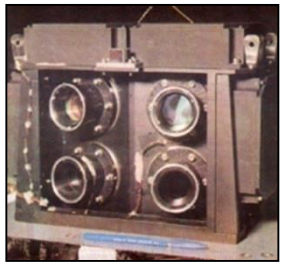
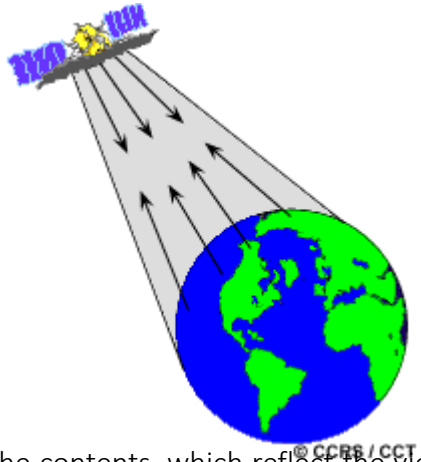


WiFS

Active and Passive Sensors

- A sensor, which measures wavelengths reflected or emitted by the objects under observation, is called a Passive Sensor.

- Active sensors emit radiation that reflects off objects and only the little energy returned to the sensor is measured – Radars.



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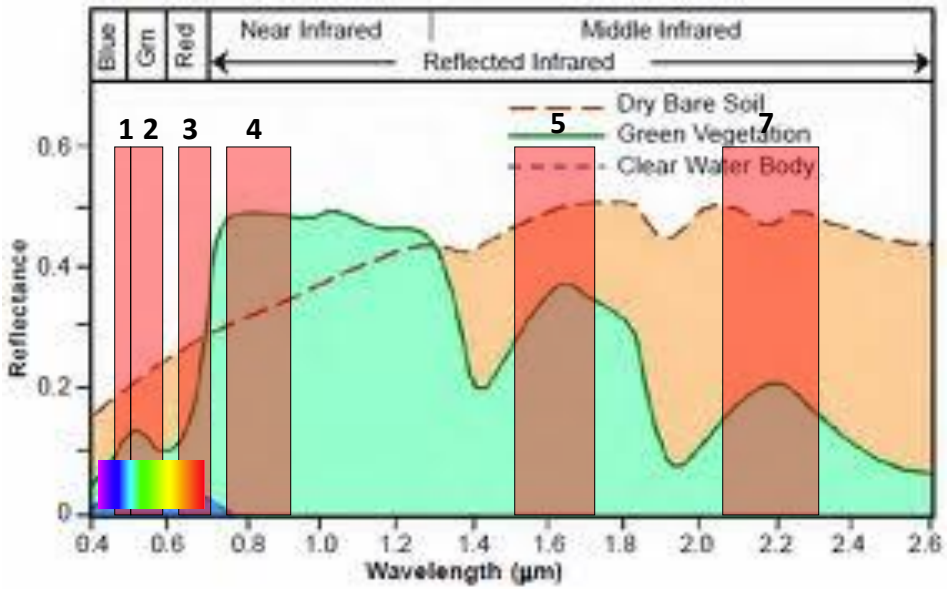
Bands / Channels

In remote sensing, we don't use the full range of visible spectrum.



Landsat - Thematic Mapper

Band No.	Wavelength Interval (µm)	Spectral Response	Resolution (m)
1	0.45 - 0.52	Blue	30
2	0.52 - 0.60	Green	30
3	0.63 - 0.69	Red	30
4	0.76 - 0.90	Near IR	30
5	1.55 - 1.75	Mid-IR	30
6	10.40 - 12.50	Thermal IR	120
7	2.08 - 2.35	Mid-IR	30

The choice of the bands has to be done in order to optimize the difference in reflection of most land cover types to be separated

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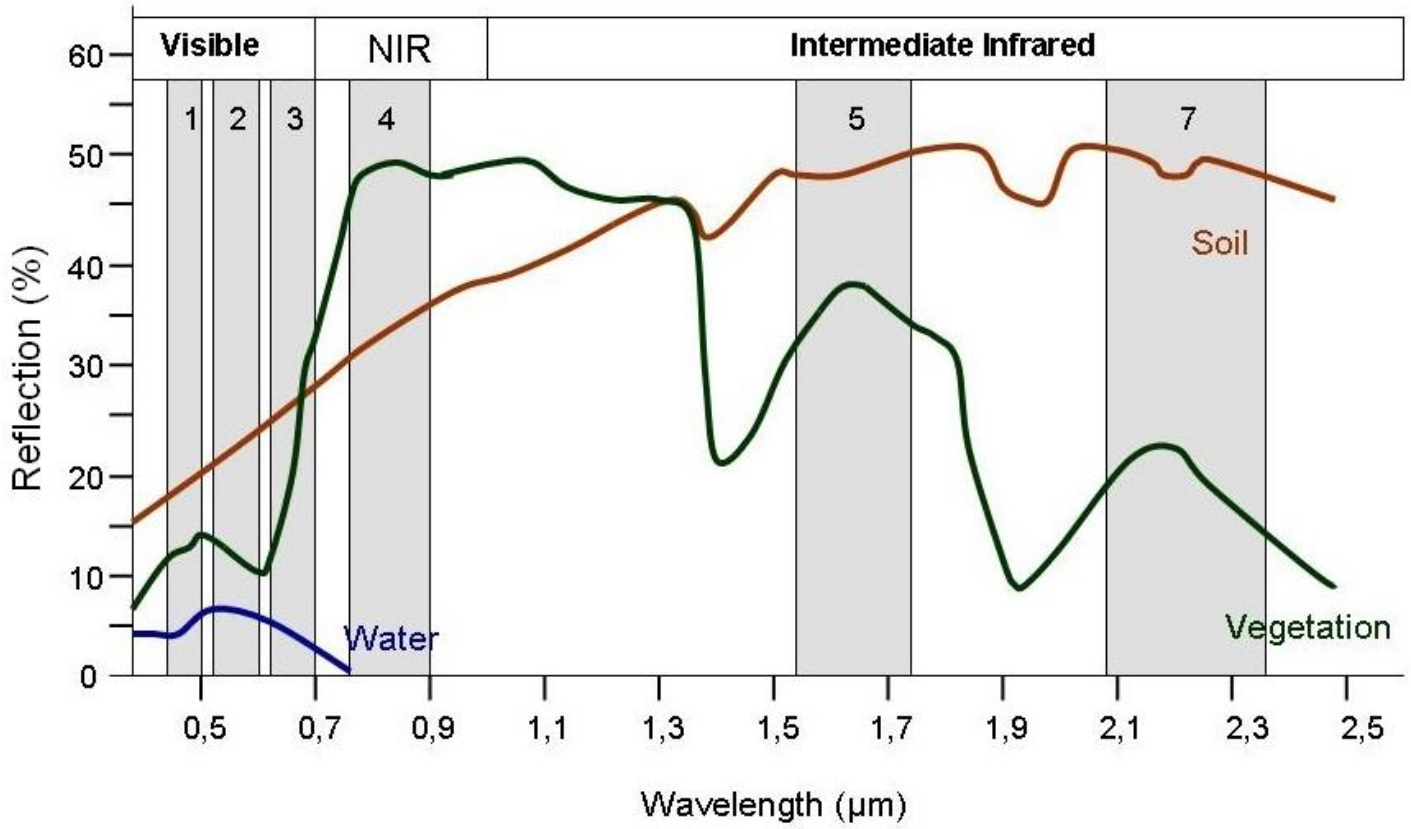
Spectral characteristics of Surface features

a. Soils, b. Vegetation, c. Water



Thermal Sensing

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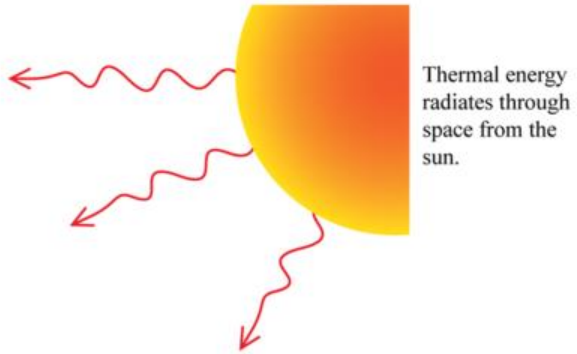
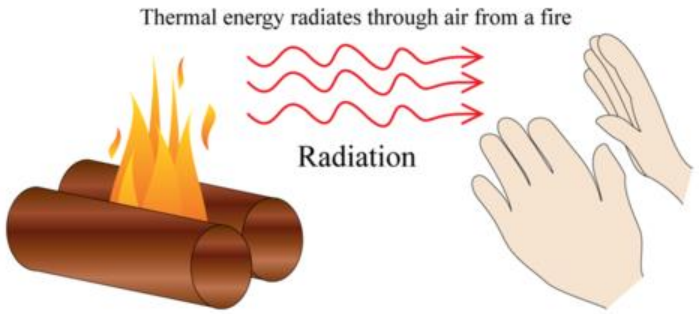
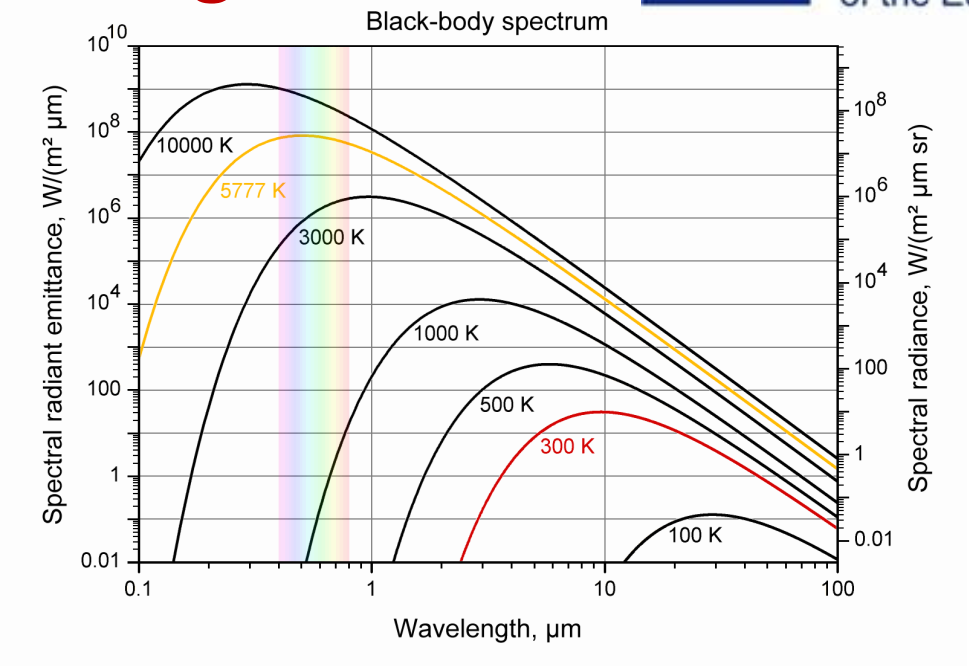
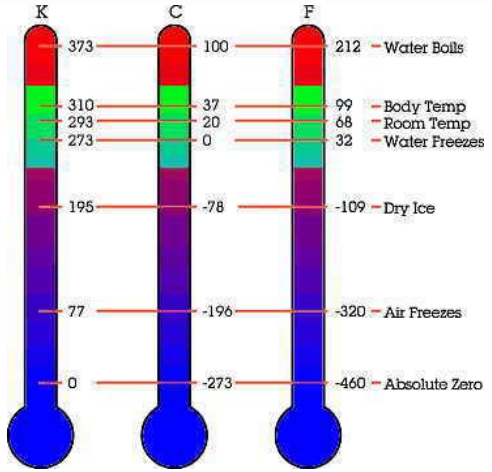
Radiation

Type of radiation being emitted depends on the temperature of the object

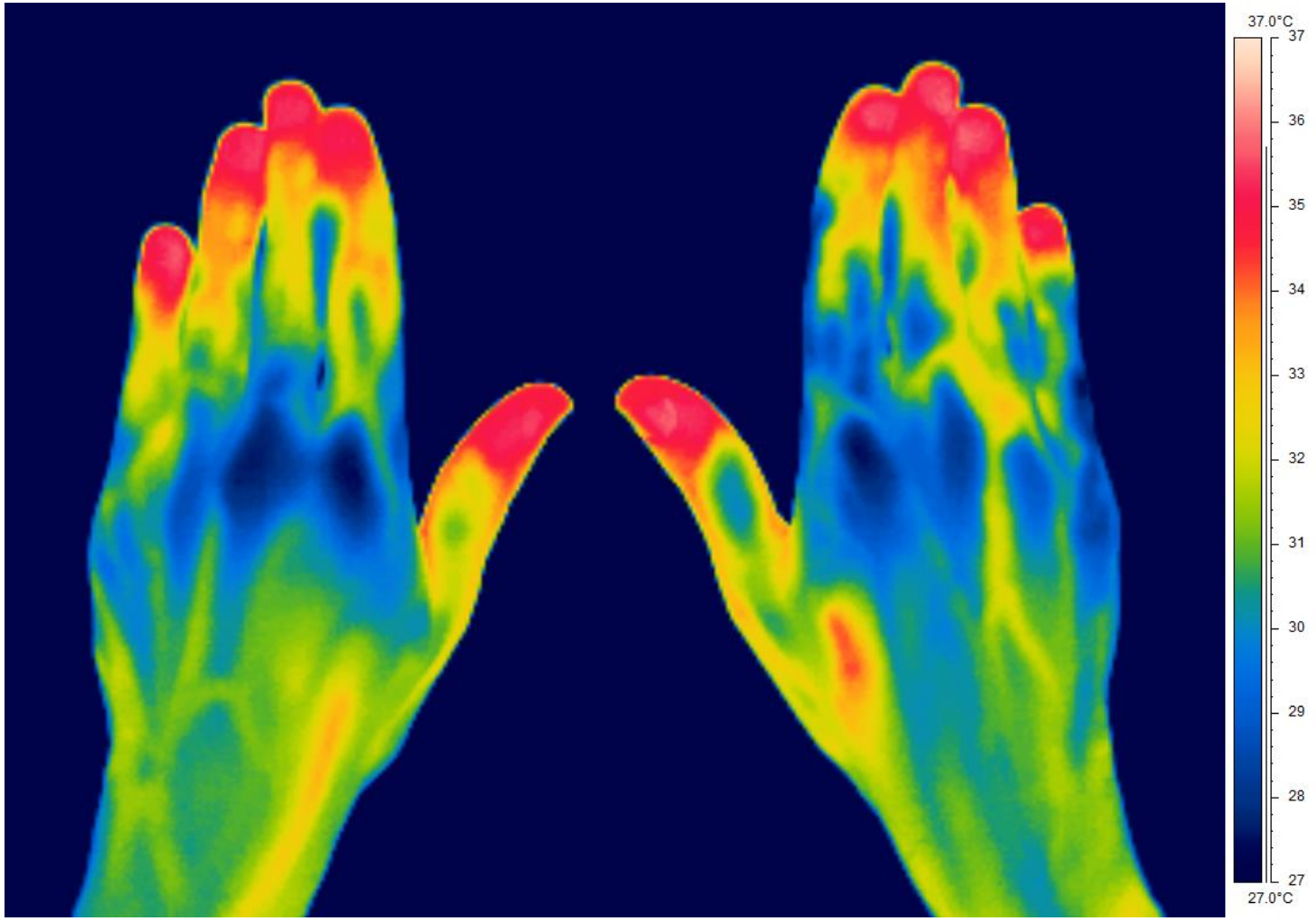








Thermal Imaging



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Thermal Scanner

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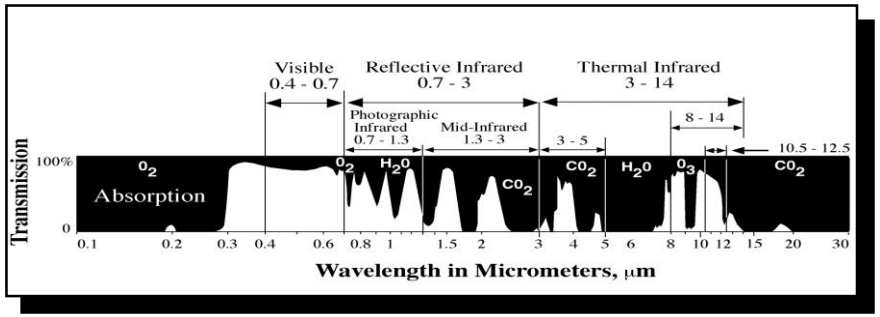
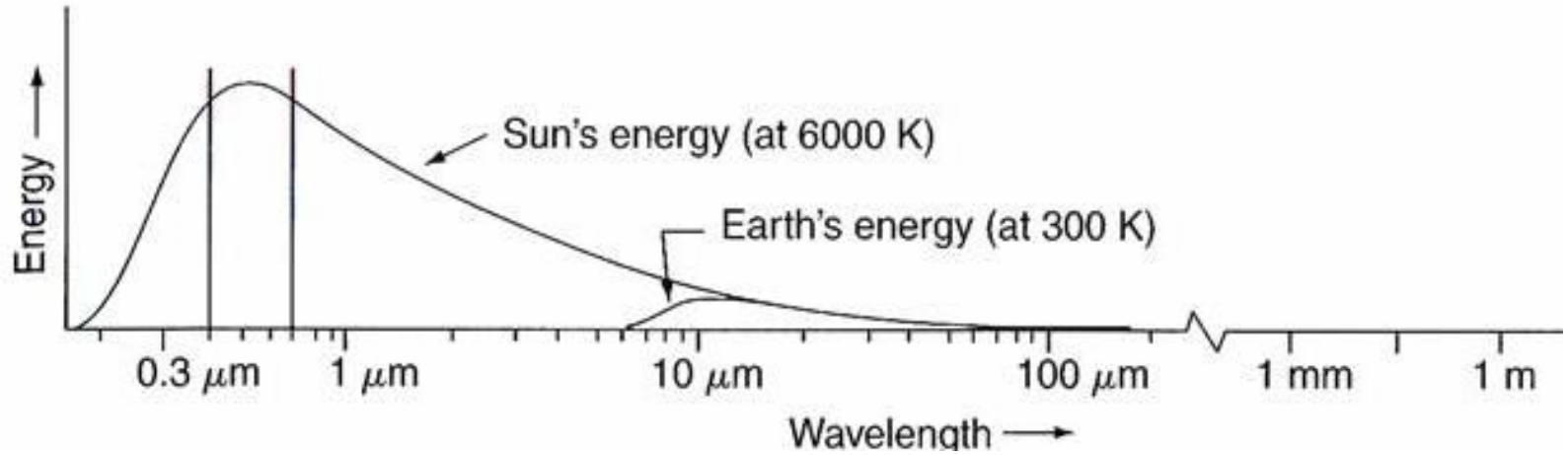


A thermal scanner is a particular kind of across track multispectral scanner.

It will sense only in the thermal portion of the spectrum.

Due to atmospheric effects, these systems are restricted to operating in the ranges 3 to 5μm and 8 to 14 μm .



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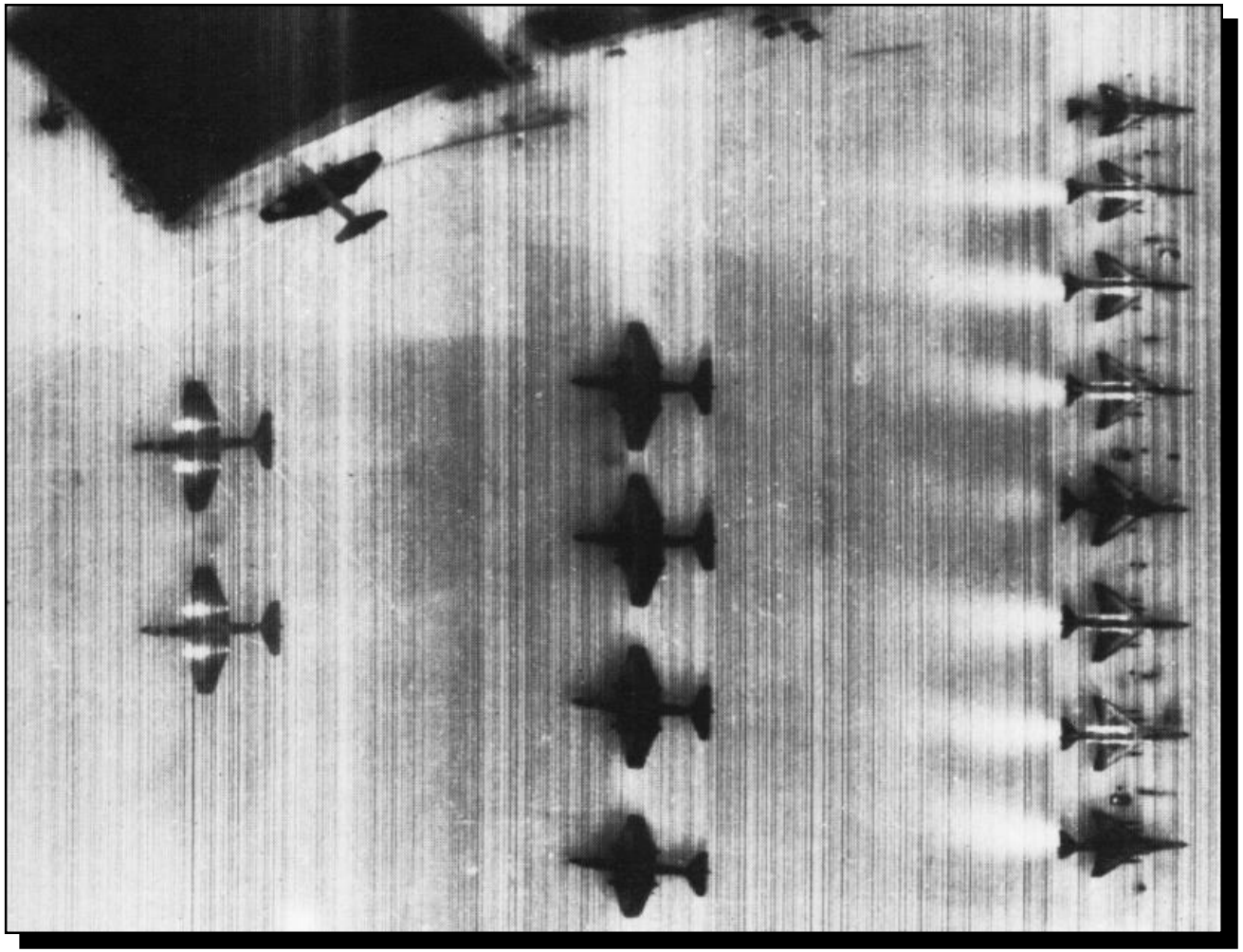
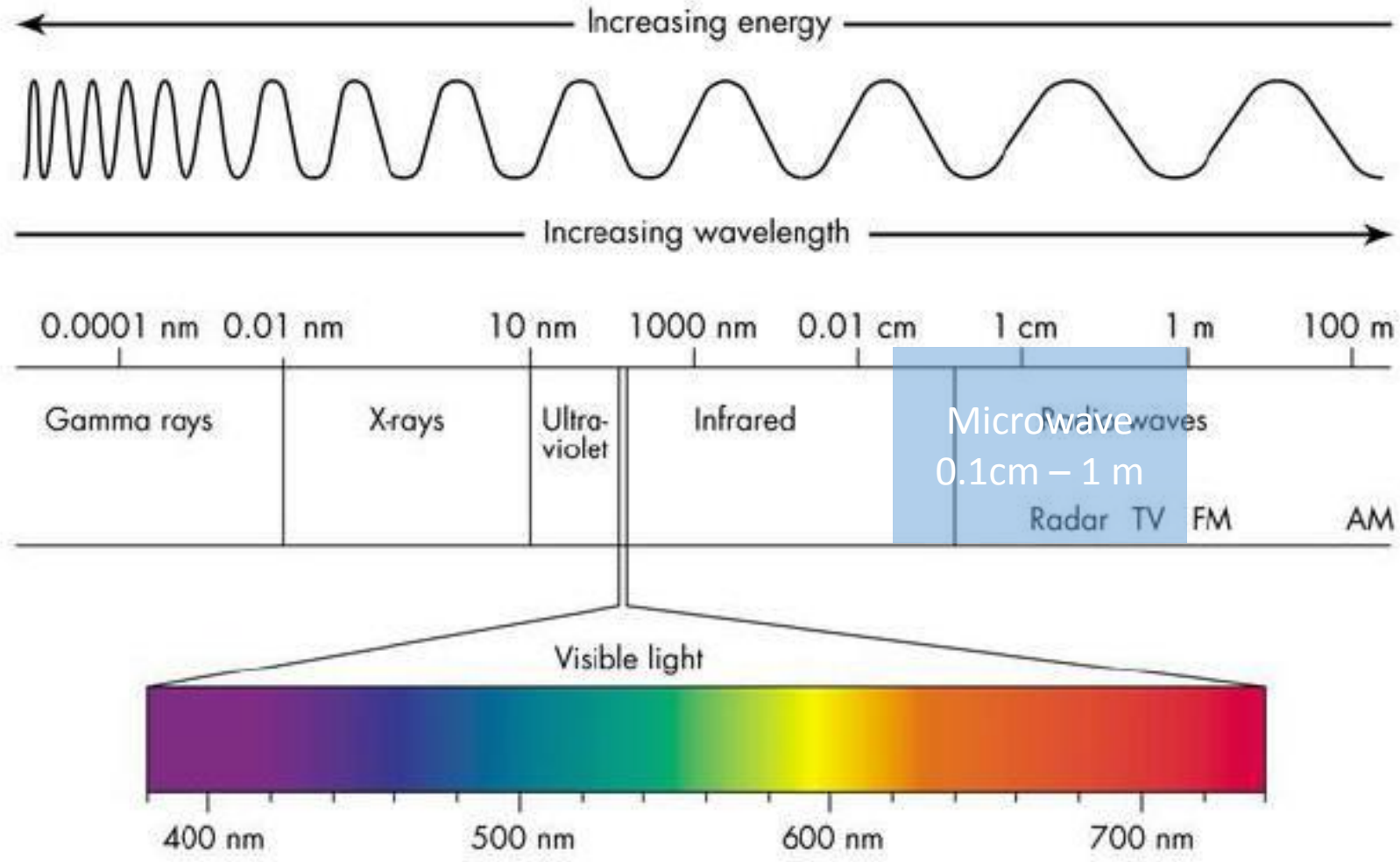
Nighttime Thermal Infrared Imagery of an Airport



Jensen, 2006

Microwave Remote Sensing



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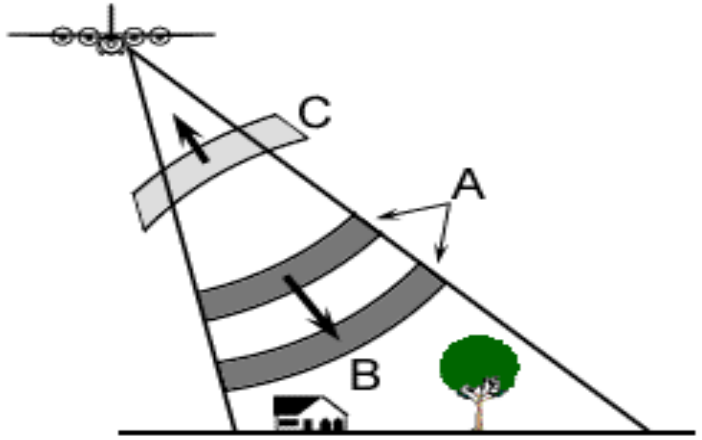
- Active Microwave remote sensing consists of satellites equipped with
  - active sensors emitting pulses of microwave radiation to illuminate the areas to be imaged,
  - the images are formed by measuring the microwave energy scattered by the ground or sea back to the sensor.
- The most common form of imaging active microwave sensor is RADAR (**RA**dio **D**etection **A**nd **R**anging).



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Fundamentals of Photogrammetry

- Phos/phot – light
- Gramma – that which is drawn or written
- Metrein – to measure

Photogrammetry

> *Definition in Manual of Photogrammetry, 1st ed., 1944, American Society for Photogrammetry:*

It is the science or art of obtaining reliable measurement by means of photographs

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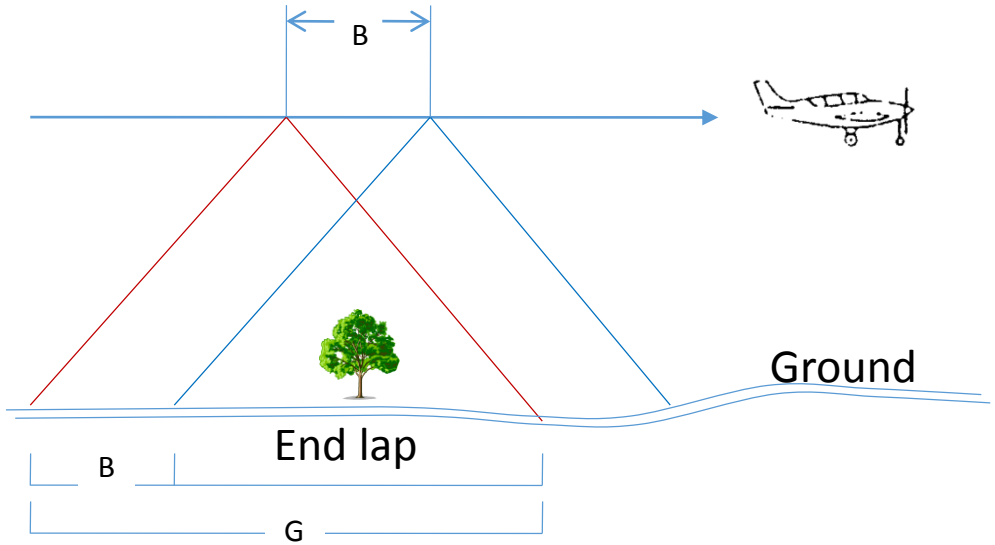


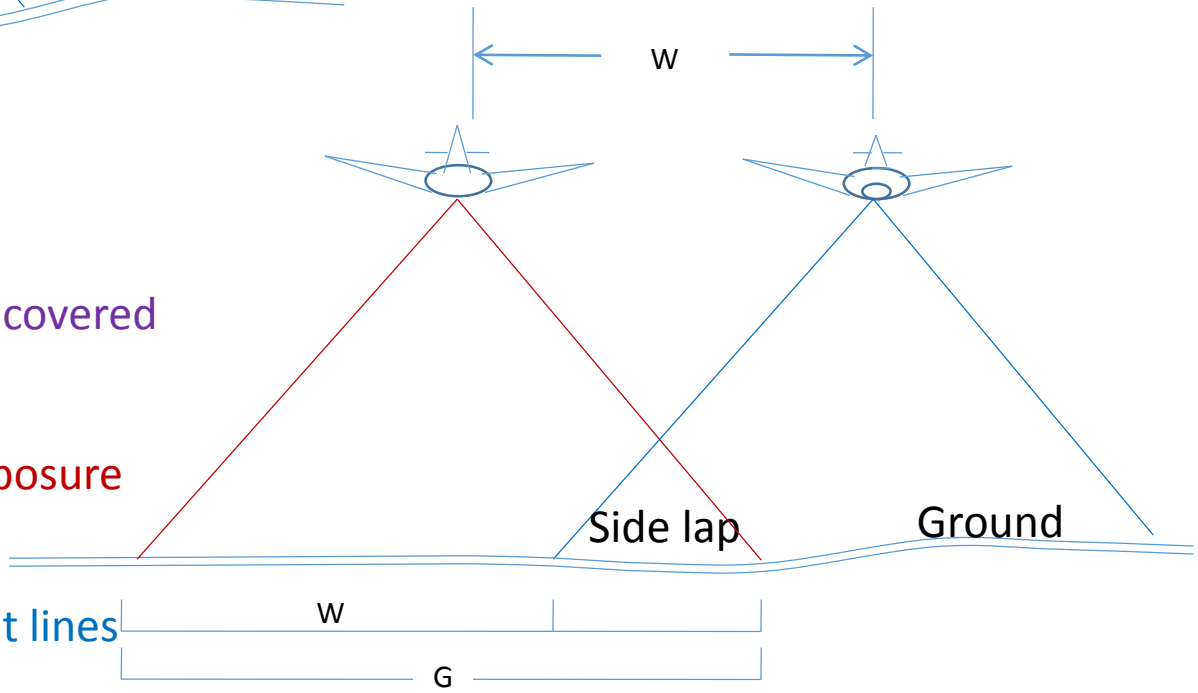
% of End lap = G-B/G*100

% of Side lap = G-W/G*100

G = dimension of square of ground covered by single photograph

B =air base or distance between exposure stations of stereo pair

W = spacing between adjacent flight lines



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Photogrammetric Workstation

Photogrammetric workstation involve

- integrated hardware
- software systems for
  - spatial data capture,
  - manipulation,
  - analysis,
  - storage,
  - display, and
  - output of softcopy images.

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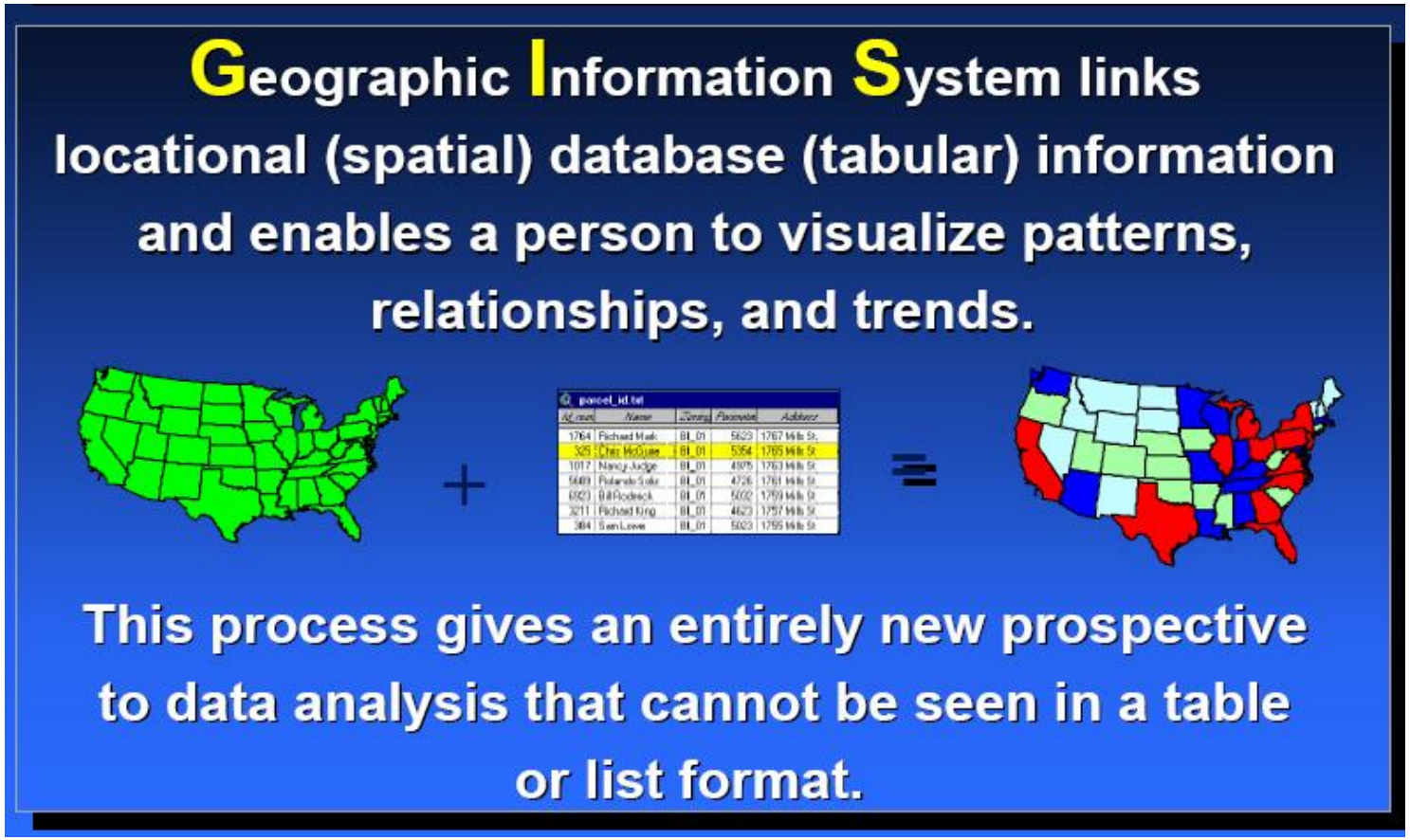
How GIS works



Raster data

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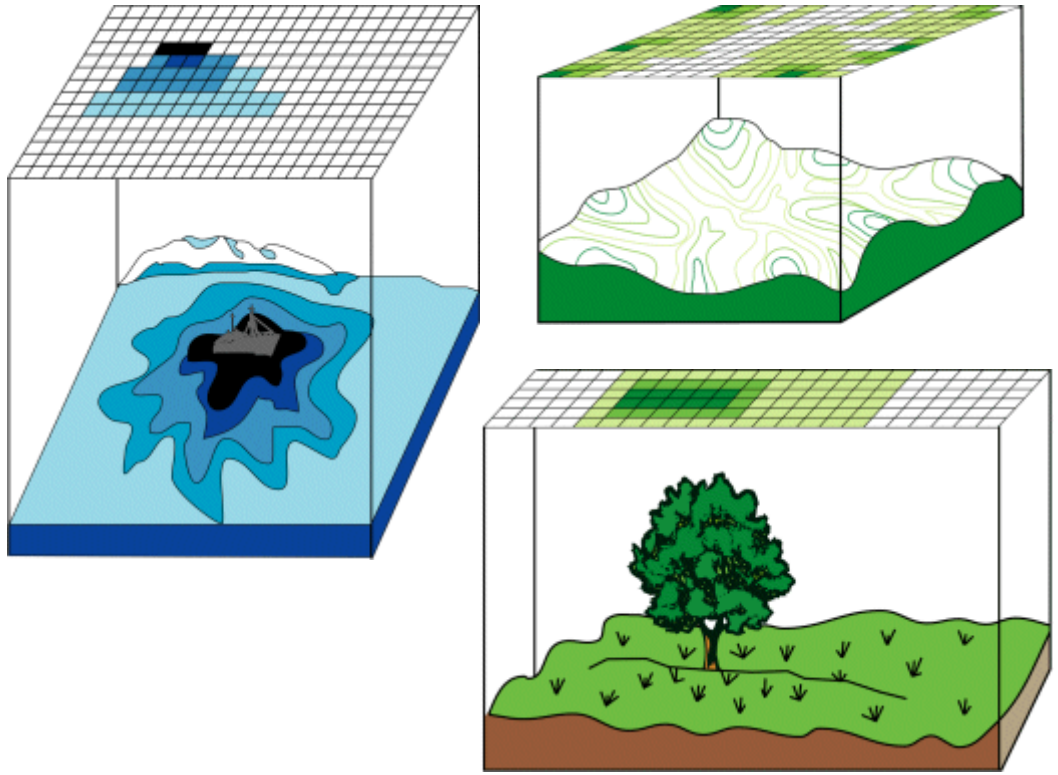

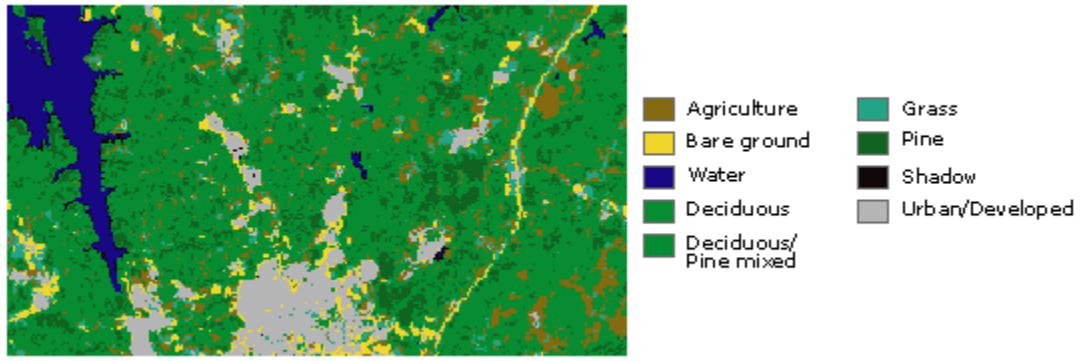

- Thematic data (also known as discrete)
- Continuous data represents phenomena such as temperature, elevation, or spectral data such as satellite images and aerial photographs.
- Pictures include scanned maps or drawings and building photographs.

Vector data structure

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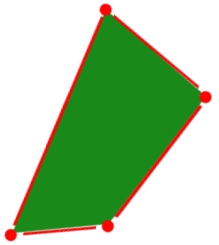
- Point

- Simply X Y coordinates
- Small features
- Scale dependent

- Line

- Series of connecting vectors/ lines
- Linear features
- Cartography - different symbols, color and thickness
- Networks are lines but different
- Networks are topologically connected elements
- Consists of junctions, turns, one way/two way, etc.,

- Polygon



- Closed vector
- Represent two
- dimensional area

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