C.V. RAMAN POLYTECHNIC, BHUBANESWAR

C.V.Raman Polytechnic

Quality Education for the New Millenium

LECTURE NOTE

LAND SURVEY-II, (Th.1)

SEM-6TH

BRANCH- CIVIL ENGINEERING

Prepared by

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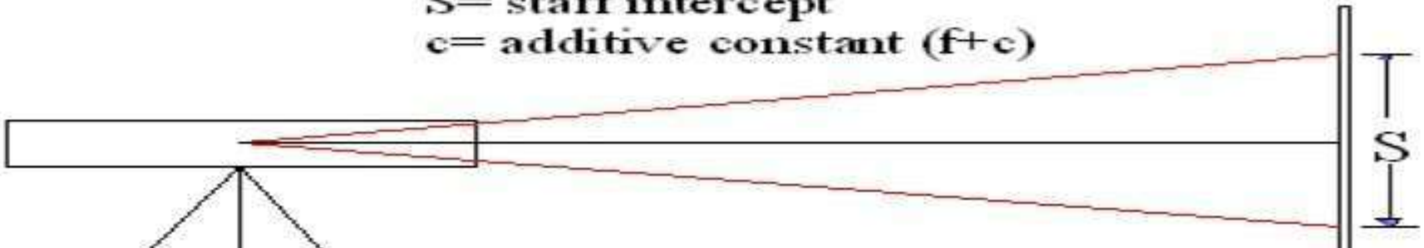
Tacheometry

Definition-It is the branch of angular surveying the Horizontal distances from station to the staff and the vertical distance of a point are determined from instrumental observation

Horizontal distance

HORIZONTAL DISTANCE (D)=mS +c

Where , m=Multiplying Constant(f/i)
S= staff intercept
c= additive constant (f+c)



Vertical distance

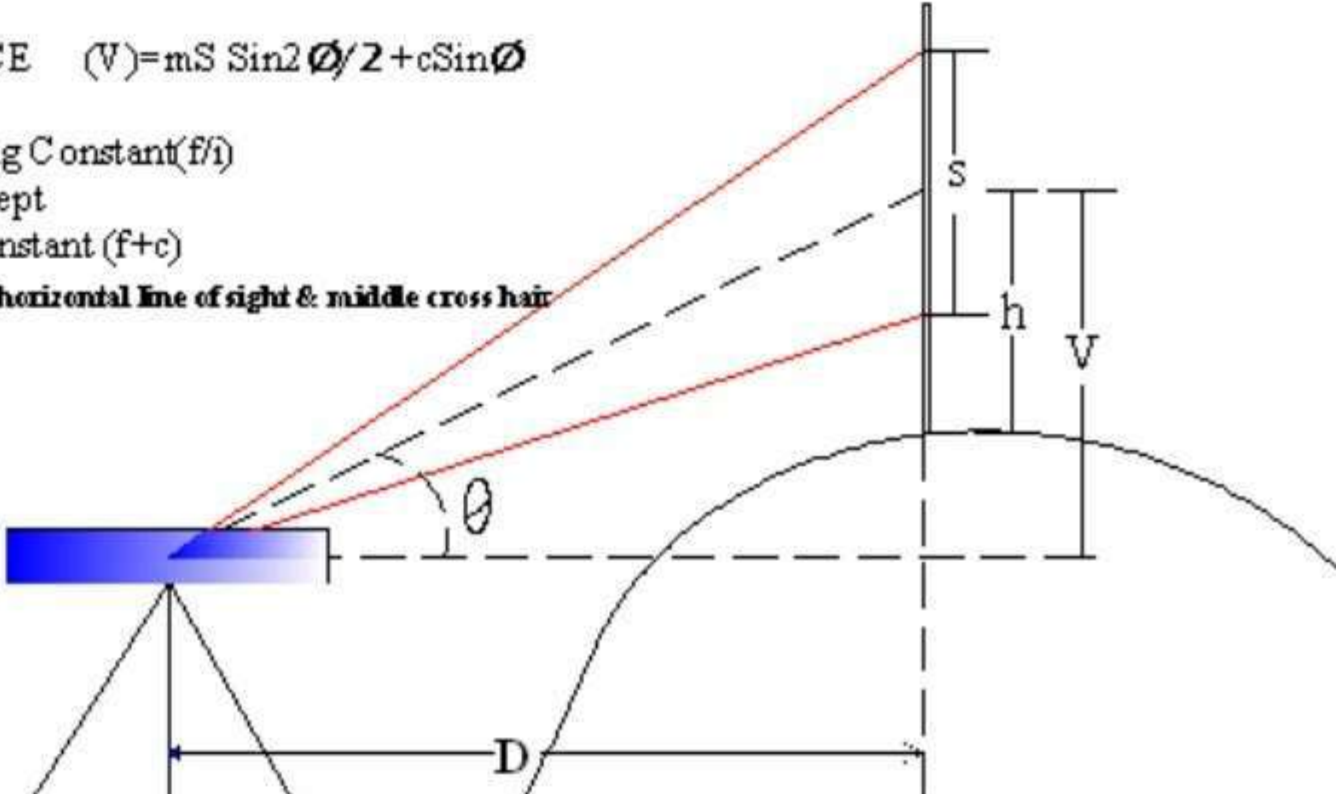
VERTICAL DISTANCE $(V)=mS\ \mathrm{Sin}2\text{Ø}/2+c\mathrm{Sin}\text{Ø}$

Where, m=Multiplying Constant(f/i)

S= staff intercept

c= additive constant (f+c)

Ø=Angle between horizontal line of sight & middle cross hair



Situation where tacheometry can be used

- When obstacles like river, broken ground,streches of water, tacheometry gives speed & accuracy to work.
- In rough country where measurement of horizontal & vertical distances are difficult, inaccurate & slow.
- In locating contours & filling details in a

Advantages of tacheometry

- Tacheometer is used where chaining is difficult such as river, vally, broken boundries, stiff slope, undulations.
- It is used in the preparation of contour maps, in which horizontal & vertical distances are required to be measured.
- It is used for the survey road, railway.
- It is also used for the hydrographic survey.
- It is used for checking distances measured by tape, chain & dumpy level.

Difference between theodolite and tacheometer

Theodolite

- It is used for measurement of horizontal & vertical angle.
- In theodolite survey , distances are measured by chain or tape.
- Suitable for plane & hilly

Tacheometer

- It is used for measurement of horizontal & vertical distances.
- In tacheomtric survey ,direct measurement of distances are possible.
- Suitable in case obstacles

Constants of Tacheometer

- Multiplying constant ie. (f/i) or m.
- Additive constant ie (f+c) or C.

Where f= focal length of image glass

c= legth of image

Object of tacheometry

- Preparation of contour maps or plans.
- Used in hydrographic survey.
- Location survey for roads,railways, reservoir etc.
- For checking of more precise measurements.

Instrument used in Tacheometer

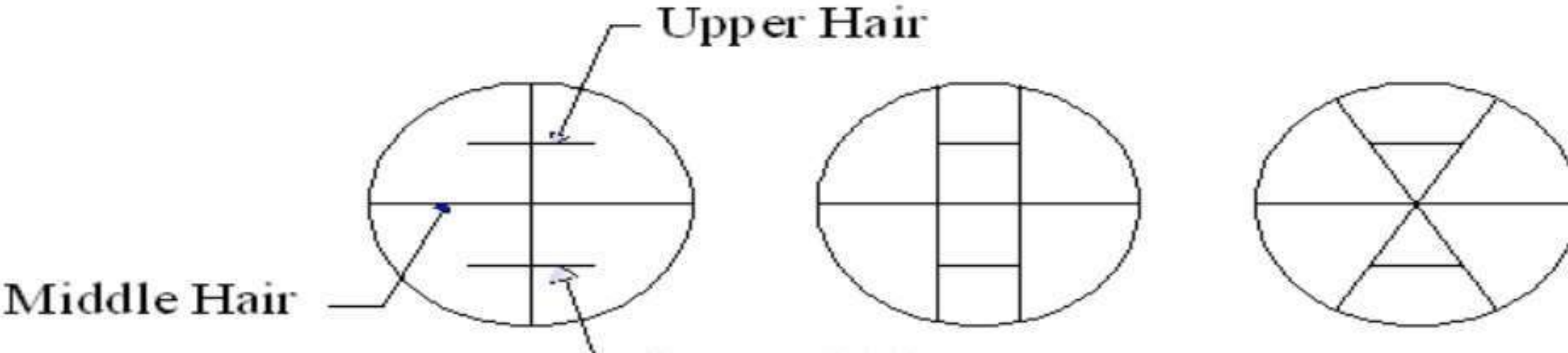
I) Tacheometer

II) Levelling or stadia rod

I)Tacheometer –It is a transit theodolite provided with a stadia diaphragm.

- The diaphragm is provided with two horizontal stadia hairs in addition to regular cross hair.
- Additional hair should be equidistant from central one.
- Types of diaphragm commonly used as follows.

Types of diaphragm



Types of Telescope in Tacheometry

- External focusing
- Internal focusing
- External focusing fitted with anallatic lens.

Anallatic lens -It is an additional lens generally provided in the external focusing tacheometer between object glass & eyepiece

Advantages of anallatic lens.

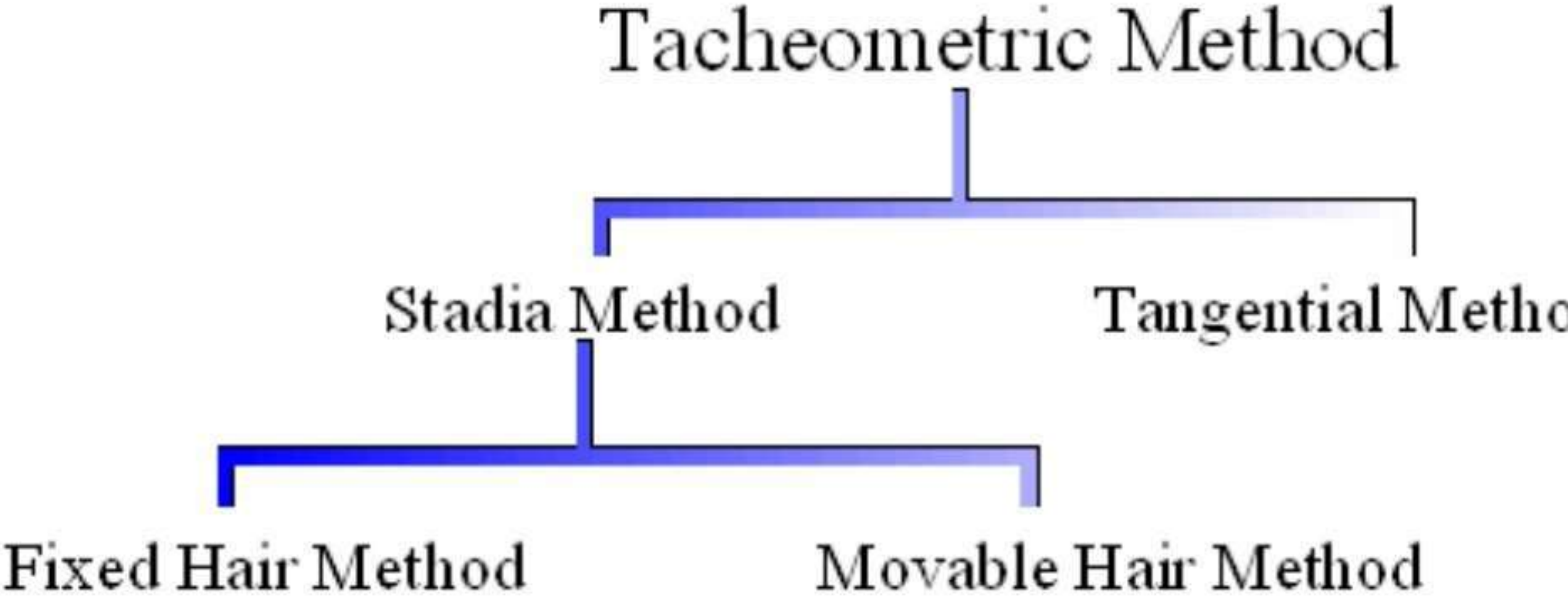
1) For calculation of horizontal & vertical distances constant (f+c)=0, if tacheometer is provided with anallatic lens.
2) Calculation becomes simple.

Essential characteristics of Tacheometer

- The value of constant (f/i)=100.
- The telescope should be provided with anallatic lens.
- The telescope should be powerful, magnification should be 20 to 30 times the diameter.

II)Levelling staff or stadia rod.

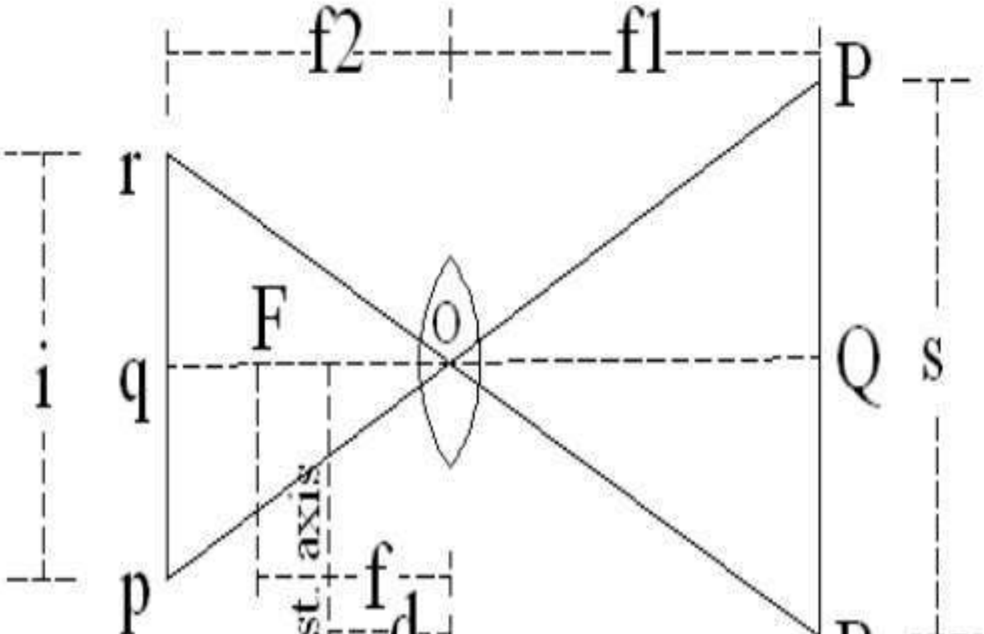
- Levelling staff or stadia rodused with tacheometer may be usual type of levelling staff.
- It may be folding or telescopic with is 5 cm to 15 cm. & height 3 m to 5 m.
- It may measure meter , decimeter &


Tacheometric Method
Stadia Method
Tangential Metho
Fixed Hair Method
Movable Hair Method

Fixed Hair Method

- In this method, the distance between two stadia hair is fixed.
- The reading corresponding to three cross hair is taken and difference between top and bottom hair is found out known as staff intercept.

Principle of stadia method



From similarity of triangle POQ & po

PR/pr =OQ/oq

S/i = f1/f2

By lens formula

1/f= (1/f1)+(1/f2)

Multyplying f1 to both side

f1×(1/f) = f1×(1/f1)+f1×(1/f2)

F1/f = 1+(f1/f2)

Put values of (f1/f2) = S/i

f1/f = 1+ (S/i)

(f1/f)-1 = S/i

(f1-f)/f = S/i

f1= S/i ×f+f eq 1

Now, D= f1+d or f1=D-d eq 2

P, Q, R=Three line of sight on staff corresponding to three line.

P, q, r=the stadia hairs

O= optical center of object glass.

pr= i = stadia interval.

PR= s = staff intercept.

f = focal length of object glass.

f_1 = horizontal distance between center of object glass to the staff station.

f_1 = horizontal distance of diaphragm from 'o'

D= horizontal distance of staff station from vertical axis of taceometer.

d= horizontal distance between vertical axis of tacheometer &

Fixed Hair Method

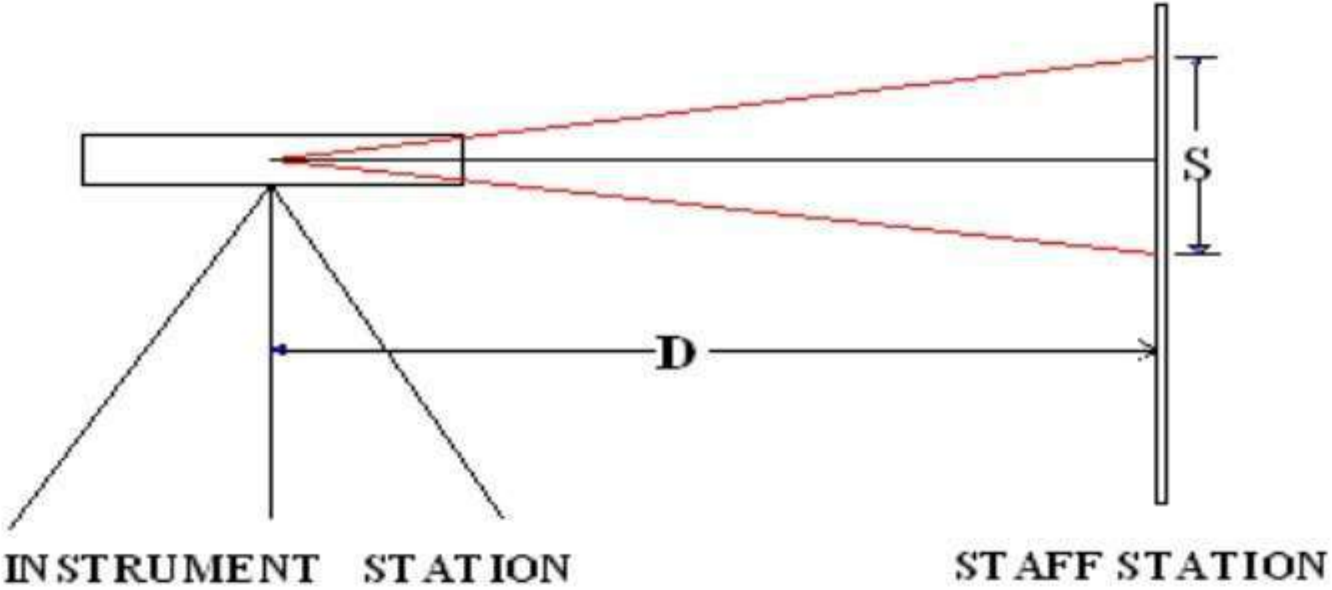
There are three different cases used.

Case I): Line of sight is horizontal and the staff held is vertical.

Case II): Line of sight is inclined and the staff held is vertical.

Case III): Line of sight is inclined and the staff held is normal to the line of sight.

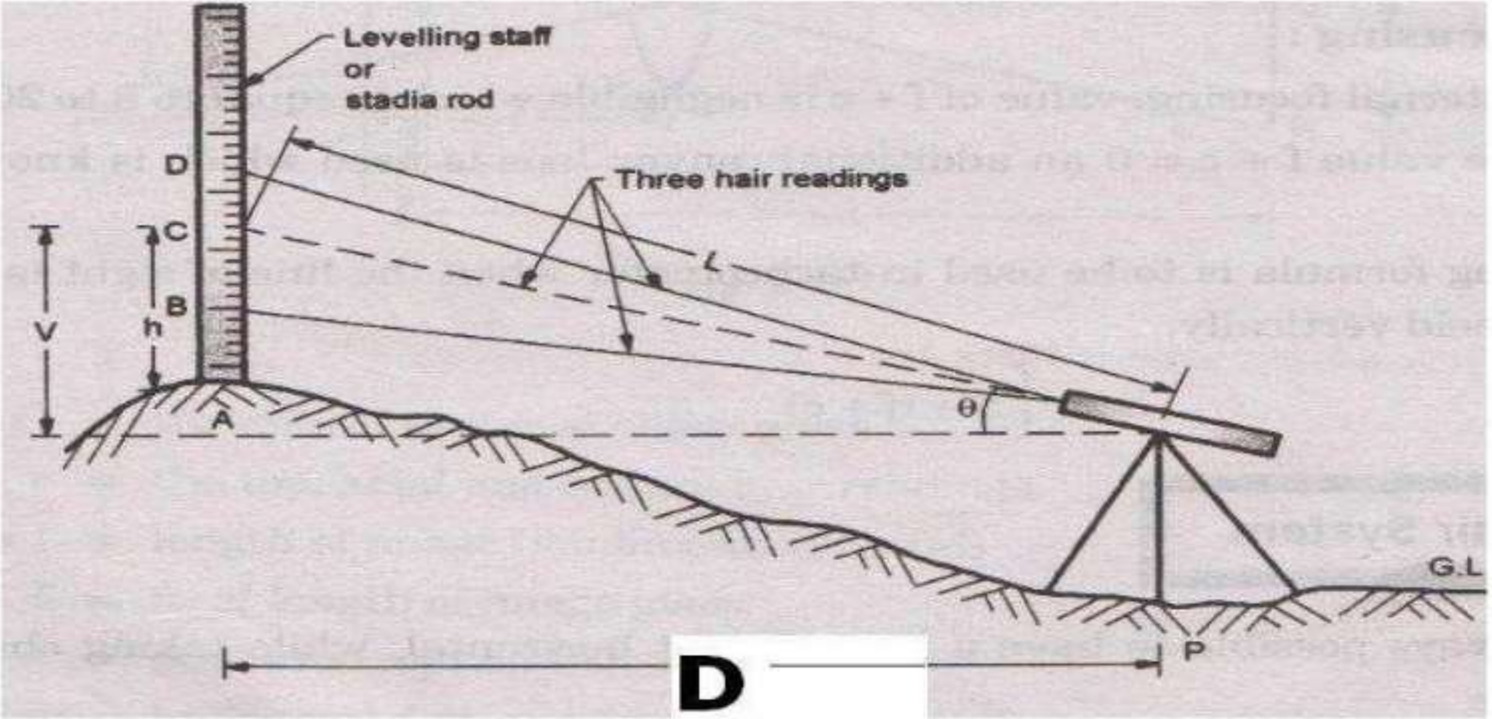
Case I): Line of sight is horizontal and the staff held is vertical.



HORIZONTAL DISTANCE(D)=(f/i)S+(f+d)

(D)=mS +c

Case II): Line of sight is inclined and the staff held is vertical.





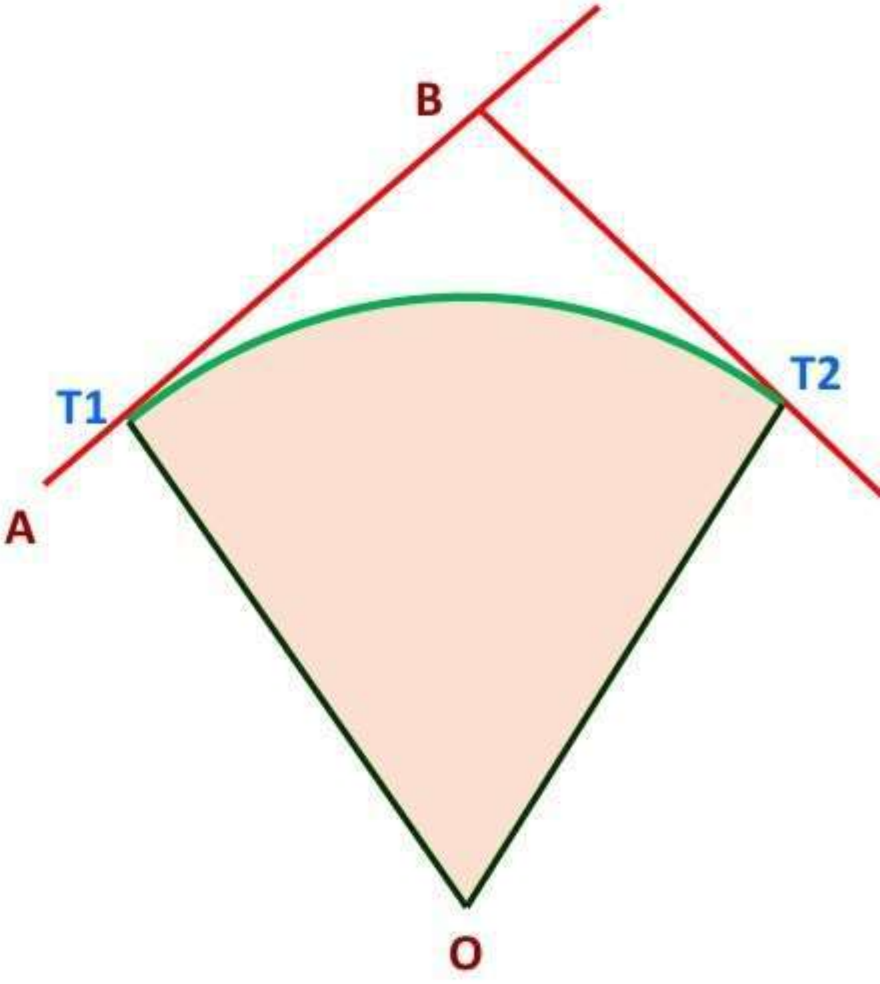



CURVES

Curves are regular bends provided in the line of communication like roads, railways an canals etc. to bring about gradual change o direction.

CURVES

They enable the vehicle to pass from one path on to another when the two paths meet at an angle. They are also used in the vertical plane at all changes of grade to



HORIZONTAL CURVES

Curves provided in the horizontal plane to have the gradual change in direction are known as *horizontal curves.*

VERTICAL CURVES

Curves provided in the vertical plane to obtain the gradual change in grade are called as *vertical curves.*

Horizontal curve

Vertical curve

NEED OF PROVIDING CURVES

Curves are needed on Highways, railways and canals for bringing about gradual change of direction of motion. They are provided for following reasons:-

i) To bring about gradual change in direction of motion.

ii) To bring about gradual change in grade

NEED OF PROVIDING CURVES

iii) To alert the driver so that he may not fall asleep.

iv) To layout Canal alignment.

v) To control erosion of canal banks by the

CLASSIFICATION OF CIRCULAR CURVES

Circular curves are classified as :

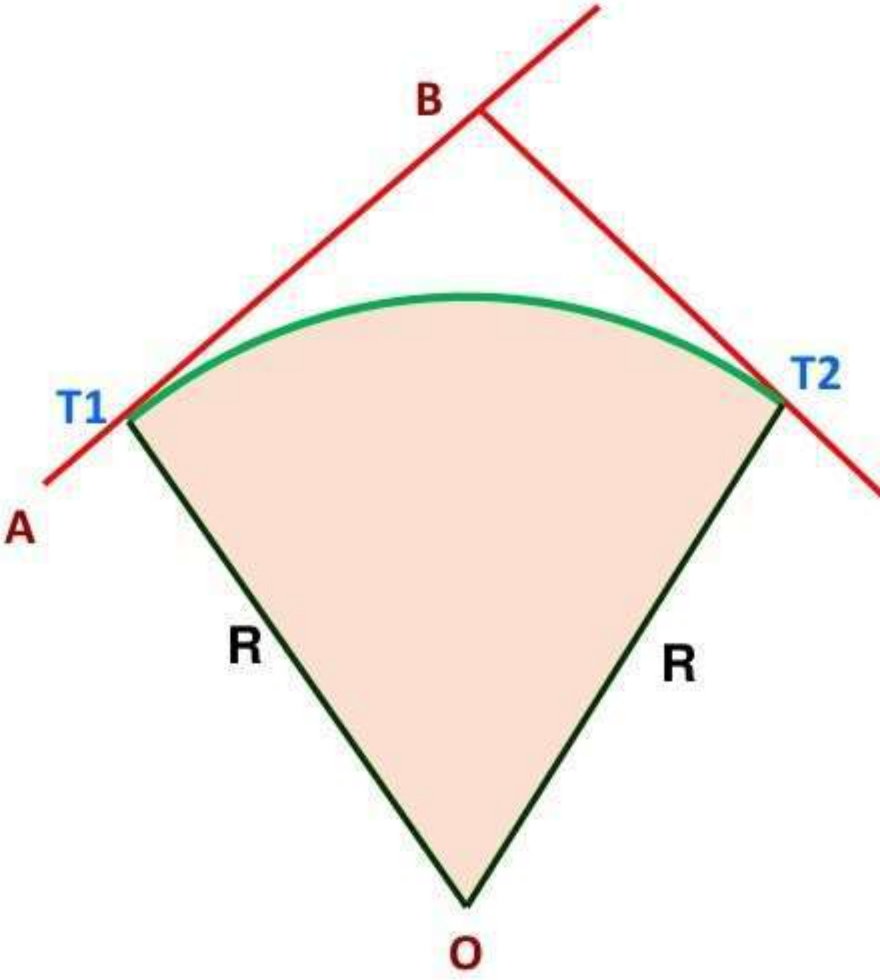
(i) Simple Curves.

(ii) Compound Curves.

(iii) Reverse Curves.

i) Simple Curve:

A simple curve Consists of a single arc of circle connecting two straights. It has radius of the



ii) COMPOUND CURVE

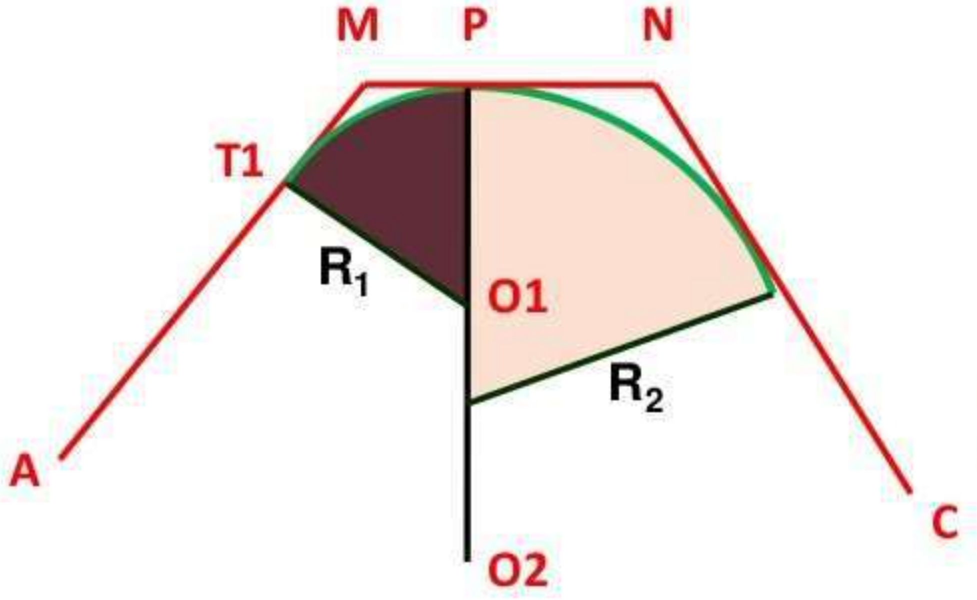


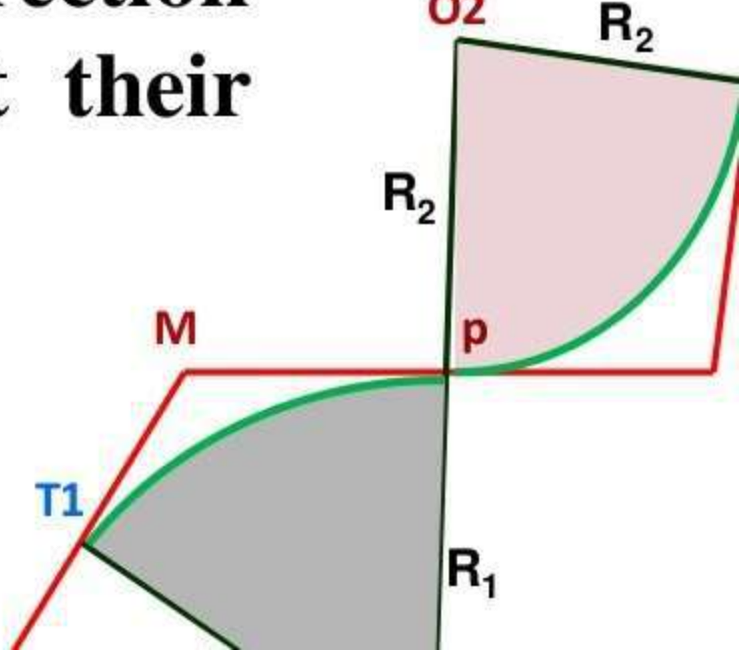
Fig.3 Compound Curve

A compound Curve consists of two or more simple curves having different radii bending in the *same* direction and lying on

iii) REVERSE CURVE

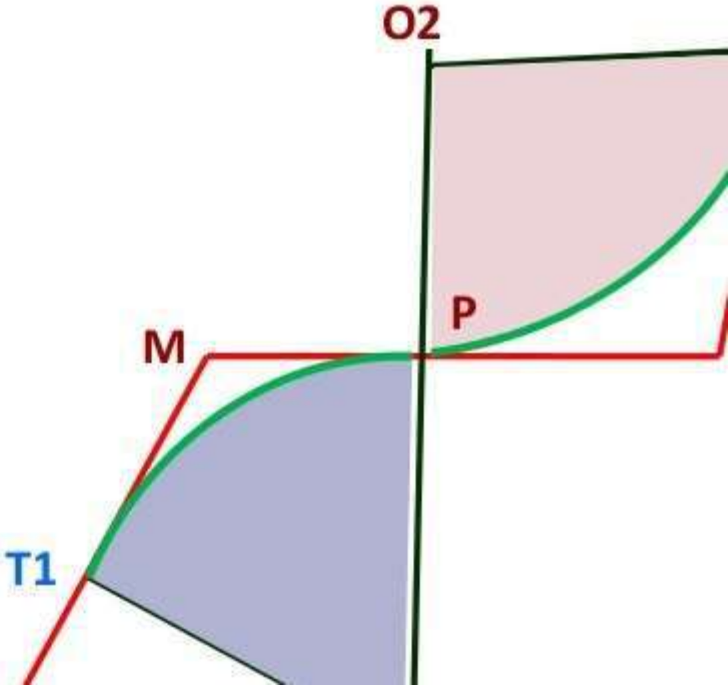
A reverse curve is made up of two arcs having equal or different radii bending in opposite direction with a common tangent at their junction .

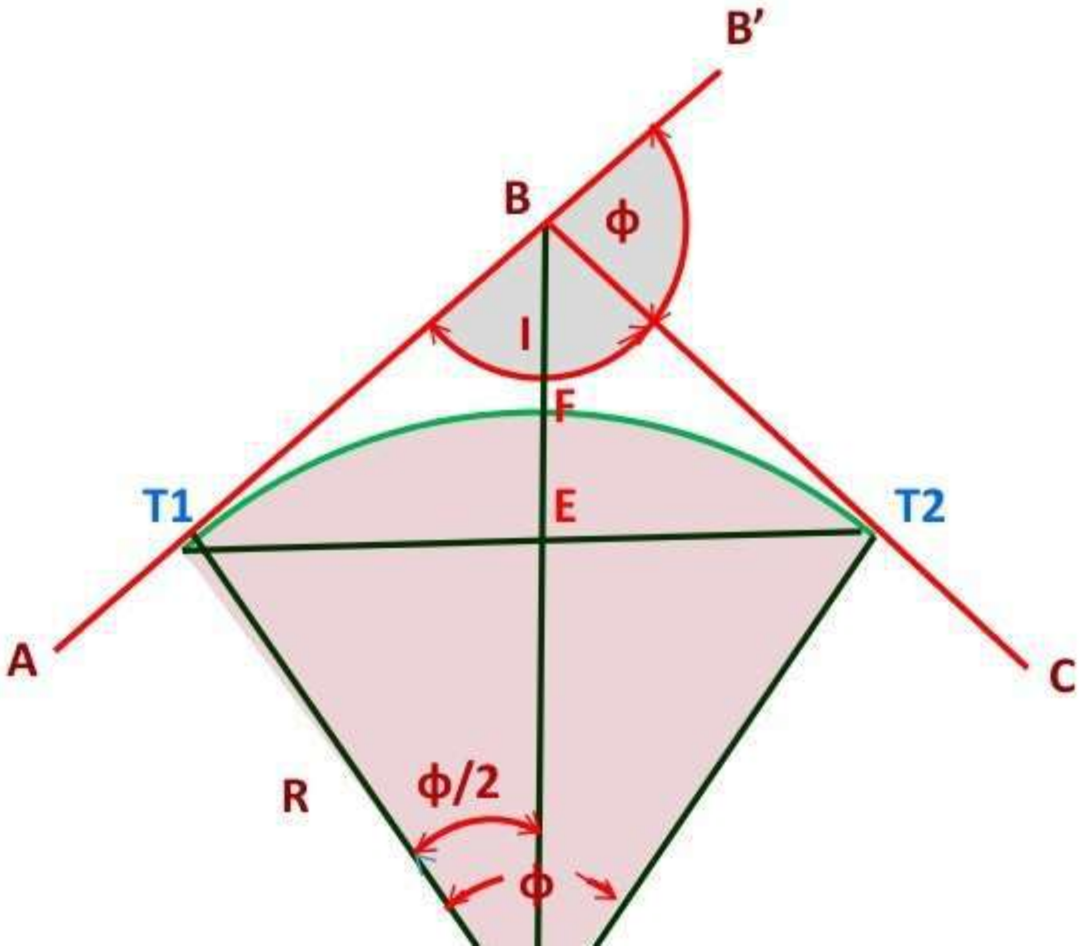
Their centres lie on opposite sides of the curve. Reverse curves are used



REVERSE CURVE

They are commonly used in railway sidings and sometimes on railway tracks and roads meant for low speeds. They should be *avoided* as far as possible on main lines and highways where





B′
B
ϕ
I
F
T1
E
T2
A
C
R
ϕ/2
ϕ

NAMES OF VARIOUS PARTS OF CURVE

(i) The two straight lines AB and BC which are connected by the curve are called the *tangents* or *straights* to the curve.

(ii) The point of intersection of the two straights (B) is called the intersection point or the vertex.

(iii) When the curve *deflects* to the right side of the progress of survey ,it is termed as *righ*

NAMES OF VARIOUS PARTS OF CURVE

(iv) The lines AB and BC are *tangents to th* *curve*. AB is called the *first tangent* or th *rear tangent* . BC is called the *secon* *tangent* or the *forward tangent.*

(*v*) The points (T_1 and T_2) at which the curve touches the tangents are calle the *tangent points*. The beginning o the curve (T_1) is called the *tangen*

NAMES OF VARIOUS PARTS OF CURVE

(vi) The angle between the lines AB and B

(⌊ABC) is called the *angle of intersectio*

(I).

(vii) The angle by which the forward tange

deflects from the rear tangent (⌊B'BC)

called the deflection angle (ϕ) of the curve.

(viii) The distance from the point of intersectio

to the tangent point is called *tangent lengt*

(x) The arc T1FT2 is called the *length of curve*

(xi) The mid point(F) of the arc (T_1FT_2) is calle
the *summit or apex of the curve.*

(xii) The distance from the point of intersectio
to the apex of the curve BF is called th
apex distance.

(xiii) The distance between the apex of the curv
and the mid point of the long chord (EF)
called *versed sine of the curve.*

(xiv) The angle subtended at the centre of the

ELEMENTS of a Simple Circular Curve

(i) **Angle of intersection +Deflection angle = 180**

or $I + \phi = 180$

(ii) $\angle T_1OT_2 = 180^0 - I = \phi$

i.e the central angle = deflection angle.

(iii) **Tangent length = BT1 =BT2=** $OT_1 \tan \phi/2$

ELEMENTS of a Simple Circular Curve

(iv) Length of long chord $=2T_1E$

$=2R \sin \phi/2$

(v) Length of curve = Length of arc T_1FT_2

$= R \times \phi$ (in radians)

$= \pi R \phi/180^0$

(vi) Apex distance = BF = BO – OF

$= R \sec \phi/2 - R$

DESIGNATION OF CURVE

A curve may be designated either by the *radius* or by *the angle subtended* at the centre by *a chord of particular length.*

a curve is designated by the angle (in degrees) subtended at the centre by a chord of 30 metres (100 ft.) length. This angle is called the *degree of curve (D).*

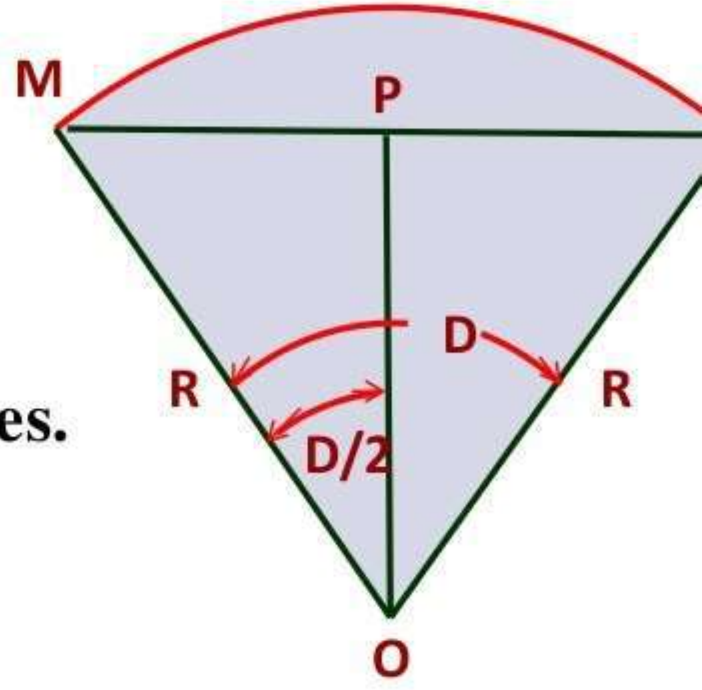
DESIGNATION OF CURVES.

In English practice , a curve is define by the radius of the curve in terms of chains such as a six chain curve means a curve havin radius equal to six full chains, chain being 3 metres unless otherwise specified.

In America,Canada,India and som other countries a curve is designated by th *degree of the curve*

RELATION between the Radius of curve and Degree of Curve.

The relation between the radius and the degree of the curve may be determined as follows:-



Degree of Curve

Let R = the radius of the curve in metres.

D = the degree of the curve.

MN = the chord, 30m long.

P = the mid-point of the chord.

In △ OMP,OM=R,

RELATION between the Radius of curve and Degree of Curve.

Then, $\sin D/2 = MP/OM = 15/R$

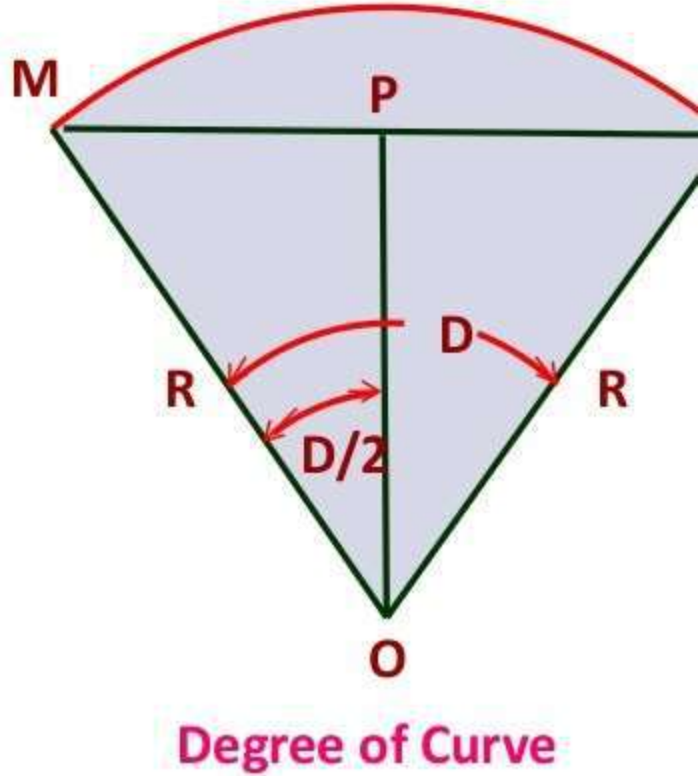
Or $$R = \frac{15}{\sin D/2}$$ (Exact)

But when D is small, sin D/2 may be assumed approximately equal to D/2 in radians.

Therefore:

$$R = \frac{15 \times 360}{\pi D}$$

$$= 1718.87$$



METHODS OF CURVE RANGING

A curve may be set ou

(1) By linear Methods, where chain and tap are used or

(2) By Angular or instrumental methods where a theodolite with or without a chain i used.

Before starting setting out a curve by an method, the exact positions of the tangent

LINEAR METHODS of setting out Curves

The following are the methods of setting out simple circular curves by the use of chain and tape :-

(i) By offsets from the tangents.

(ii) By successive bisection of arcs.

(iii) By offsets from chords produced.

LINEAR METHODS of setting out Curves

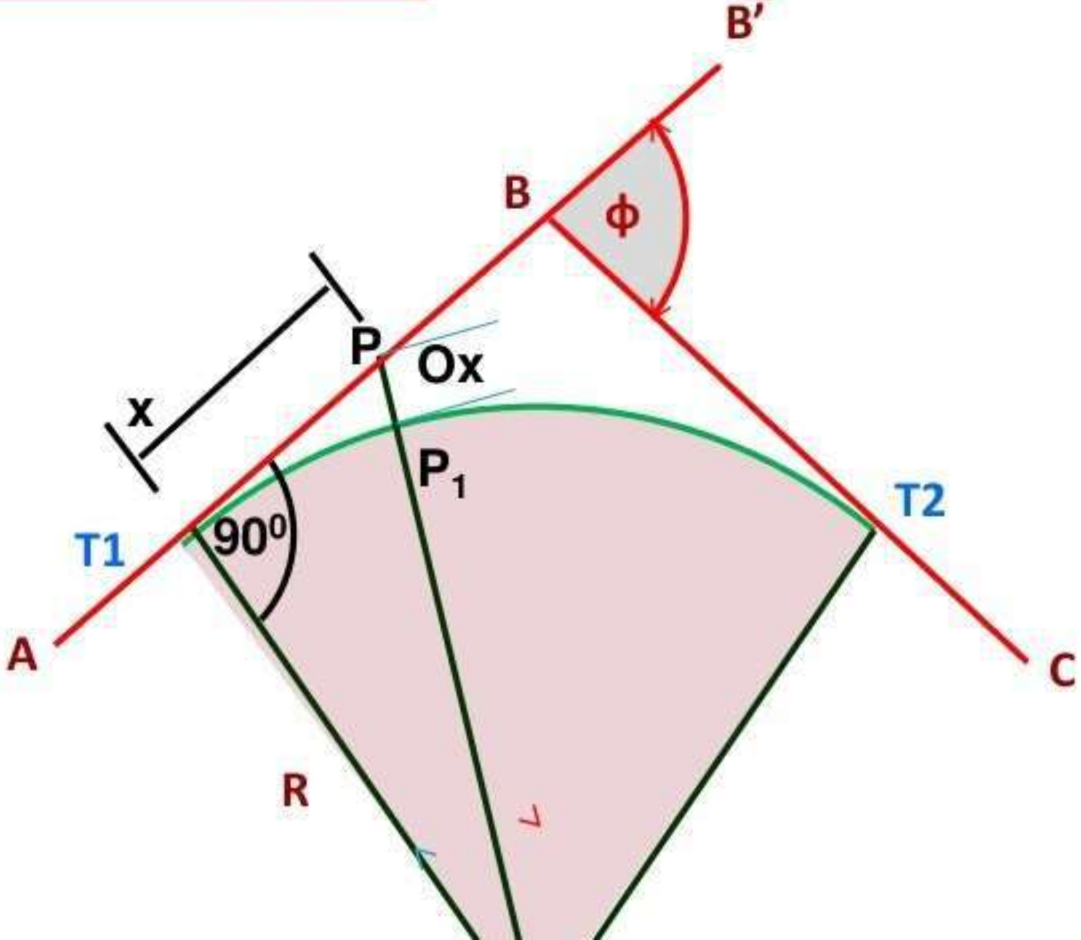
1. By offsets from the tangents. When the deflection angle and the radius of the curve both are small, the curves are set out by offsets from the tangents.

   Offsets are set out either

   (i) radially or

   (ii) perpendicular to the tangents according as the centre of the curve is

LINEAR METHODS of setting out Curves



LINEAR METHODS of setting out Curves

B′

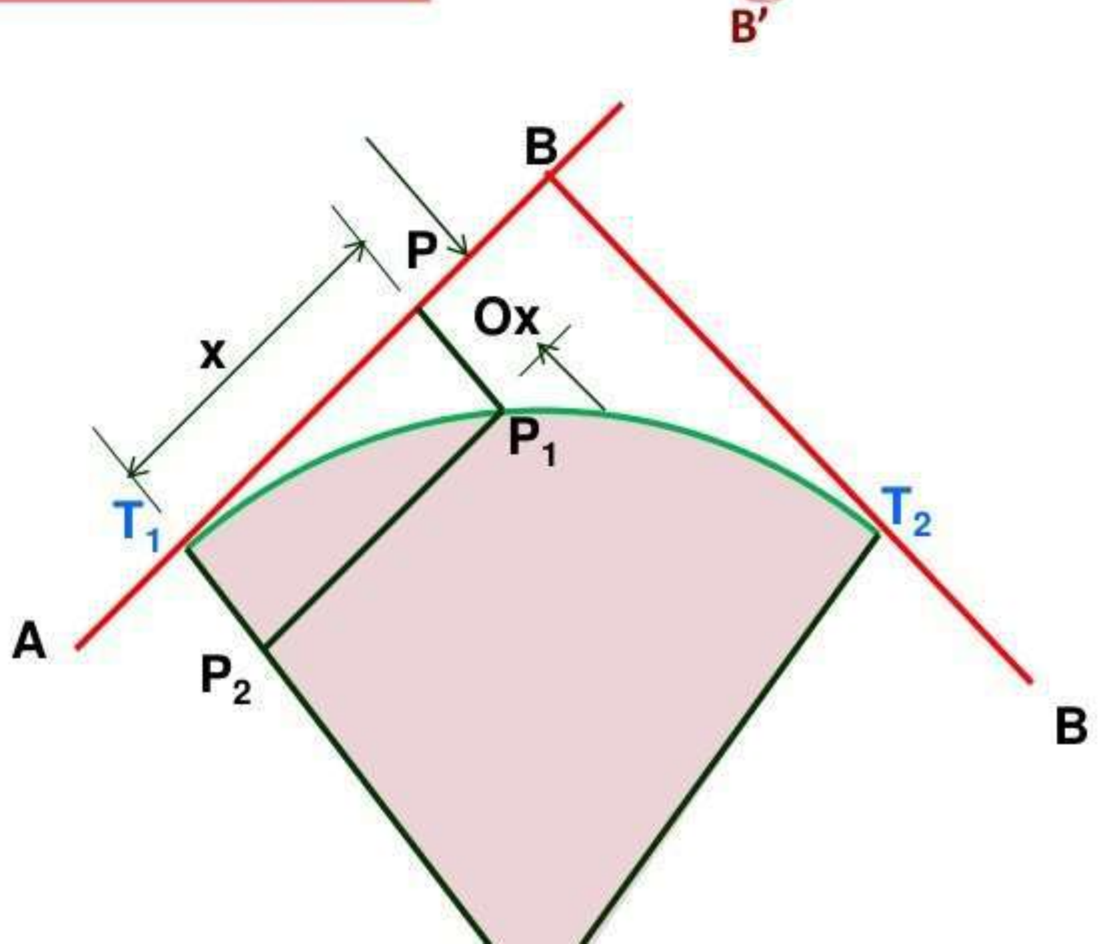
Offsets is given by :

$O_x = \sqrt{R^2 + x^2} - R$ …….. (Exact relation.)

When the radius is large ,the offsets may be calculated by the approximate formula which is as under

$O_x = \frac{x^2}{2R}$ ……… (Approximate)

LINEAR METHODS of setting out Curves



LINEAR METHODS of setting out Curves

1. (ii) By offsets perpendicular to the Tangents

$$O_x = R - \sqrt{R^2 - x^2}$$ …………… **(Exact)**

$$O_x = \frac{x^2}{2R}$$ ……… **(Approximate)**

LINEAR METHODS of setting out Curves

By offsets from the tangents: Procedure

(i) Locate the tangent points T_1 and $T_{2.}$

(ii) Measure equal distances , say 15 or 30 m along the tangent fro T_1.

(iii) Set out the offsets calculated by any of

LINEAR METHODS of setting out Curves

By offsets from the tangents: Procedure….

(iv) Continue the process until the apex of the curve is reached.

(v) Set out the other half of the curve from second tangent.

(vi) This method is suitable for setting out sharp curves where the ground outside

Example. Calculate the offsets at 20m intervals along the tangents to locate a curve having a radius of 400m ,the deflection angle being 60^0 .

Solution . Given:

Radius of the curve ,R = 400m

Deflection angle, $\varphi = 60^0$

Therefore tangent length = R. tan $\varphi/2$

= 400 x tan 60^0

= 230.96 m

Radial offsets. (Exact method)

Radial offsets. (Exact method)

$O_x = \sqrt{R^2 + x^2} - R$ ……………… (Exact)

$O20 = \sqrt{400^2+20^2} - 400 = 400.50 - 400 = 0.50$ m

$O40 = \sqrt{400^2+40^2} - 400 = 402.00 - 400 = 2.00$ m

$O60 = \sqrt{400^2+60^2} - 400 = 404.47 - 400 = 4.47$ m

$O80 = \sqrt{400^2+80^2} - 400 = 407.92 - 400 = 7.92$ m

B) Perpendicular offsets (Exact method)

$$O_x = R - \sqrt{R^2 - x^2} \quad \cdots\cdots\cdots\cdots \text{(Exact)}$$

$$O_{20} = 400 - \sqrt{400^2 - 20^2} = 400 - 399.50 = 0.50 \text{ m}$$

$$O_{40} = 400 - \sqrt{400^2 - 40^2} = 400 - 398.00 = 2.00 \text{ m}$$

$$O_{60} = 400 - \sqrt{400^2 - 60^2} = 400 - 395.47 = 4.53 \text{ m}$$

$$O_{80} = 400 - \sqrt{400^2 - 80^2} = 400 - 391.92 = 8.08 \text{ m}$$

B) By the approximate Formula

(Both radial and perpendicular offsets)

$$O_x = \frac{x^2}{2R}$$

Therefore $O_{20} = \frac{20^2}{2 \times 400} = 0.50\text{ m}$

$$O_{40} = \frac{40^2}{2 \times 400} = 2.00\text{ m}$$

$$O_{60} = \frac{60^2}{2 \times 400} = 4.50\text{ m}$$

$$O_{80} = \frac{80^2}{2 \times 400} = 8.00\text{ m}$$

THANKS

MAP Reading

PREPAIRED BY-
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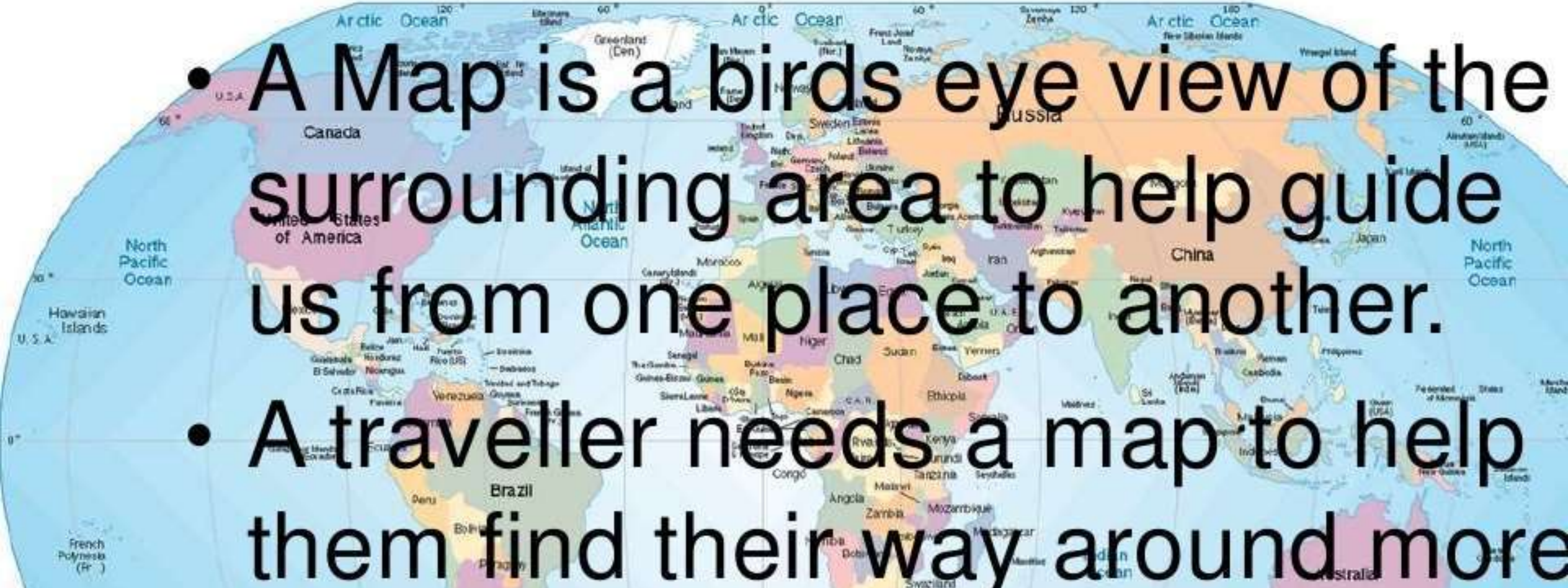
Map Reading

What is Map?



- A Map is a birds eye view of the surrounding area to help guide us from one place to another.
- A traveller needs a map to help them find their way around more

Types of Map

- Political Map
- Physical Map
- Weather Map
- Arial Map
- Road Map
- Climatic map

Types Maps

Political Map

Physical Map

Types Maps

Road Map

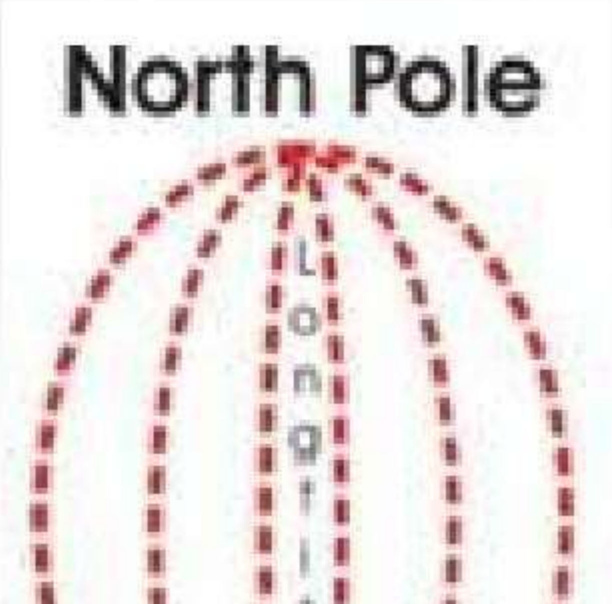
Whether Map

Guess About the Arial Map of Area


Ghorikot

Latitude and Longitude

- The earth is divided into lots of lines called **latitude** and **longitude**



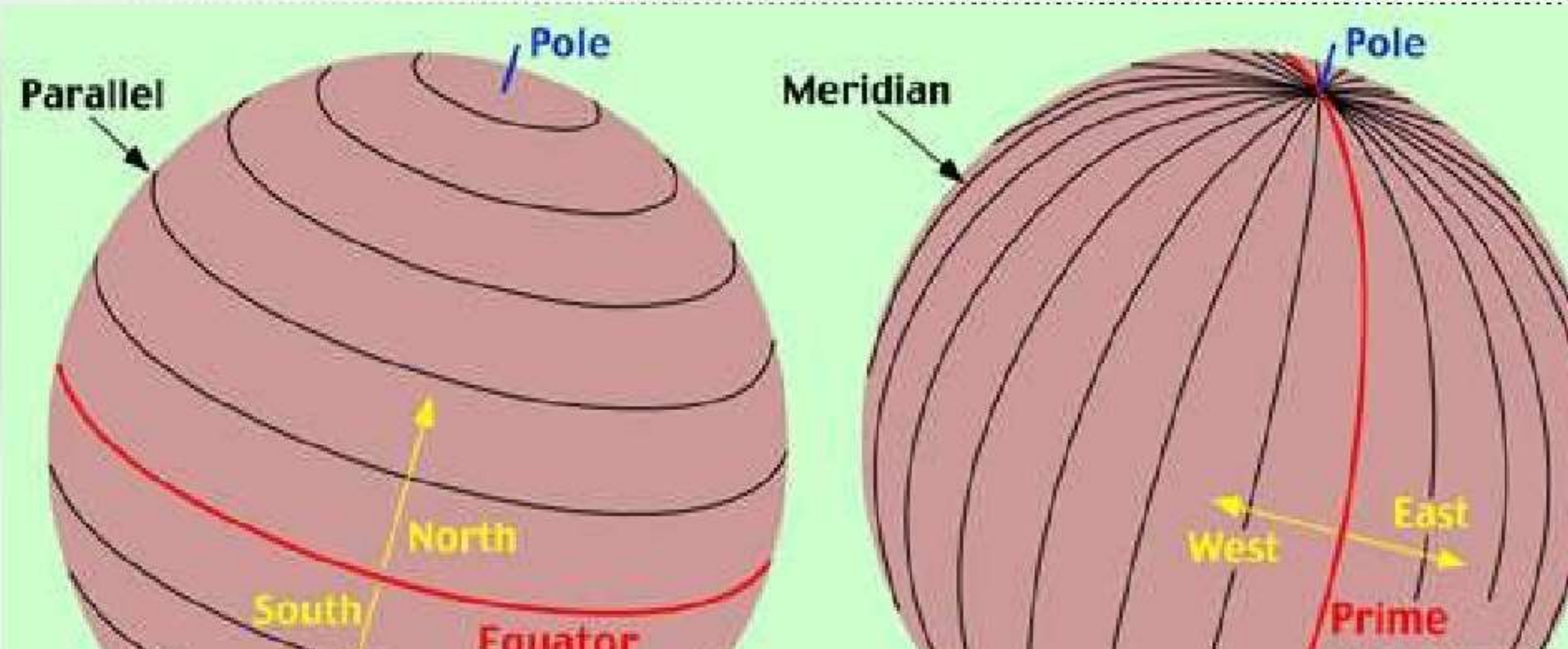
Latitude

- The lines that run from left to right, or west to east, are called **lines of latitude**. The equator is in the exact middle of the latitude lines. These lines are always the same distance apart, and never cross. Lines of latitude are also called **parallels**, a they are "parallel" to the equator.

Longitude

- The lines run from top to bottom or the north pole t the south pole **lines of longitude**. . The distance between lines of longitude is greatest at the equator, and gets smaller as they move towards th poles, where they touch. This means they are *not* parallel. Sometimes lines of longitude are also called **meridians**. The Prime Meridian separates the Eastern Hemisphere from the Western

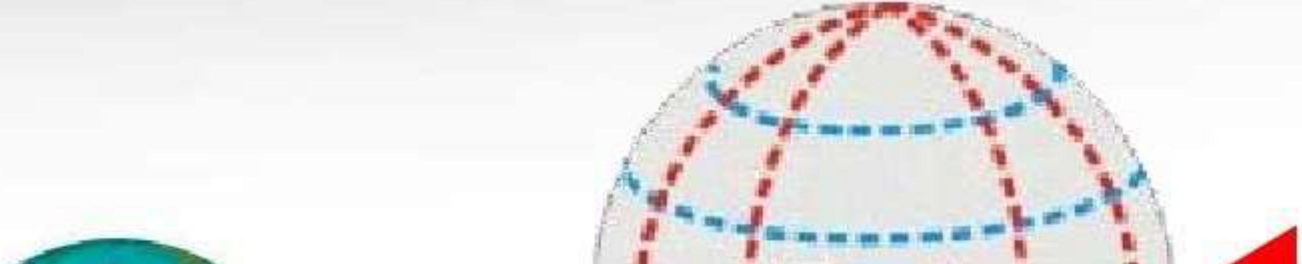
Cont….



Pole
Parallel
North
South
Equator
Pole
Meridian
West
East
Prime

Cont…

- Longitude lines run north and south.
- Latitude lines run east and west.
- The lines measure distances in degrees.



Main features of Map

- **Definitions**
- **equator:** an imaginary line that goes all the way around the earth, dividing it into two equal halves, a northern half and a southern half
- **Northern Hemisphere:** the half of the earth that is north of the equator
- **Southern Hemisphere:** the half of the earth that is south of the equator
- **Prime Meridian:** an imaginary line that goes all the way around the earth, dividing it into tw equal halves, an eastern half and a western half
- **Eastern Hemisphere:** the half of the earth that is east of the Prime Meridian
- **Western Hemisphere:** the half of the earth that is west of the Prime Meridian
- **North Pole:** the point on the earth which is furthest north
- **South Pole:** the point on the earth which is furthest south
- **lines of latitude:** imaginary parallel lines, that run east and west around the earth, also cal

Food for Thoughts

Thanks for sparing time and sharing

Aerial Photography and Photogrammetry

Structure

- **Definitions of Remote Sensing**
- Origins of remote sensing
- Types of aerial photograph
- Photogrammetry
- Parallax
- Human vision
- Conclusions

Definitions of Remote Sensing

Can be very general, e.g.
"The acquisition of physical data of an object **without touch or contact**" (Lintz and Simonett, 1976)
"The observation of a target by a device **some distance away**" (Barrett and Curtis, 1982)

Definitions of Remote Sensing

Or more specific, e.g.
"The use of **electromagnetic radiation sensors** to record images of **the environment**, which can be interpreted to yield **useful information**" (Curran, 1985)

Definitions of Remote Sensing

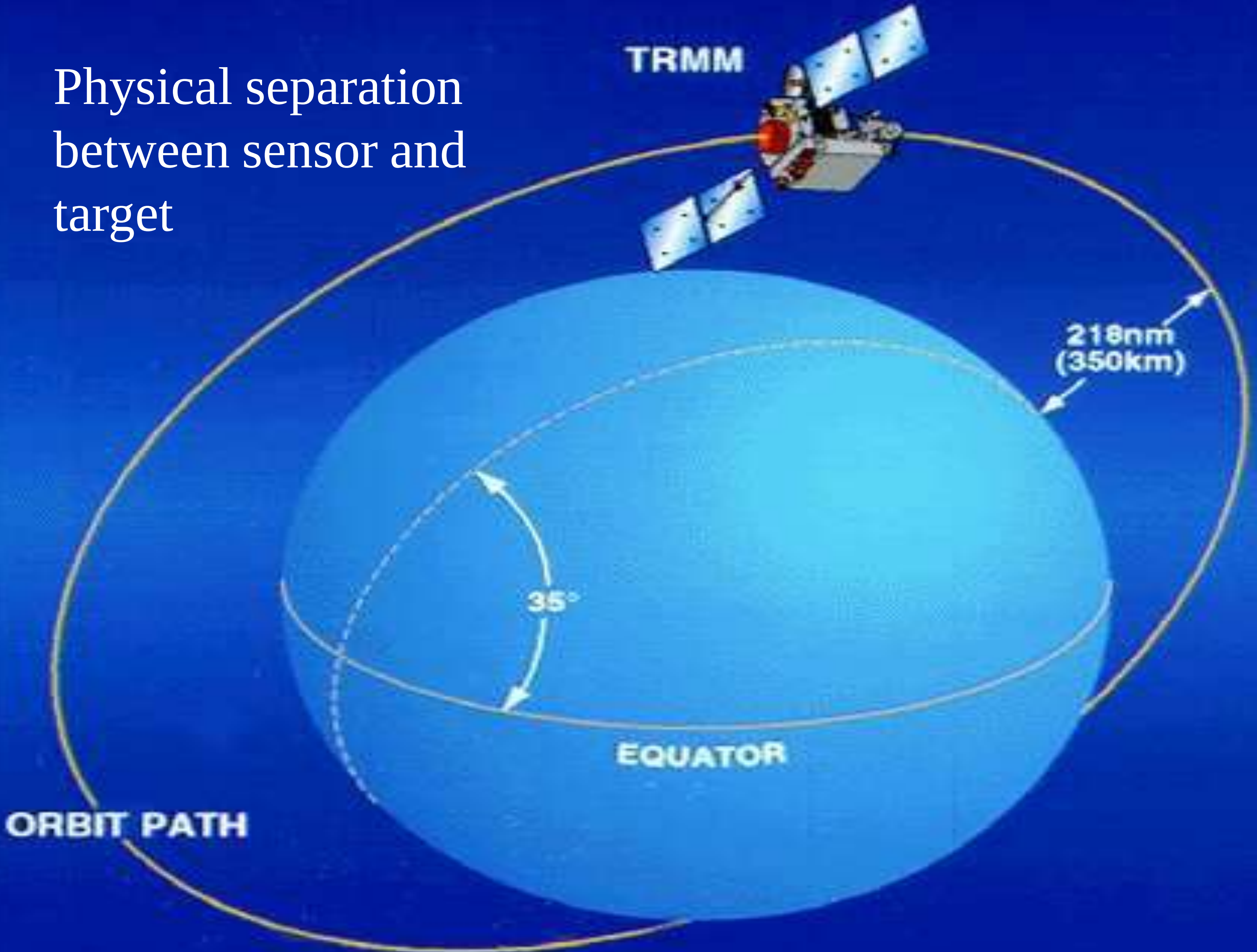
Or more specific, e.g.
"The use of sensors, normally operating at wavelengths from the **visible to the microwave**, to collect information about the Earth's **atmosphere, oceans, land and ice surfaces**" (Harris, 1987)

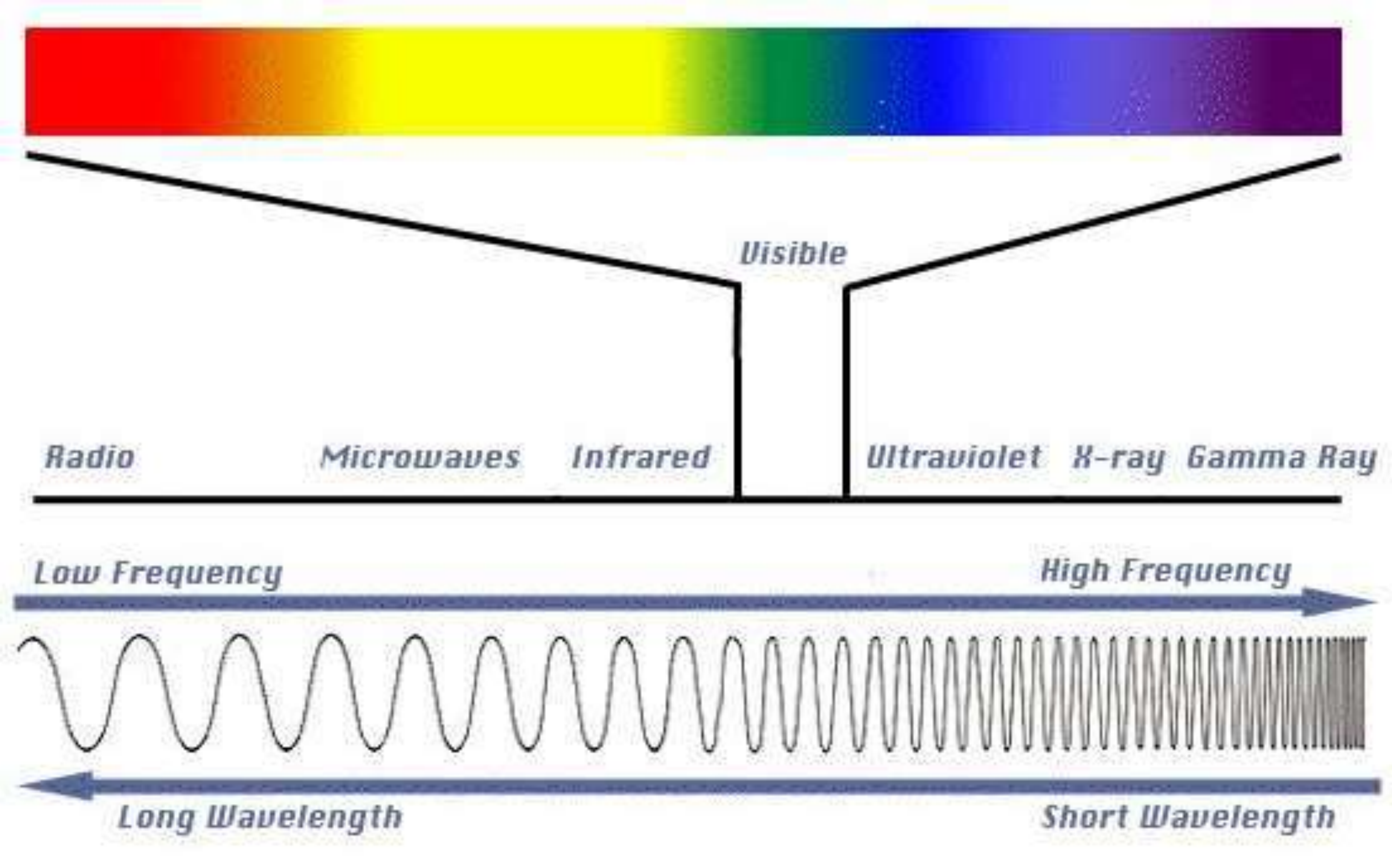
Definitions of Remote Sensing

Main characteristics

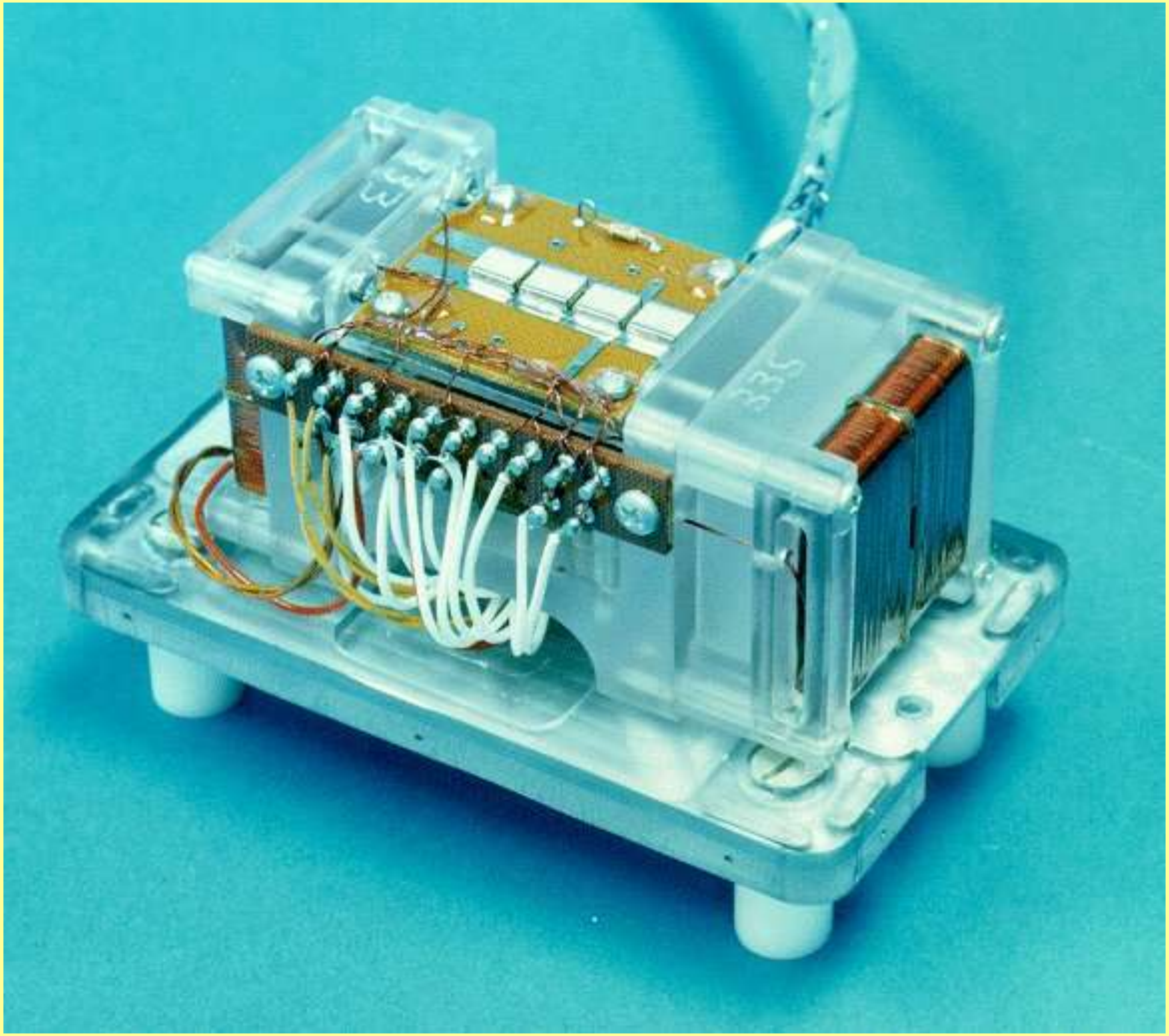
- Physical separation between sensor and target
- Medium = electromagnetic radiation (sonar is an exception)
- Device to sample and measure radiation (sensor)
- Target is the terrestrial environment (atmosphere, oceans, land surface)

Physical separation between sensor and target

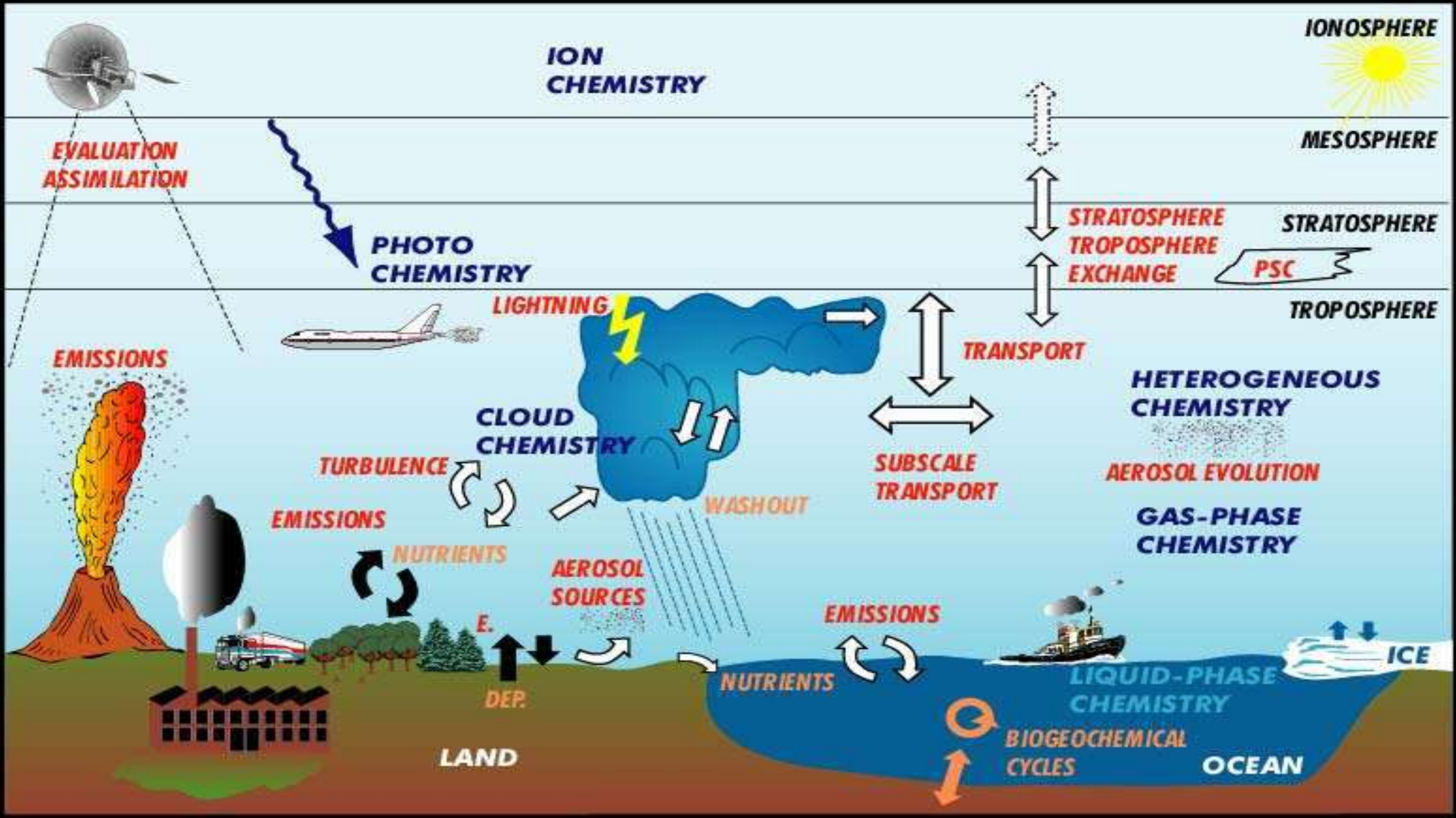




Medium = electromagnetic radiation (sonar is an exception)



Device to sample and measure radiation (sensor)



Target is the terrestrial environment (atmosphere, oceans, land surface)

Structure

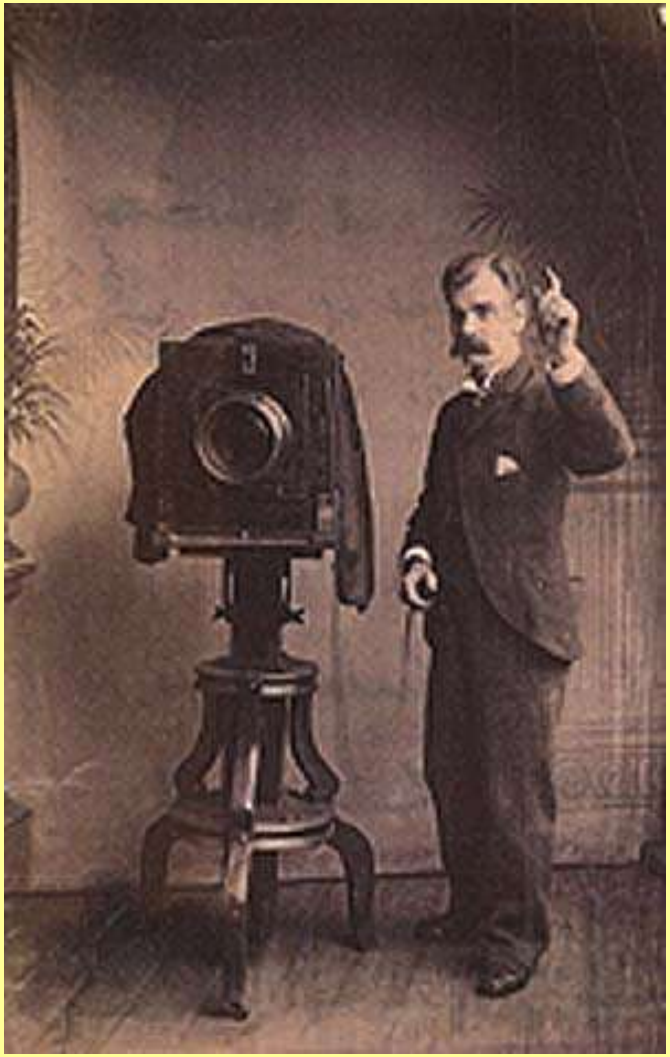
- Definitions of Remote Sensing
- **Origins of remote sensing**
- Types of aerial photograph
- Photogrammetry
- Parallax
- Human vision
- Conclusions

Origins of Remote Sensing

Remote sensing began with aerial photography

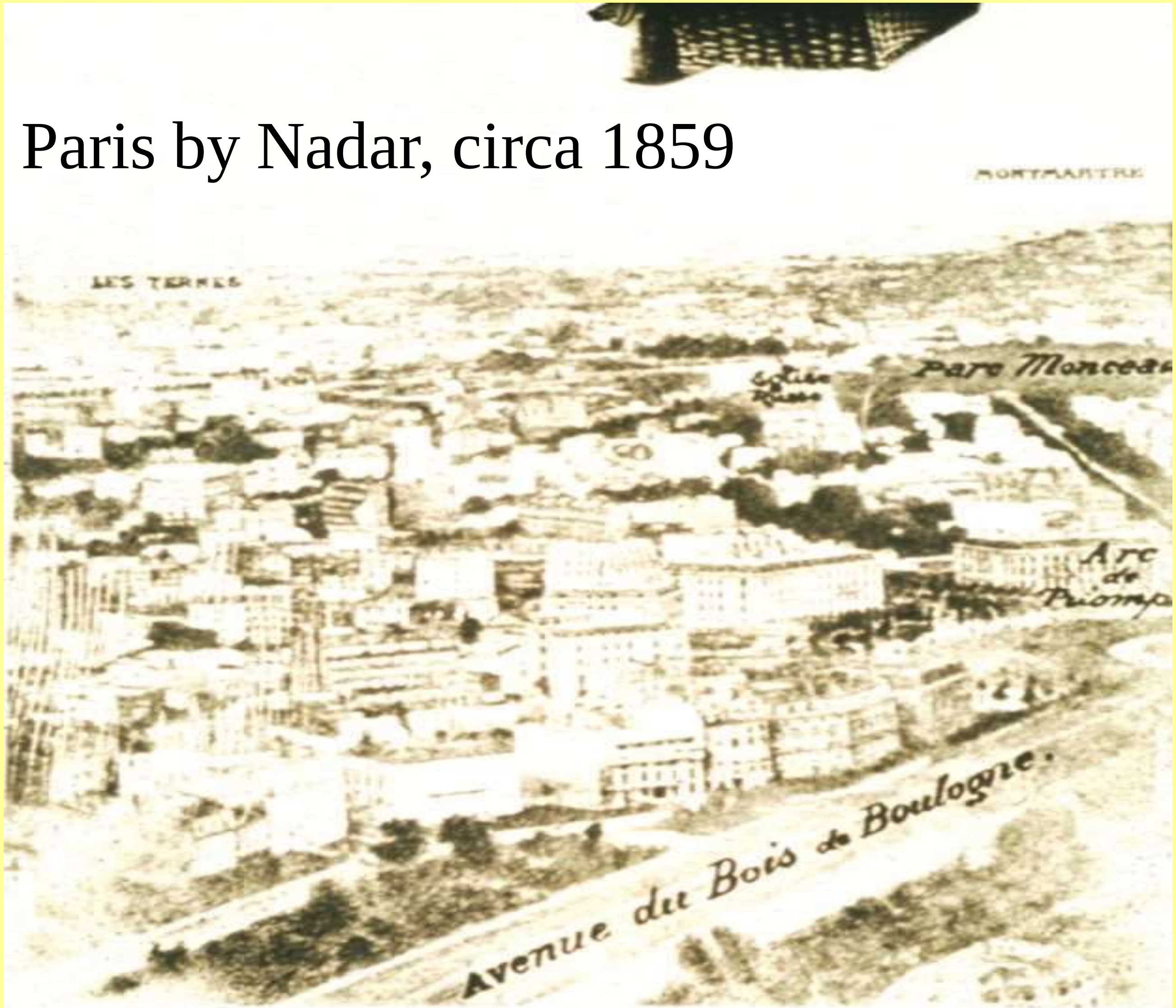
Origins of Remote Sensing

First photographs taken in 1839



Origins of Remote Sensing

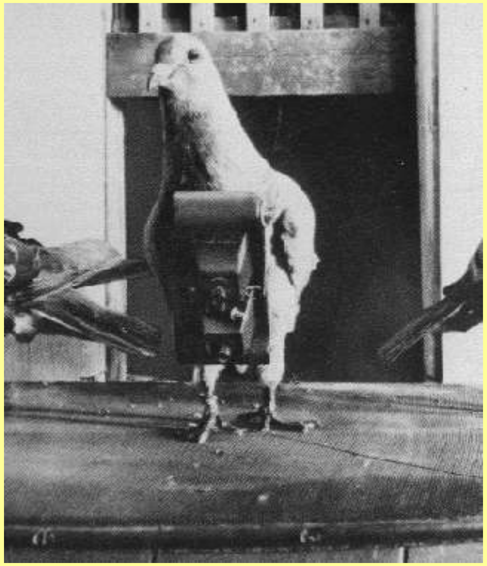
1858 Gasper Felix Tournachon "Nadar" takes photograph of village of Petit Bicetre in France from a balloon



Paris by Nadar, circa 1859

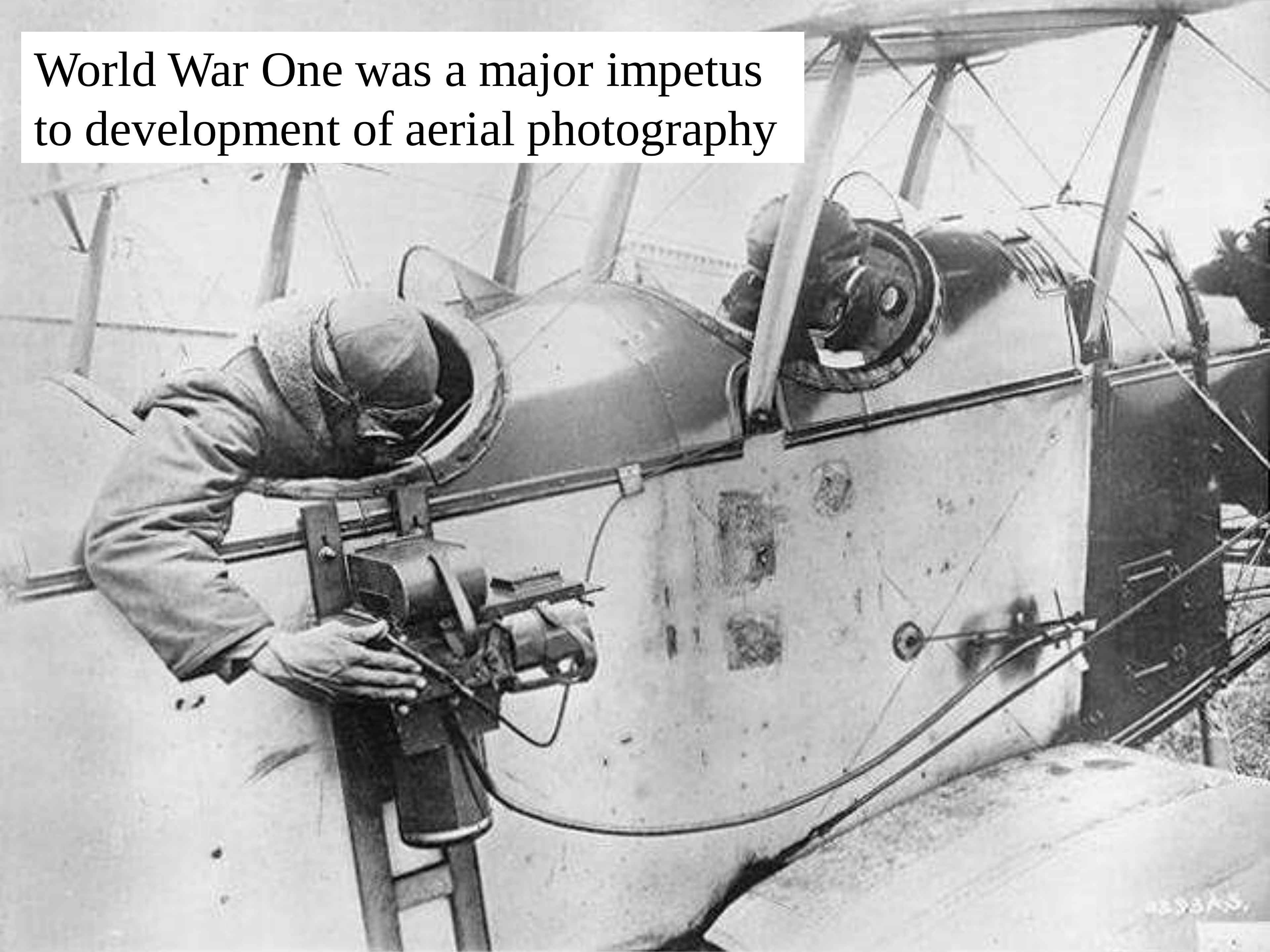
History of Aerial Photography

- US Civil War - Union General George McClellen photographs confederate troop positions in VA.
- 1882 - E.D. Archibald, British Meterologist takes first kite photograph
- 1903 - Pigeon cameras
- 1906 - George Lawrence photographs San Francisco after great earthquake and fire

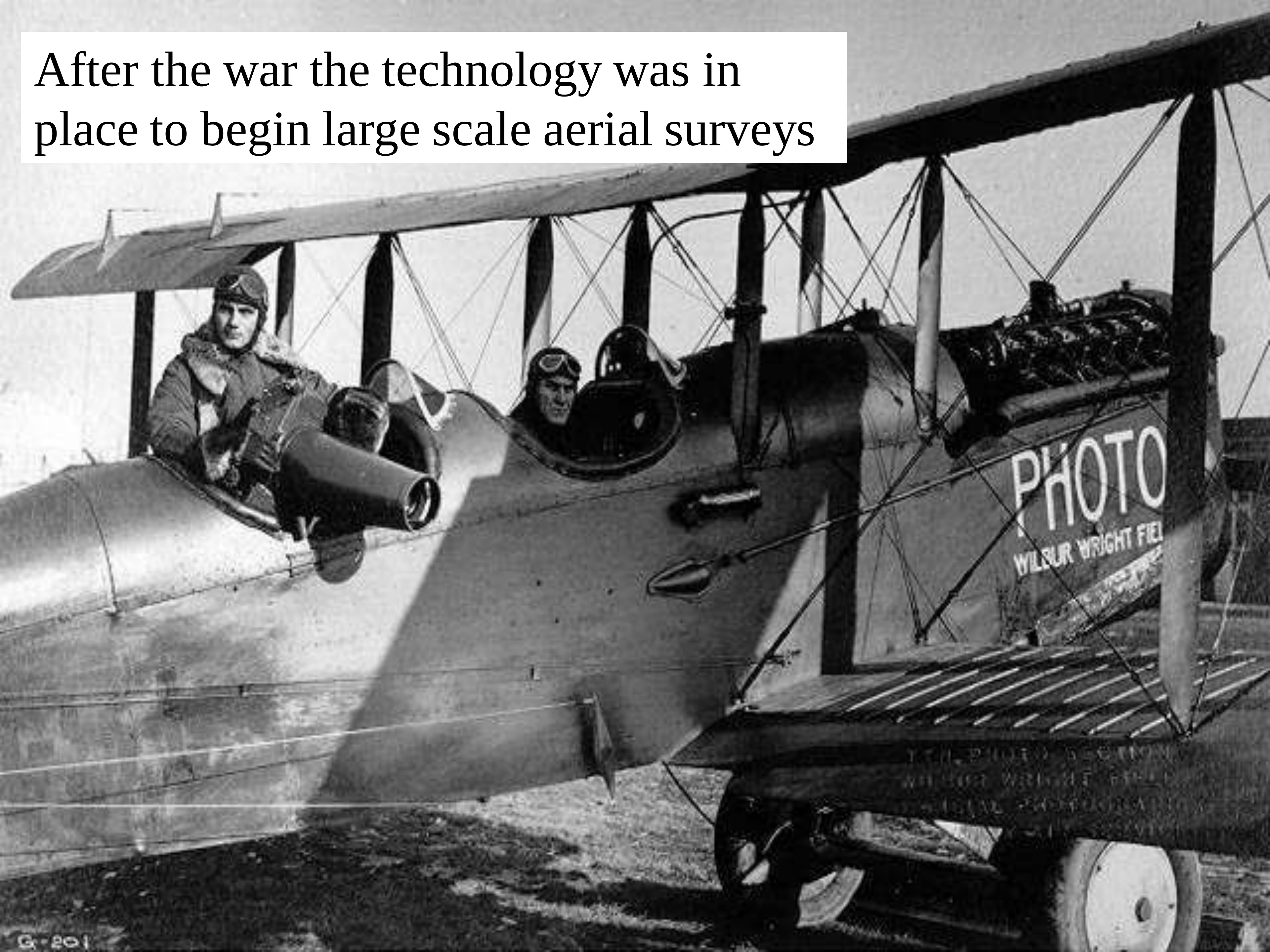


Boston by Black and King (1860)

World War One was a major impetus to development of aerial photography



After the war the technology was in place to begin large scale aerial surveys



Aerial Photography

Introduction

- A “bird’s eye view” is very useful for map making
  - Features obscure each other less when viewed from above than when viewed from ground level
- Air photography can come from many sources
  - Airplanes of all types can be equipped with cameras
  - So can hot air balloons, helicopters, pigeons, etc.
- We’ll discuss primarily film cameras, but most of the same concepts also apply to digital cameras

Basic Terminology

- Focal Length – the distance between the camera lens and the film
- Flying Height – the height of the plane (and therefore the camera) above the ground
- Nadir – the point on the ground directly below the camera
- Flight Line – the path of the airplane over which a sequence of pictures is taken
- Stereoscope - a device used to view/measure feature heights and/or landscape elevations using pairs of air photographs
- Fiducial Marks – marks on photographs used to align adjacent photos for stereoscopic analysis

Air Photo Scale

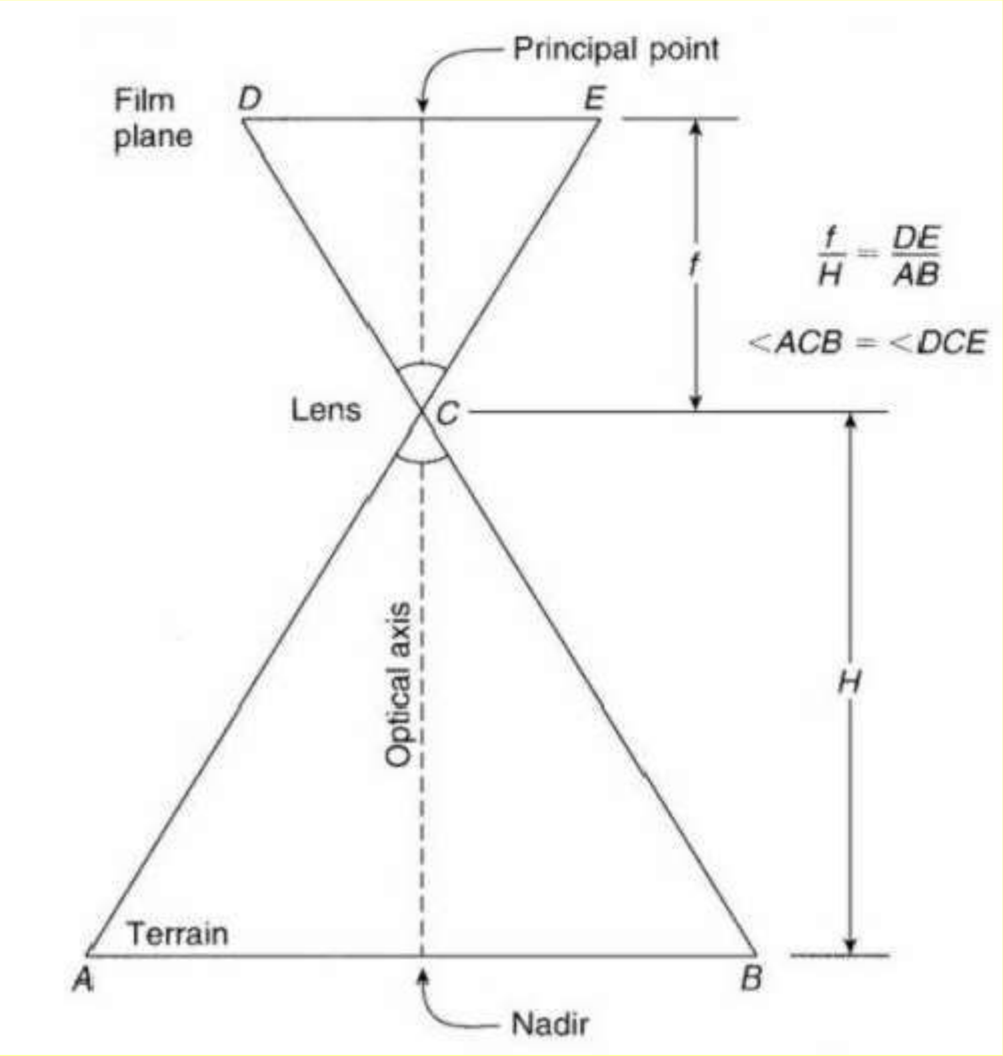
- Scale (RF) = 1 : (focal length / flying height)

- Focal length and flying height should be in the same units

- Example:
  – Focal length = 6 inches
  – Flying height = 10,000 ft
  – Scale = 0.5 / 10,000 = 1:20,000

Ray, R.G. (1960) Aerial Photographs in Geologic Interpretation and Mapping. Geological Survey Professional Paper 373.

Basic Camera



- Everything above "C" is inside the camera
- The film sits on the film plane
- f = focal length
- H = Elevation above ground
- ACB = angle of coverage
- Scale: RF = 1/(H / f)

http://www.clas.ufl.edu/users/mbinford/geo4120c/Lectures/week_2_2005_Image%20Acquisition,%20Aerial%20Photography%20Programs,%20Cameras%20and%20Films.pdf

Basic Camera

f-stop, or relative aperture
f / effective lens diameter

- Film exposure:
  - The quantity of energy that is allowed to reach the film
  - Controlled by relative aperture (f-stop) and shutter speed, as well as energy source

http://www.clas.ufl.edu/users/mbinford/geo4120c/Lectures/week_2_2005_Image%20Acquisition,%20Aerial%20Photography%20Programs,%20Cameras%20and%20Films.pdf

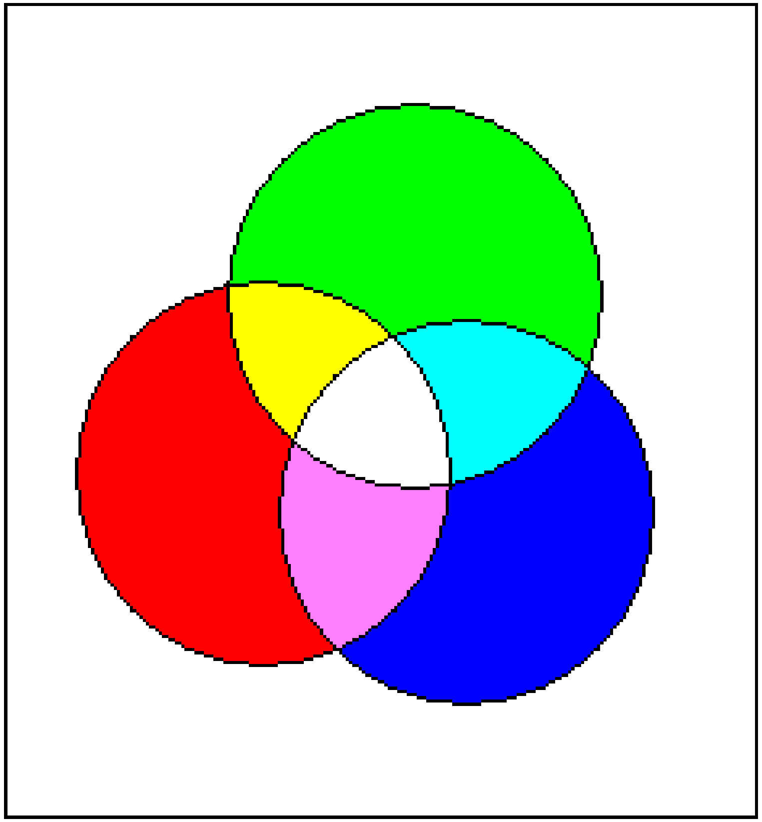
Film Basics

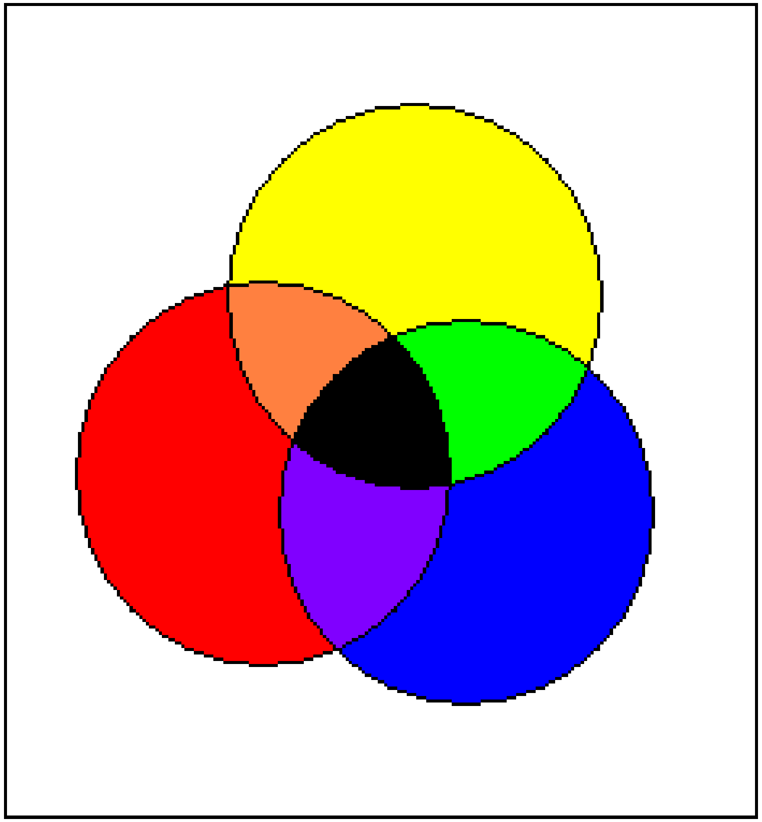
- Types of film
  - Black and White (a.k.a. panchromatic)
  - Color
  - Infrared
  - Color Infrared (CIR)

Basic Color Theory

Additive Color

Subtractive Color

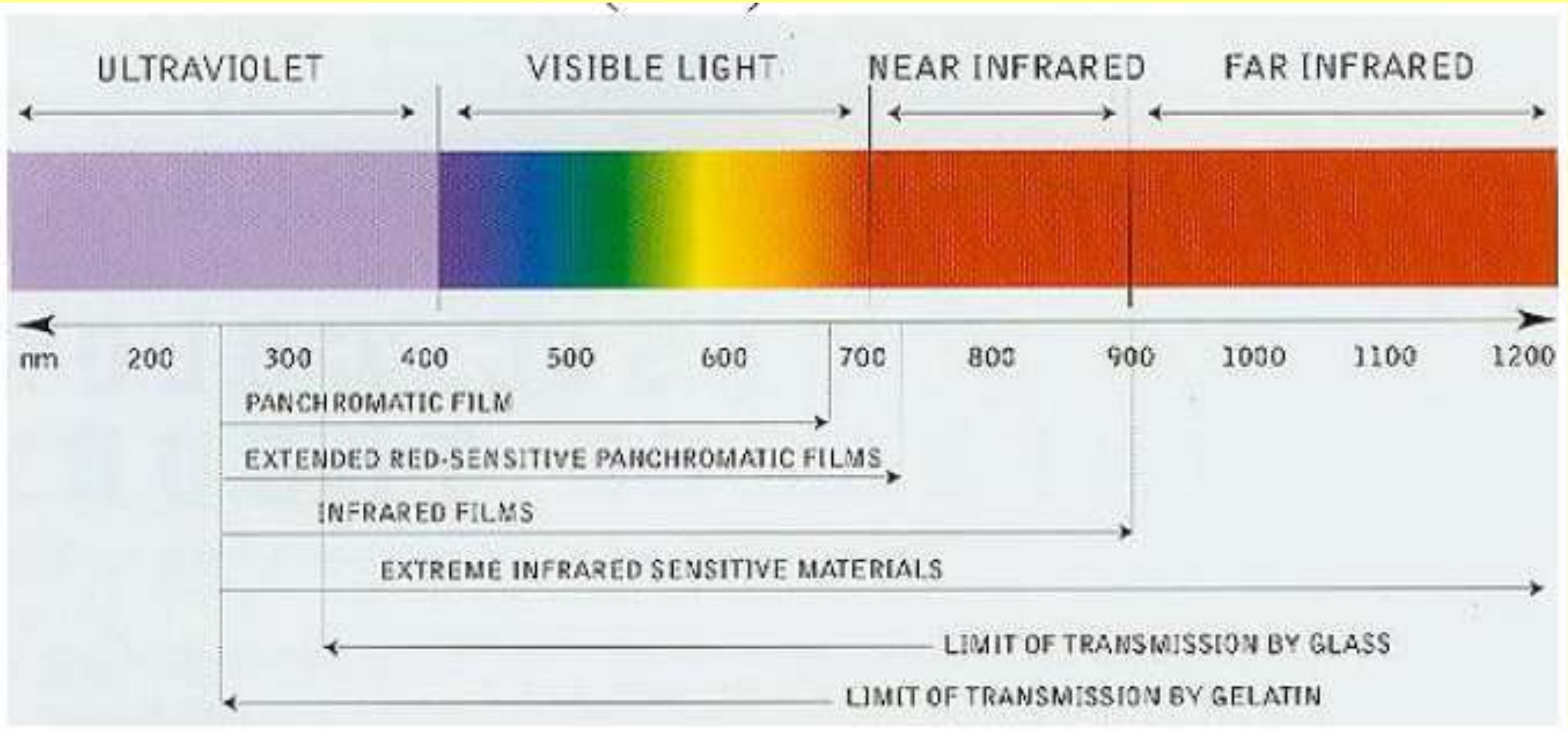




Colors of light
(e.g., on a computer monitor)

Colors of pigment
(e.g., paint)

Film and the Electromagnetic Spectrum



http://www.clas.ufl.edu/users/mbinford/geo4120c/Lectures/week_2_2005_Image%20Acquisition,%20Aerial%20Photography%20Programs,%20Cameras%20and%20Films.pdf

CIR Films


Color photograph—near Burlington, Vt.


Color-infrared photograph—near same area

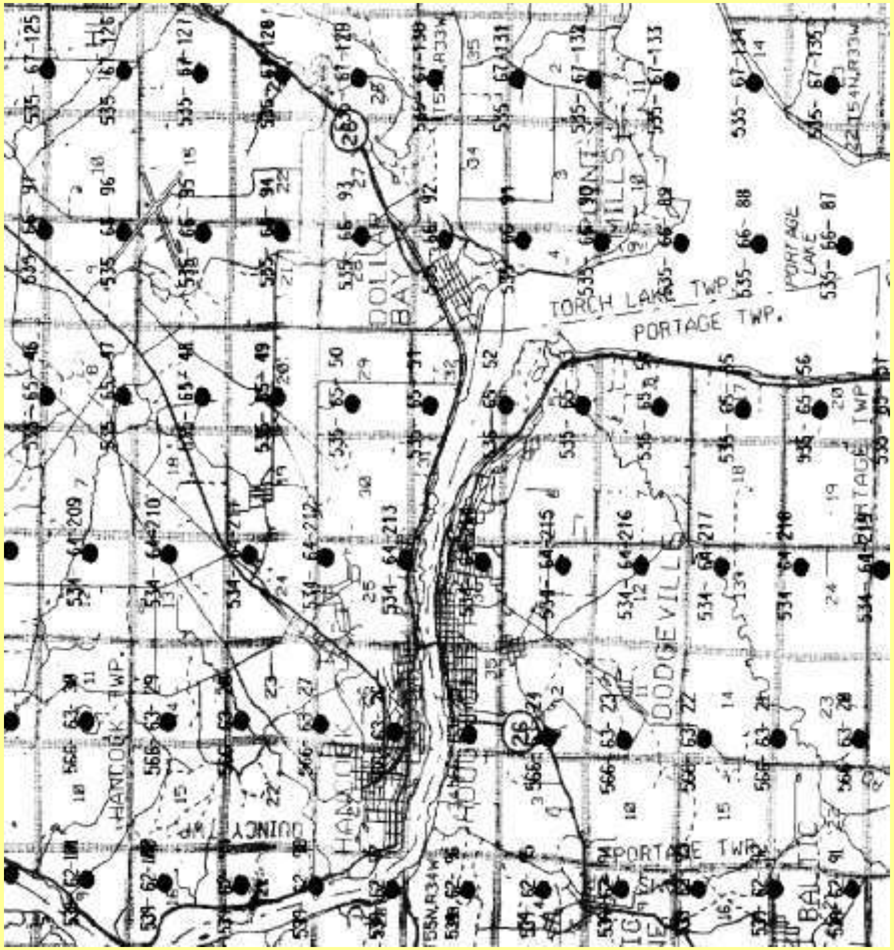
http://www.clas.ufl.edu/users/mbinford/geo4120c/Lectures/week_2_2005_Image%20Acquisition,%20Aerial%20Photography%20Programs,%20Cameras%20and%20Films.pdf

Resolution

- Currently, a 9 x 9 inch format digital camera would require about 400 million pixels to approach the resolution of a typical 9 x 9 inch film camera (Paine and Kaiser 2003).
- This is roughly 2222 pixels/inch.

http://www.clas.ufl.edu/users/mbinford/geo4120c/Lectures/week_2_2005_Image%20Acquisition,%20Aerial%20Photography%20Programs,%20Cameras%20and%20Films.pdf

Flight Lines



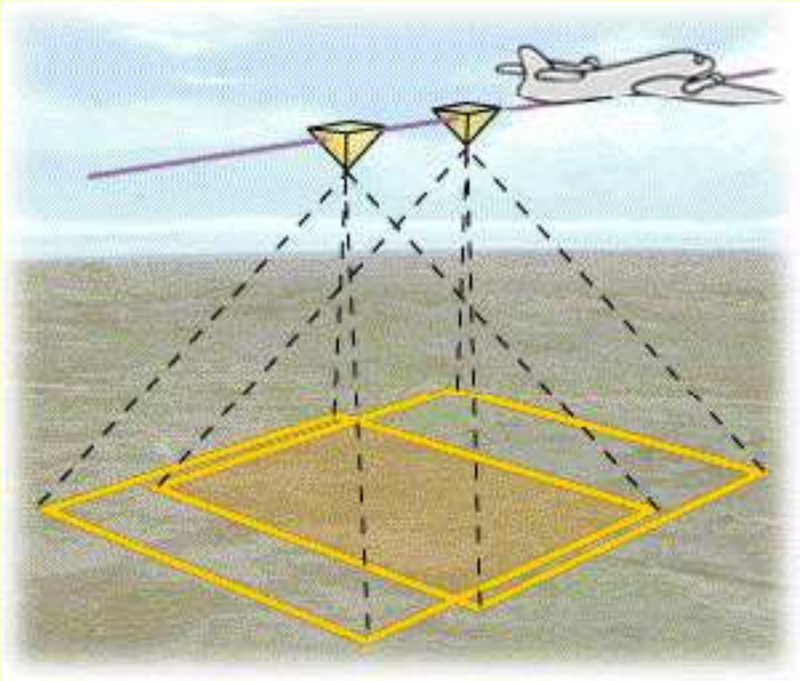
- Successive photos on a flight line typically have ~60-65% overlap to allow stereoscopic viewing
- Adjacent flight lines typically have ~20-30% overlap
- Some location of the ground may be imaged on 3 photographs along the same flight line and 6 photographs in total

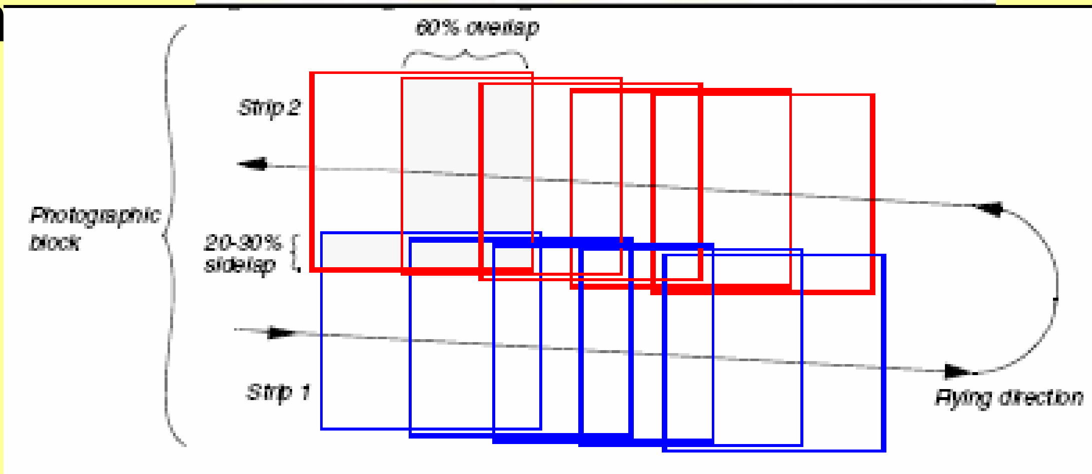
http://forest.mtu.edu/classes/fw4540/lectures/aerialphoto.pdf

Stereoscopic Parallax

- Stereoscopic Parallax is caused by a shift in the position of observation

- Parallax is directly related to the elevation / height of features





http://www.geog.okstate.edu/users/rao/raoweb/4333/fall07/lectures/lec5.pdf

Air Photo Mosaic

http://www.acsu.buffalo.edu/~liangmao/RS_LAB/Lab9.pdf

Stereopair

http://www.acsu.buffalo.edu/~liangmao/RS_LAB/Lab9.pdf

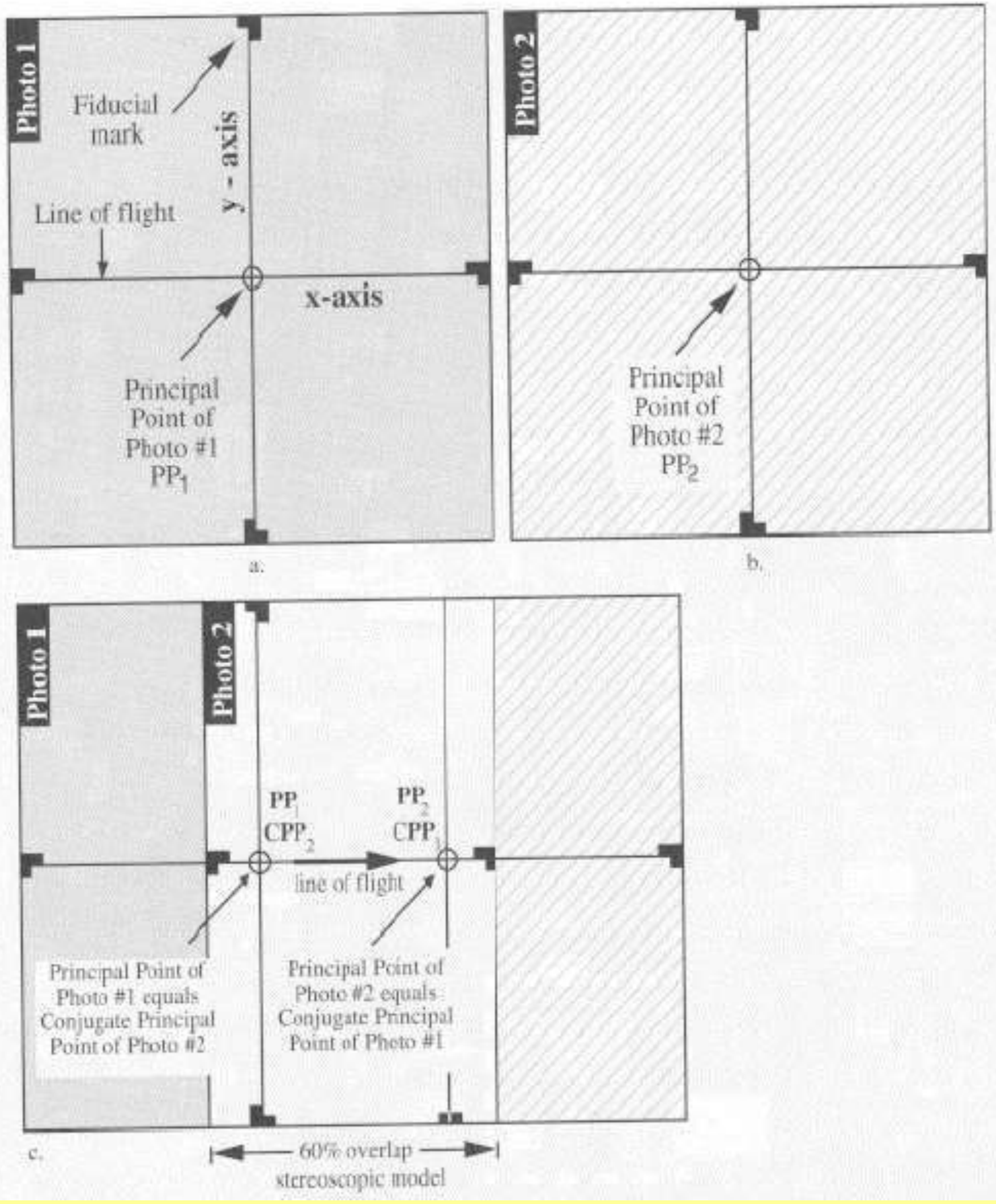
Stereoscope

http://www.acsu.buffalo.edu/~liangmao/RS_LAB/Lab9.pdf

Aligning Air Photos

- Fiducial marks
  - Type and number vary amongst cameras
  - 4-8 marks (e.g., top, bottom, left, right, & 4 corners)
- Principal Point (PP) - the exact point at which the camera was aimed when the photo was acquired
- Conjugate Principal Point (CPP) – the principal point of an adjacent photograph in the flight line

http://forest.mtu.edu/classes/fw4540/lectures/aerialphoto.pdf



http://forest.mtu.edu/classes/fw4540/lectures/aerialphoto.pdf

Sources of Distortion

- From Collection:
  - Yaw – plane fuselage not parallel to flight line
    - Think about having to steer your car slightly into a strong cross wind
    - Leads to pictures not being square with the flight-line
  - Pitch – nose or tail higher than the other
    - Leads to principal point not being at nadir
  - Roll – one wing higher than the other
    - Leads to principal point not being at nadir

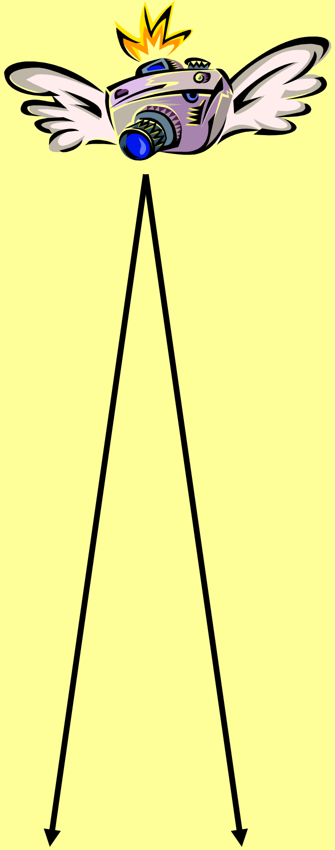
- Natural:
  - Haze
  - Topographic changes
    - For example, if flying over mountains, the height above the ground will a) change from picture to picture, and b) not be uniform in a single picture. Both of these lead to irregularities in the photo scale

Structure

- Definitions of Remote Sensing
- Origins of remote sensing
- **Types of aerial photograph**
- Photogrammetry
- Parallax
- Human vision
- Conclusions

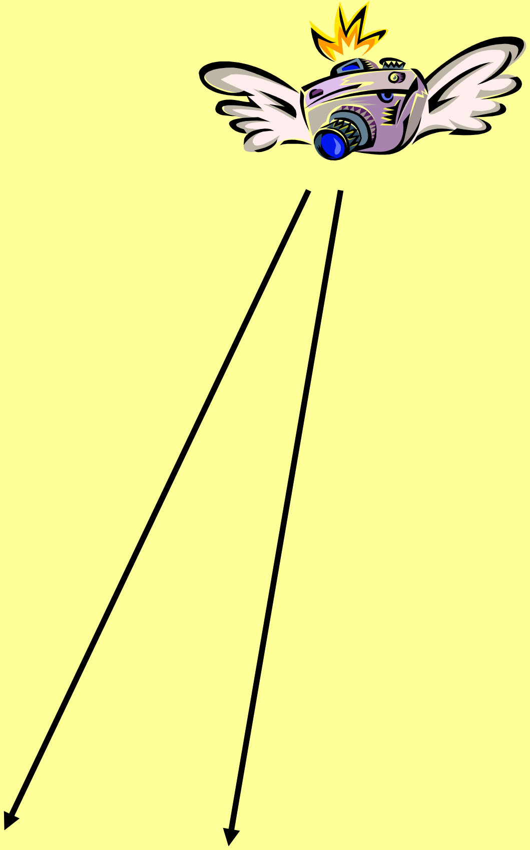
Types of aerial photograph

- Vertical
- Low oblique
- High oblique

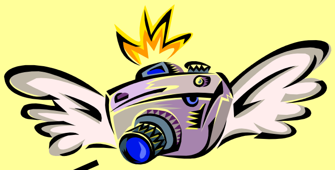


Types of aerial photograph

- Vertical
- Low oblique (no horizon)
- High oblique



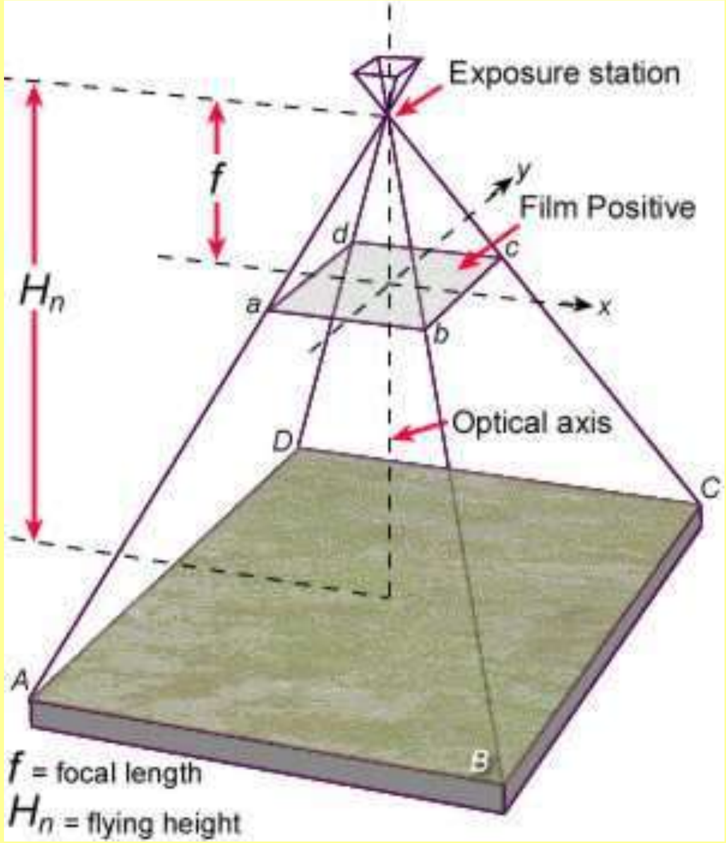
Types of aerial photograph



- Vertical
- Low oblique
- High oblique

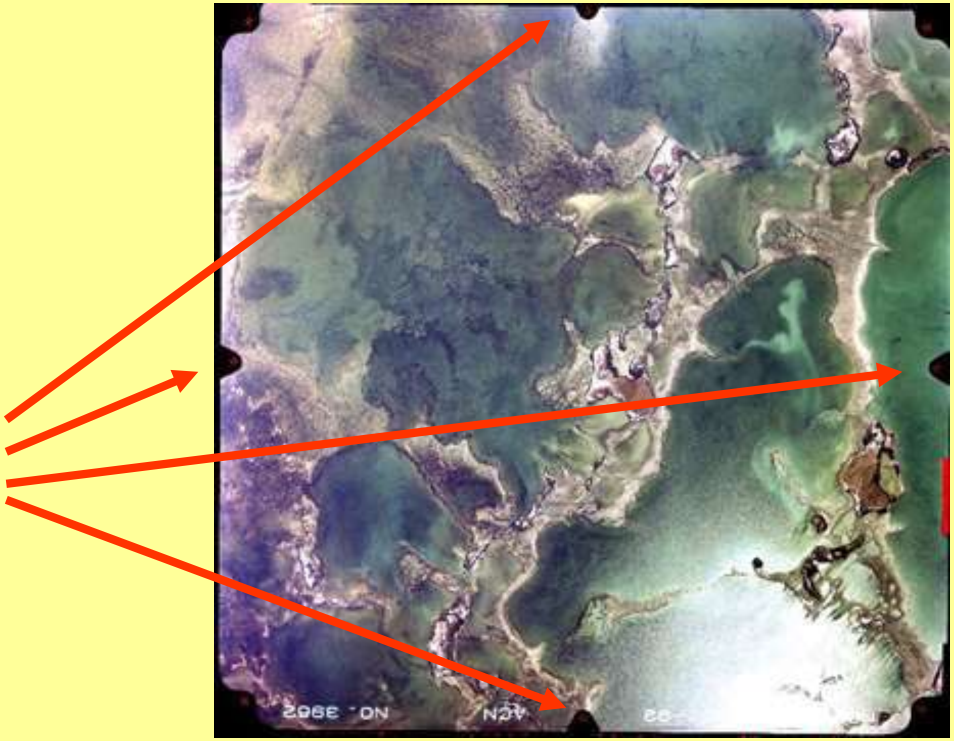
Types of aerial photograph

Vertical is most important as it has minimum distortion and can be used for taking measurements



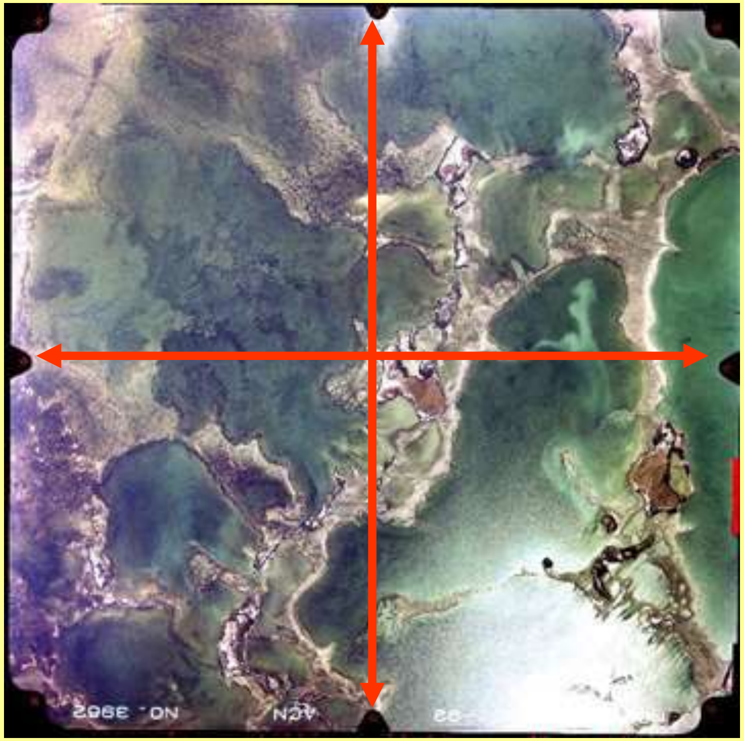
Types of aerial photograph

Fiducial marks



Types of aerial photograph

Fiducial
axes



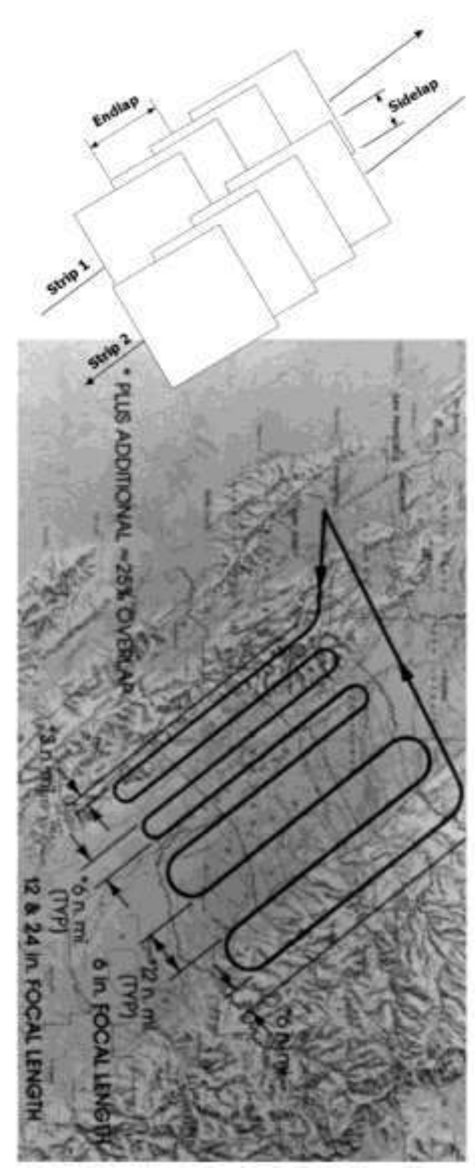
Types of aerial photograph

Principal point

Marginal information

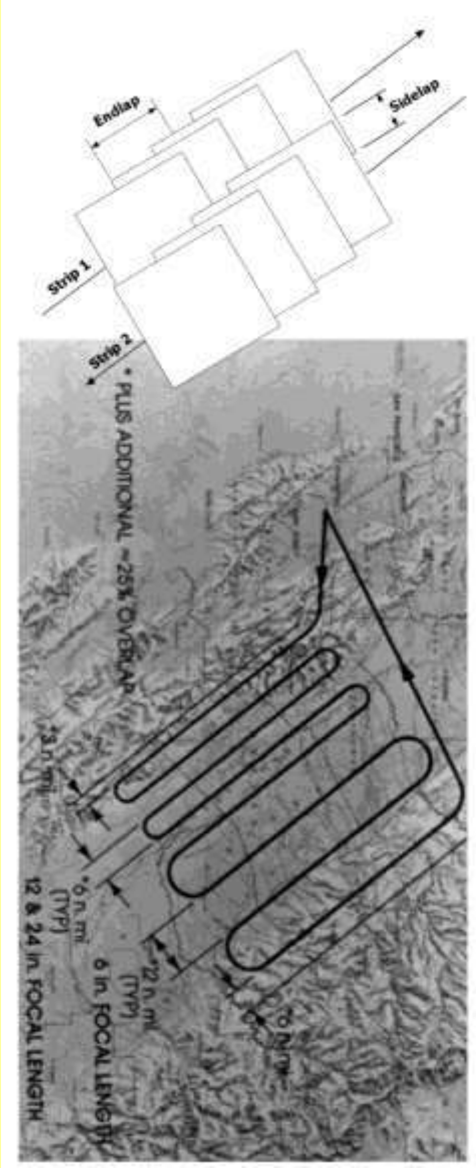
Types of aerial photograph

An aerial photograph mission will be flown in strips, shutter timing set for 60% endlap (needed for parallax) and strips spaced for 30% sidelap (to avoid missing bits)



Types of aerial photograph

• Endlap (or forelap) is the important bit
• It ensures every point on the ground appears in at least two photographs
• Distance between principal point of adjacent photographs is known as the “air base”



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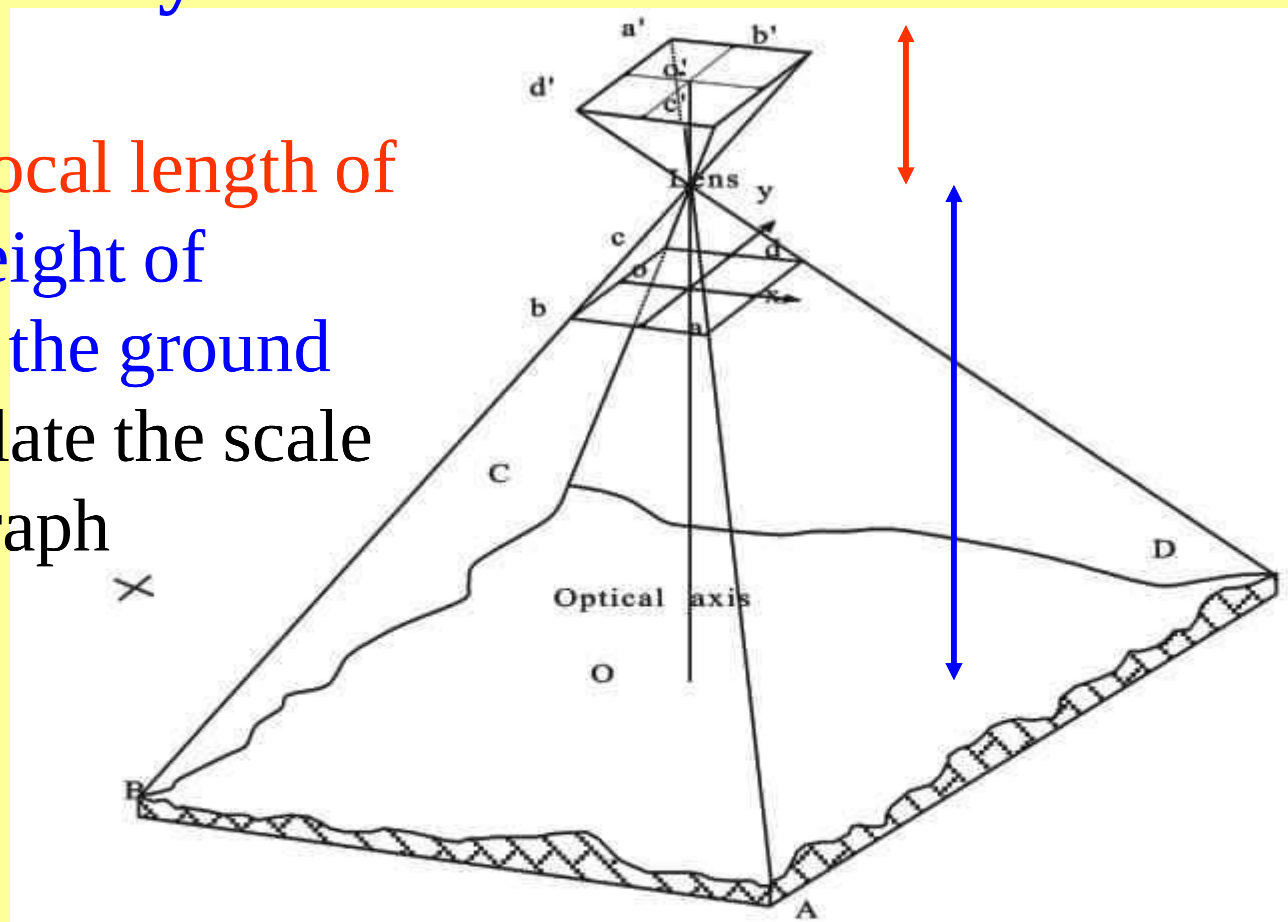
Photogrammetry

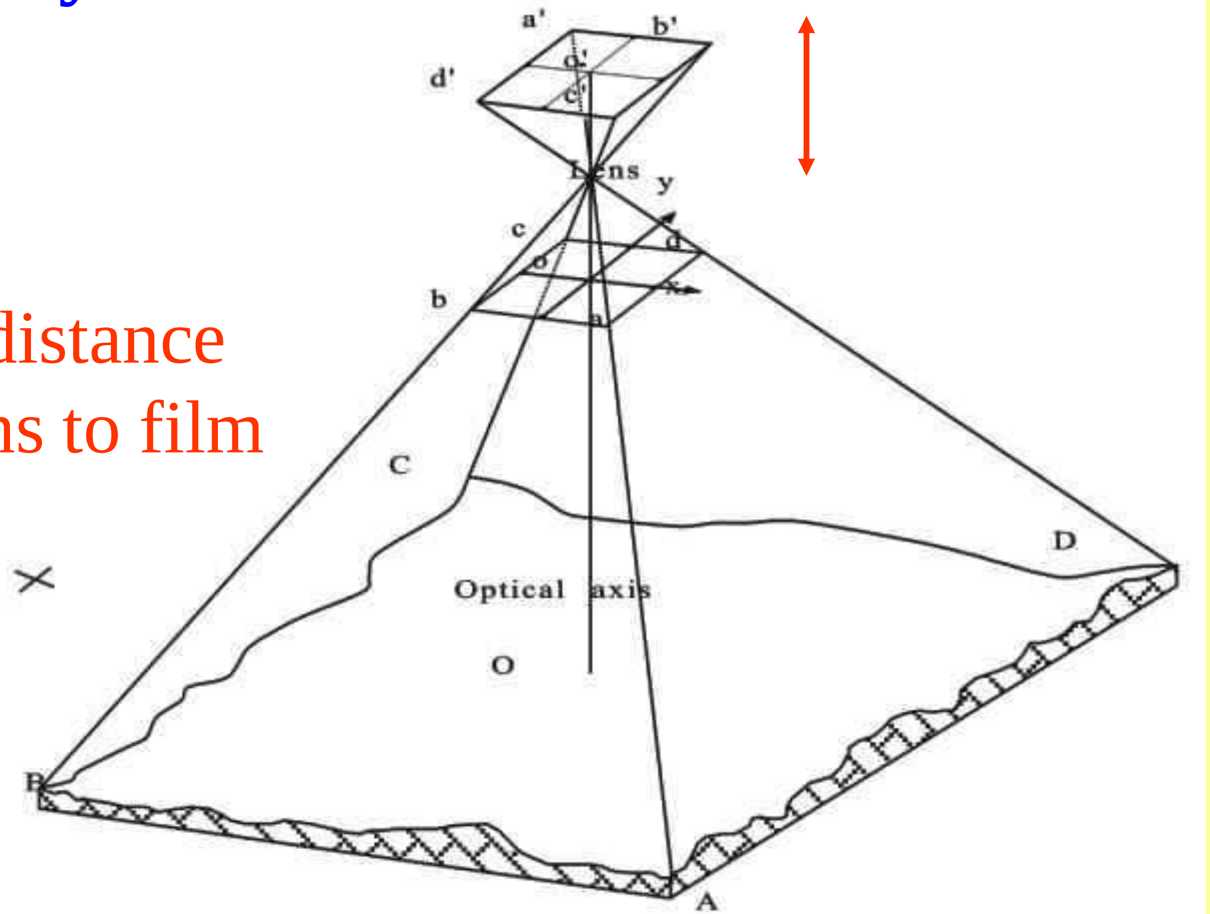
If you know focal length of camera and height of aircraft above the ground you can calculate the scale of the photograph



Photogrammetry

Scale = $f/H-h$

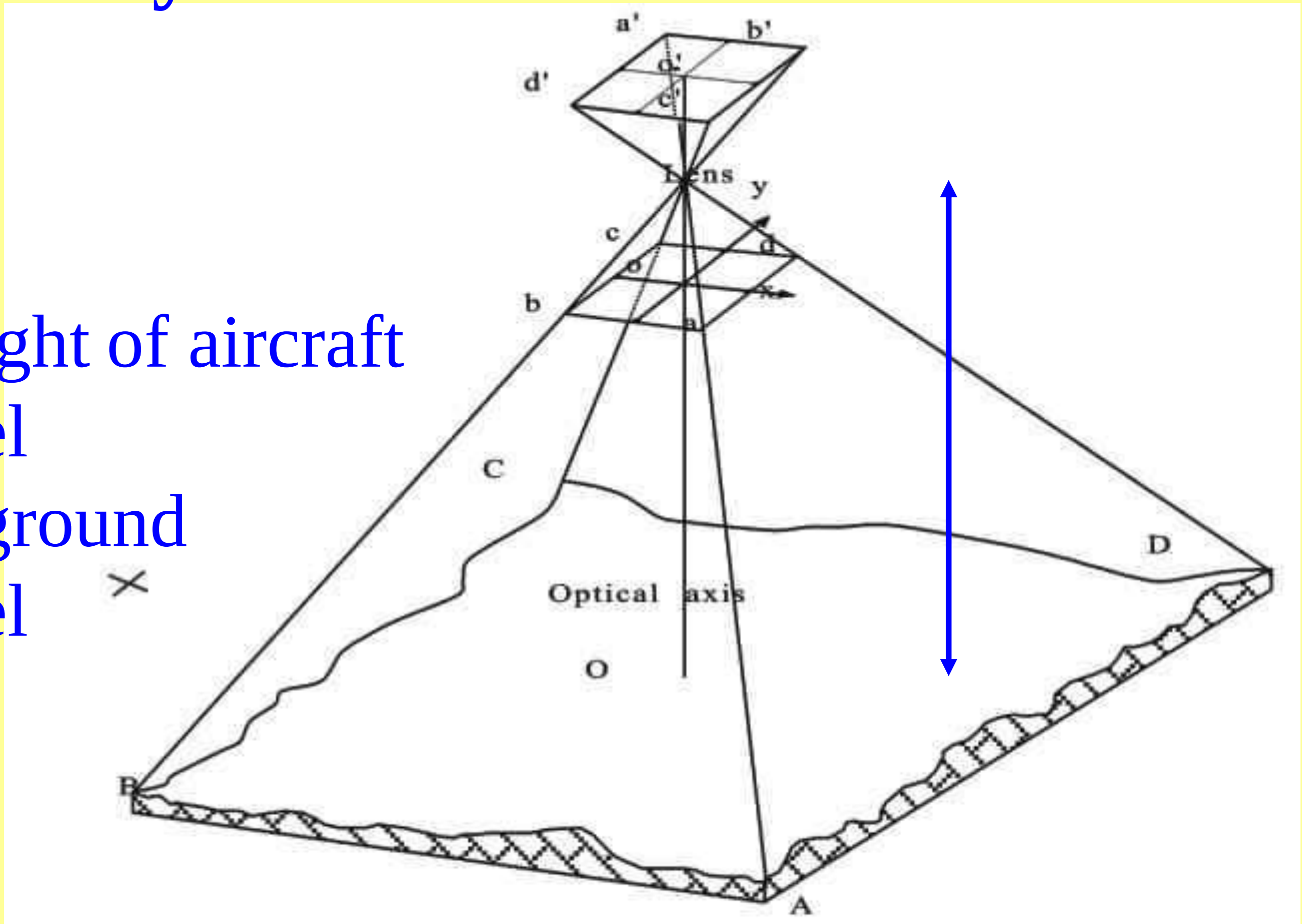
f = focal length (distance from centre of lens to film surface)



Photogrammetry

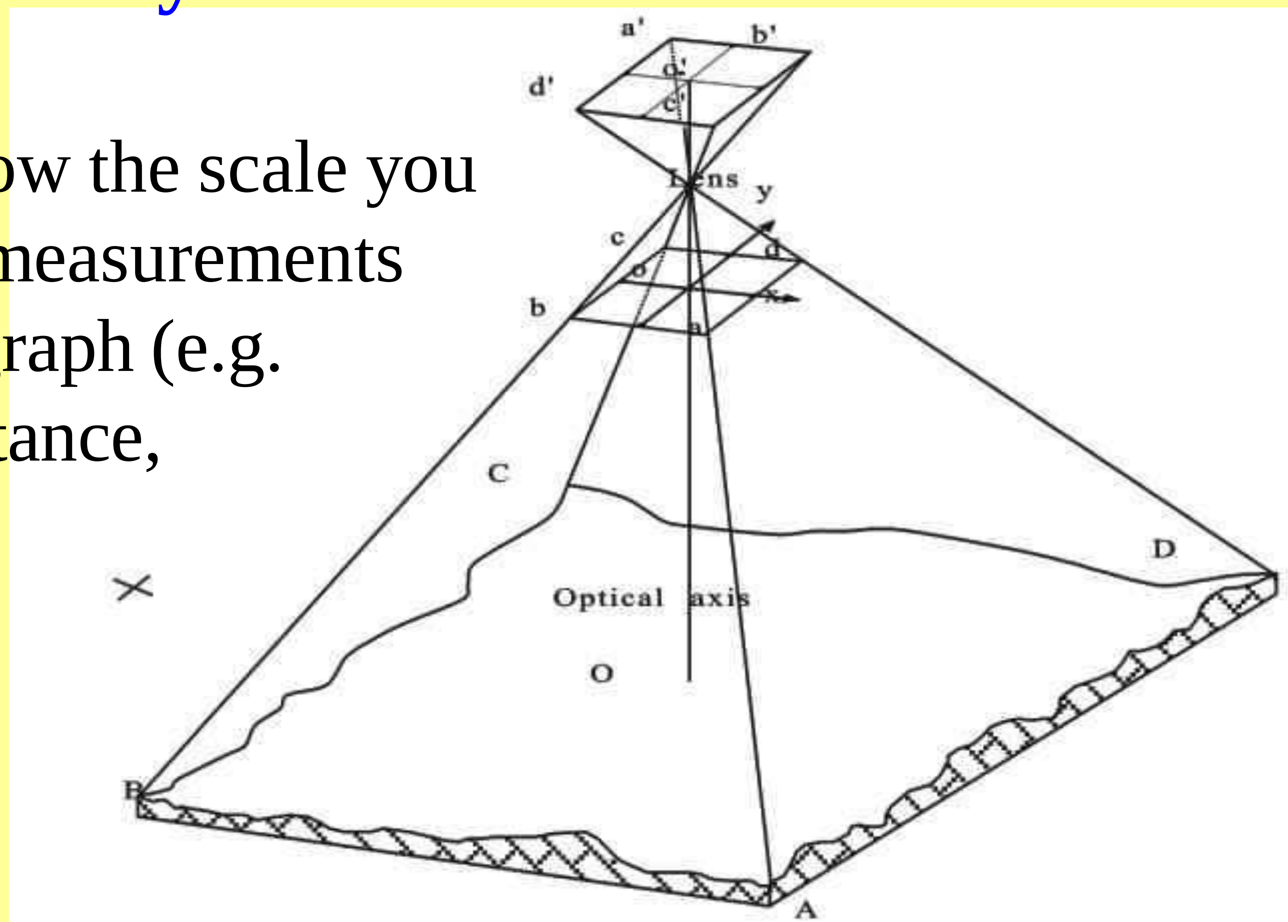
Scale = f/H-h

H = flying height of aircraft above sea level
h = height of ground above sea level



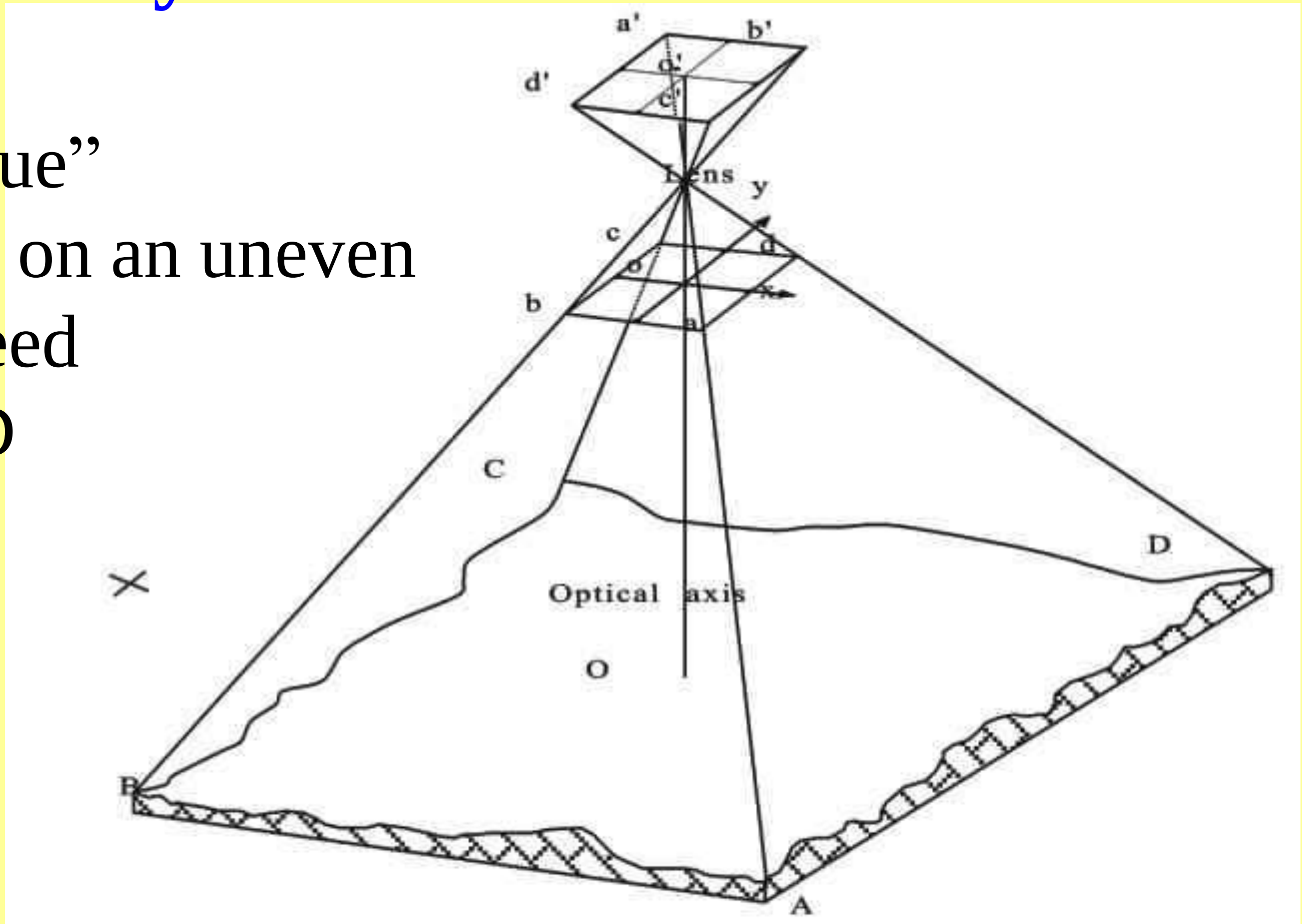
Photogrammetry

When you know the scale you can take 2-D measurements from a photograph (e.g. horizontal distance, horizontal area, etc.)



Photogrammetry

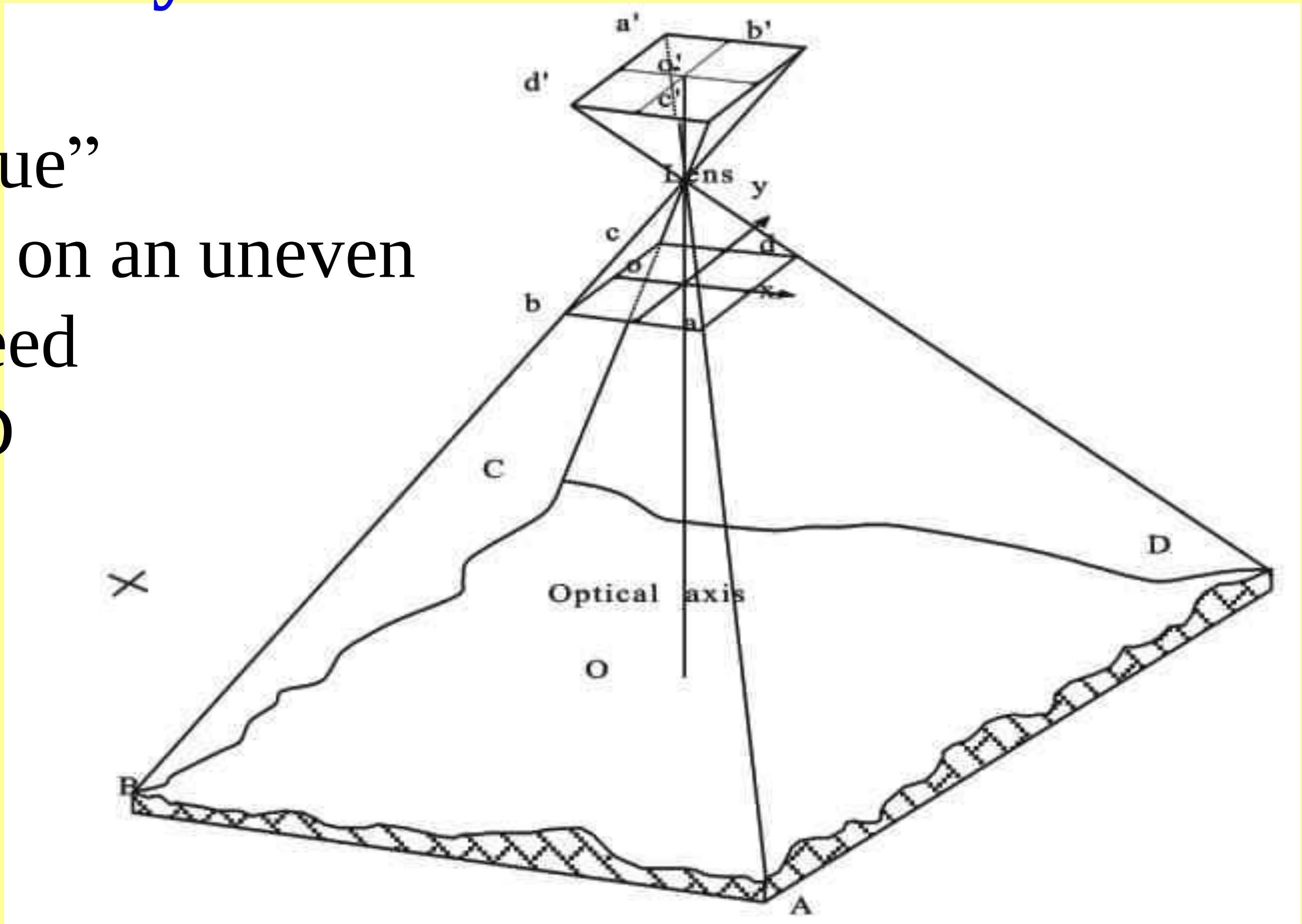
But to take "true" measurements on an uneven surface you need to work in 3-D



Photogrammetry

But to take “true” measurements on an uneven surface you need to work in 3-D

You can do this thanks to parallax



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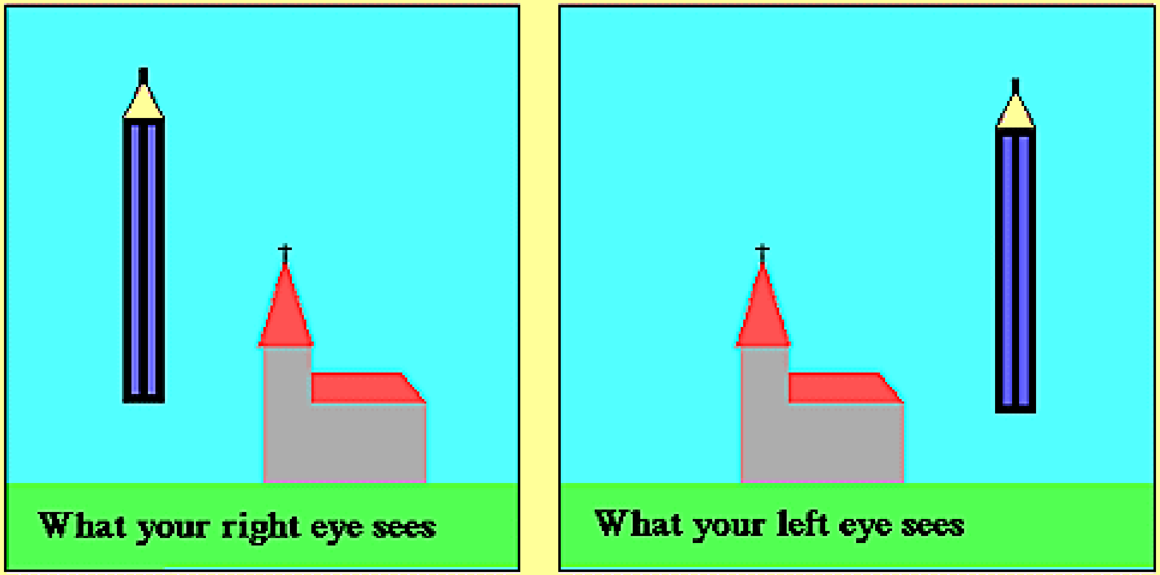
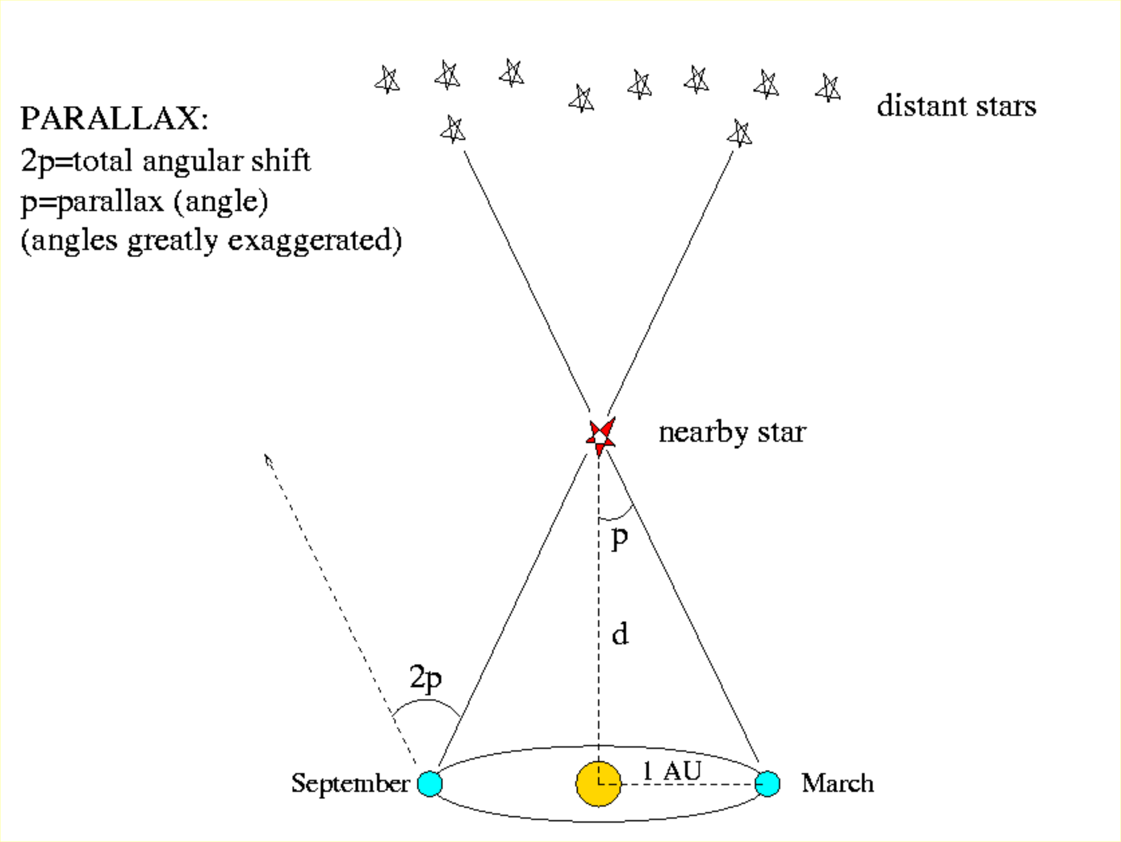
Parallax



Pencil is very displaced because it is close to observer
Church is less displaced because it is further away

Parallax



Parallax is used to find distance to stars, using two viewing points on either side of Earth's orbit

Parallax

The same principle can be used to find height of objects in stereopairs of vertical aerial photographs

Parallax

$$\text{Height of object} = \frac{H \cdot dP}{P + dP}$$

H = height of aircraft above ground
P = absolute parallax at base of object being measured*
dP = differential parallax

* For convenience the photo base length of a stereo pair is commonly substituted for absolute stereoscopic parallax (**P**)

Structure

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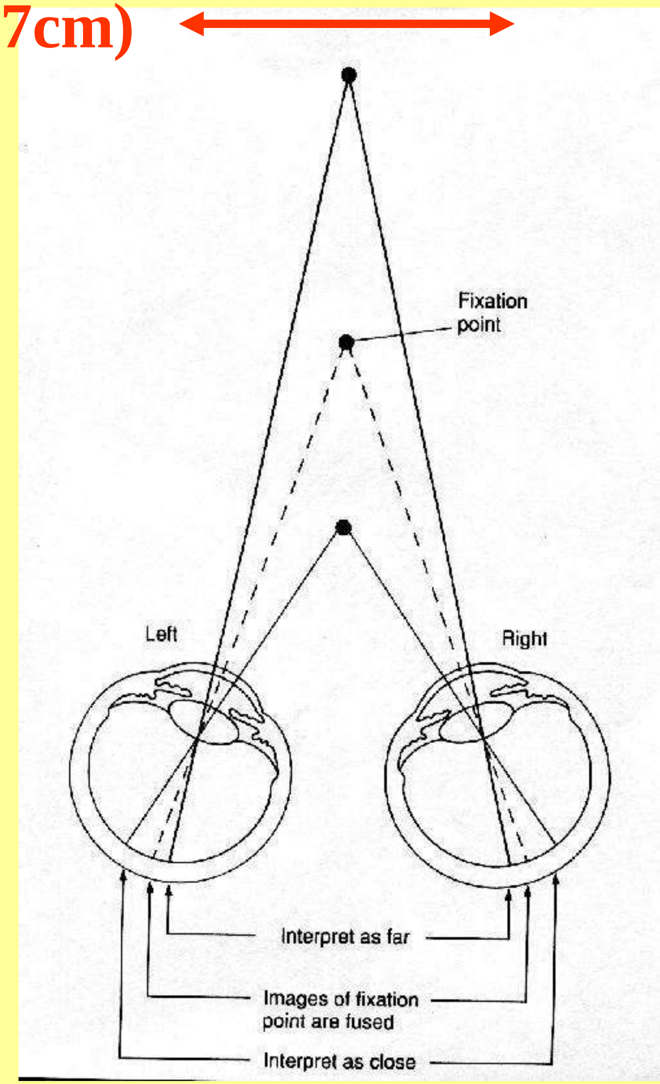
Eye base (6-7cm)

Human vision

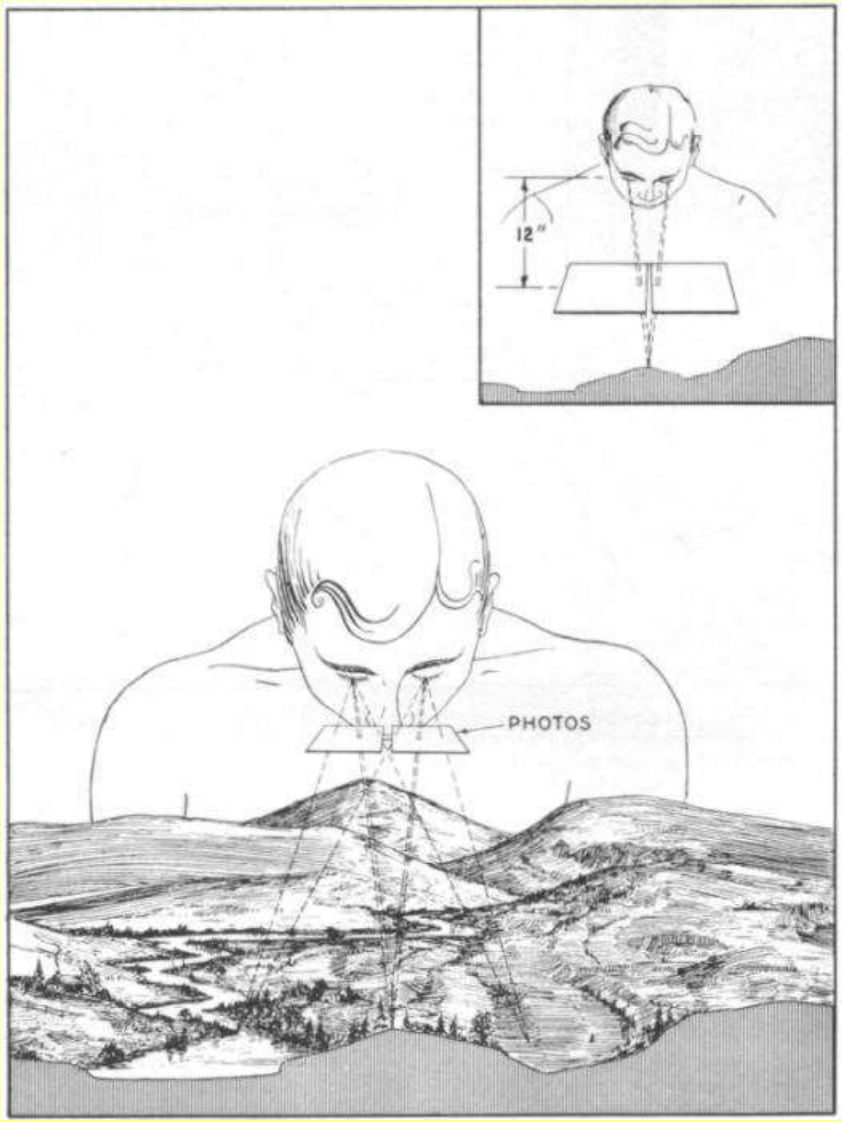
Human vision is binocular in most cases, and human eyes can resolve parallax as angle of convergence

This provides perception of “depth” and enables us to judge distances (up to 400m)



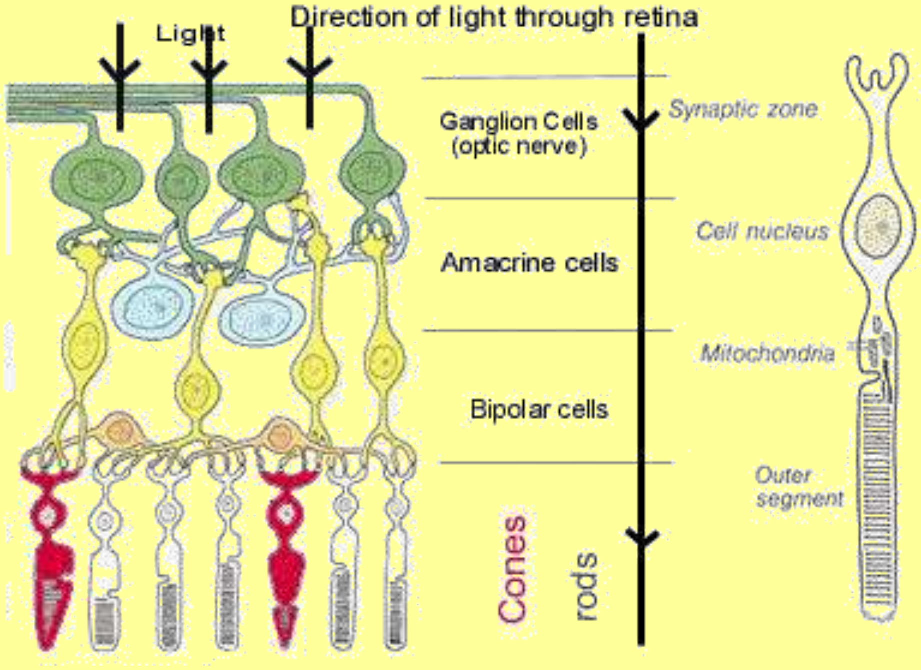
Human vision

3-D stereoptic viewing of the Earth's surface is possible using overlapping pairs of vertical stereo aerial photographs



Human vision

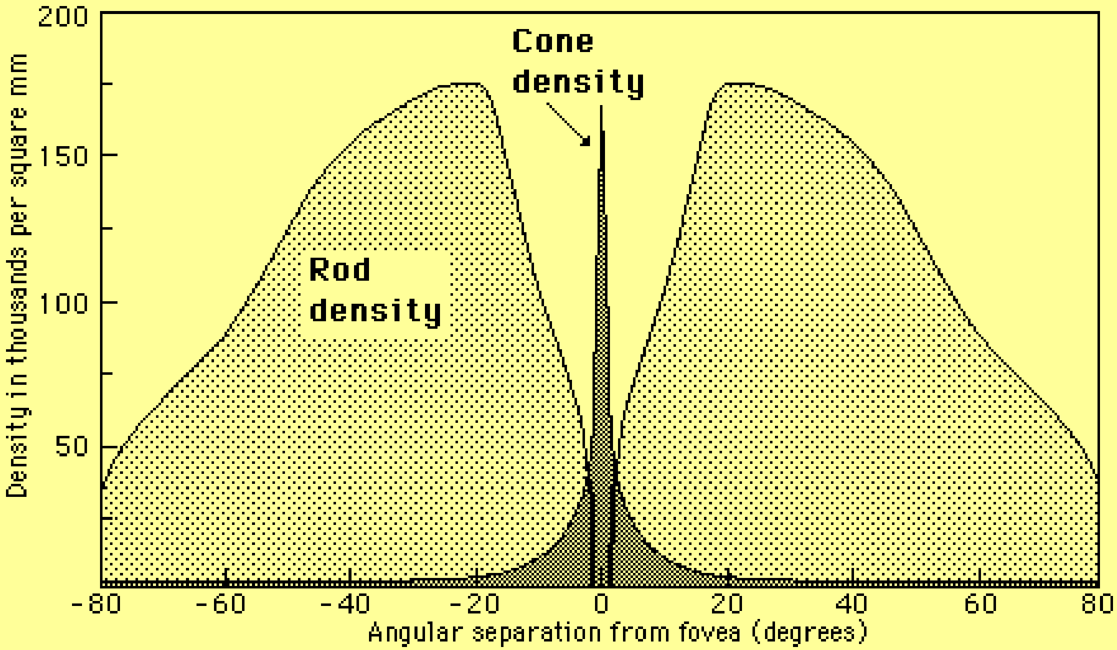
Two types of light-sensitive cells are present in the retina:



- Cones are sensitive to radiation of specific wavelengths (either red, green or blue)
- Rods are sensitive to all visible wavelengths

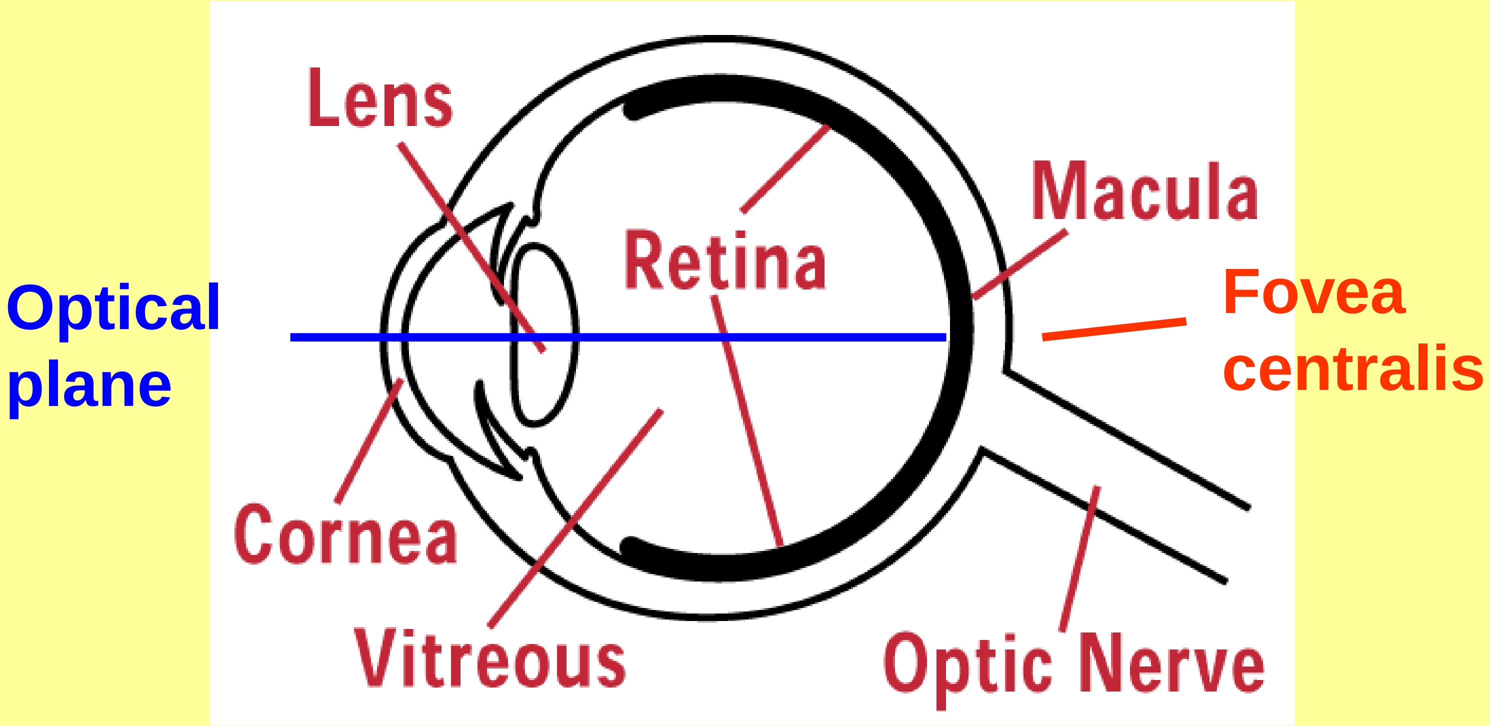
Human vision

Two types of light-sensitive cells are present in the retina:



- Cones are clustered around the *fovea centralis*
- Rods are widely distributed elsewhere

Human vision



Structure

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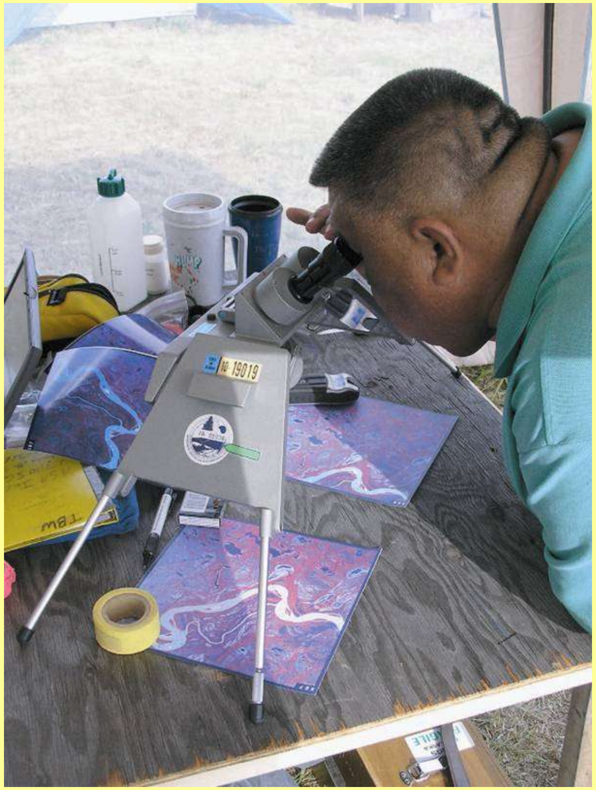
Summary

• Remote sensing involves collecting information about the Earth from a distance using electromagnetic sensors
• It evolved from aerial photography
• Vertical stereopairs of aerial photographs are used to take 3-D measurements by measuring parallax
• Human vision is binocular, enabling us to resolve parallax for depth perception
• Human vision includes perception of colour

Introduction to Aerial Photography Interpretation



MapTEACH
...new ways to tell old stories

DRAFT

History of Aerial Photography

- 1906 - George Lawrence photographs San Francisco after great earthquake and fire

“San Francisco in Ruins,” by George Lawrence, was taken with a kite 6 weeks after the Great 1906 Earthquake.

History of Aerial Photography

- 1909 - Wilbur Wright and a motion picture photographer are first to use an aircraft as a platform - over Centocelli, Italy
- WW2 - Kodak develops camouflage-detection film
  - used with yellow filter
  - sensitive to green, red, NIR
  - camouflage netting, tanks painted green show up as blue instead of red like surrounding vegetation

History of Aerial Photography

- 2002 - Field workers document the effects of the M7.9 Denali Fault Earthquake with digital cameras from planes and helicopters

Mosaic view of rock avalanches across Black Rapids Glacier. Photo by Dennis Trabant, USGS; mosaic by Rod March, USGS.

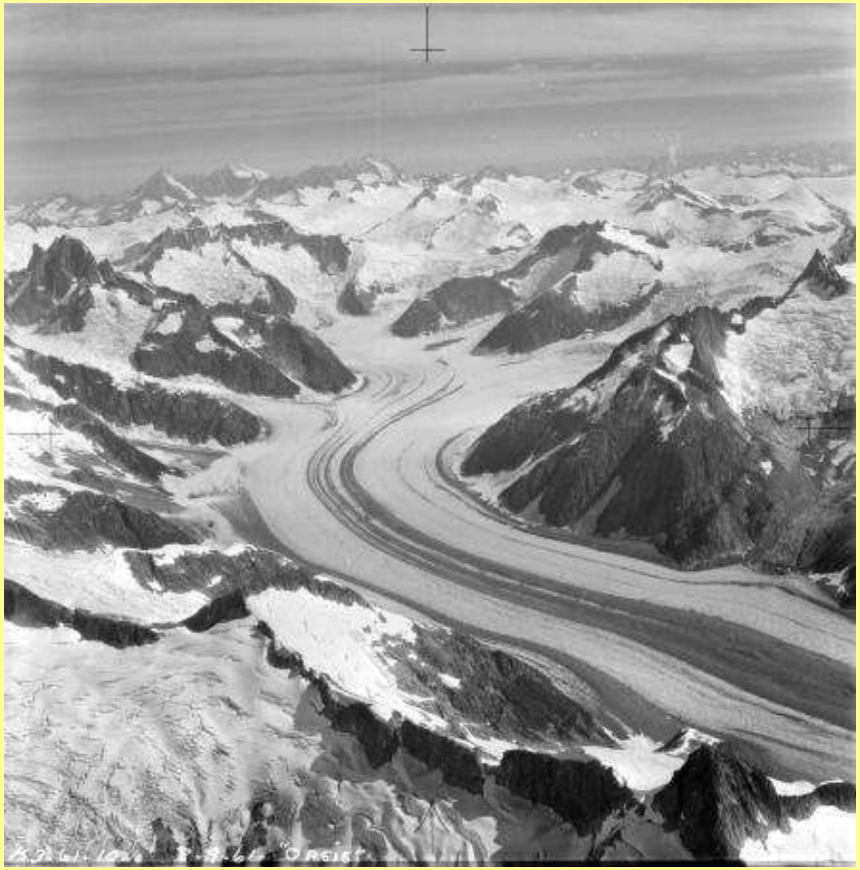
Aerial view of the Trans-Alaska Pipeline and Richardson Highway. Rupture along the fault resulted in displacement of the highway. Photo by Patty Craw, DGGS.

History of Aerial Photography

- 2006 - Effie Kokrine Charer School Students take digital “flotographs” at Twin Bears Camp, Alaska

Types of Air Photos

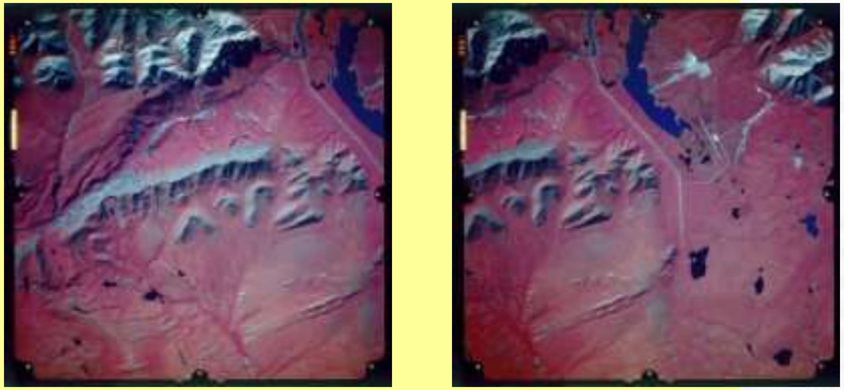
☞ High (horizon) & Low (no horizon) Oblique



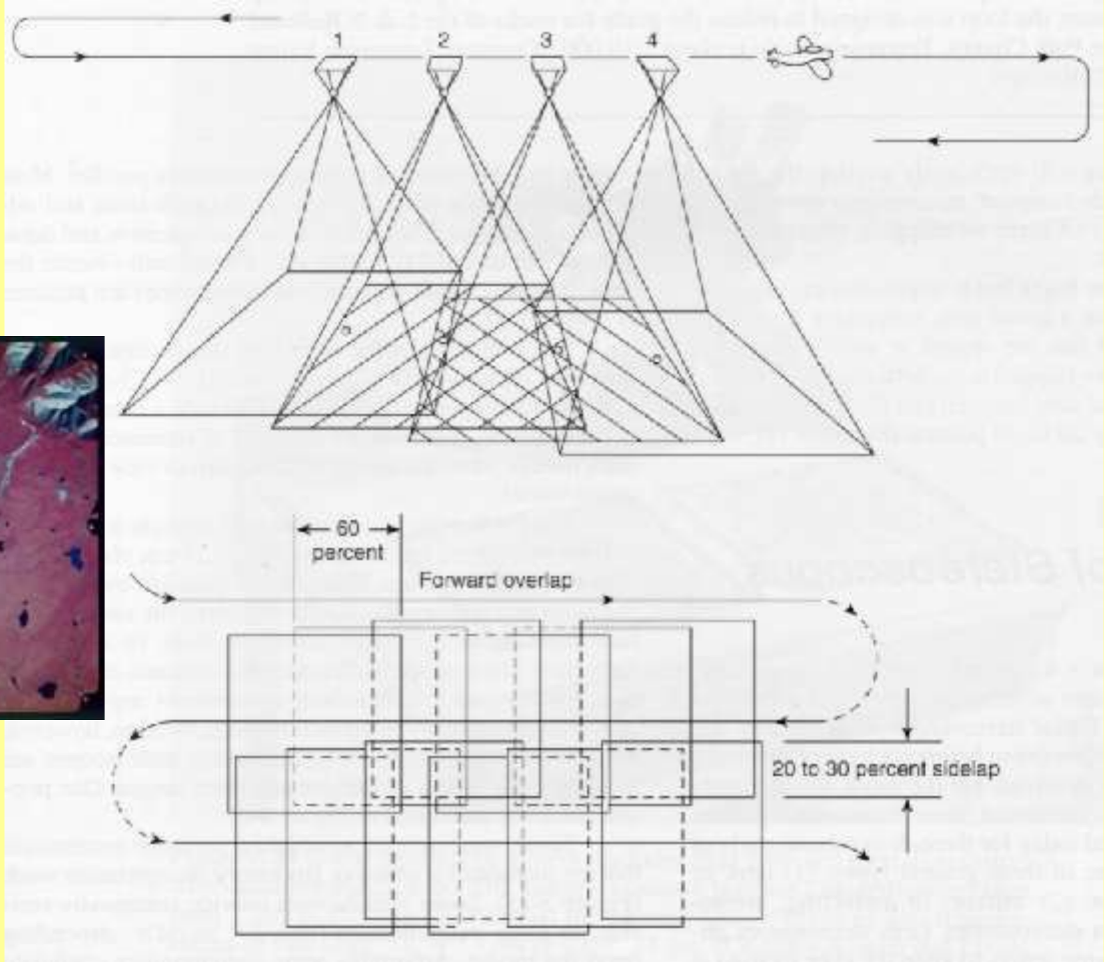
High oblique photo by Austin Post. Oasis Branch, Baird Glacier, Alaska 08/09/61.

Types of Air Photos

- Vertical
- Stereo/3D

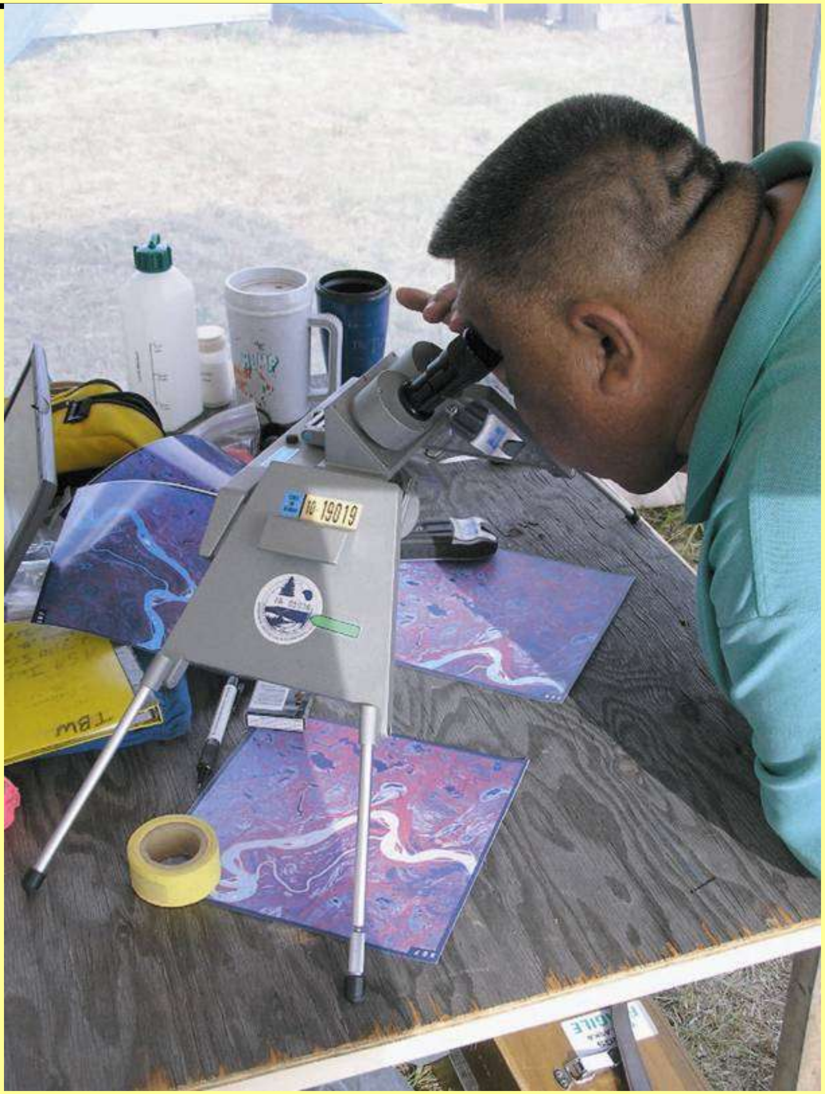


Color infrared (CIR) stereopair of the Galbraith Lake, Alaska area.



Types of Air Photos

- Using a stereoscope to view CIR stereopairs in the field



Aerial Cameras

A large format oblique camera

Keystone's Wild RC-10 mapping camera

Film Types

- Black & White Infrared
  - popular for flood mapping (water appears very dark)
  - vegetation mapping
  - soils - dry vs. moist
- False Color Infrared (CIR, Standard False Color)
  - vegetation studies
  - water turbidity

CIR and True Color Film Type Examples

CIR

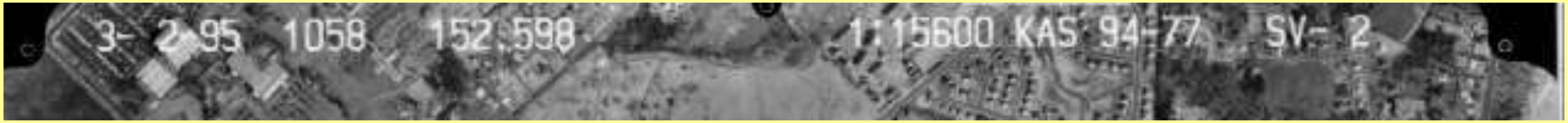
True Color

Products

- Contact Prints - 9"x 9"s
- Film Positives - Diapositives
- Enlargements
- Mosaics
- Indices (a reference map for air photo locations)
- Rectified Photos (can import into a GIS)
- Orthorectified Photos (can import into a GIS)
- Digital Orthophotos (can import into a GIS)

Printed Information/Annotation

- Along the top edge, you'll find:
  - Date of Flight
  - Time - (optional - beginning/end of flight line)
  - Camera focal length in mm (optional - frequently 152.598 mm = 6")
  - Nominal scale (RF)
  - Vendor/Job #
  - Roll #, Flight line & Exposure #



Determining Photo Scale

- Sometimes (at beginning and end of a flight line) ***Nominal Scale*** is printed at the top of a photo, usually as RF

Determining Photo Scale

- More likely you will have to compute scale using ruler, map, calculator and this formula

$$\mathbf{RF = \frac{1}{(MD)(MS)/(PD)}}$$

where:

MD = distance measured on map with ruler (cm or in)

MS = map scale denominator (e.g., 24,000 for USGS Quads)

PD = photo distance measured in same units as map distance

Determining Photo Scale

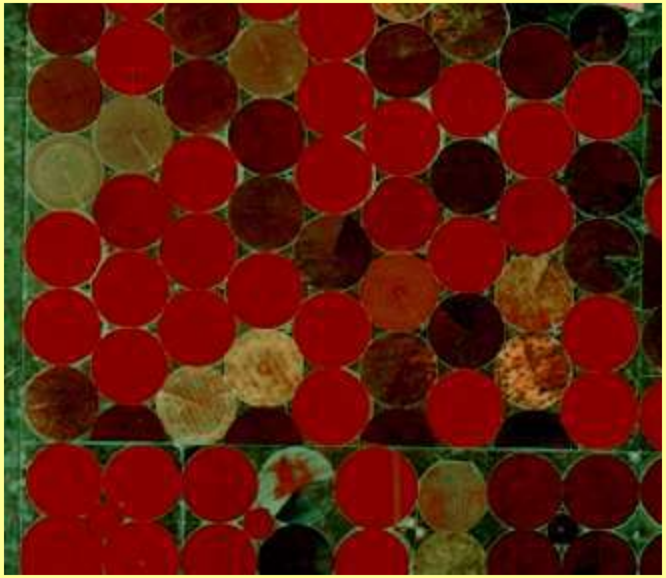
- You can also roughly estimate scale from cultural features if there are any in the image (problematic in Alaska), e.g., tracks, athletic fields, etc.

Determining Photo Orientation

- Labels and annotation are almost always along northern edge of photo
- Sometimes eastern edge is used
- Only way to be certain is to use a map

Photointerpretation: Recognition Elements

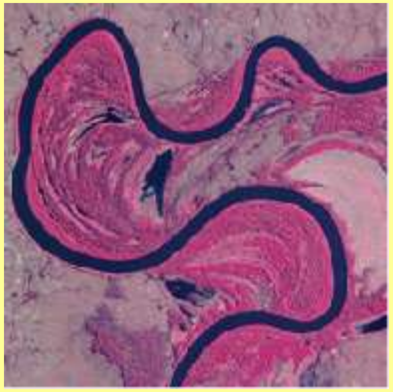
- Shape
- Size
- Color/Tone
- Texture
- Pattern
- Site
- Association
- Shadow



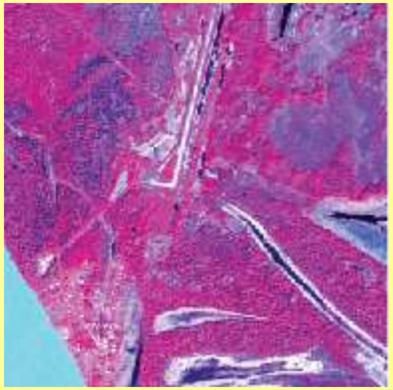
Photointerpretation: Recognition Elements

- Shape
  - cultural features - geometric, distinct boundaries
  - natural features - irregular shapes and boundaries
  - Shape helps us distinguish old vs. new subdivisions, some tree species, athletic fields, etc.

The pentagon



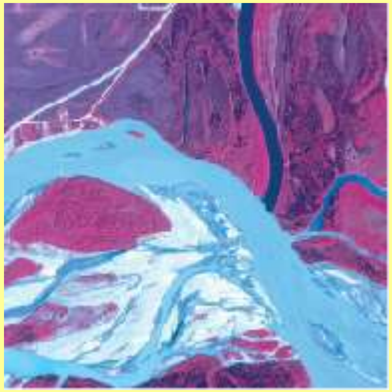
Meandering river in Alaska



Interior Alaskan village (note airstrip near top of image)

Photointerpretation: Recognition Elements

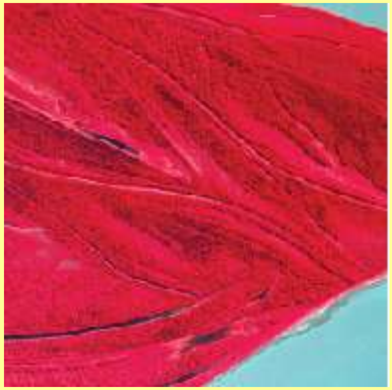
- Size
  - relative size is an important clue
  - big, wide river vs. smaller river or slough
  - apartments vs. houses
  - single lane road vs. multilane



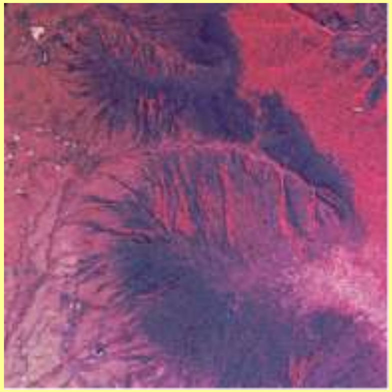
Photointerpretation: Recognition Elements

- Color/Tone
  - coniferous vs. deciduous trees

CIR - Spruce forest (black) with some deciduous (red) trees.



CIR – Deciduous (leafy) vegetation (red).



CIR- Mixed spruce And deciduous forest on hillside with tundra in valley bottom.

Photointerpretation: Recognition Elements

- Color/Tone
  - Turbidity - relative amounts of sediment in water
  - Vegetation presence or absence

CIR – The big, light blue river in the lower part of the image is the Tanana River. It carries fine particles eroded by glaciers in the Alaska Range.

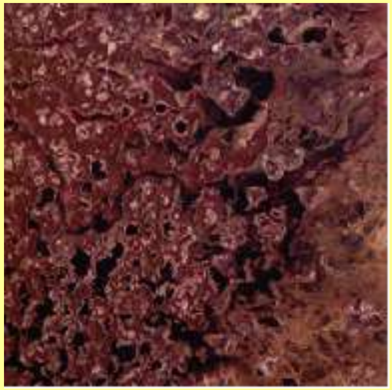
The smaller dark blue river flows south from top of the image to the Tanana River. It is fed by surface runoff and groundwater sources and does not carry much sediment.

Unvegetated gravel bars look bright bluish white.

Photo by Maria Sotelo

Photointerpretation: Recognition Elements

- Texture
  - coarseness/smoothness caused by variability or uniformity of image tone or color
  - smoothness – tundra, swamps, fields, water, etc.
  - coarseness - forest, lava flows, mountains etc.



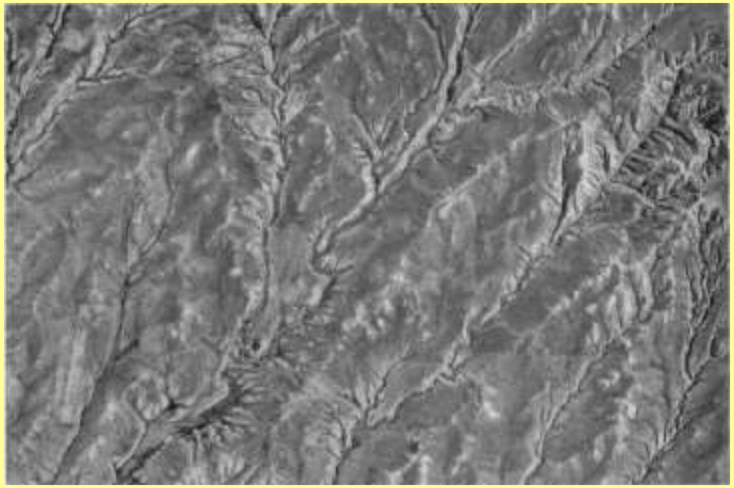
CIR- Marshy tundra with many small ponds.

CIR - Bare rounded Mountains (blue) surrounded by tundra and lakes.

CIR - Tundra showing drainage pattern

Photointerpretation: Recognition Elements

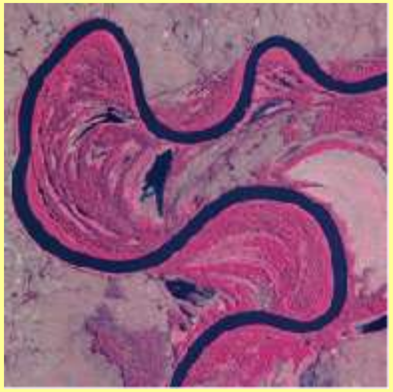
- Pattern
  - overall spatial form of related features
  - repeating patterns tend to indicate cultural features - random = natural
  - drainage patterns can help geologists determine bedrock type



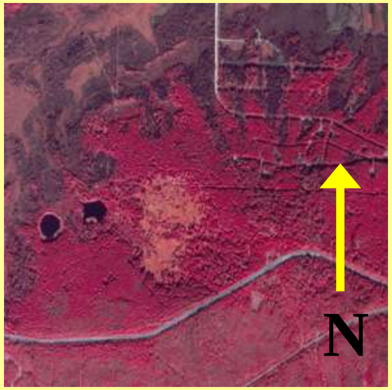
A dendritic pattern is characteristic of flat-lying sedimentary bedrock

Photointerpretation: Recognition Elements

- Site
  - site - relationship of a feature to its environment
  - differences in vegetation based on location:
    - In interior Alaska, black spruce dominant on the north side of hills and deciduous trees on the south side.
    - Vegetation is often has different characteristics by rivers than away from them



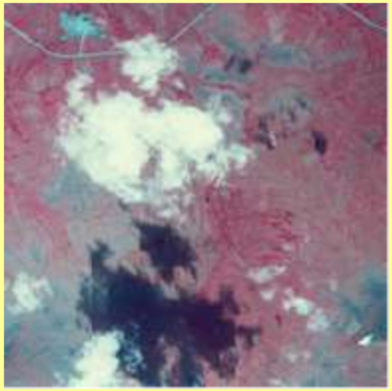
Meandering Alaskan river



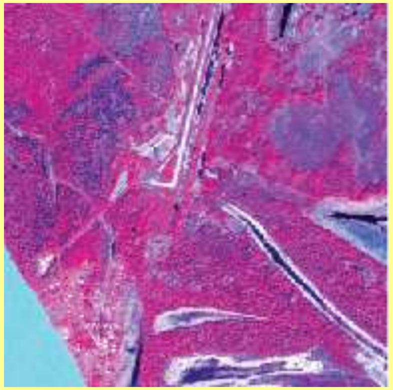
Interior Alaskan hillside

Photointerpretation: Recognition Elements

- Association
  - identifying one feature can help identify another - correlation



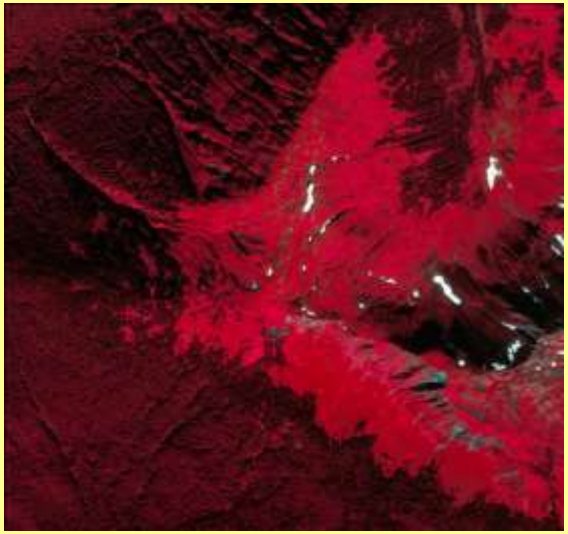
The white cloud and black shadow have the same shape, they are related



The long straight airstrip near the top of the image indicates that there might be a village or settlement nearby

Photointerpretation: Recognition Elements

- Shadows
  - shadows cast by some features can aid in their identification
  - some tree types, storage tanks, bridges can be identified in this way
  - shadows can accentuate terrain



The mountain ridge on the right side of this image is accentuated by shadow

THANK YOU

FOR

PATIENT HEARING

PRINCIPLES AND FUNCTIONING OF GPS/ DGPS /ETS

Prepared By:

JHARANARANI SENAPATI

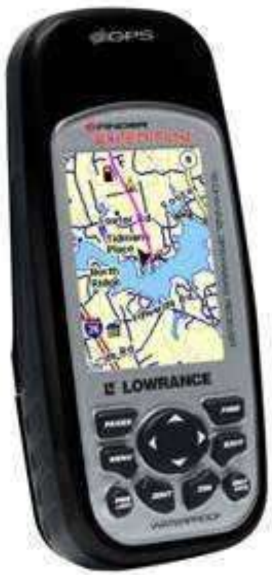
Asst. Professor

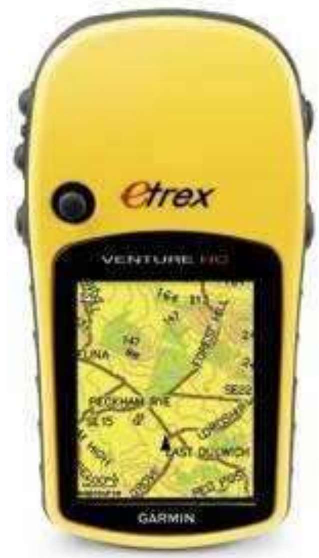
Department of Civil Engineering

GPS

GPS, which stands for Global Positioning System, is the only system today able to show you your exact position on the Earth anytime, in any weather, anywhere.

Typical Recreational Grade GPS units





Applications of GPS

- Providing Geodetic Control
- Photogrammetry
- Finding out location of offshore drilling
- Pipe line and power line survey
- Navigation of civilian ships and planes
- Crustal movement studies

The History of GPS

- **Feasibility studies begun in 1960 .**
- **Pentagon appropriates funding in 1973.**
- **First satellite launched in 1978.**
- **System declared fully operational in April, 1995.**

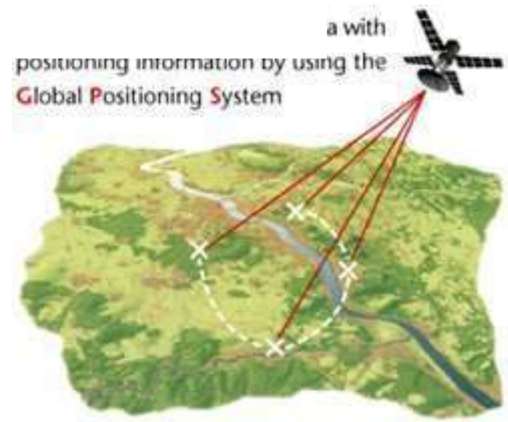
There are four GNSS systems in existence

GPS, GLONASS,Galileo & Compass

- The Global Positioning System (GPS) is also called NAVSTAR GPS (Navigational System with Time and Ranging)operated by United States Government.
- The GLObal NAvigation Satellite System (GLONASS) operated by the Russian Government.
- The Galileo Navigation Satellite System to be operated by European Union.
- The Compass Navigation Satellite System to be operated by Chinese Government.

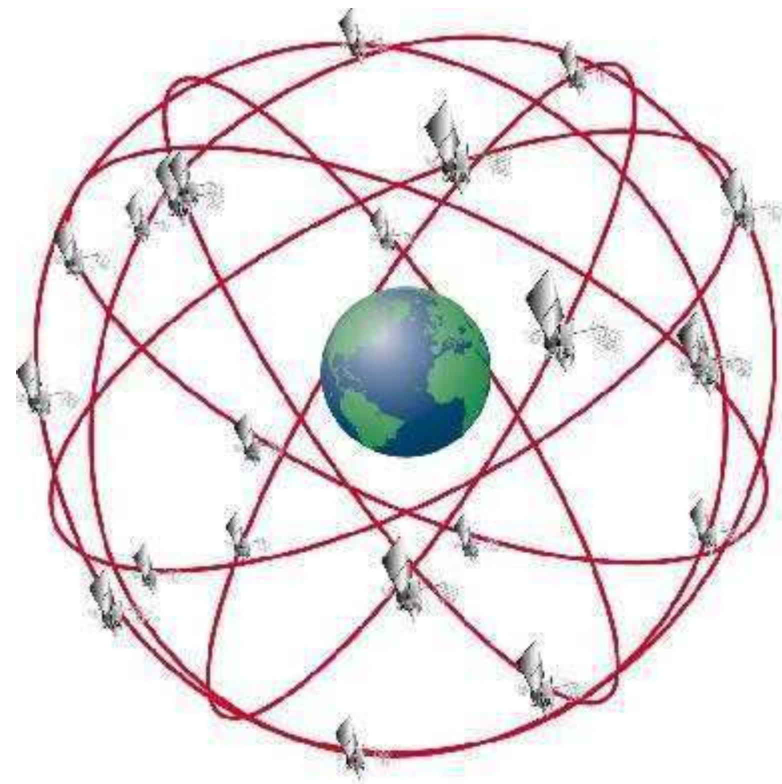
Receivers and Satellites

GPS units are made to communicate with GPS satellites (which have a much better view of the Earth) to find out exactly where they are on the global scale of things.



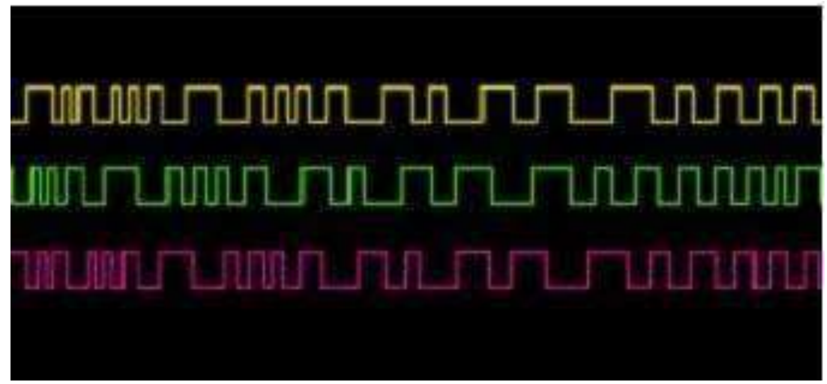
GPS Satellites

The GPS Operational Constellation consists of 24 satellites that orbit the Earth in very precise orbits twice a day. GPS satellites emit continuous navigation signals.



GPS Signals

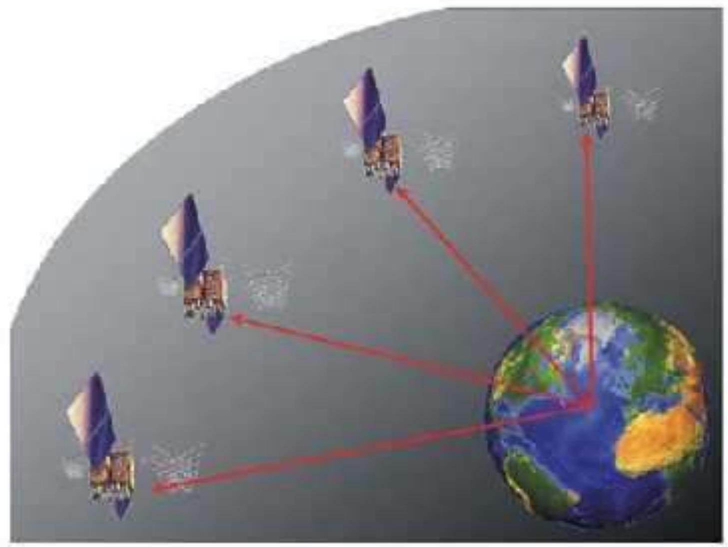
Each GPS satellite transmits data that indicates its location and the current time. All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant.

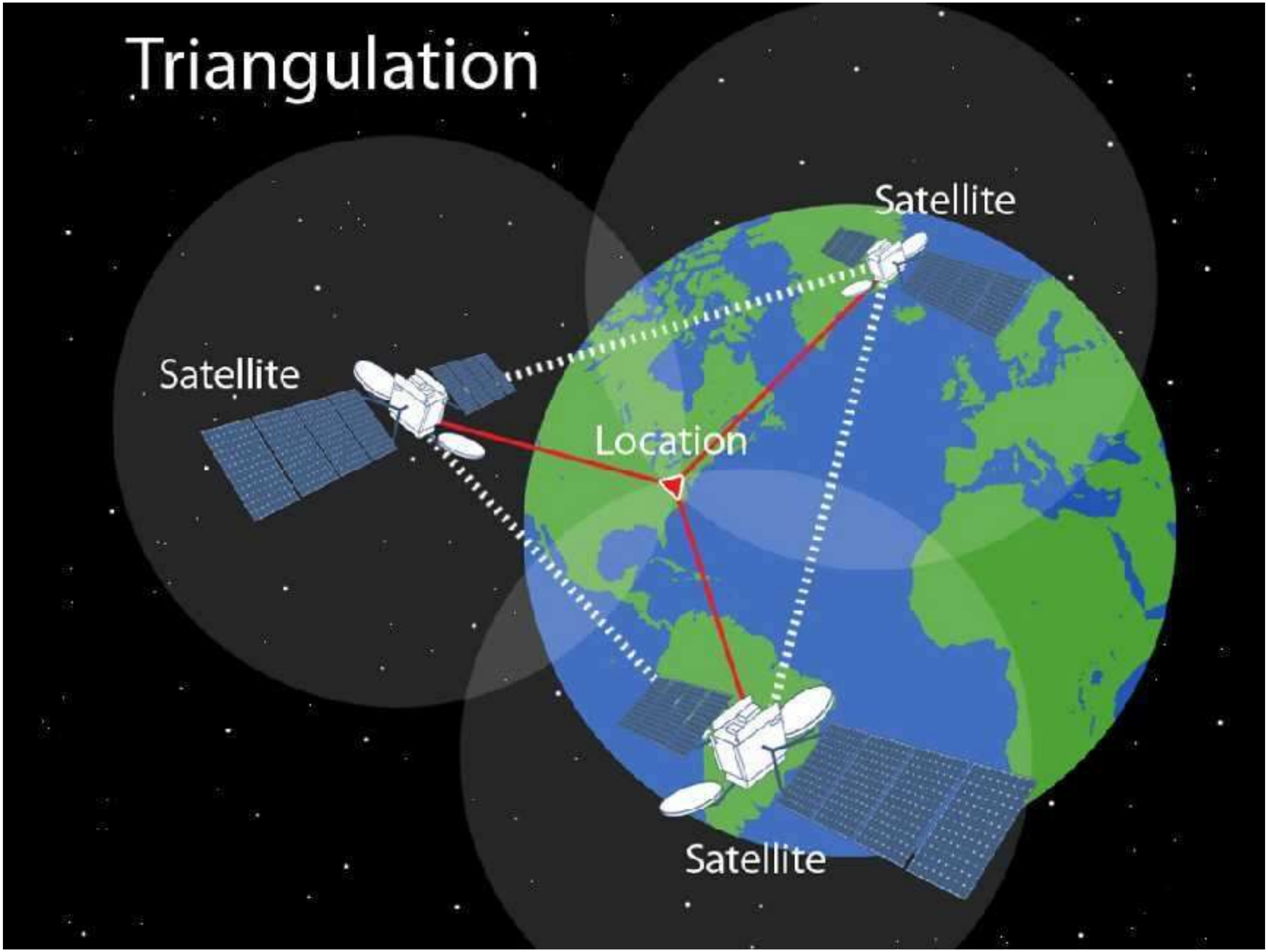


Physically the signal is just a complicated digital code, or in other words, a complicated sequence of “on” and “off” pulses.

Time Difference

The GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is.




Triangulation
Satellite
Satellite
Location
Satellite

Measurement of GPS Satellites Signals and position determination

- Measurement of Travel time of the signals from a constellation of GPS Satellites orbiting the earth for enabling the position in the earth.

The GPS satellites are in orbits such that one can be able to receive signals from at least four satellites to enable for the determination of latitude, longitude,

altitude and time.

Calculating Distance

Velocity x Time = Distance

Radio waves travel at the speed of light, roughly 186,000 miles per second (mps)

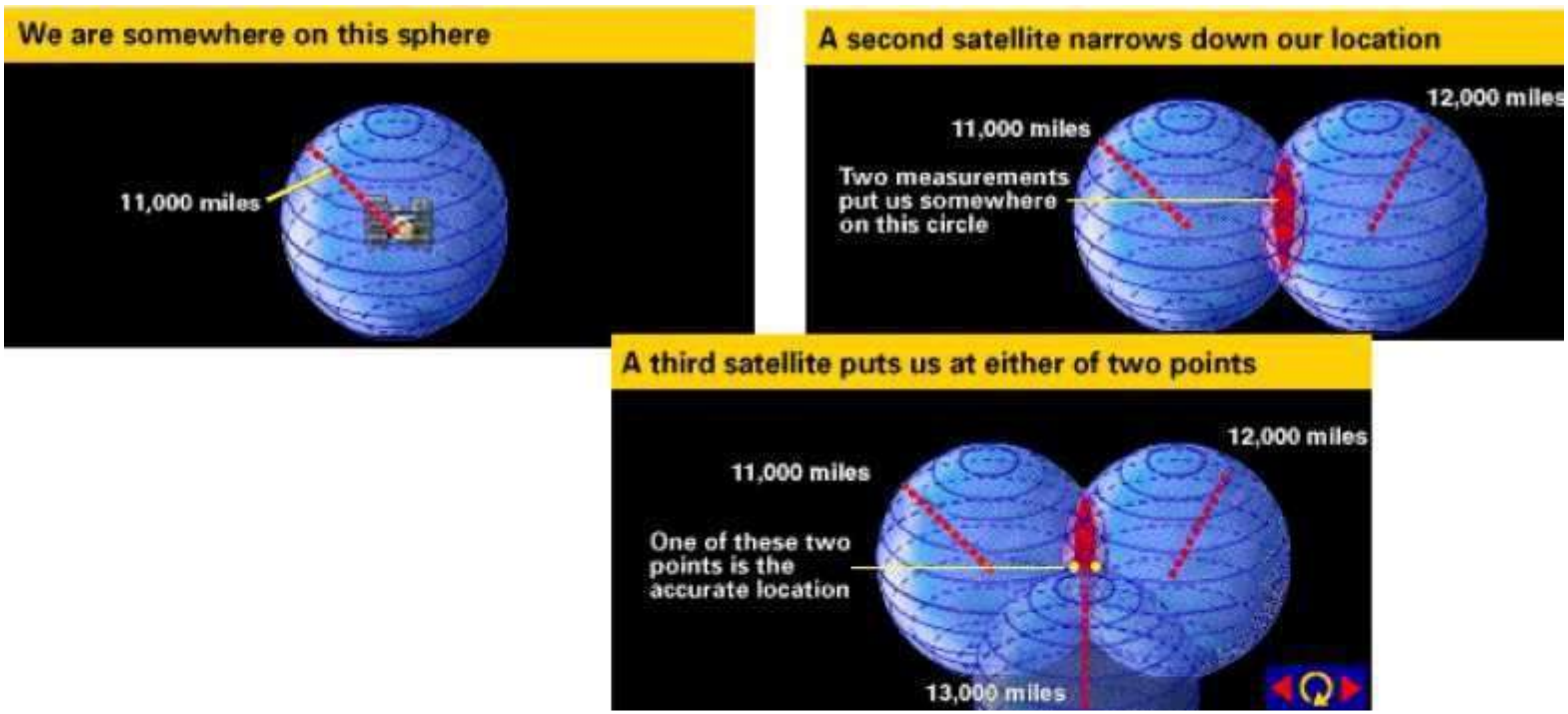
If it took 0.06 seconds to receive a signal transmitted by a satellite floating directly overhead, use this formula to find your distance from the satellite.

186,000 mps **x 0.06** seconds **= 11,160 miles**

POSITION CONCEPTS OF GPS

- Latitude
- Longitude
- Altitude

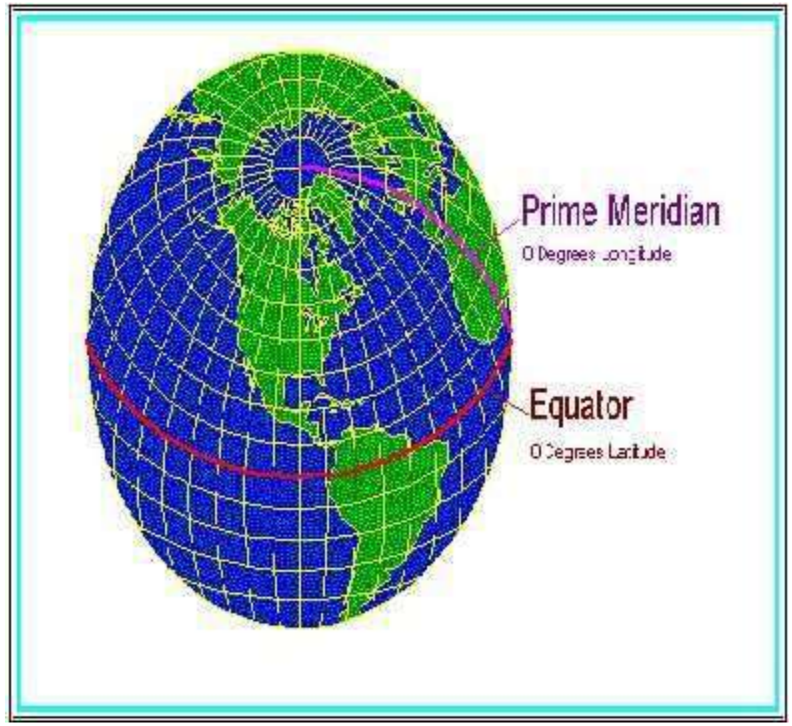
Sphere Concept



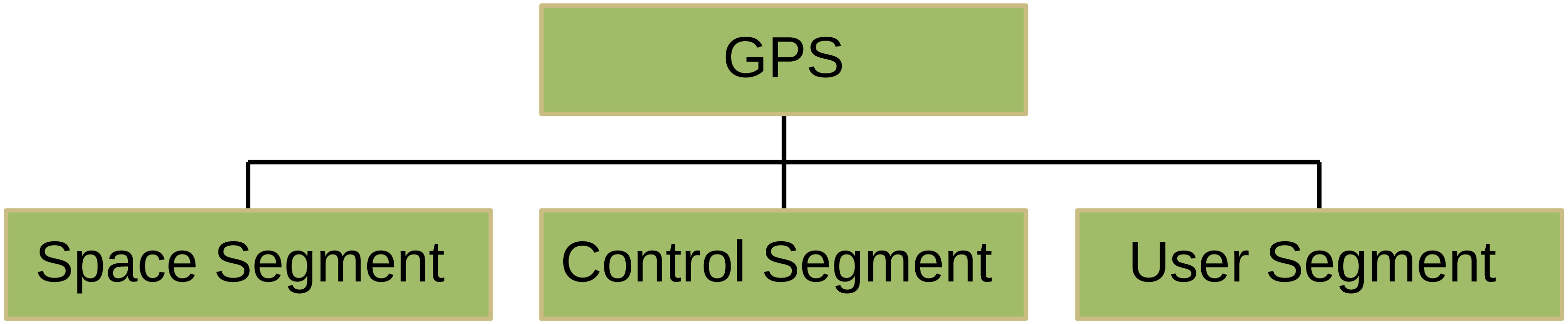
A fourth satellite narrows it from 2 possible points to 1 point

Latitude and Longitude

Latitude and Longitude are *spherical coordinates* on the surface of the earth. Latitude is measured North or South of the Equator. Longitude is measured East or West of Greenwich. GPS uses Latitudes and Longitudes to reference locations.

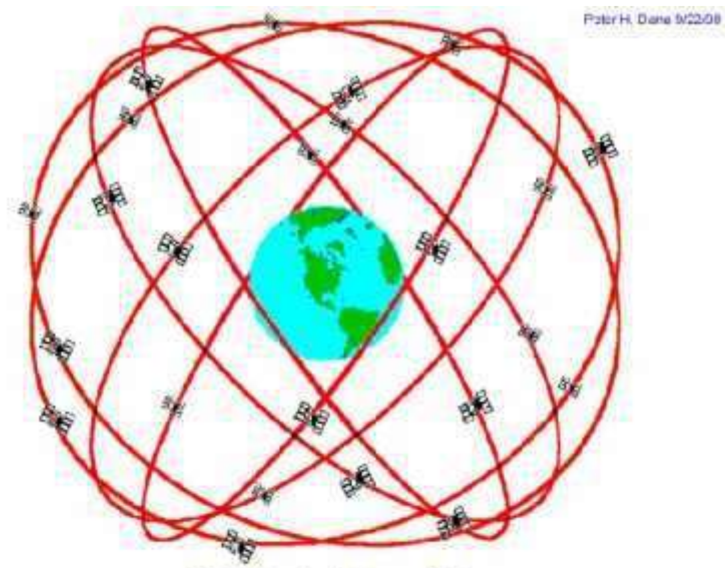


Components of the GPS



Space Segment:

- 24 GPS space vehicles(SVs).
- Satellites orbit the earth in 12 hrs.
- 6 orbital planes inclined at 55 degrees with the equator.
- This constellation provides 5 to 8 SVs from any point on the earth.



GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

Control Segment:

Global Positioning System (GPS) Master Control and Monitor Station Network

- The control segment comprises of 5 stations.
- They measure the distances of the overhead satellites every 1.5 seconds and send the corrected data to Master control.
- Here the satellite orbit, clock performance and health of the satellite are determined and determines whether repositioning is required.
- This information is sent to the three uplink stations

Control Segment

The tasks of Control Segment is as follows:

- To monitor and control the satellite system continuously
- To predict the satellite ephemerides and the behaviour of satellite clocks.
- To update periodically the navigation message for each satellite

User Segment:

- It consists of receivers that decode the signals from the satellites.

- The receiver performs following tasks:
  - Selecting one or more satellites
  - Acquiring GPS signals
  - Measuring and tracking
  - Recovering navigation data

User segment (Contd.)

- Precision Oscillator
- Power Supply
- User Interface ,Command and Display Panel
- Memory data Storage

User Segment(Contd.)

Functions of Antenna :

- Detection of the electromagnetic waves arriving from the satellites
- Convert the wave energy into Electric Current
- Amplifies the signal strength
- Hands the Signals over to the Receiver Electronics

GPS service and civilian users

- Available of basic GPS service to civilian users with an accuracy of 100 meters.

- Removal of selective availability to improve the accuracy   of a few meters

Satellite Transmission signals

- L1 Carrier signals 154x 10.23 M Hz =1575.42 MHz (Wave length 19.05 cm)

- L 2 Carrier signals 120x 10.23 M Hz =1227.60 MHz (Wave length 24.45cm)

Differential GPS

Differential GPS(DGPS) is a system in which differences between observed and computed co-ordinates ranges(known as differential corrections) at a particular known point are transmitted to users(GPS receivers at other points) to upgrade the accuracy of the users receivers position.

Types of Antenna

Monopole orDipole

Quadrifilar Helix Spiral

Helix Microstrip Antenna

Choke Ring

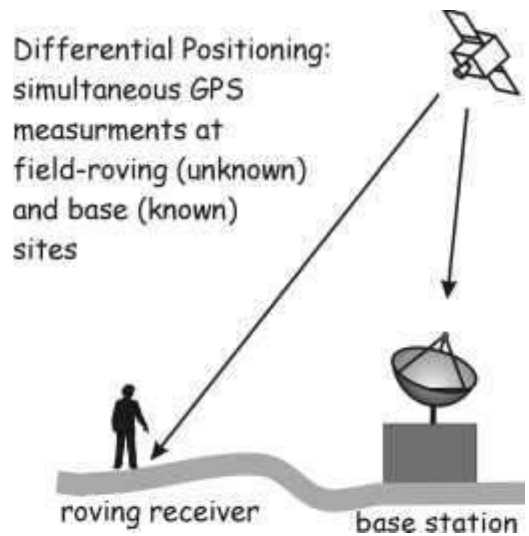
Differential GPS Positioning

Differential positioning user finds the point position derived from the satellite signals and applies correction to that position. These corrections, difference of the determined position and the known position are generated by a Reference Receiver ,whose position is known and is fed to the instrument and are used by the second Receiver to correct its

internally generated position. This is known as Differential GPS positioning.

Differential Correction

Differential correction is a technique that greatly increases the accuracy of the collected DGPS data. It involves using a receiver at a known location - the "base station"- and comparing that data with DGPS positions collected from unknown locations with "roving receivers."



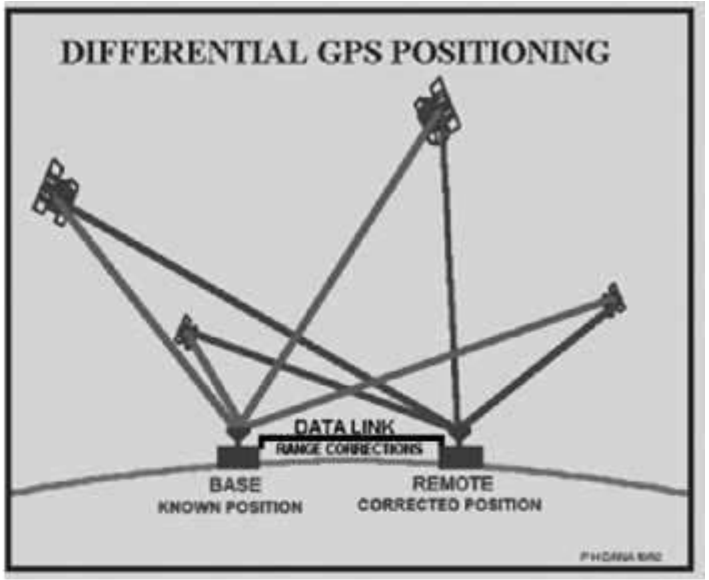
Geodetic/ High Precision Applications

- To use the carrier phase as observables
- To use both the frequencies(L_1,L_2)
- To have access to the P-code

(For long distances and geographical regions with strong ionospheric disturbances)

Differential GPS survey

Differential GPS Positioning



Limitation & Errors of GPS/DGPS

a) International Limitation of Accuracy
b) Receiver Independent Exchange Format
c) Reference System Co-ordinates

DUAL FREQUENCY DGPS RECEIVER

Dual-Frequency receivers receive signals from the satellites on two frequencies simultaneously. Receiving GPS signals on two frequencies simultaneously allows the receiver to determine very precise positions.

Classification Criteria

GPS receivers can be classified into different groups according different criteria. One such classification depending upon data type (available signal structure)yields receiver with :

- C/A code
- C/A code + L_1 Carrier Phase
- C/A code + L_1 Carrier Phase + L_2 Carrier Phase
- C/A code + P code +L_1 ,L_2 Carrier Phase

Broad Classification of GPS receiver

1. Code dependant Receiver
2. Code free receiver

Classification of GPS receivers as per use

- Military Receiver
- Civilian Receiver
- Navigation Receiver
- Timing Receiver
- Geodetic Receiver

Selection of DGPS observation Mode

- Static
- Rapid Static/PPK
- Real Time Kinematic (RTK)

DGPS survey

Establishment of Ground Control Points :

- Primary Control Points (PCPs)
- Secondary Control Points (SCPs)

ALMANAC DATA

The Almanac data tell the GPS receiver where each GPS satellite should be at any time through out the day. Each satellite transmits the almanac data showing the orbital information for that satellite and every other satellite in that system.

Ephemeris

A GPS ephemeris is the predictions of current satellite positions. Accurate GPS

planning is only accomplished when a current ephemeris is used for the GPS planning.For precise navigation information,ephemeris data is used by GPSs.Every navigation satellite broadcasts have its own ephemeris data only.

Sources of GPS signal errors

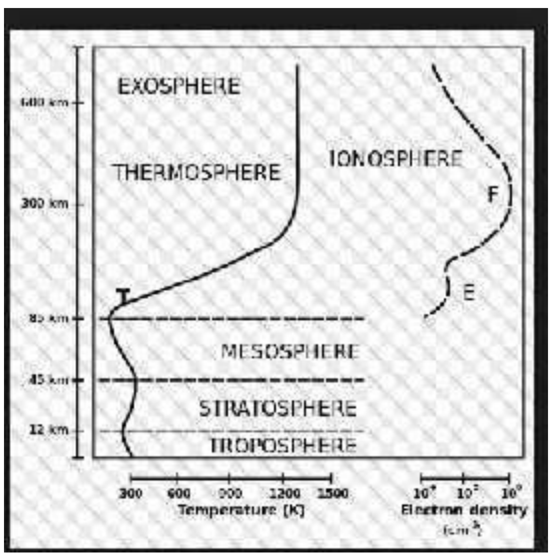
Factors that can affect the GPS signal and thus affect accuracy includes as follows :

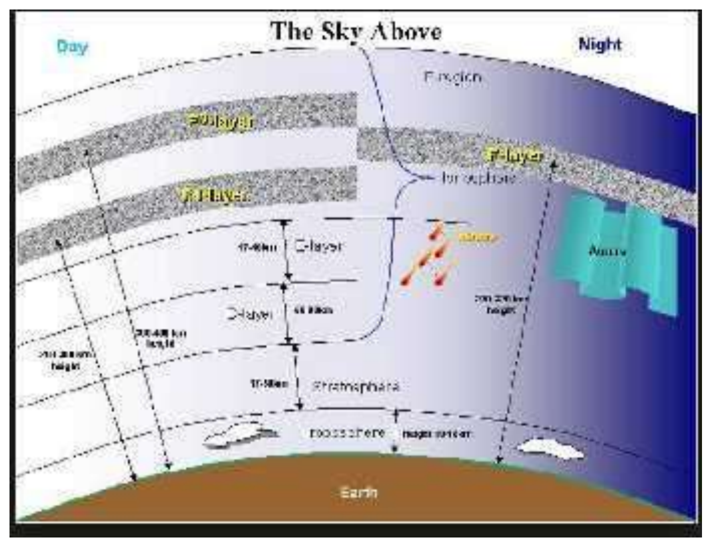
1. Ionospheric and Troposphere Delays
2. Signal Multipath
3. Receiver clock Errors
4. Orbital errors/ Ephemeris errors
5. Satellite Geometry / Shading

Sources of GPS signal errors

Ionospheric and Troposphere delays :

The satellite signal slows as it passes through the atmosphere. The GPS system uses a ‘built in model’ that calculates an average amount of delay to partially correct for this type of error.

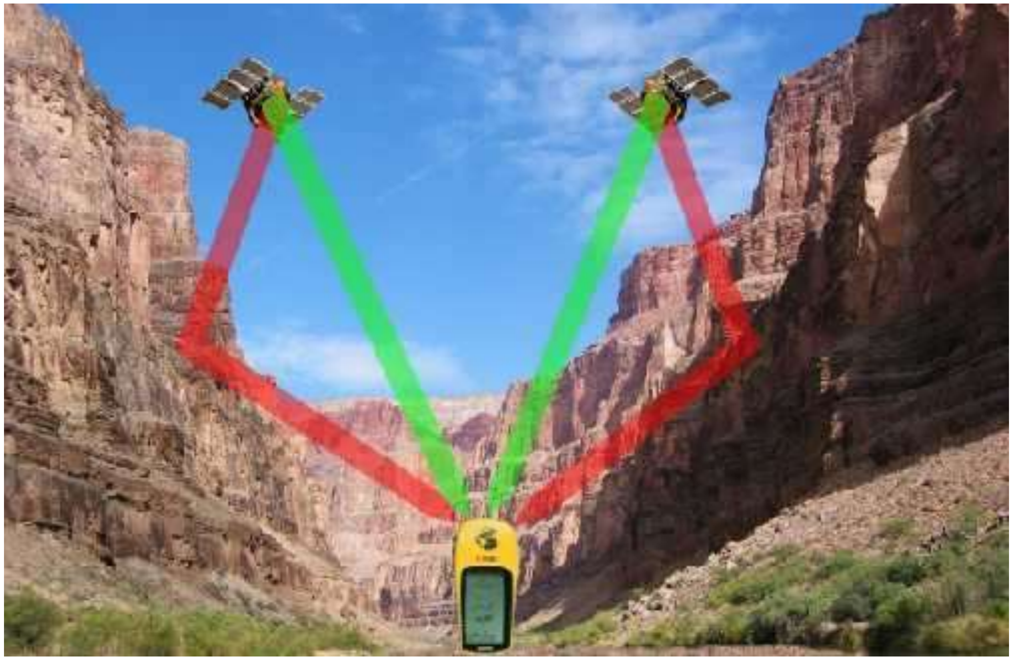




Sources of GPS signal errors

Signal Multipath

This occurs when the GPS signal is reflected off objects such as tall buildings ,large rock surfaces etc. before it reaches the receiver. This increases the travel time of the signal thereby causing errors.



Sources of GPS Signal errors

Receiver Clock Errors

A receiver's built –in clock is not as accurate as the atomic clocks on board the GPS satellites. Therefore, it may have very slight timing errors.

Sources of GPS Signals

Orbital Errors

Also known as ephemeris errors.These are inaccuracies of the satellite reported location.

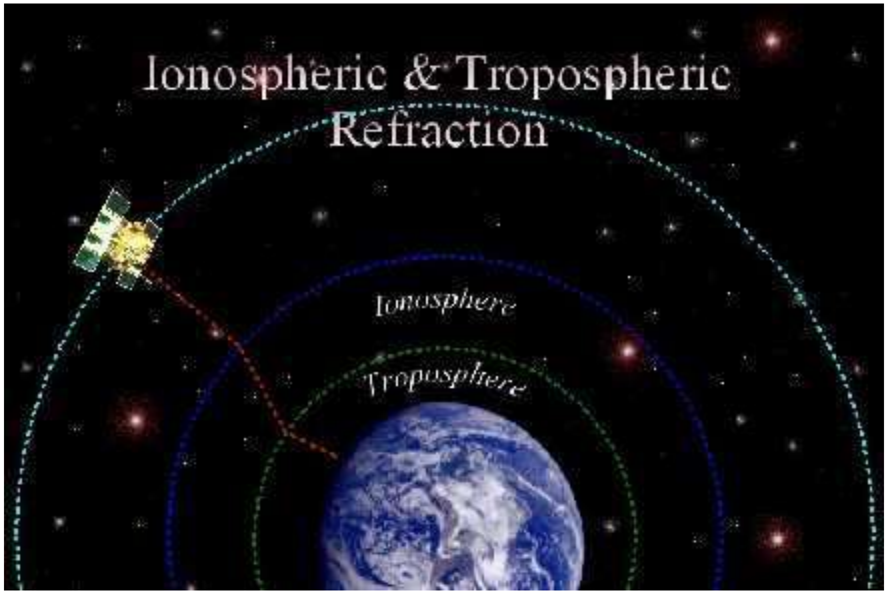
Light Refraction

Sometimes the GPS signal from the satellite doesn't follow a straight line.

Refraction is the bending of light as it travels through one media to another

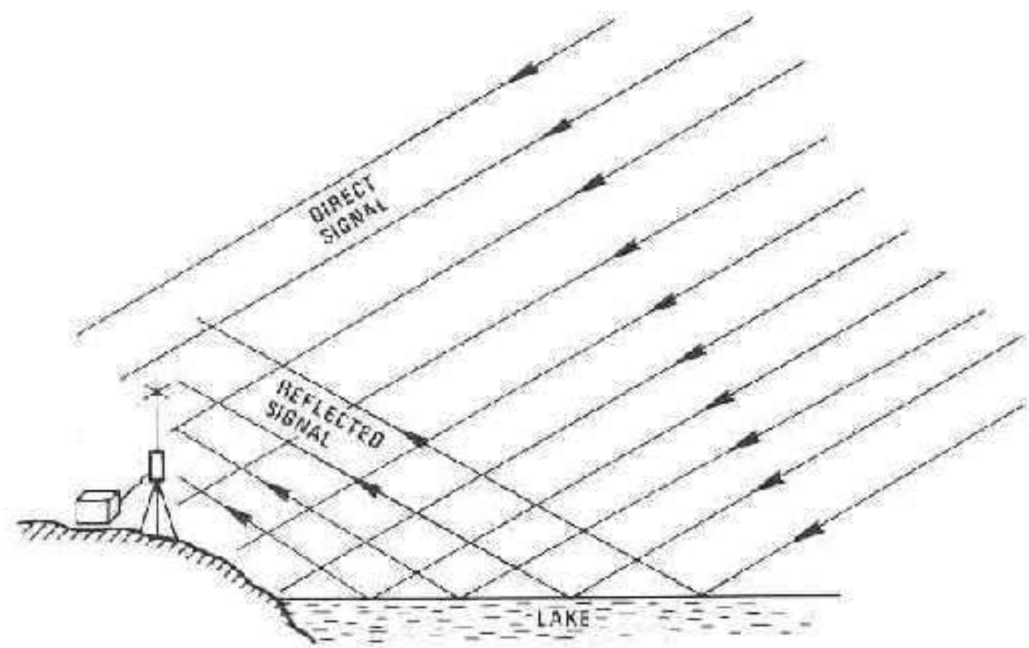
Signal Refraction

Signals from satellites can be like light. When they hit some interference (air patterns in the atmosphere, uneven geography, etc.) they sometimes bend a little.



Signal Interference

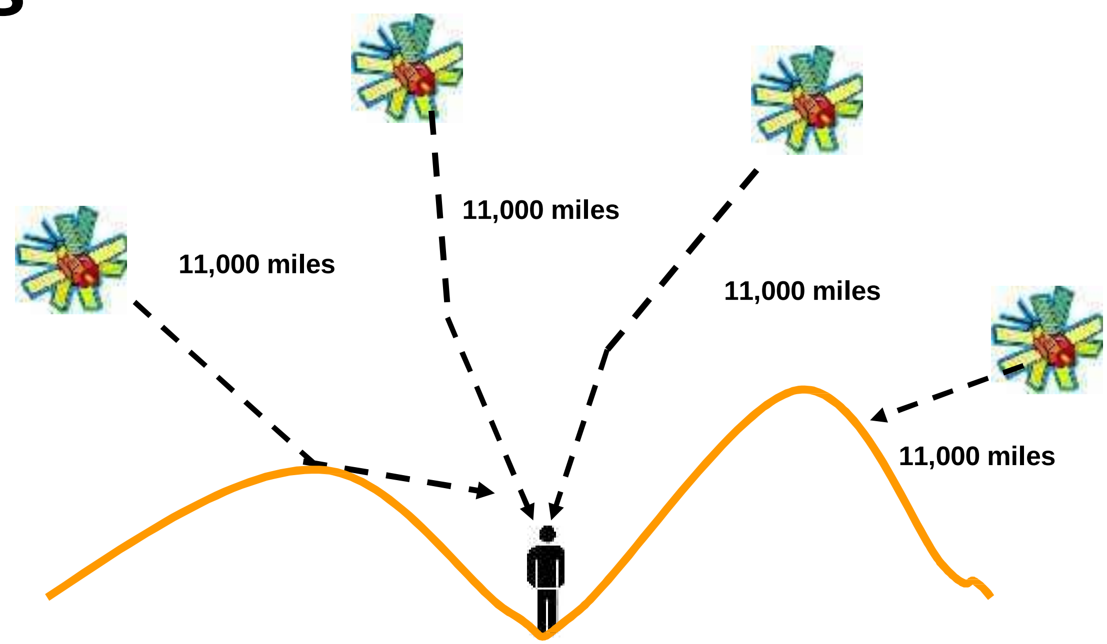
Sometimes the signals bounce off things before hit the receiv



PDOP

PDOP = Positional Dilution of Precision

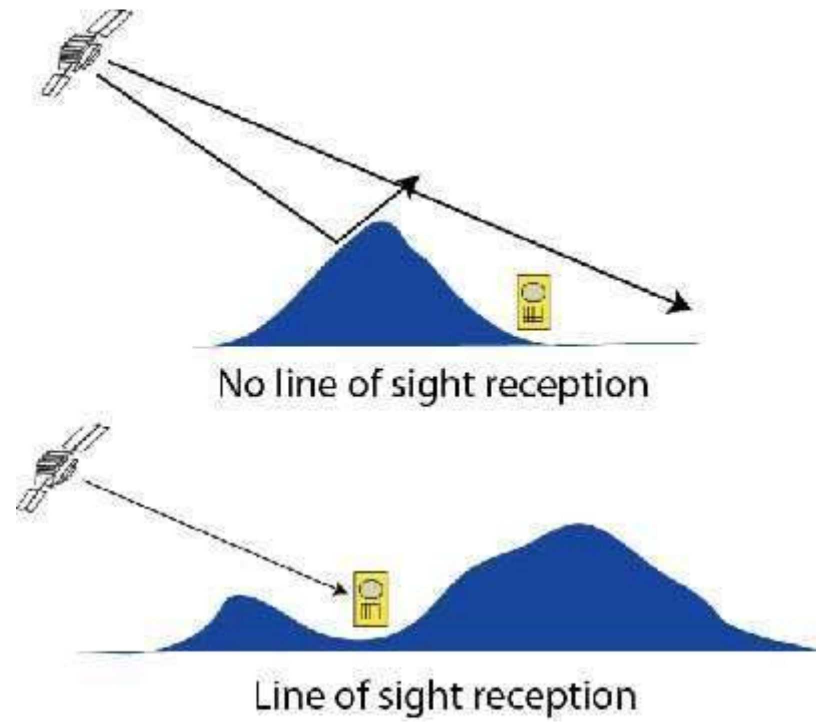
All of this combines to make the signal less accurate, and
gives it what we call a high "PDOP."



- ***A PDOP of <4 is excellent***
- ***A PDOP of 4-8 is good***
- ***A PDOP of >8 is poor***

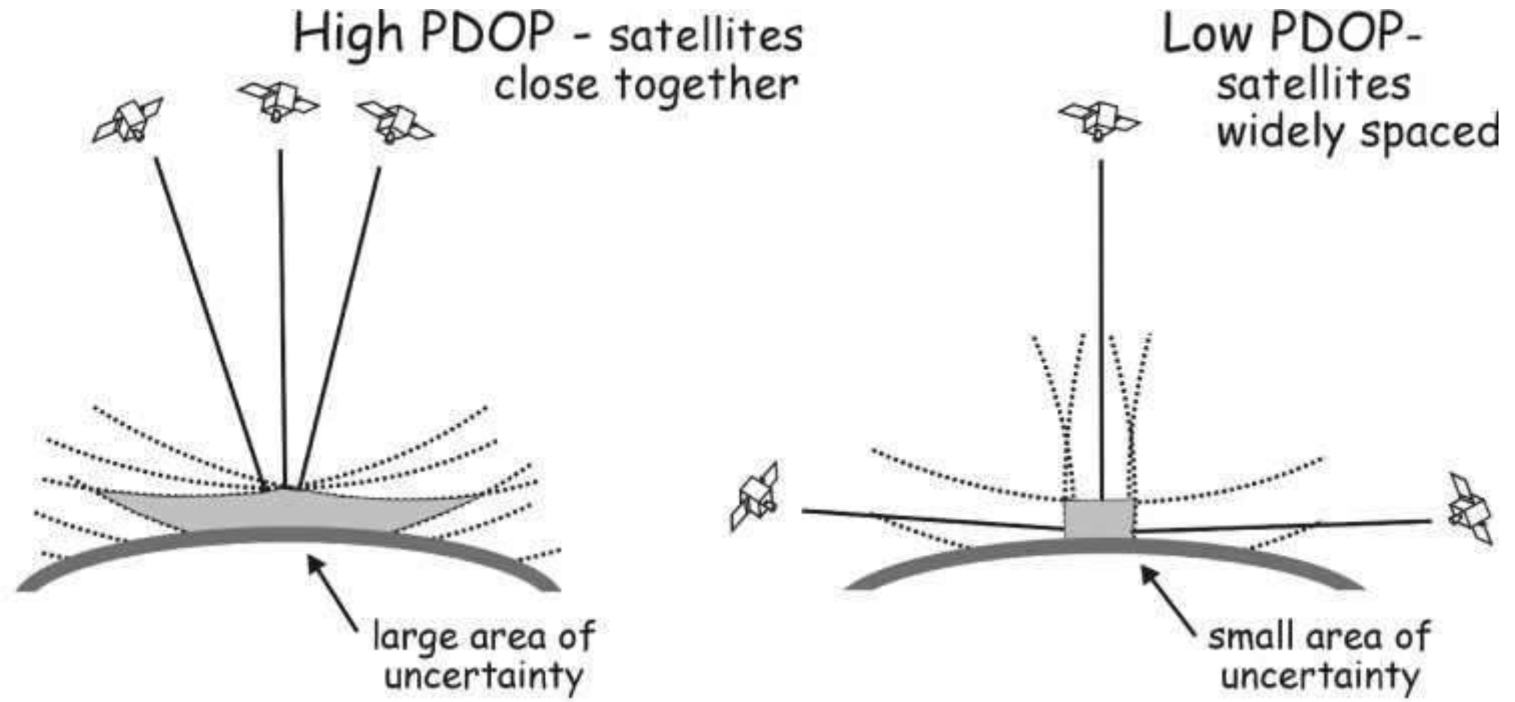
Line of Sight Transmissions

Line of sight is the ability to draw a straight line between two objects without any other objects getting in the way. GPS transmission are line-of- sight transmissions.



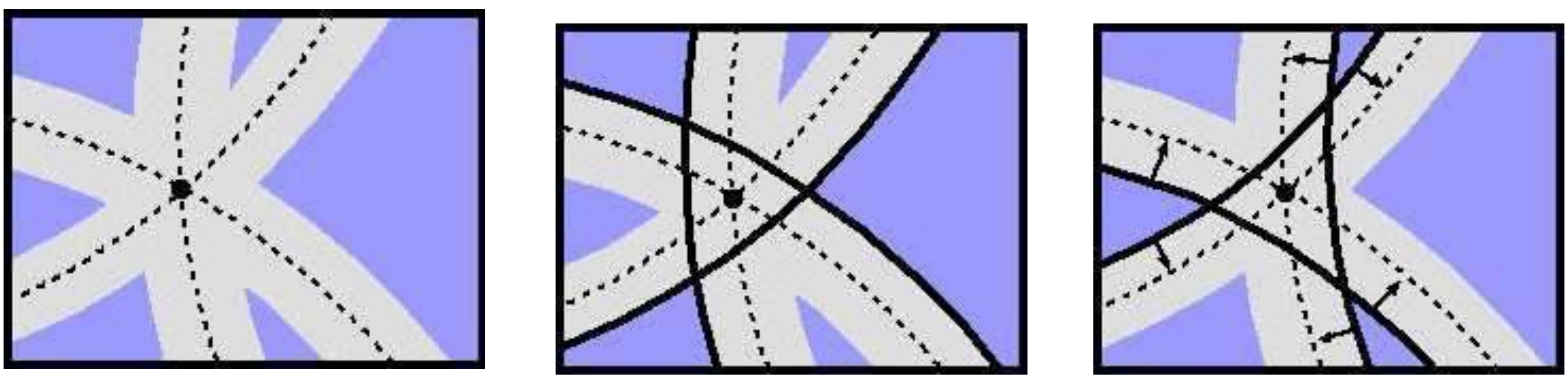
Satellite Distribution

When the satellites are all in the same part of the sky, readings will be less accurate.



Atomic Clocks

GPS satellites use Atomic Clocks for accuracy, but because of the expense, most GPS receivers do not.



Networks

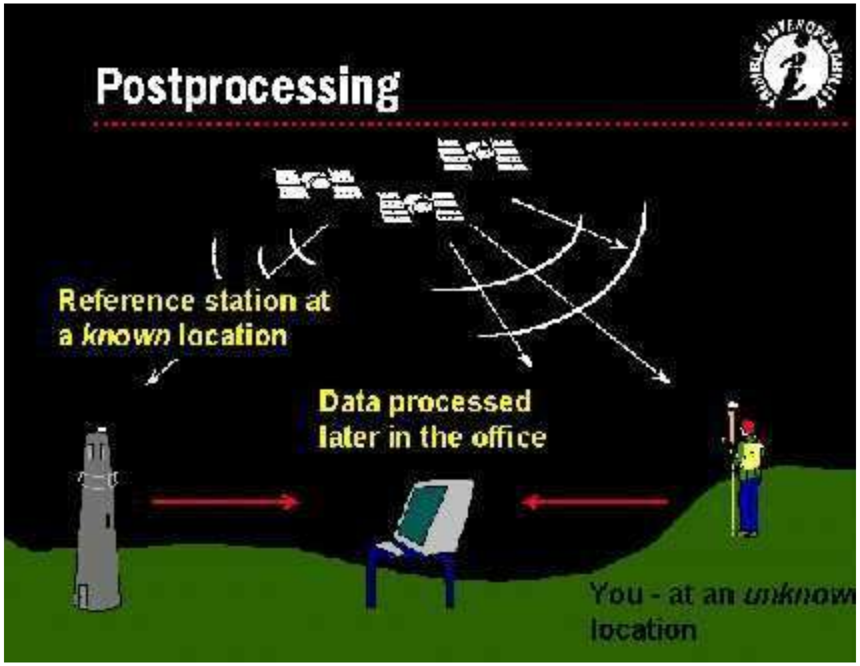
- Networks shall only contain closed loops. Each station in a network shall be connected with at least two different independent baselines. Avoid connecting stations to a network by multiple baselines to only one other network station.
    - First-order and second-order GPS control networks shall consist of a series of interconnecting closed-loops & geometric figures.

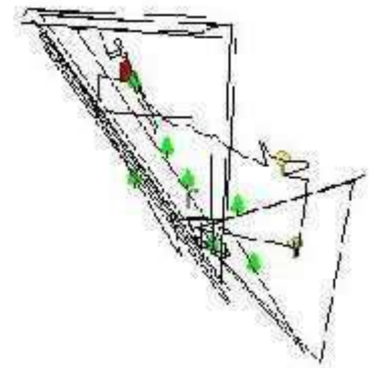
GPS Survey Specifications (Loop closure &Networking)

Loop

- A loop is defined as a series of at least three independent, connecting baselines, which start and end at the same station. Each loop shall have at least one baseline in common with another loop.

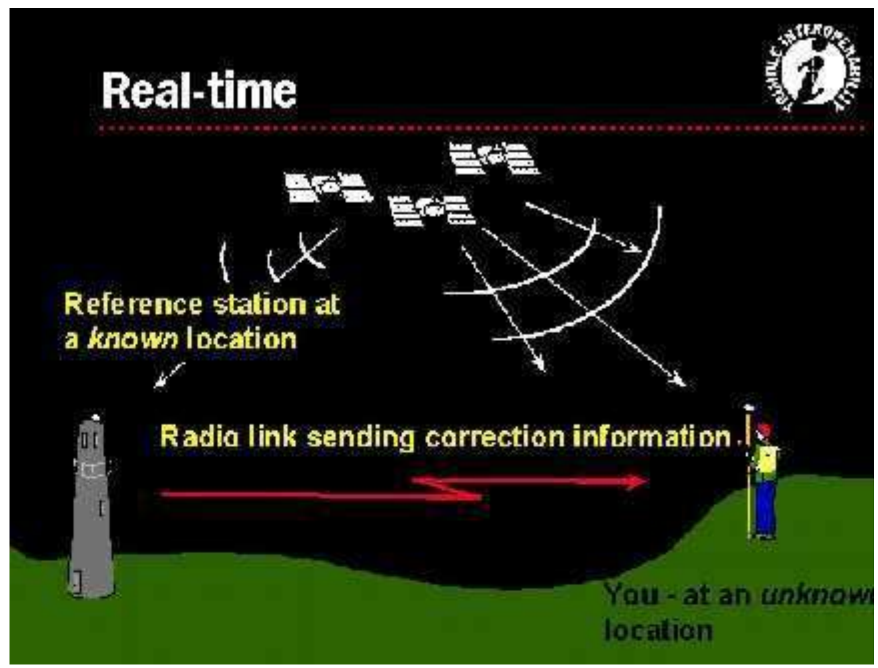
Postprocessing / Real-time



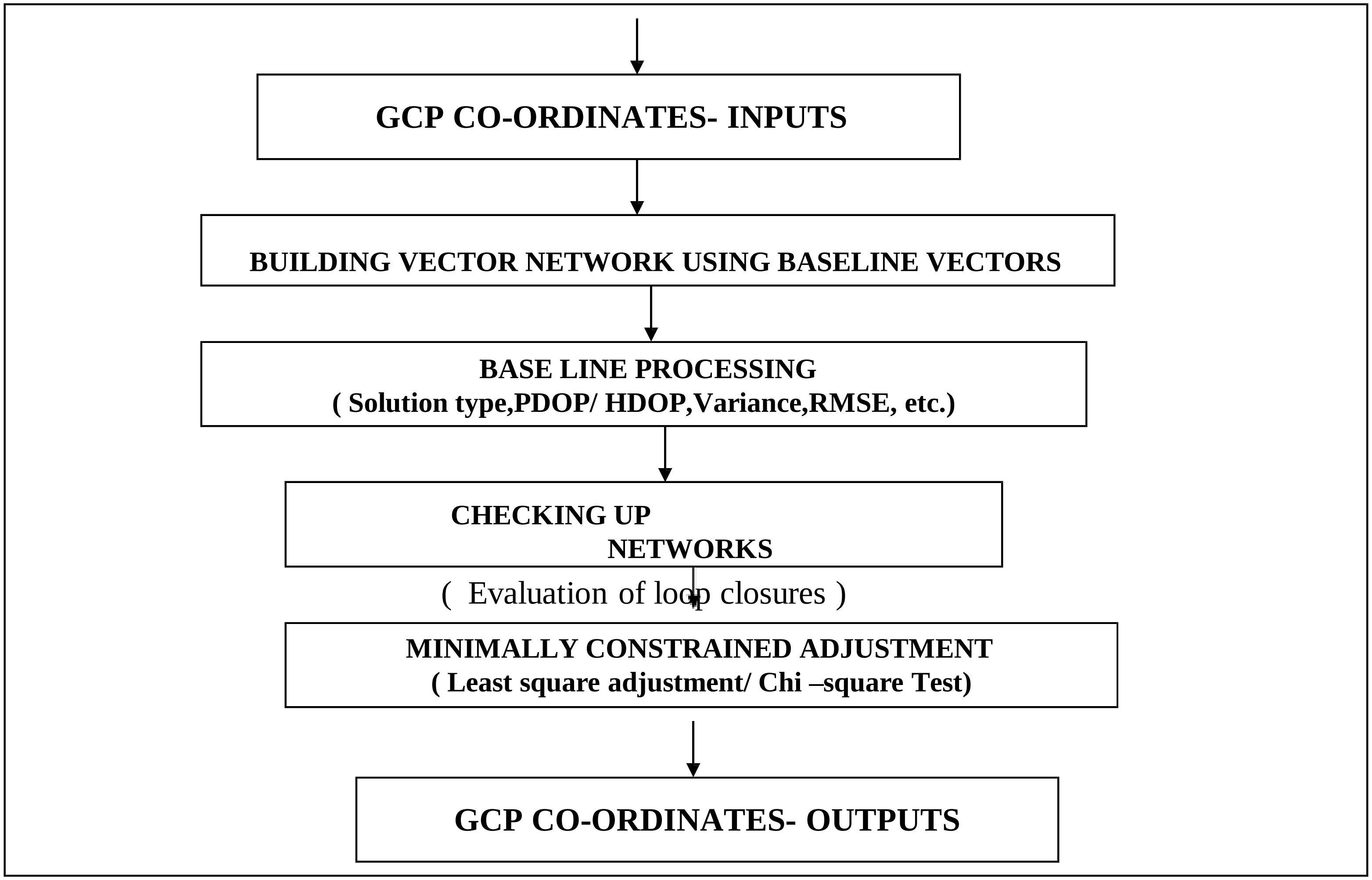


Before

After



NETWORK ADJUSTMENT



**A minimally constrained or free adjustment acts as one quality control check on the network.
This adjustment helps to identify bad observations in the network.
If an observation does not fit with the rest of the observations
, it is highlighted as an outlier.**

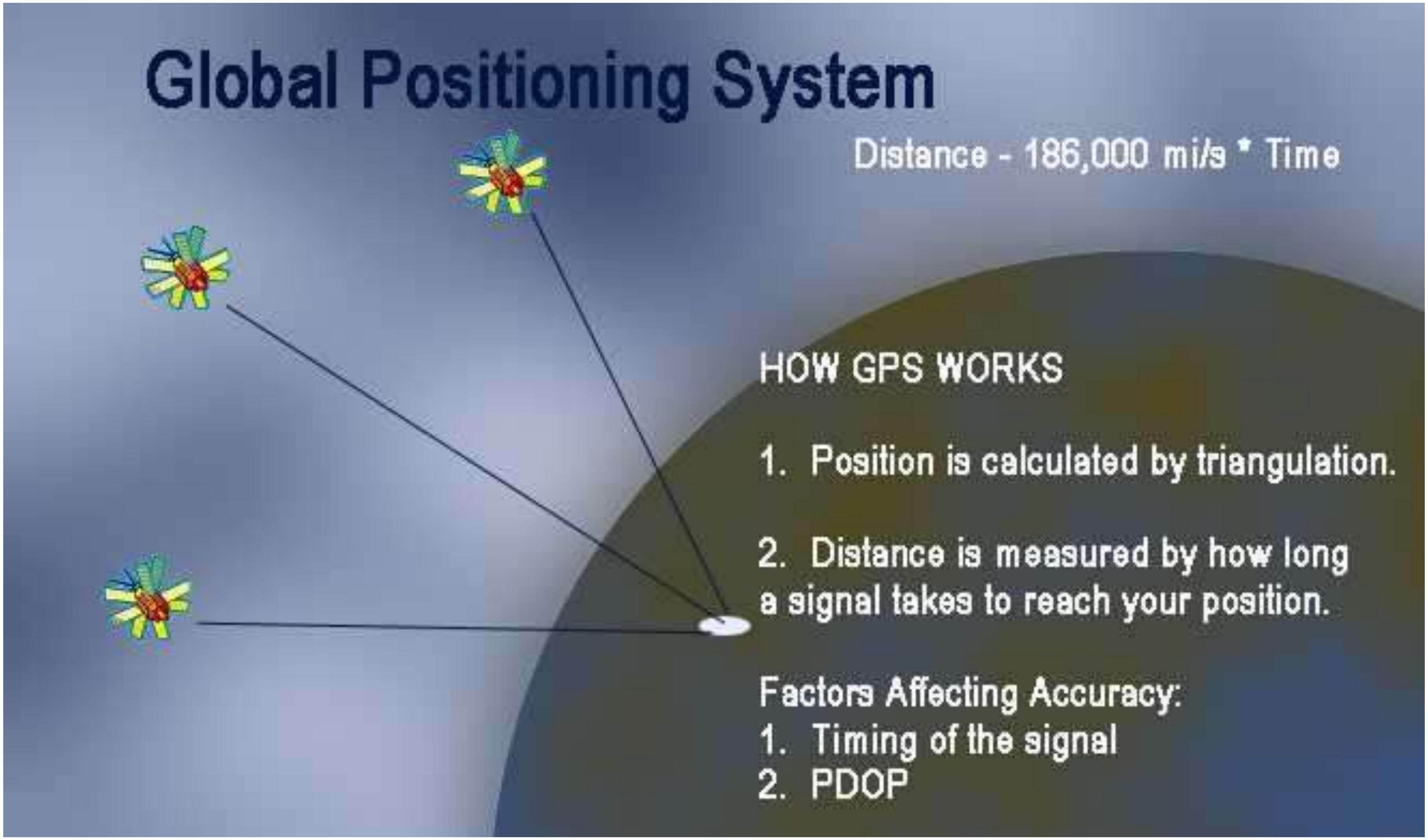
**The minimally constrained or free adjustment also checks
on how well the observations hold together as a cohesive unit.**

All minimally constrained adjustments must be performed in the WGS-84 datum.

**Since all GPS observations are made
on the WGS-84 datum, the adjustment of the observations should be
tied closely to the WGS-84 datum.**

**Realistic error estimates for tribrach centering and H.I. measurement should
also be factored into the minimally constrained adjustment**

In a Nutshell



DGPS / ETS survey

- DGPS Survey
- ETS survey

In Obscure /Crown cover Transmission line, Microwave tower areas etc , the Geo-co-ordinates for the point (s) has to be determined through Integrated ETS

Electronic Total Station (ETS)

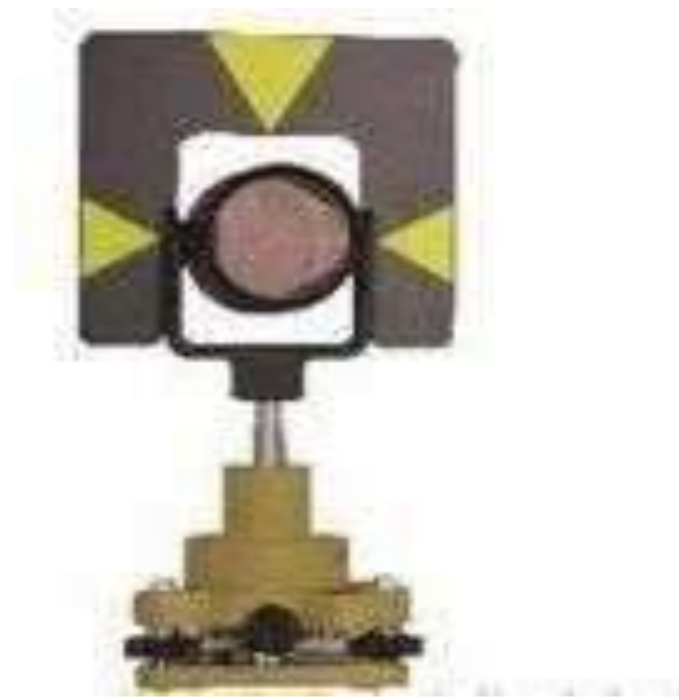
- **The total station** is an electronic/optical instrument used in modern surveying.

The total station is an electronic theodolite integrated with an electronic distance meter (EDM) to read slope distances from the instrument to a particular point

Distance Measuring (Electronic Distance Meters)

- *In the early 1950's the first Electronic Distance Measuring (EDM) equipment were developed.*
- *Primarily consisted of electro-optical (light waves) and electromagnetic (microwave) instruments.*
- *Bulky, heavy and expensive.*
- *The typical EDM today uses the electro-optical principle. They are small, reasonably light weight, highly accurate, but still expensive.*

Electronic Total station & Prism



Thank U

COURSE:-REMOTE SENSING AND GIS

Prepared By:
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UNIT-II

PHOTOGRAPHY

AERIAL PHOTOGRAPHY

- Science of making photographs from the air for studying the surface of the earth
- Offers pictorial representation of earth‟s surface and a synoptic „BIRDS EYE VEIW‟ of the terrain which is of help for planning purposes
- Economizes and expedites natural resources surveys
- Used for Preparation of base maps in the field of geology, soils, land use, civil engineering and town planning

ADVANTAGES AERIAL PHOTOGRAPHS

•Saves time

•Larger coverage area

•More detailed ground surface than maps

•Can be studied anytime and at anywhere

•Studies on the photographs are cheaper than field studies

•Studies on the aerial photographs are easier than in the field

•The only disadvantage of the aerial photographs is the absence of the topographic contours and the geographic names.

HISTORICAL BACKGROUND

- Prior to the invention of airplanes, photographs taken from the ground borne cameras (i.e. Terrestrial Photographs) were used to extract the relationship between objects using geometric principles.

- Use of photograph in topographical map making started in 1840 by French geodesist "Aragon". The "Photo-theodolite" was the instrument used for taking terrestrial photographs.

- The terrestrial photography owing to limitations such as less coverage, more cost effective and less known geometry were dispensed with. The aerial photographs replaced the same.

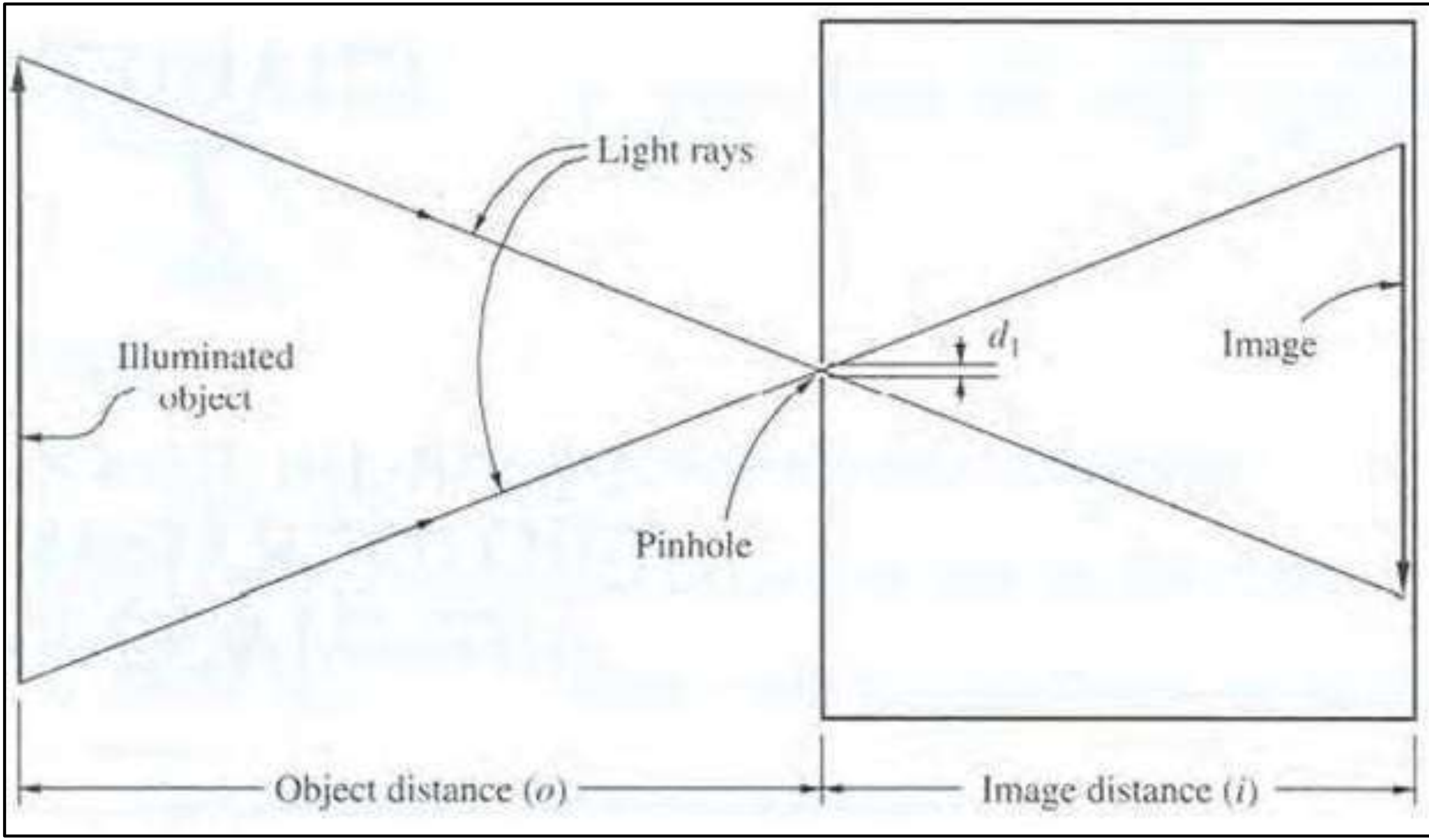
- 1783 - First manned balloon flight
- 1859 - Gaspard Tournachon a French amateur photographer ascended in balloon and photographed a village near Paris

- Major break through for military applications during World War-I
- 1920s and 1930s - Significant use for cartography, forestry and geology developed.
- 1940s - Extensive use during world war II

- In India, SOI started terrestrial photogrammetry in 1899-1900
- 1939-40 - Aerial photography for topographic mapping by SOI
- 1980s - Full fledged aerial photography in mid 1950s and reached climax

First aerial photo in France

Pegions as Aerial Photographers


Light rays
Illuminated object
d_1
Image
Pinhole
Object distance (o)
Image distance (i)

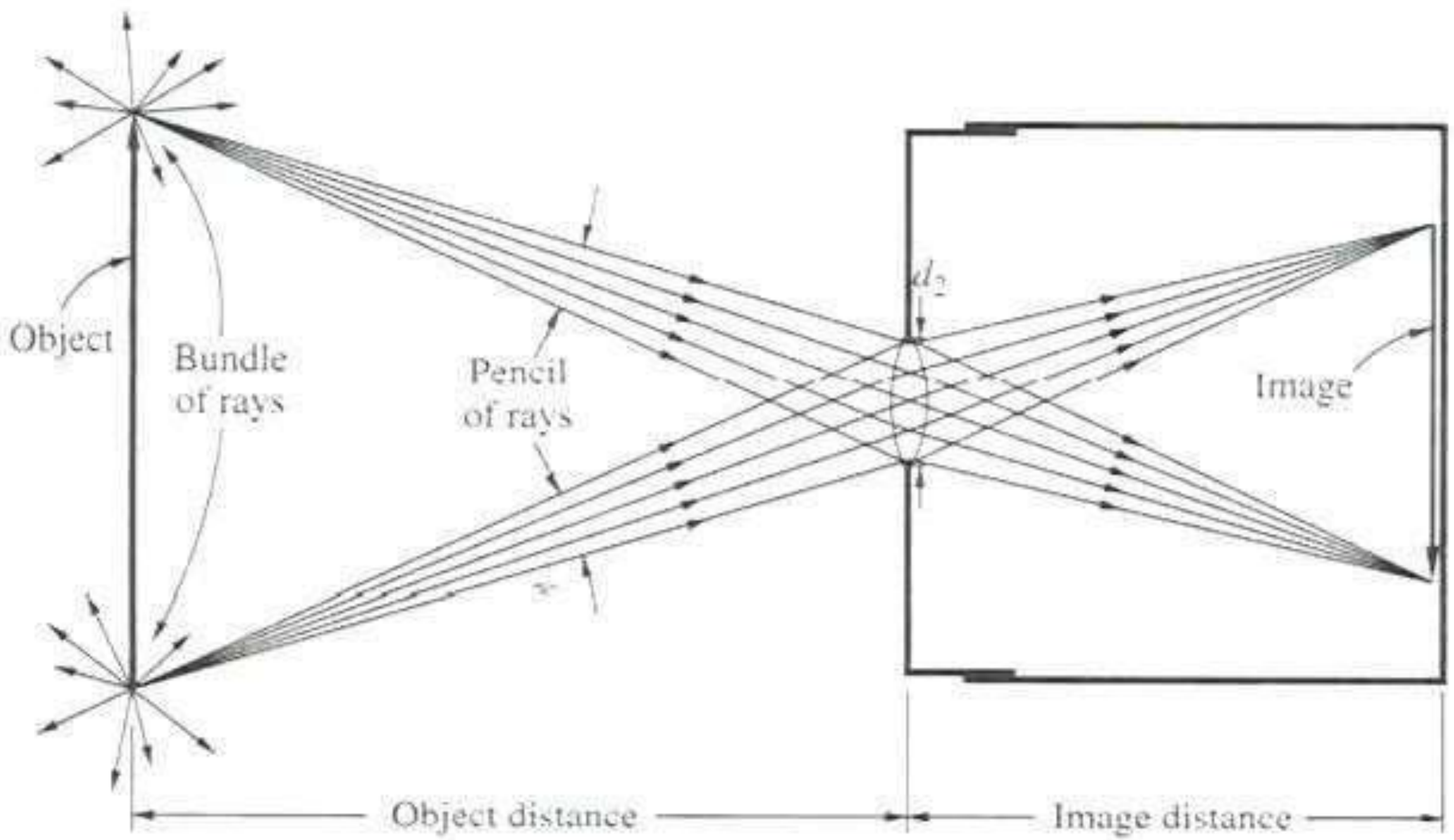


FIGURE 2-6
Pencils of light and image formation in a single-lens camera.

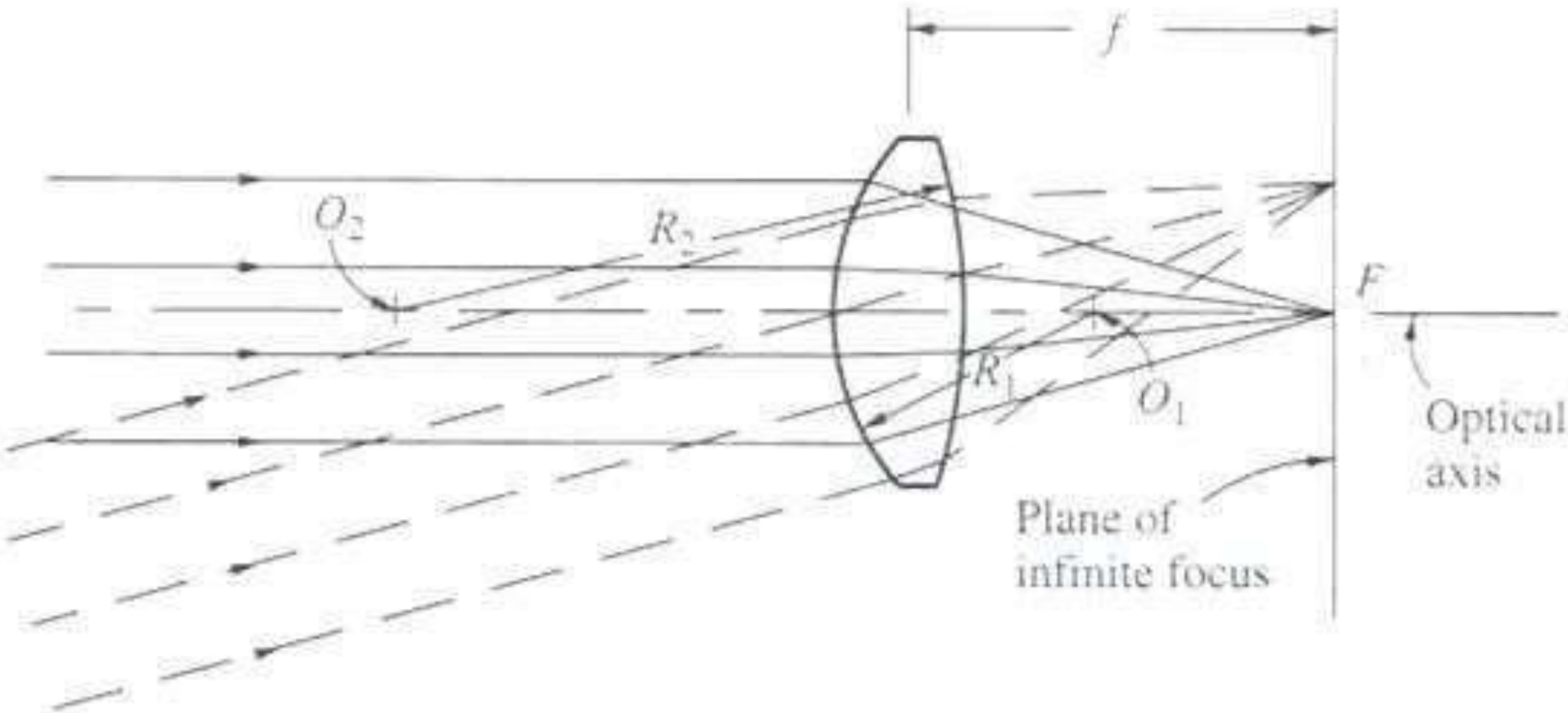
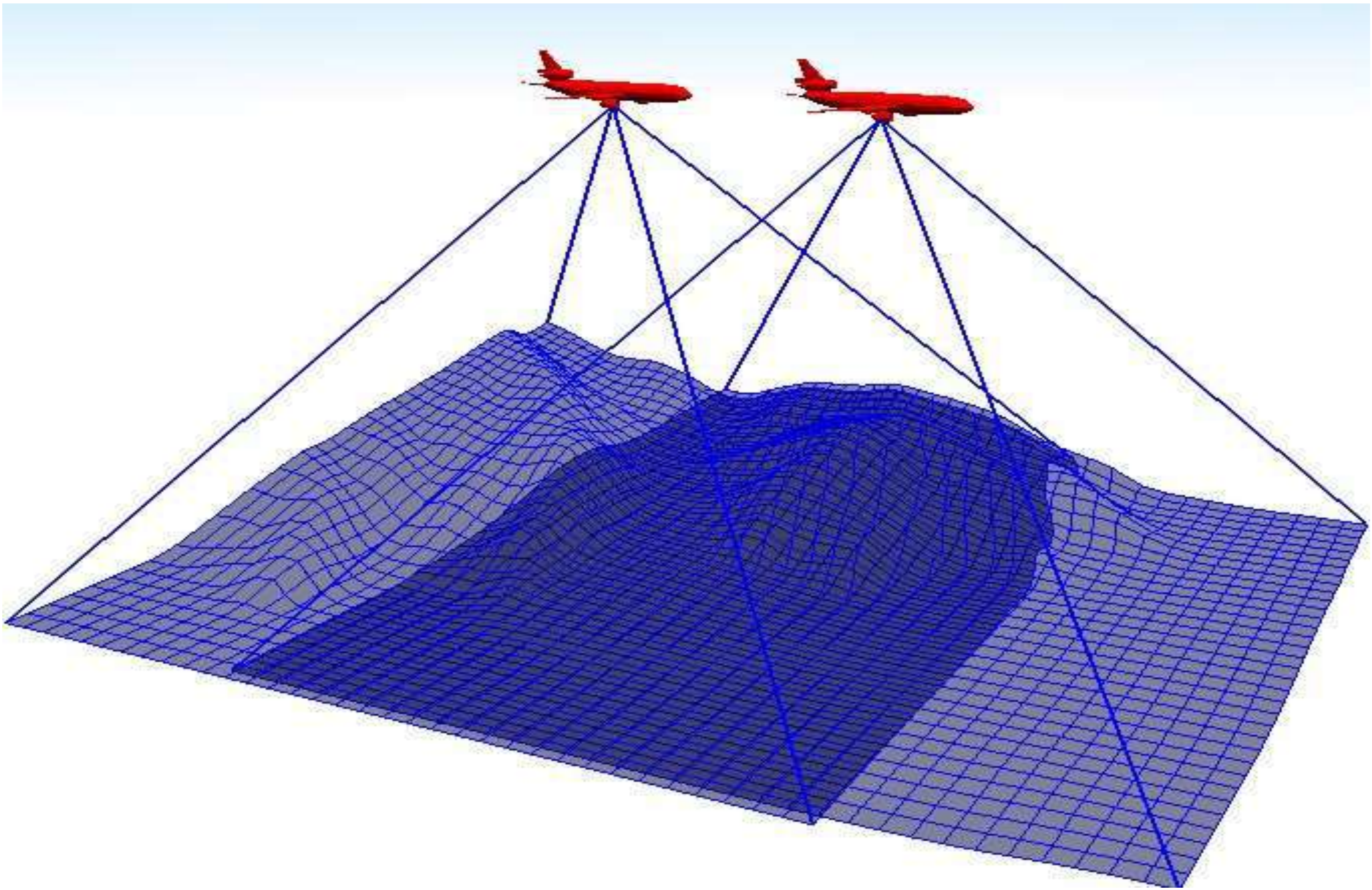


FIGURE 2-7
Optical axis, focal length, and plane of infinite focus of a lens.



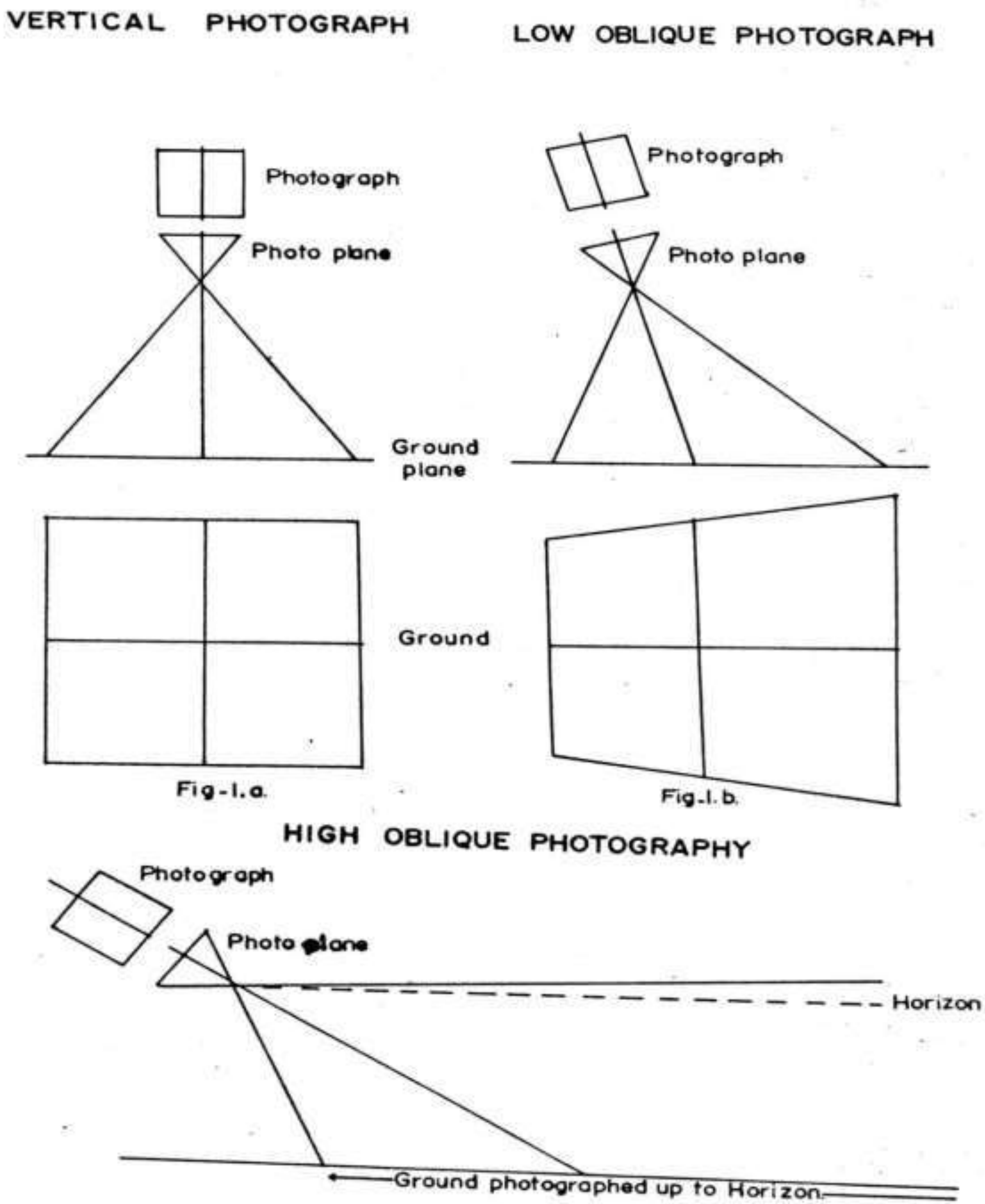
AERIAL PHOTO AND TOPOSHEET- DIFFERENCE

	Toposheets	**Aerial Photos**
Projection	Orthographic	Centre Perspective
Scale	Uniform	Not uniform
Objects	Shown as symbols	Actual photo features of the ground

TYPES OF AERIAL PHOTOGRAPHS

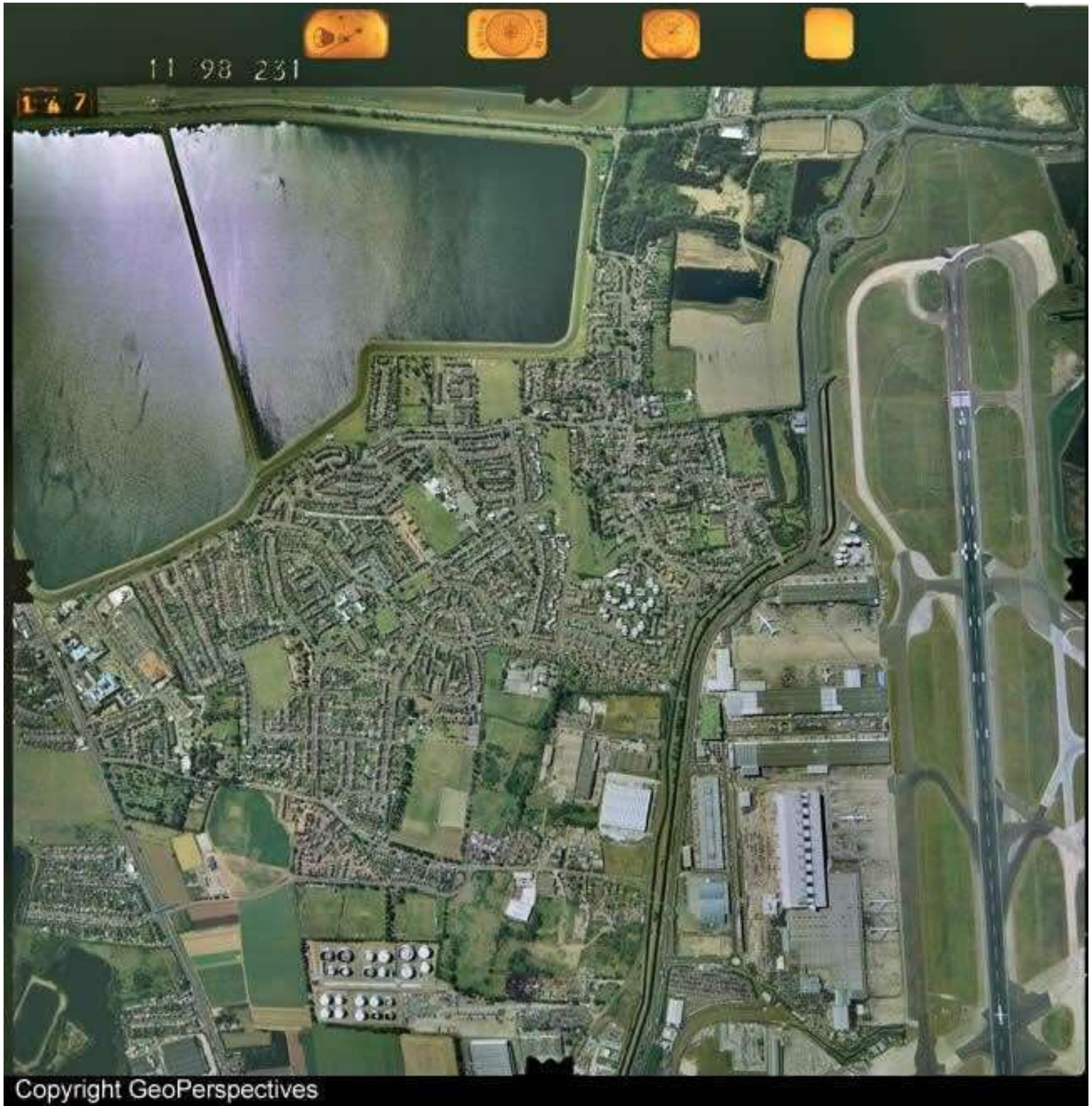
Aerial photographs are generally classified according to the orientation of the optical axis of the camera

1. Vertical -camera pointing vertically downwards.
2. Oblique -when the optical axis is considerably inclined from the vertical.
3. High oblique photographs - inclination is sufficiently great to permit photography of the horizon
4. Low oblique -less inclination

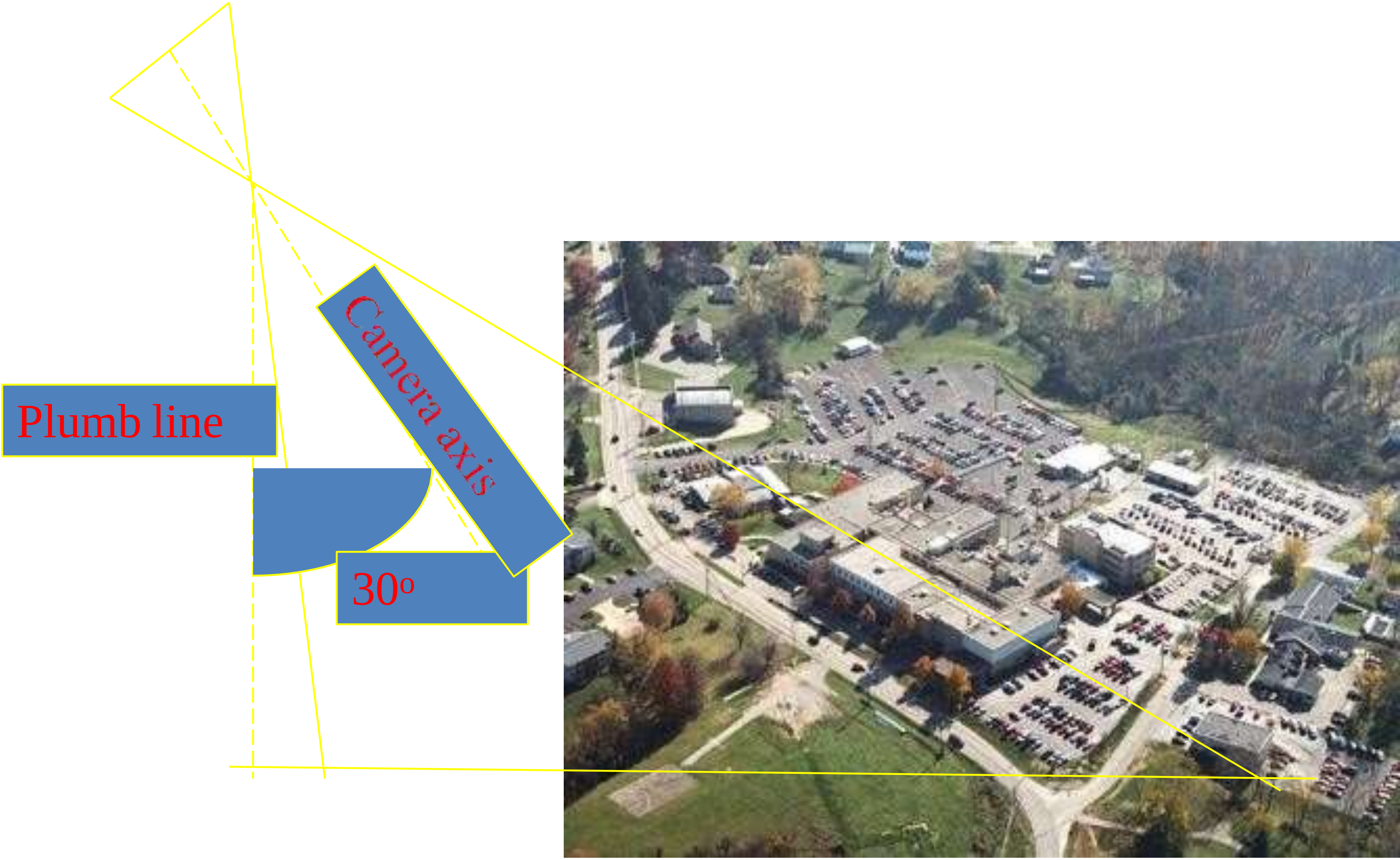

VERTICAL PHOTOGRAPH
LOW OBLIQUE PHOTOGRAPH
Photograph
Photo plane
Photograph
Photo plane
Ground plane
Ground
Fig-1.a.
Fig.-1.b.
HIGH OBLIQUE PHOTOGRAPHY
Photograph
Photo plane
Horizon
Ground photographed up to Horizon

VERTICAL PHOTOGRAPH

Vertical Aerial Photograph

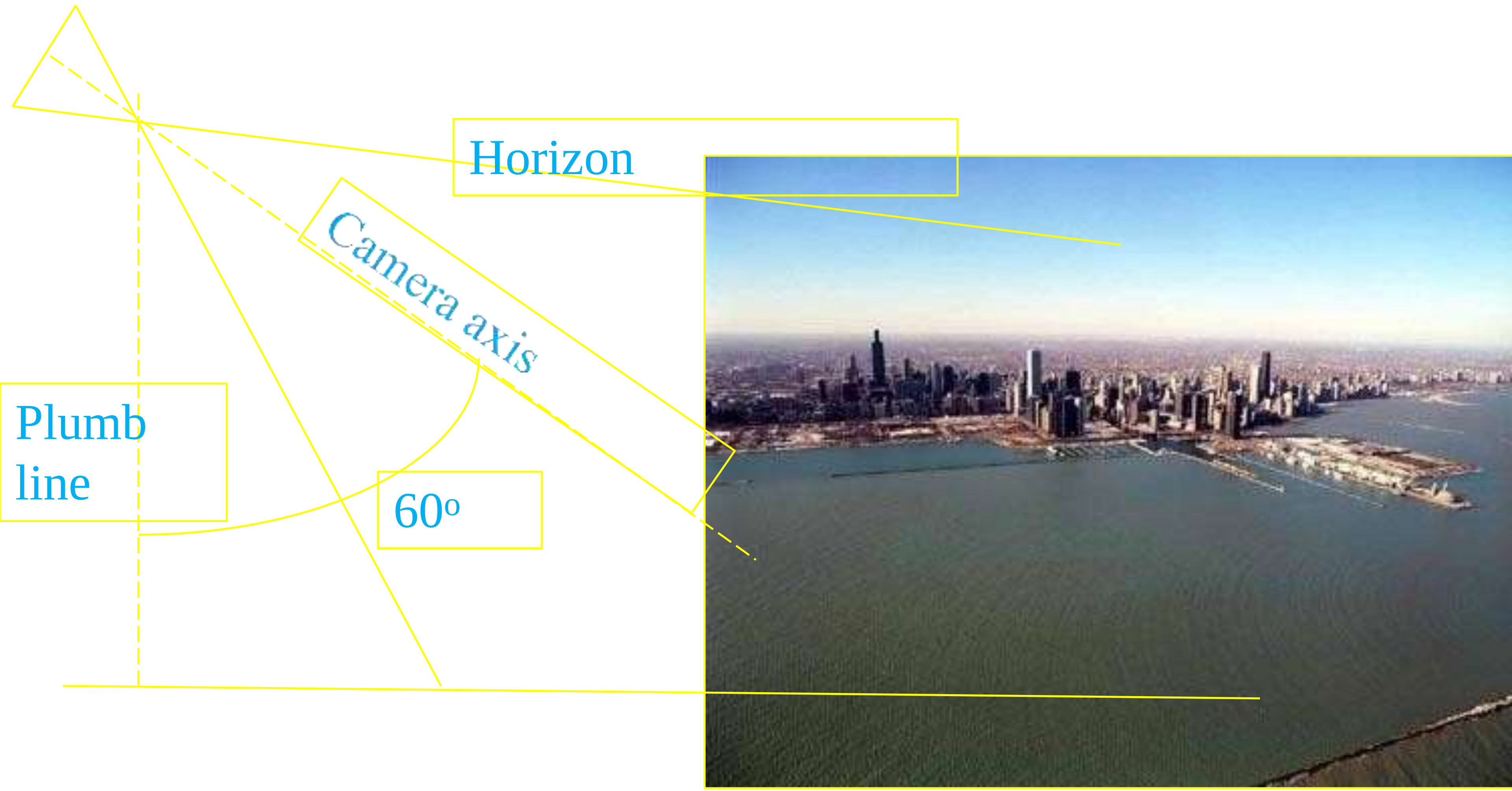


LOW OBLIQUE PHOTOGRAPH




copyright Bluesky

HIGH OBLIQUE PHOTOGRAPH



PHOTOGRAPHY

AERIAL CAMERA-types

1. Frame type - most common – successive exposures are taken on the entire frame format

2. Strip type - the film is moved continuously along the focal plane and a narrow slit like aperture is kept open constantly. Film speed is adjusted to the aircraft speed.

3. Panoramic -the portion of the lens near the optical axis is used with the lens scanning through large angles across the direction of flight and the film is advanced parallel to the direction of scanning at rates compatible with the vehicle speed

4. Multispectral – for obtaining image of the terrain on different spectral bands. An assemblage of cameras with identical lens systems but different filters imaging either on the different parts of the same film roll or different film rolls

Panoramic photo of Sydney Bridge

AERIAL CAMERAS (contd.)

Type of Camera	Focal length	Coverage
Normal or standard	200 –300 mm	Up to 75^0
Wide angle	100 – 150 mm	75^o – 100^o
Super wide angle	45 – 90 mm	>100^o

Modern aerial survey cameras produce negatives measuring 23cms x 23cms (9 x 9in)

Up to 600 photographs may be recorded in a single film roll.

PHOTOGRAPHIC SCALE

Focal length of camera/Flying height (f/h)

The scale is not uniform

Variation in scale is due to

Centre Perspective projection

Optical or photographic deficiencies

Inferior camera

Faulty Optical shutters

Optical photographic deficiencies: These are caused by optical distortions due to inferior, camera lens, faulty shutters, film shrinkage or failure of film flattening mechanism in camera focal plane.

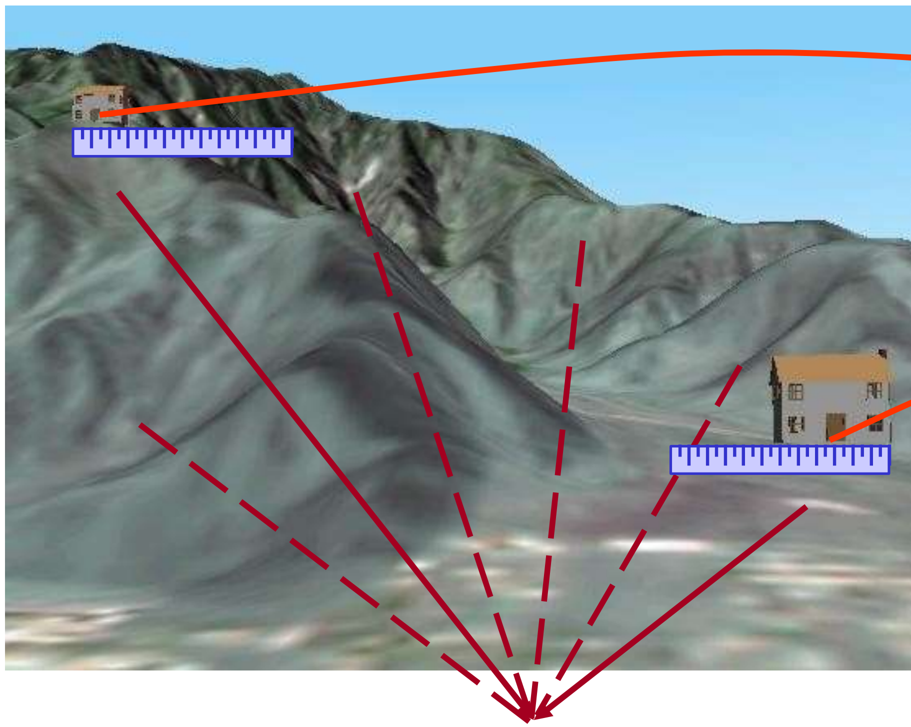
Inclination of optical axis: Such inclination / tilt caused by movement of camera normal to the direction of flight. The images are displaced radially towards the isocentre on the upper side of a tilted photograph and away from the isocentre on the lower side. Along the axis of tilt, there is no displacement Topographic relief of the terrain:

All the objects that extend above or below a specified ground datum have their photographic images displaced. The images of ground objects with greater elevation will be displaced radially outwards from the Centre of the photograph. Conversely, ground points lying below a selected datum plane are displaced radially inward.

Scale

- **Occurs in all photography**

House width = 8m



2 cm

Scale is 1:400

6 cm

Scale is 1:133

Scale varies across the photograph

Scale in oblique photographs

In the case of tilted photograph the scale is not constant even if the terrain if flat.
The scale is constant only along a particular line on the photo, parallel to the axis of tilt. Such lines are called “plate parallels”.

Scales used in natural resource surveys vary between 1:5,000 and 1:50,000 depending upon the purpose for which the photographs are used.

- For general regional mapping purpose in the field of geology 1:50,000 scale are used.

- For detailed mapping (Specialized Thematic Mapping) 1:25,000 scales are more suitable.

- These scales have the advantage of corresponding to the scale of modern toposheets.

- Selection of scale often depends on relief and other considerations. The higher the relief of the terrain and higher the density of vegetation, smaller should be the scale selected.

PLANNING AND EXECUTION OF PHOTOGRAPHY

- Aerial photography is a delicate operation and demands painstaking preparation and professional execution.

- Many factors must be considered and many problems solved before the execution of a photographic flight.

- The purpose of the project largely determines the scale and other specifications required. The proper camera, necessary filters, suitable film, the photographic plate and other equipment will be selected and the flight mission is assigned to trained photographic crew.

- Area to be photographed: The limits of the area should be indicated on the existing degree sheets or maps of scale 1:2,50,000. Large area may be divided into blocks A,B,C etc.

- Purpose of photography: This is important as it helps in the designing of the photographic specifications and planning of the flight mission.

Planning and Execution of Photography (contd)

Season of Photography

Selection of the season for photography depends on various factors such as seasonal changes in light reflection, seasonal changes in vegetation cover, seasonal changes in climatological factors. In India : September - October and March to April.

The purpose of photography however dictates the season to a great extent.

For photogrammetric, geological and soil surveys the ground should be visible as clearly as possible. In forested areas such a time will be when the trees shed their leaves. In higher latitudes and altitudes the melting of snow has to be awaited. The soil should be without standing crops. Thus, for these purposes early spring to beginning of summer is most suitable.

In forestry surveys, the density of foliage is important.

For the land use surveys, it is preferable to have the photography when the crops are standing. Therefore, for these purposes the later part of the year from the end of rainy season to the beginning of winter is suitable.

Planning and Execution of Photography (contd)

Time of Photography

The time of photography should be so decided as to avoid long shadows and haze conditions. Long shadows obscure the detail and bring down the interpretational value of the photographs.

Normally the time is confined to the period when the sun is between 30^0 and 60^0 (8 to 10 AM and 2 to 4 PM are preferred).

In mountainous areas however the period around noon is preferred to avoid shadows of the hills.

In tropics where the atmospheric haze is the main consideration, the time is limited to 1.5 to 3 hrs after the sunrise.

Planning and Execution of Photography (contd)

Flight Direction

In aerial photography E-W direction of flight is generally preferred on account of the winds. Some other direction may also be decided upon in consideration of other factors. The direction along the length of the area is commonly decided upon to keep the number of strips to minimum.

For geological interpretation, flight direction across the strike of the formations (cross stripping) is preferred in highly folded areas to ensure sufficient overlap across the strike. It is also preferred in high mountainous areas where relief displacement is more.

Planning and Execution of Photography (contd)

Flying Height

Flying height is decided depending upon the scale desired and the terrain.

As the scale of photography is the function of focal length of the camera lens and flying height, the less the flying height the more the scale variations in a rugged country.

To keep the scale variations within tolerable limits the flying height should be kept more in rugged mountainous area.

The desired scale can in such cases be maintained by using camera lens of proportionately longer focal length.

Planning and Execution of Photography (contd)

Flying Height of the Aircrafts commonly used in India

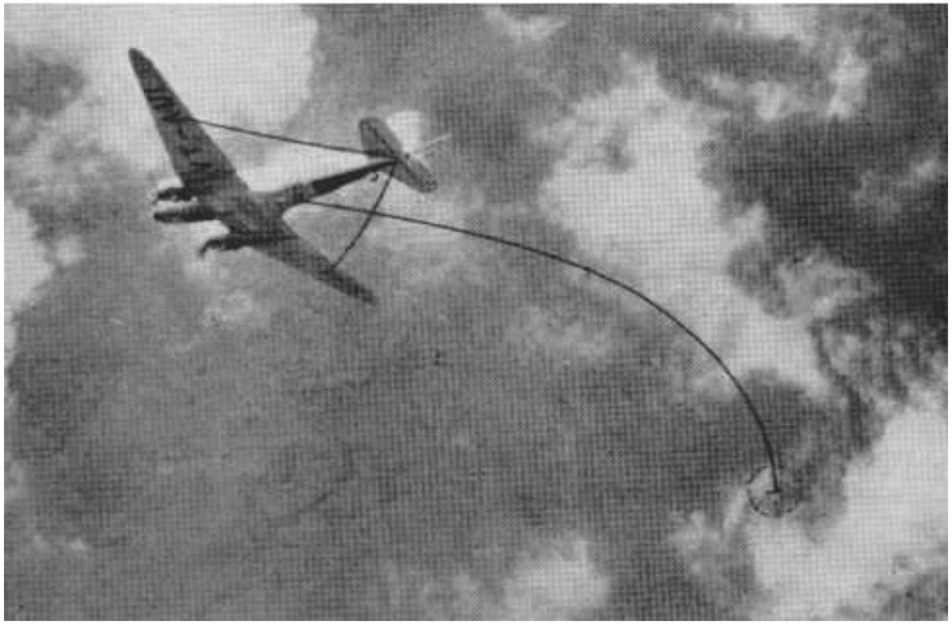
Aircraft	**Flying Height (km)**	**Speed km/hr**
Dakota	5.6 – 6.2	240
Avro	7.8	600
Cessna	9	350
Canberra	14	560
U –2	21	798
Rockell X - 15	108	6620

Aircrafts deployed for aerial photography/survey

Dakota

Casa 212

KingAir



DC3

Beechcraft Kingair prepared for installation

AERIAL PHOTOGRAPHY MISSION

•When a mapping project requires aerial photographs, one of the first tasks is to select the photo scale factor, type of the lens to be and the desired overlap for stereo viewing.

•Forward overlap usually around 60%, while sideways overlap is around 20%. Furthermore, the date, time and season of photography should be considered for light condition and shadow effect.

• If the required scale is defined, the following parameters can be determined-

- Flying height required above the terrain.
- Ground coverage of a single photograph.
- Number of photo required along a flight line.
- Number of flight lines required.

MISSION PLANNING:

- ***Inputs***

  . Area extents (lat / long)

  2. Scale of photography

  3. Focal length

  4. Format size

  5. Forward and lateral overlaps

  6. Average terrain heights

- ***Navigation***

  - Computer Controlled Navigational System with GPS

MISSION EXECUTION

- After entering a number of mission parameters, a computer programme determines the 3D coordinates of all position from which photos are to be taken and stored in a job data base.

- On, board the crew can obtain all relevant info from that data base, such as project area, camera type, film, sun angle, season, atmospheric condition etc. Also the list of camera position is loaded to a guidance system.

- The pilot is then guided along the flight lines, such that the deviation from the ideal line (horizontal and vertical) and the time of exposure is shown on display.

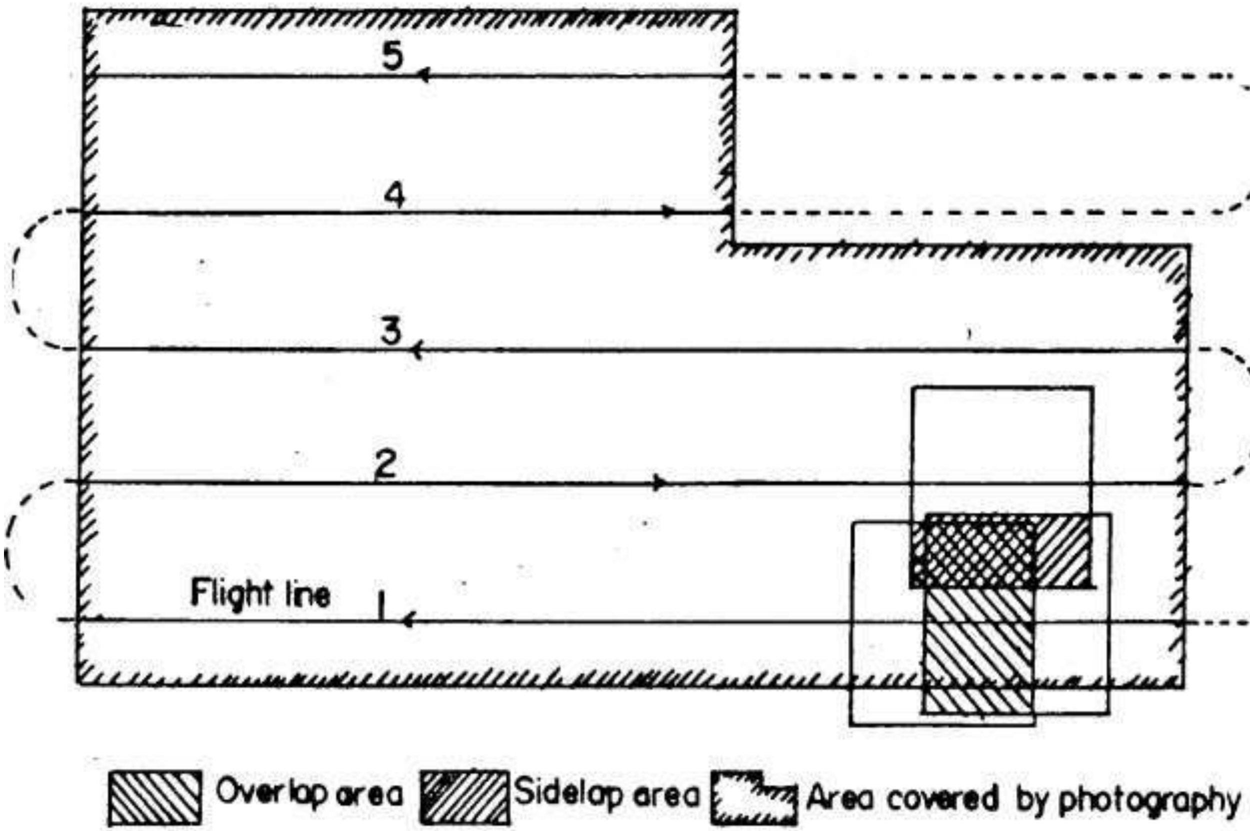
- When the plane passes close enough to the pre determined station, the Camera is fired automatically.

Organisations Identified for mission execution

In India three Organisations are identified for carrying out Aerial Survey/Photography.

- Indian Air Force(Task A)
- Air Survey Company, Kolkota (Task B)
- National Remote Sensing Centre, Hyderabad (Task, C)

PLANNING OF FLIGHT LINES



Photography ------ No photography.

Fig-2 c

CRAB EFFECT AND CAMERA ORIENTATI

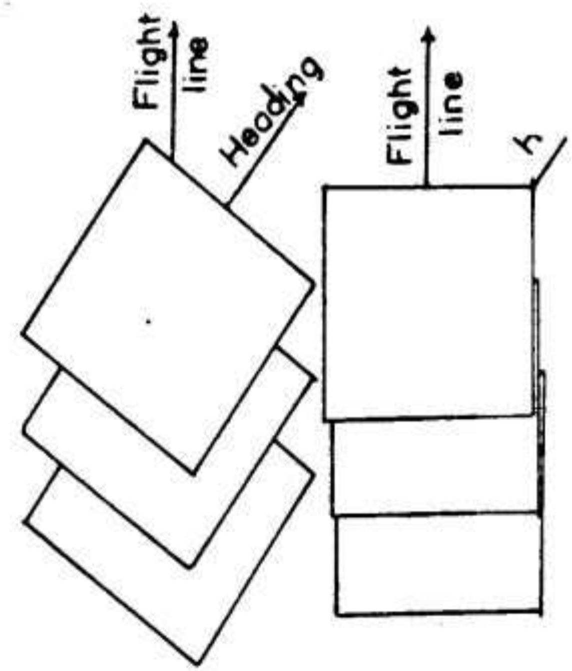


Fig-2 d

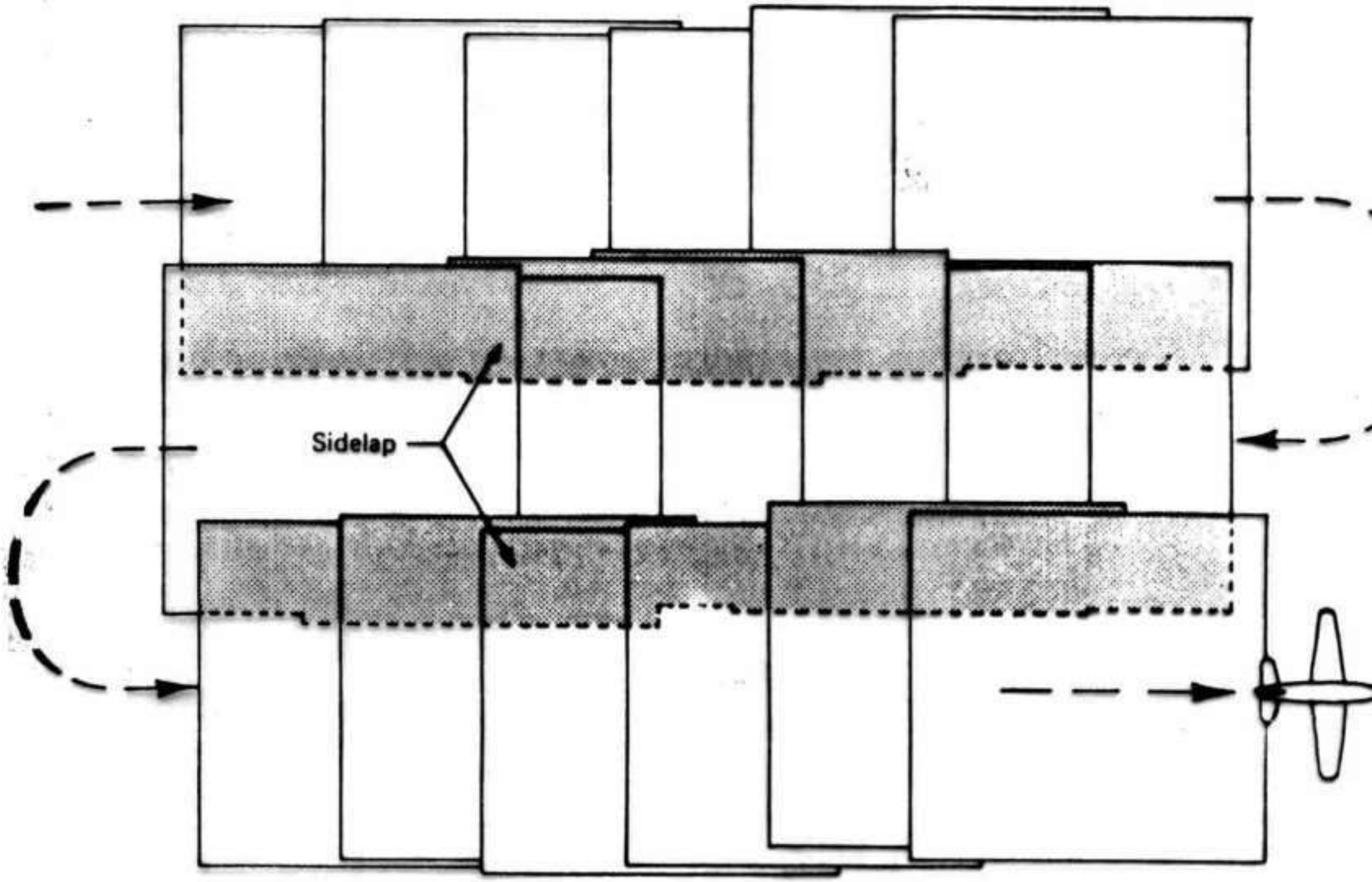


FIGURE 2.42 Adjacent flight lines over a project area.

Forward and Lateral Overlaps

Essential - In order to get stereo vision of the ground objects

Forward overlap – 60 ± 5 %

Lateral overlap – 20 ± 5%

OVERLAP AND SIDELAP IN VERTICAL AERIAL PHOTOGRAPHS

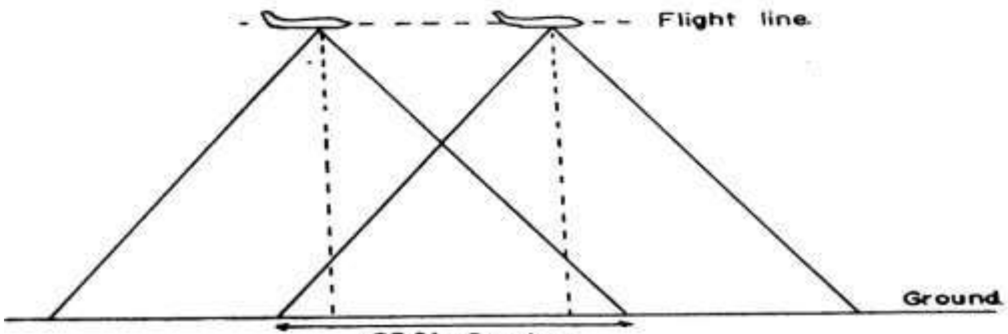


Fig. 2a.

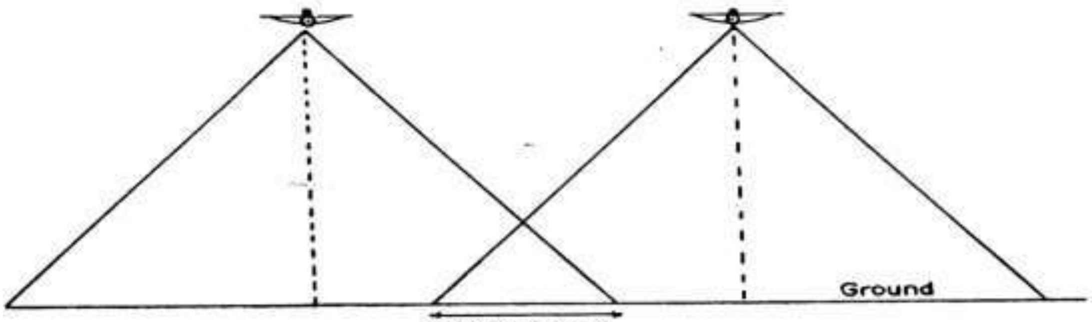


Fig. 2b

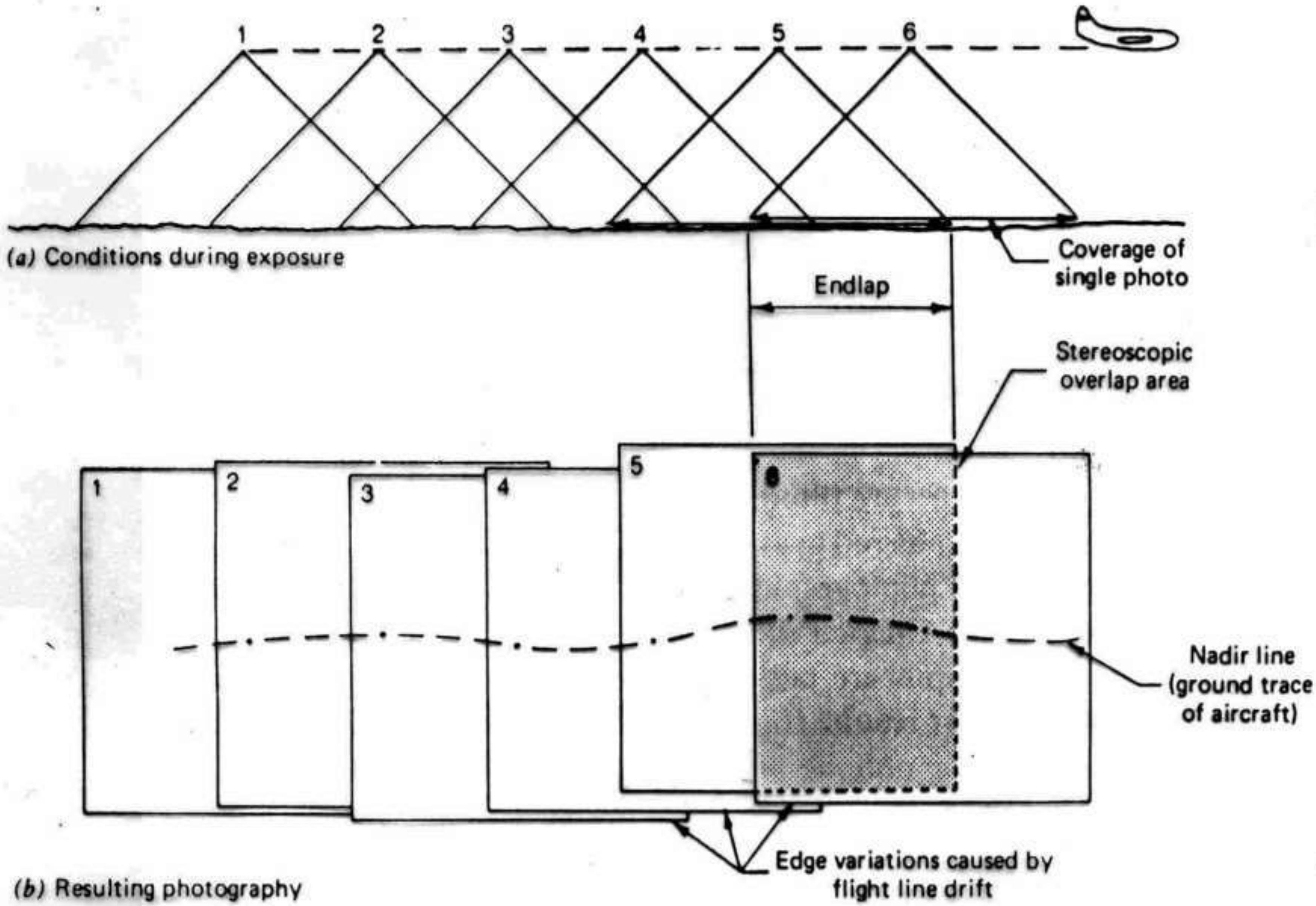


FIGURE 2.39 Photographic coverage along a flight strip.

INFORMATION RECORDED ON AERIAL PHOTOGRAPHS

- **Fiducial marks:** Fiducial marks or collimating marks for the determination of the principal points.
- **Altimeter reading**: for knowing the flying height of the aircraft above mean sea level (msl) at the time of exposure.
- **Time:** Recording of time at the moment of exposure.
- **Level bubble:** To indicate the tilt of the camera axis at the moment of exposure (not very accurate).
- **Principal distance**: For determining the scale of the photograph.
- **Number of the photograph**: e.g. 342-A 52-13
- 342 - Job number, (A - Indian Air Force, B - Air Survey Co. C -NRSC),

  52 - Strip number 13 - Photo number
- **Number of camera:** Useful for obtaining camera calibration report, if required.
- **Date of photography:** Written later on.


98
363-A
34-40

NUMBERING OF AERIAL PHOTOGRAPHS

•**Agencies for Aerial photography: Indian Air Force (IAF), Air Survey Company (A.S. Co) and National Remote Sensing Centre (NRSC) – controlled and coordinated by Surveyor General of India**

•**Job Number:** Every photographic task is allotted a job number by the Surveyor General of India for easy reference and handling. eg:346-A, 331-B.

•Task by I.A.F. - suffixed by letter „A"

•Task by A.S Co. – suffixed by latter „B"

•Task by NRSC – suffixed by letter „C"

•**Strip Number:** If the strips are flown E-W, numbering of the strips is given from N to S. If they are flown N-S, the numbering is given from W to E.

•**Photo Number:** If the strip is flown E-W, the photos of the strip are numbered from W to E. If the strip is flown N-S, the photos are numbered from S to N.

PREPARATION OF PHOTO INDEX

- To show the position of any one photo relative to the other and also its approximate geographical position on a published map.

Prepared for the areas where no reliable map coverage exists and for reconnaissance operations.

Line index It is photo layout with flight lines, photo-numbers etc. It is prepared on 1:250,000 scale and the longitude and latitude are marked at intervals of 15 minutes.

Digital Camera

- These include Airborne Digital Sensor (ADS) of LH (Leica Helava) system and Digital Modular Camera (DMC) of Z/I (RMK-TOP) system.
- The sensors developed have characteristics that relate both to a camera and to a multispectral scanner. Charge couple devices (CCD) are used to record the EM.
- The main advantages over film camera are simultaneous acquisition of multispectral data with overlapping (multi angle) images along the track, enabling generation of DEM.
- Allows recording of data over a larger spectral domain.
- The resulting data being in digital format are amenable for image processing and direct integration in to the GIS data base.

Factors Influencing the Image Quality of Photographs

1. Reflectivity of the object	Light intensity and distribution, shade, colour
2. Atmospheric factors	Haze, clouds
3. Aircraft	Vibration, steadiness
4. Camera	Rigidity of the lens, shutter and magazine assembly, efficiency of shutters, scatter and loss through filters, optional flatness of filter, light loss and scatter, spectral transmission through filter, distortion and aberrations of the lens
5. Negative and positive base and emulsions	Speed and sensitivity of the emulsion, flatness of the base, dimensional stability of the base
6. Processing and printing	Mode of processing of negative, condition of printing equipment, mode of printing; quality of chemicals

AERIAL MOSAICS

It is an array of overlapping aerial photographs systematically assembled to form a continuous pictorial representation of a terrain

- Planning purpose.
- It provides the overview of the terrain- nature and distribution of the materials and features occupying the terrain.
- Scale variation from photo to photo will be known causing gap in the overlap
- A mosaic annotated with local information on rivers,villages etc helps in knowing about the geographic position of the area interpreted.

TYPES OF MOSAICS

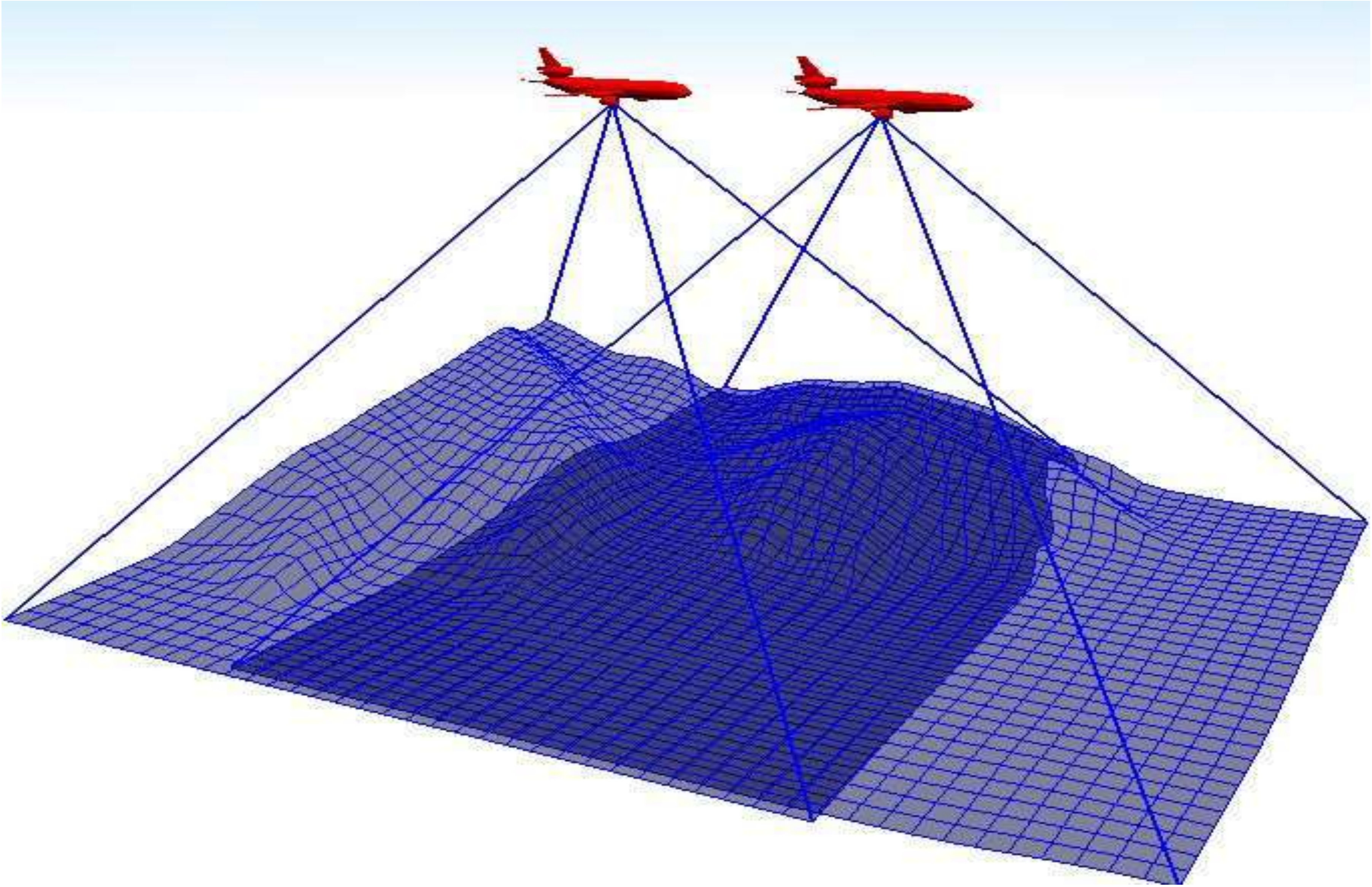
Uncontrolled mosaic: The photographs are oriented in to a position by matching corresponding images on adjacent photos.

Semi-controlled mosaic: This is a compilation of photographs without using rectified photographs but using control for positioning of each photograph.

Controlled mosaic: It is a compilation of scaled and rectified photographs assembled to fit plotted controlled points. The task of controlled mosaic is generally entrusted to an air survey company or photogrammetric organization.

Topographic map and Mosaic – Difference

Projection,	Map is an orthographic where all rays from object to the map are perpendicular	Mosaic is a central perspective projection, where all rays from the object surface to the image plane, pass through a point called perspective center.
Scale	uniform	Mosaic suffers from non- uniformity of scale
Features	represented by symbols	Mosaic shows actual photographic image of ground surface



STEREOSCOPIC VISION

- Aerial photography, and some satellite systems, allow the terrain to be imaged from two different viewpoints

- An overlapping pair of photographs or images can be used to form an optical relief model or stereoscopic model

- Stereoscopic models can be used for
  - 3-dimensional interpretation
  - measurement of terrain heights

CONDITIONS OF STEREOSCOPY

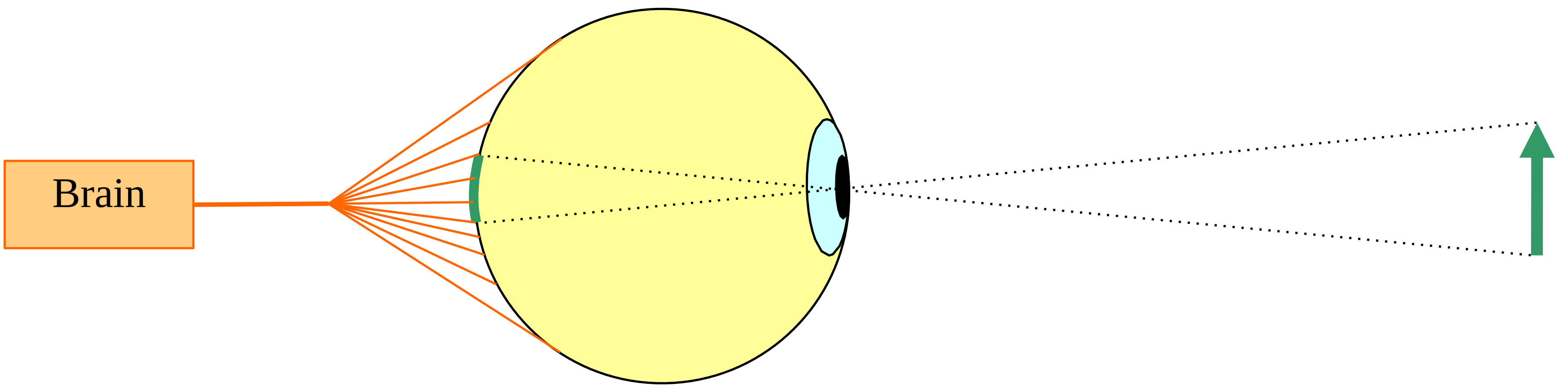
1. The optical axes of the camera must be approximately in one plane though the eyes can accommodate to a limited degree.
2. The ratio of the distance between the exposure stations and the flying height or the base – height ratio (B/H) must have an appropriate value. If this value is < 0.2 the depth perception is no stronger than if only one photograph is used. The ideal value, though not exactly known is about 0.25.
3. The scale of the two photographs should be approximately the same. Differences up to 15% may be successfully fused. For continuous observations, however, differences $> 5\%$ may be disadvantageous.
4. Each photograph of the pair should be viewed with one eye only.
5. The brightness of the photographs should be similar.
6. While viewing the photographs should be given the same relative position as they had during the time of exposure.

NATURAL STEREOSCOPIC VISION

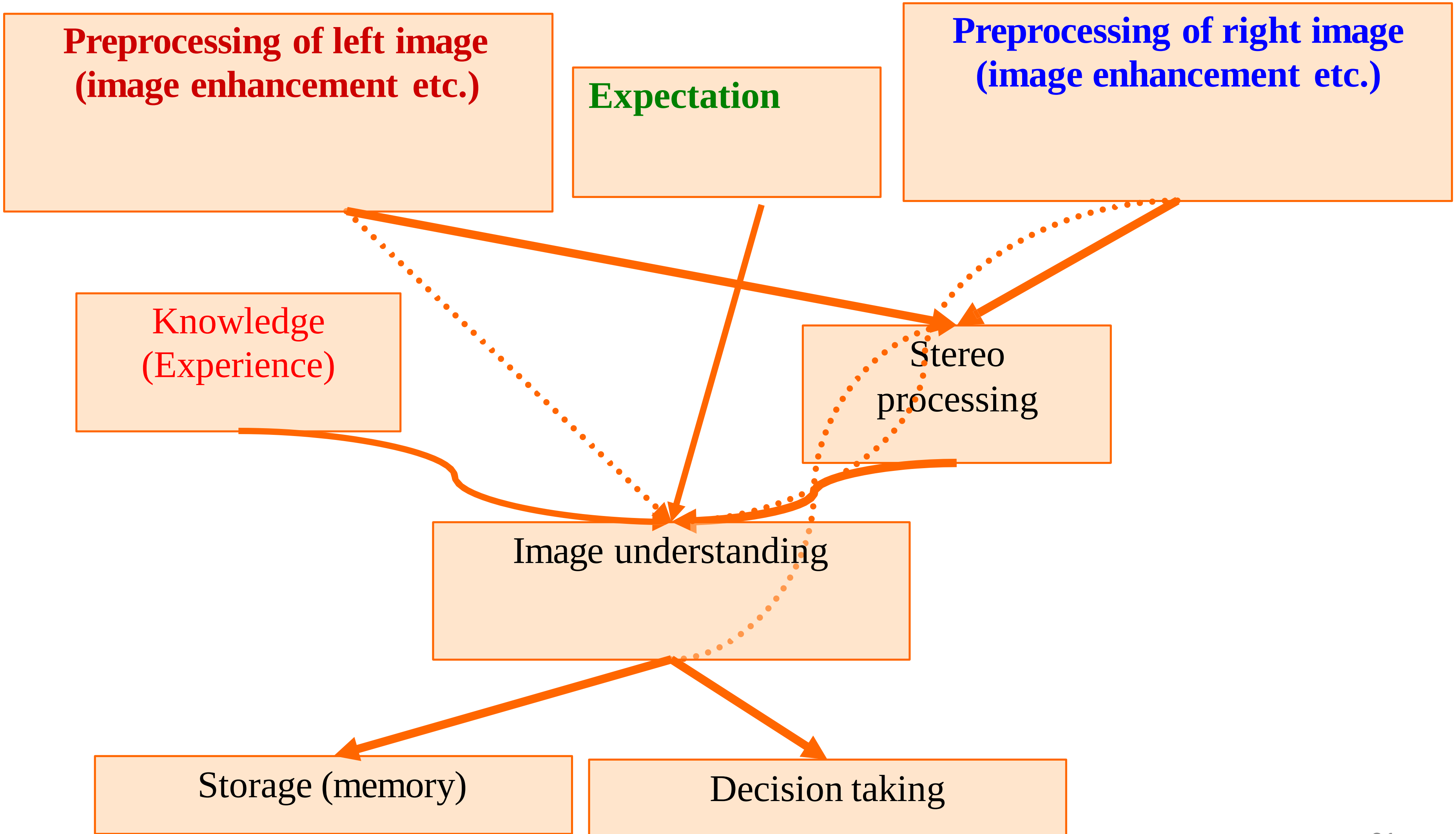
- The shape of the lens of the human eye may be altered to change its focal length
  - the eye is ***accommodated*** to view objects at different distances

- The lines of sight of our two eyes can be made to *converge* when viewing at different distances

Human Vision

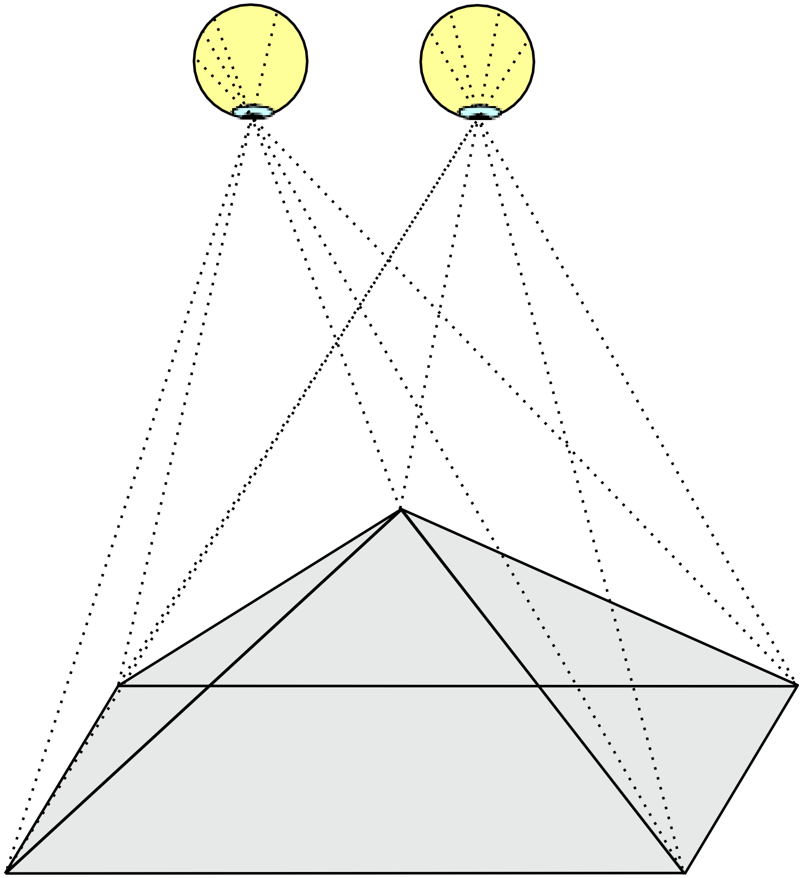


In The Brain

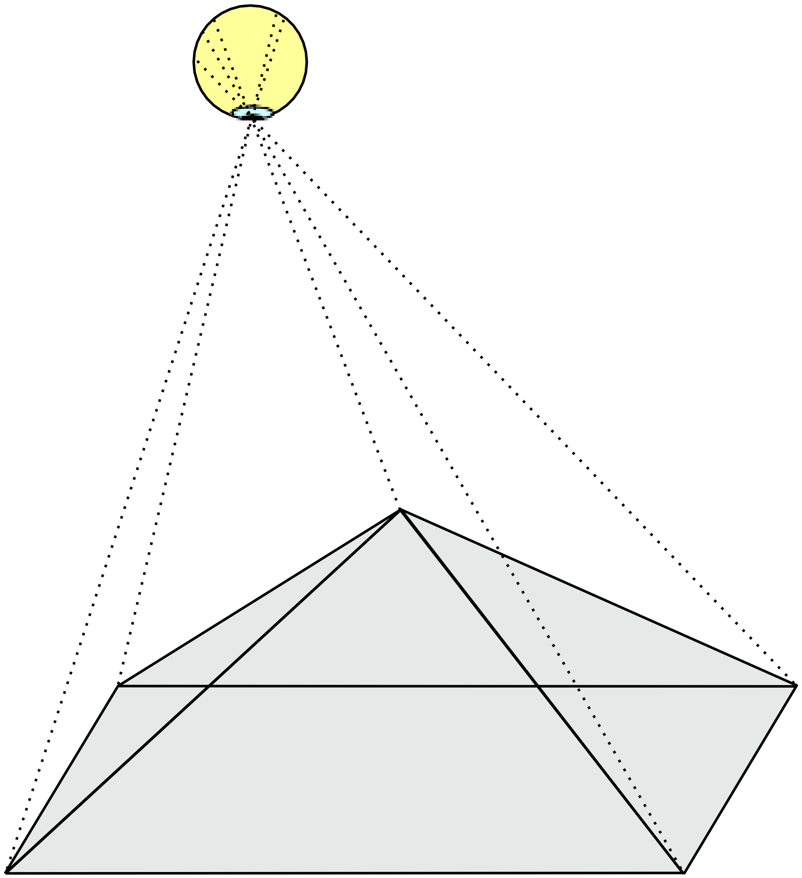


Preprocessing of left image
(image enhancement etc.)
Expectation
Preprocessing of right image
(image enhancement etc.)
Knowledge
(Experience)
Stereo
processing
Image understanding
Storage (memory)
Decision taking

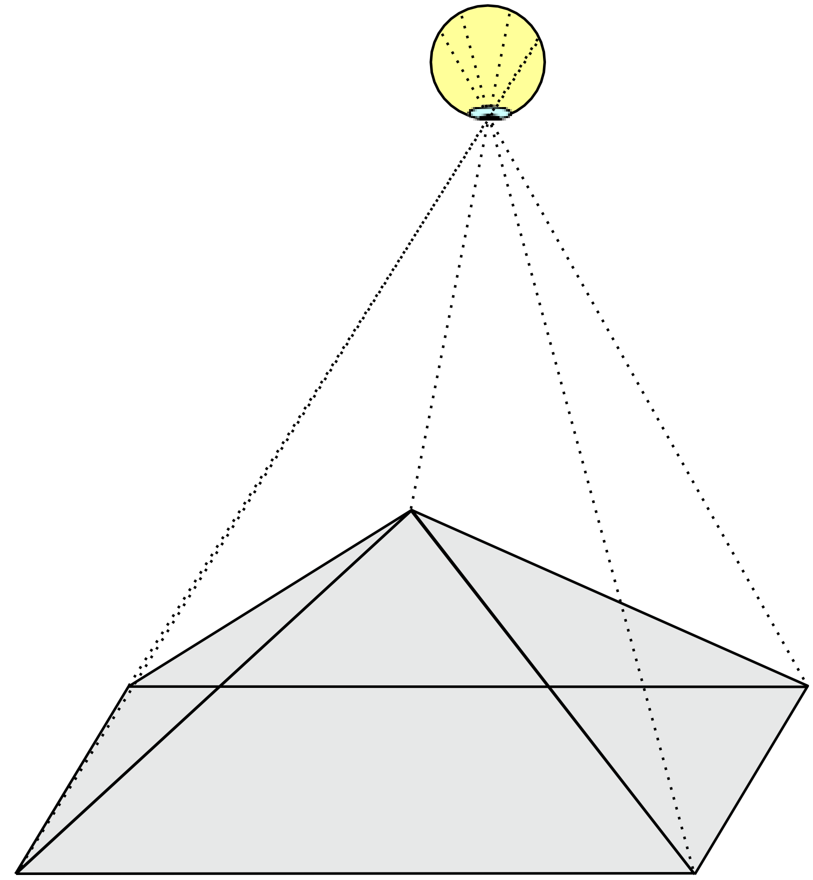
Viewing a 3D Object



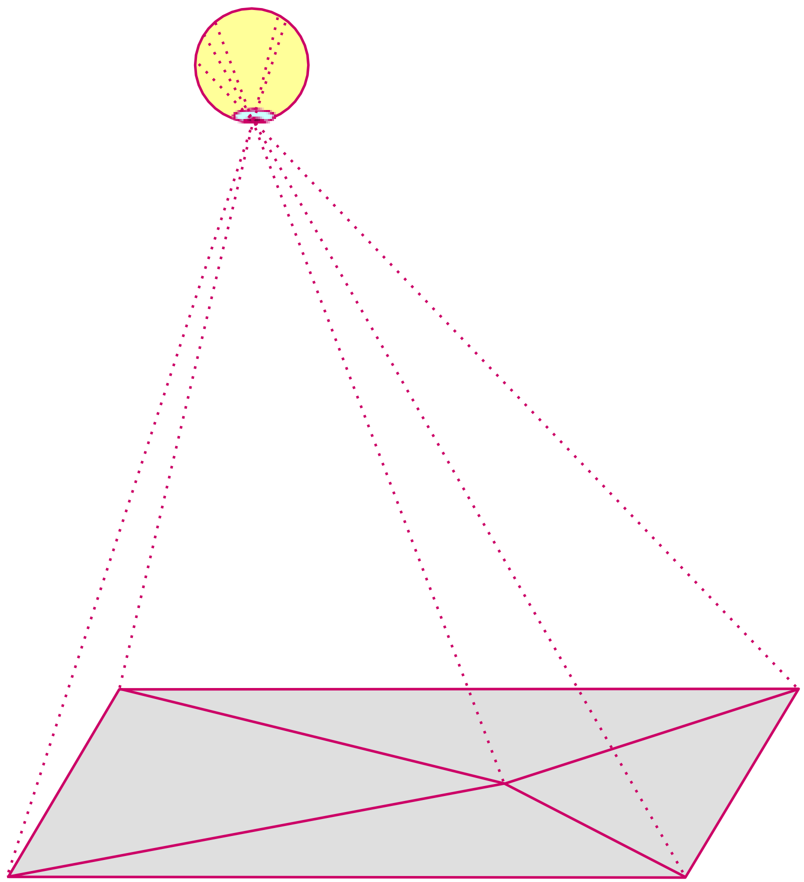
The Left Eye‟s View (Real Object)



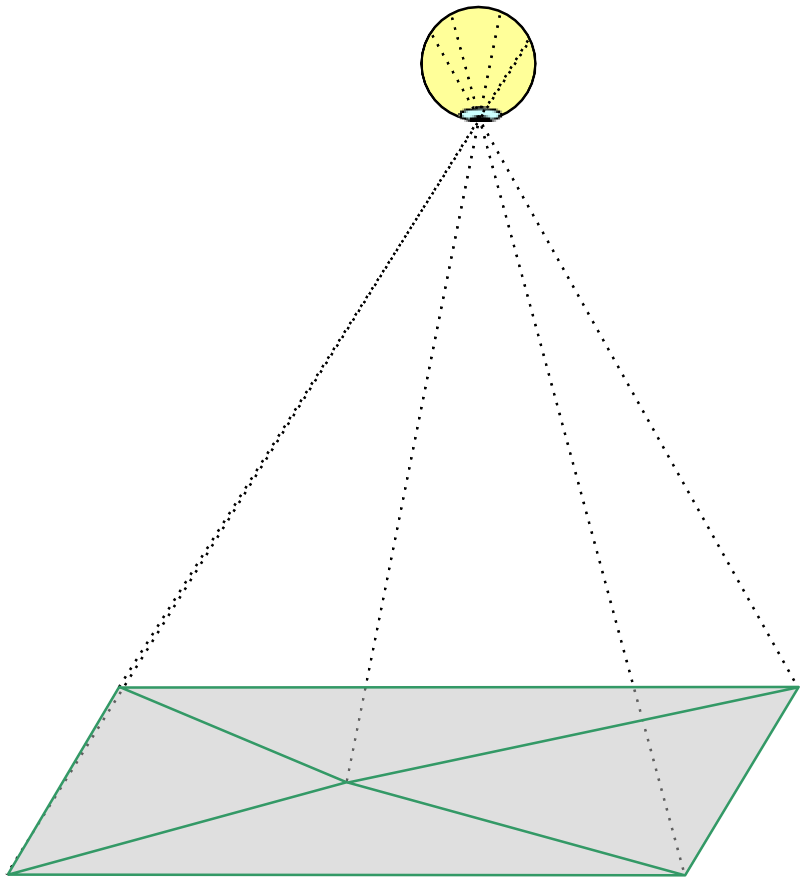
The Right Eye‟s View (Real Object)



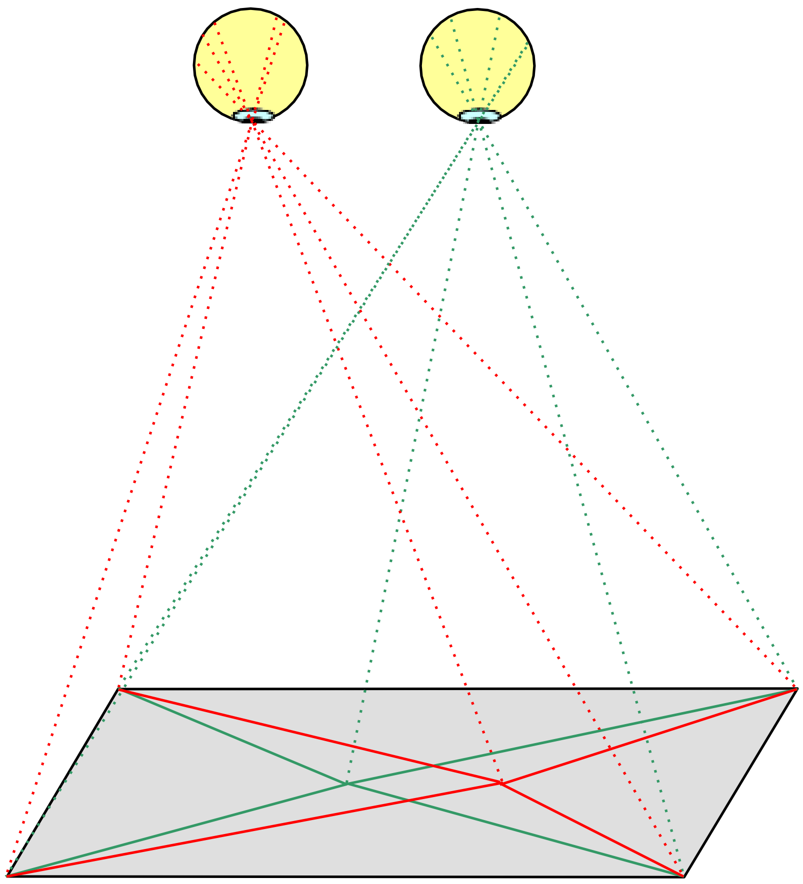
The Left Eye's View (Image)



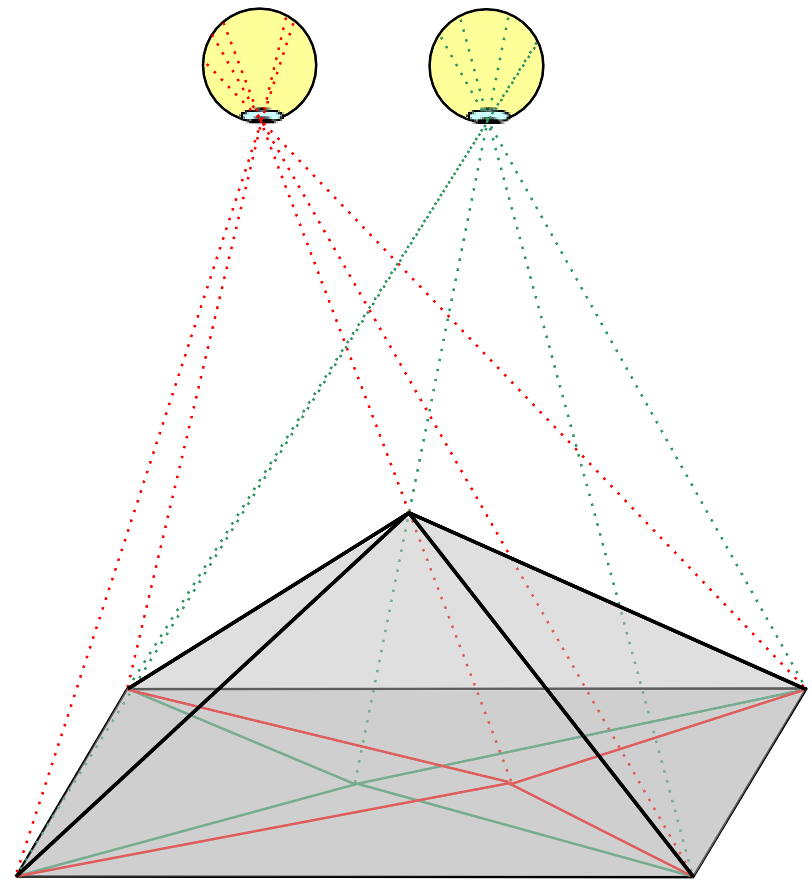
The Right Eye's View (Image)



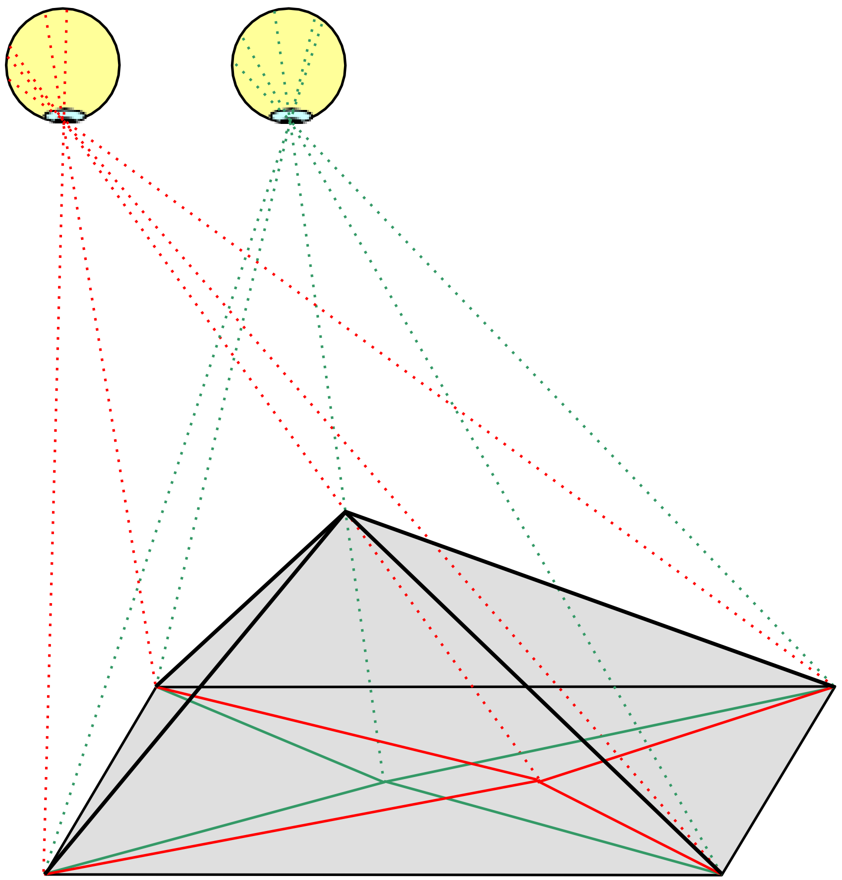
Viewing these two Images



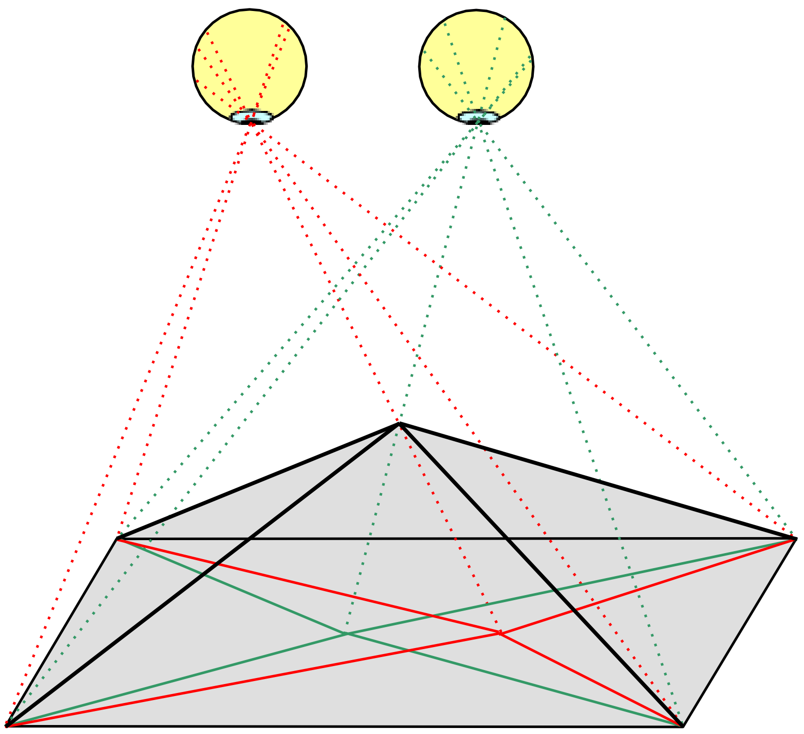
Gives a 3D Impression



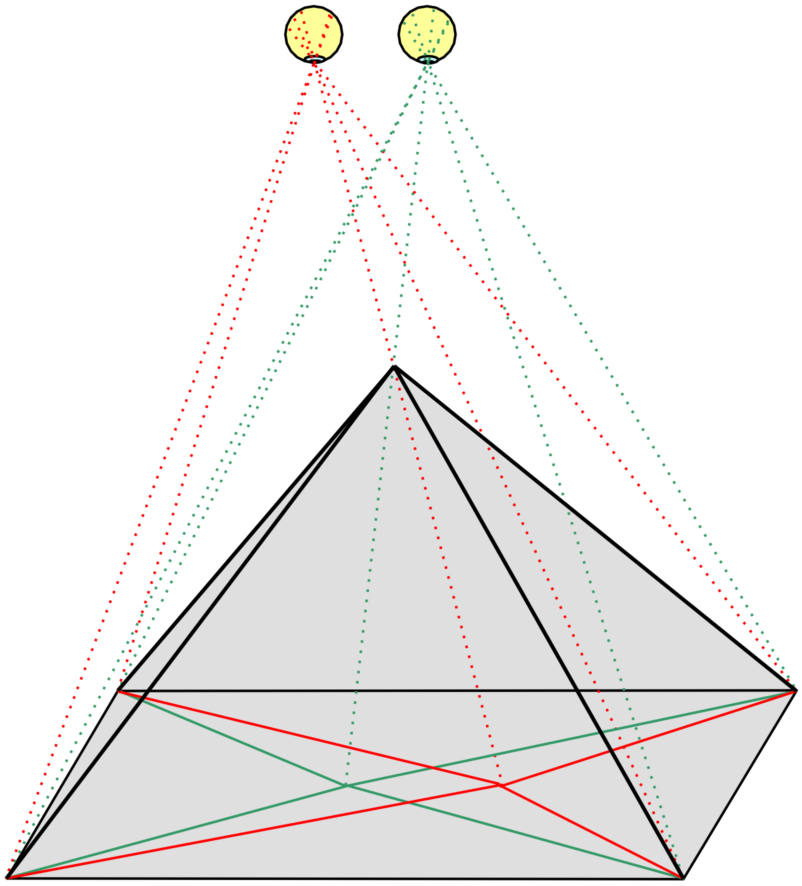
Depending on Viewing Position



And Viewing Distance



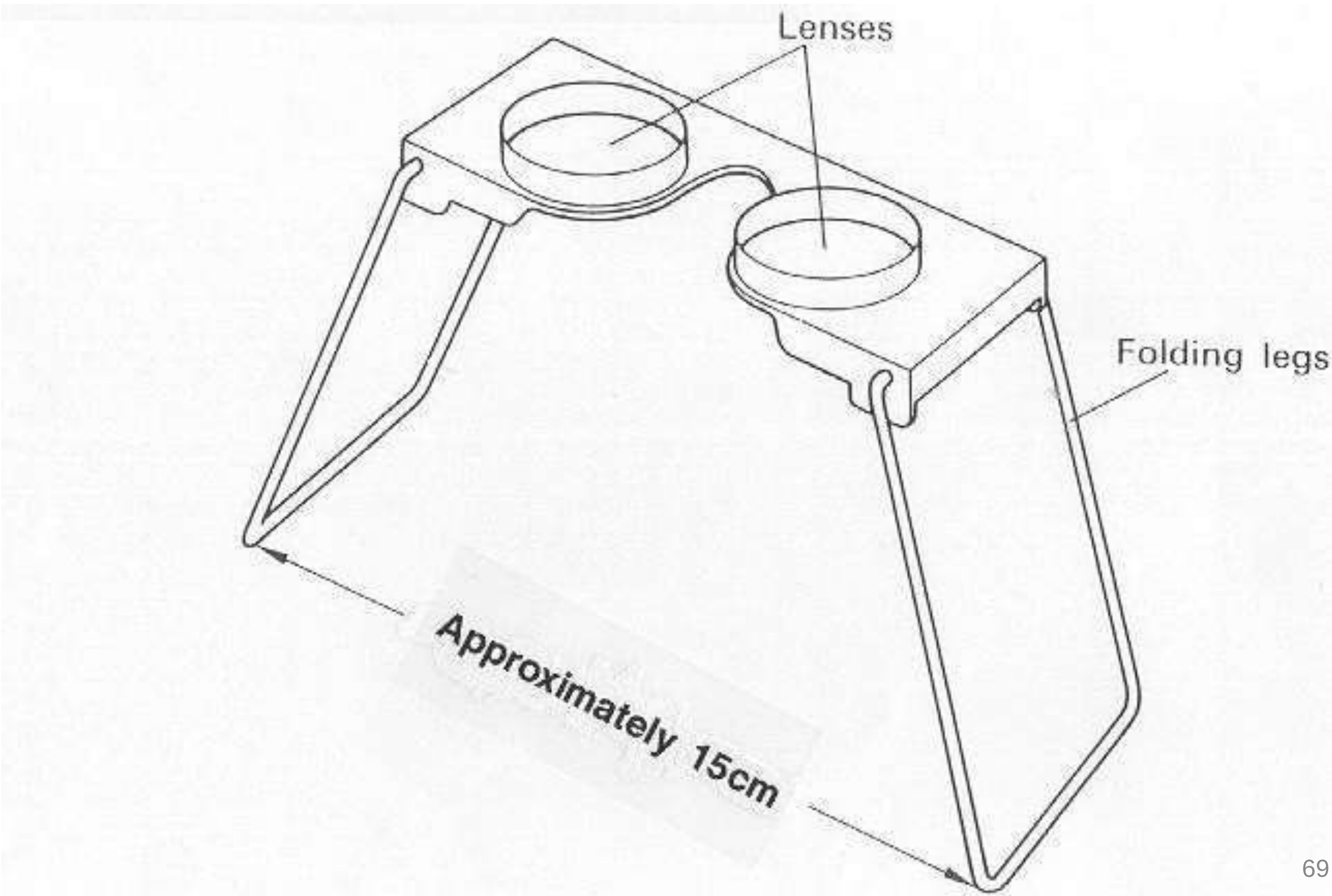
And Magnification



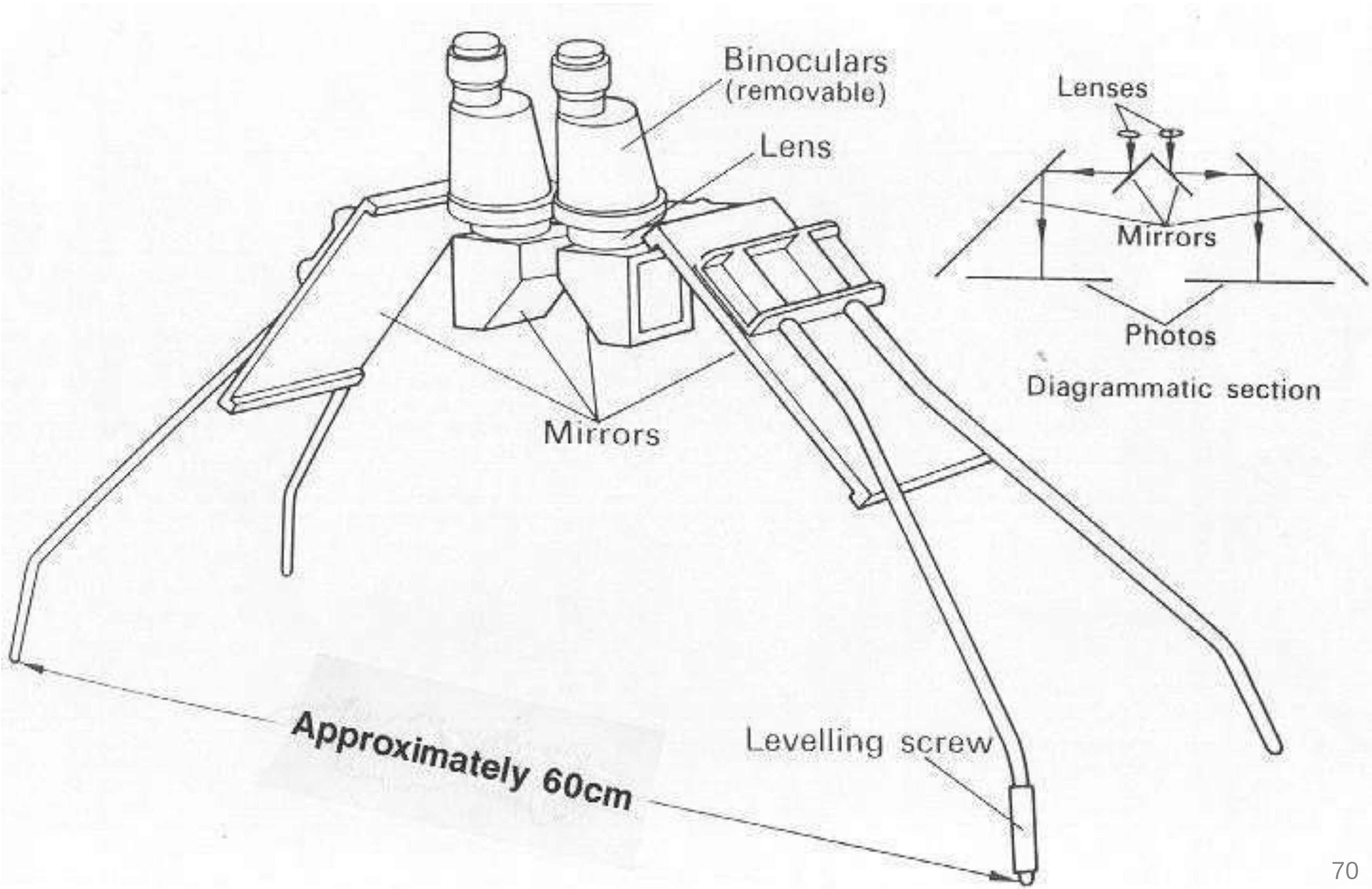
Artificial Stereoscopic Vision

- To observe stereoscopic pair of photographic prints, they must be
  - separated
  - viewed with parallel eye axes
- The observer‟s eyes must therefore be
  - accommodated at 250mm
  - converged to infinity
  - ***this cannot be done naturally !!***

Pocket Stereoscope



Mirror Stereoscope



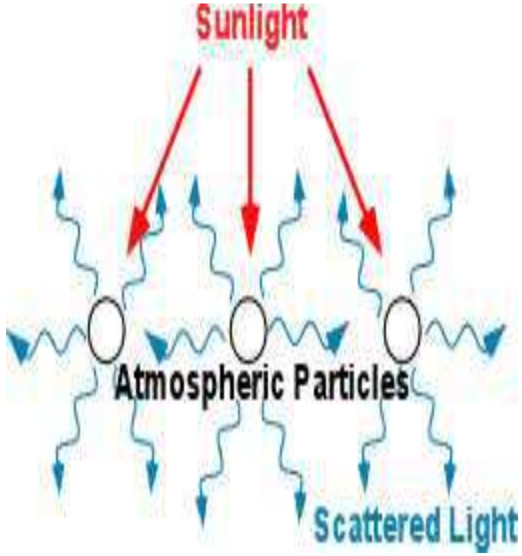
Energy interactions in the atmosphere

- The composition of the atmosphere influences both the incoming solar radiation and the outgoing terrestrial radiation

- The radiance (the energy reflected by the surface) received at a satellite is a result of electromagnetic radiation that undergoes several processes which are wavelength dependent

Scattering

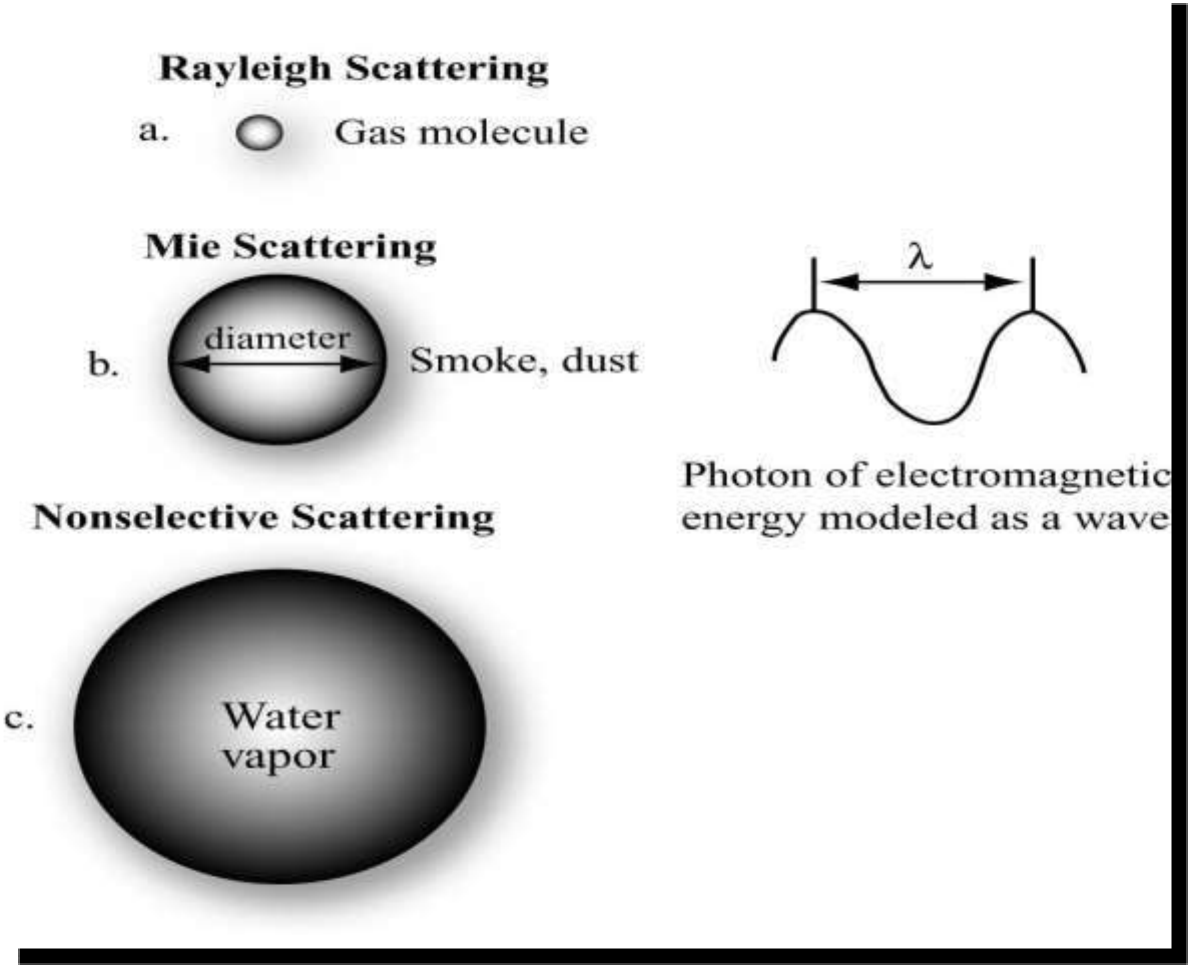
- The redirection of EM energy by particles suspended in the atmosphere or large molecules of atmospheric gases
- Scatter differs from reflection in that the direction associated with scattering is unpredictable, whereas the direction of reflection is predictable
- Type of scattering is a function of:
  - the wavelength of the incident radiant energy, and
  - the size of the gas molecule, dust particle, and/or water vapor droplet encountered.



Scattering

- Types of scattering
  - Rayleigh scattering
  - Mie scattering
  - Nonselective scattering

Atmospheric scattering



Rayleigh scattering

- It occurs when atmospheric particles' diameters are much smaller than the wavelength of the radiation d<<l

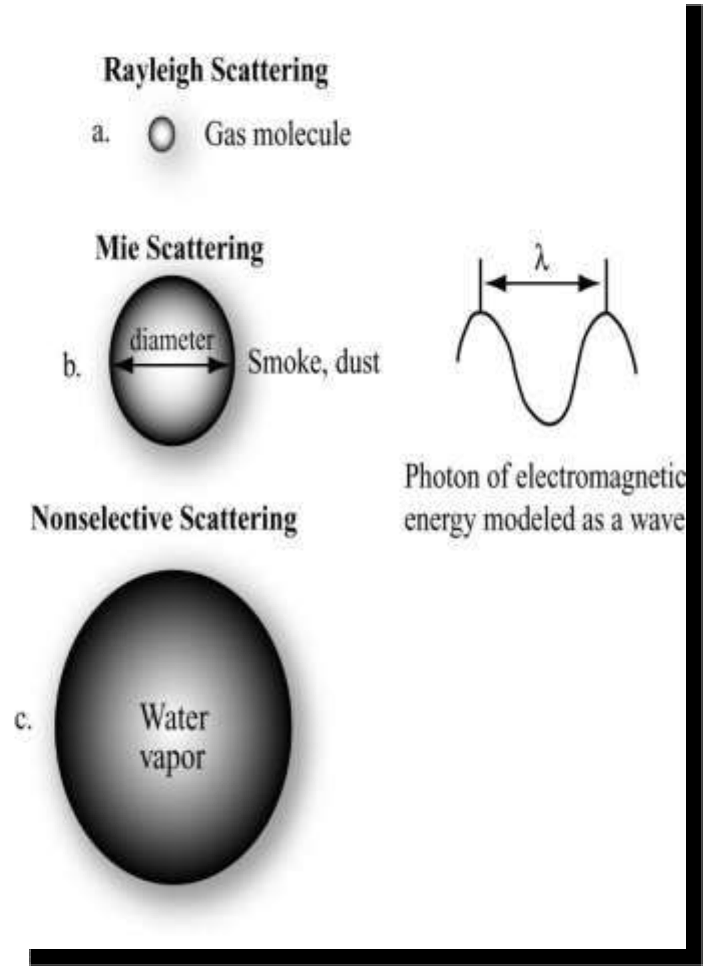
- It is common in the high atmosphere (3-8 km)

- Rayleigh scattering is proportional to the inverse of the wavelength raised to the fourth power: shorter wavelengths are scattered more than longer wavelengths

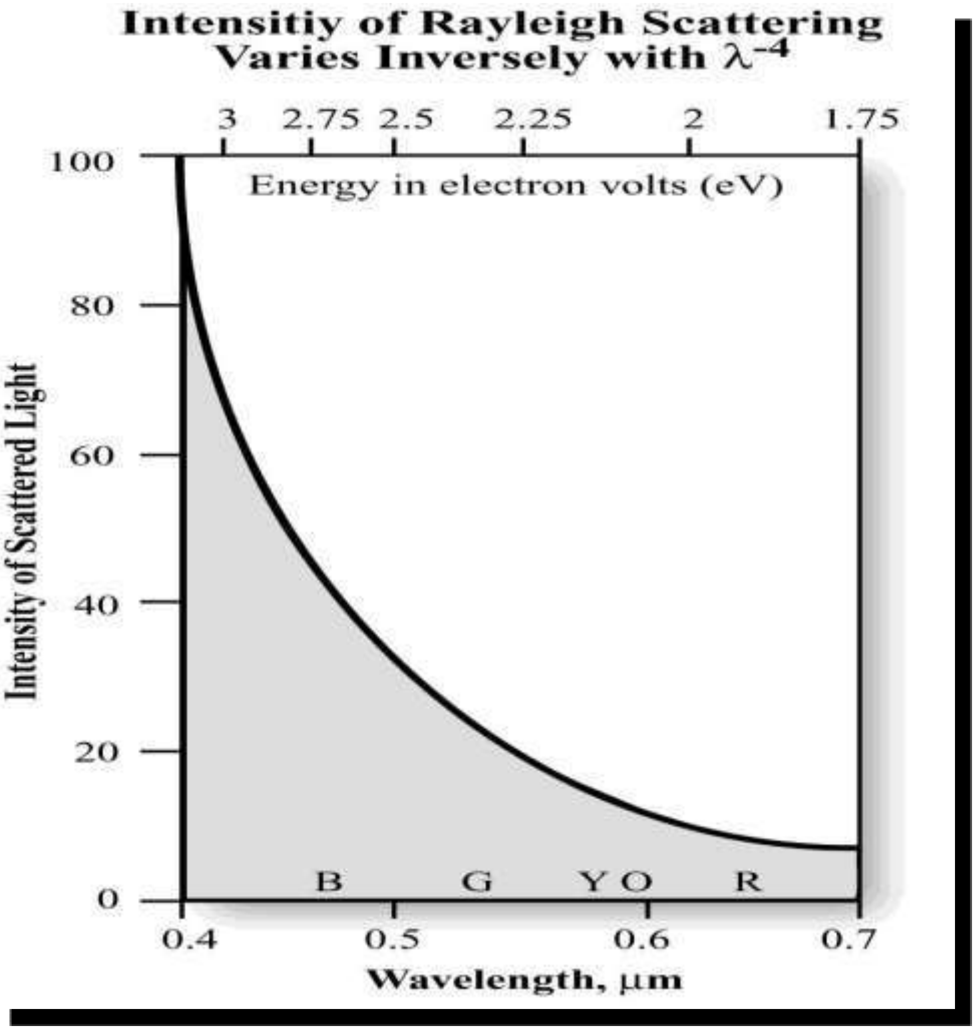
- At daytime, the sun rays travel the shortest distance through the atmosphere- Blue sky

- At sunrise and sunset, the sun travel a longer distance through the Earth‟s atmosphere before they reach the surface- The sky appears orange or red.

- Tends to dominate under most atmospheric conditions



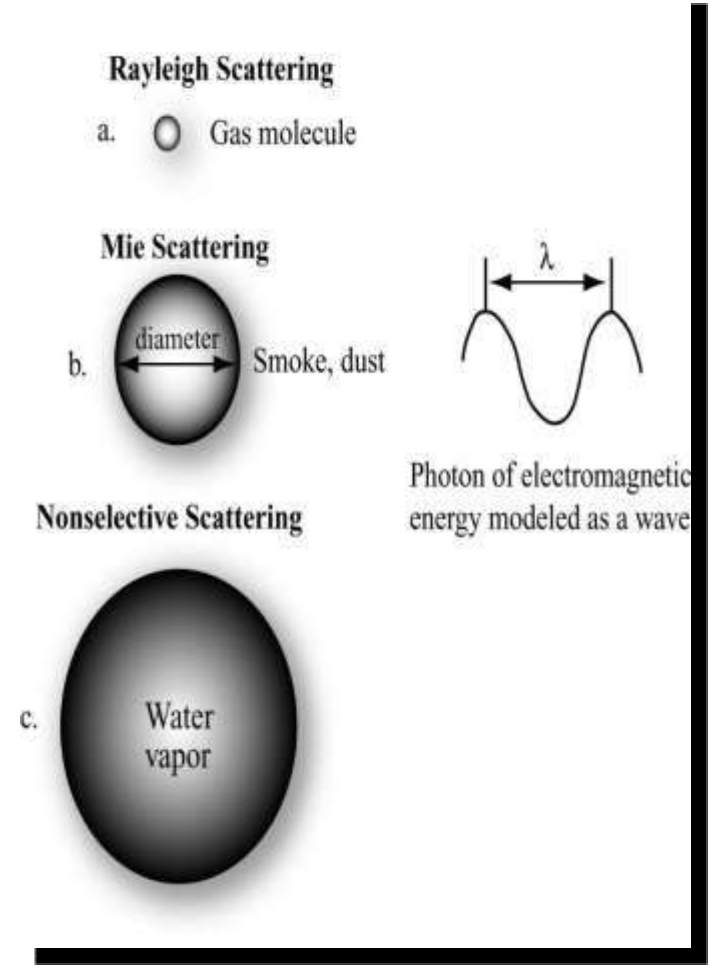
Rayleigh scattering



Mie scattering

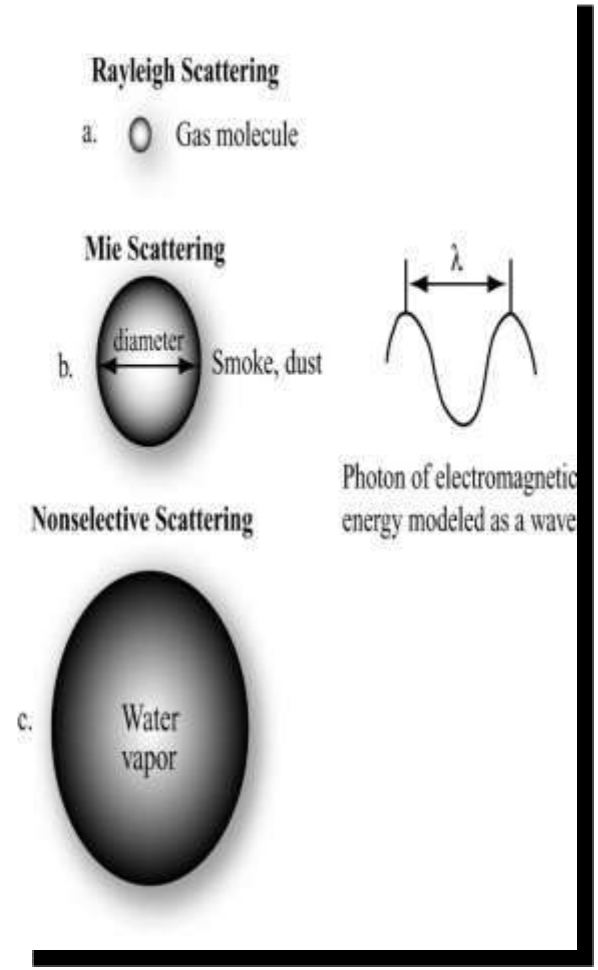
- Particles' diameters are equivalent to the wavelength d ≈ l

- Water vapor and dust are major causes of Mie scattering
- Mie scattering tends to influence longer wavelengths.
- It is common in lower atmosphere where large particles are more abundant, and dominates under overcast could conditions.



Nonselective scattering

- Particles are much larger than the wavelength d>>l
- Water droplets (5-100 μm) and larger dust particles
- Non-selective scattering is independent of wavelength
- All wavelength are scattered equally (A could appears white)
- It scatters all visible and near to mid IR wavelengths.



Absorption

- Absorption is the process by which radiant energy is absorbed and converted into other forms of energy

- The atmosphere prevents, or strongly attenuates, transmission of radiation through the atmosphere

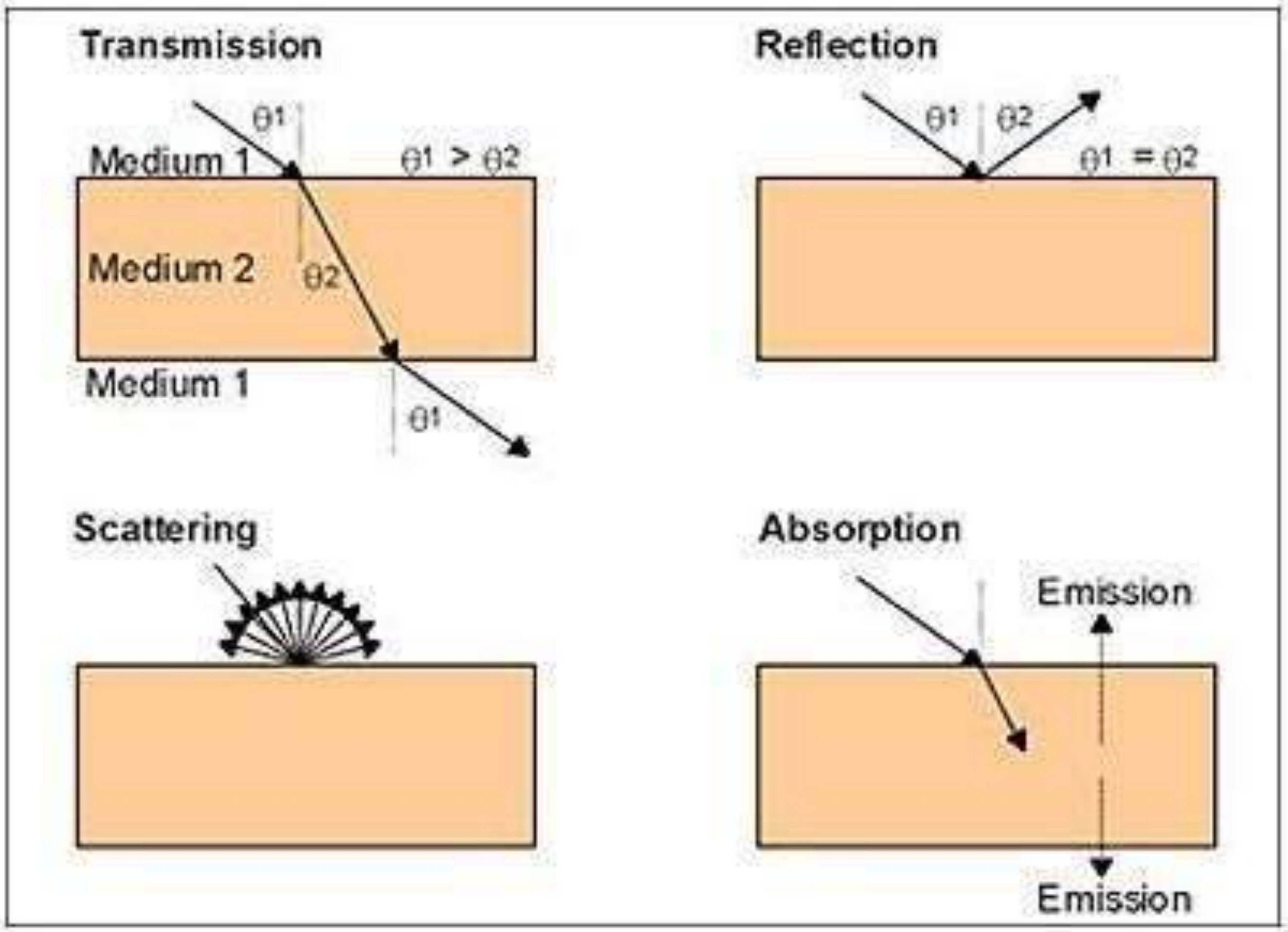
- An absorption band is a range of wavelengths (or frequencies) in the electromagnetic spectrum within which radiant energy is absorbed by substances such as water (H_2O), carbon dioxide (CO_2), oxygen (O_2), ozone (O_3), and nitrous oxide (N_2O).
- Three gases:

- Ozone (O_3): absorbs ultraviolet radiation high in atmosphere

- Carbon-dioxide (CO_2): absorbs mid and far infrared (13-17.5 μm) in lower atmosphere

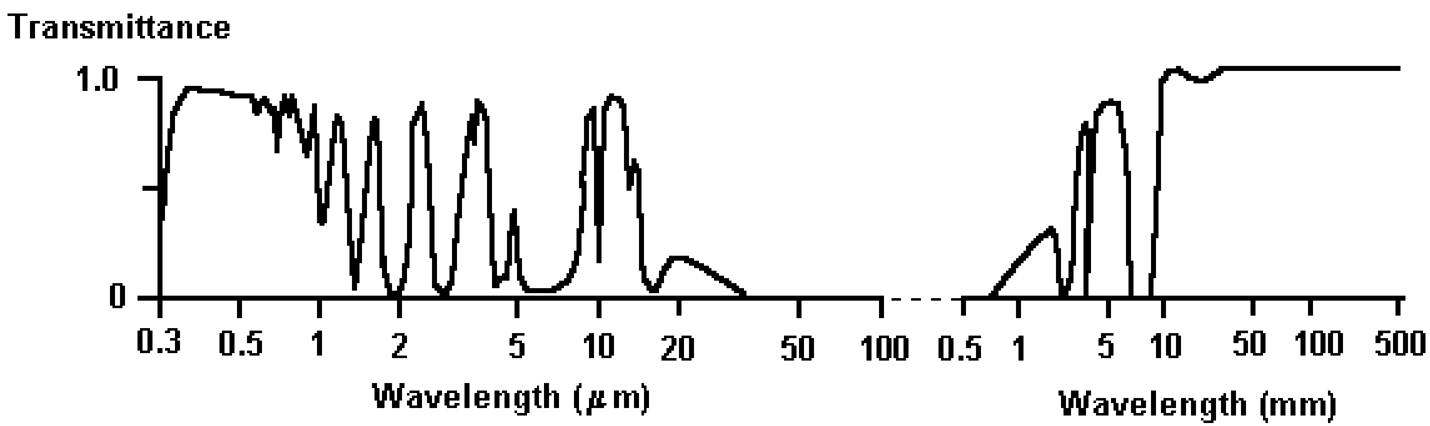
-Water vapor (H_2O): absorbs mid-far infrared (5.5-7.0, >27 μm) in lower atmosphere

Transmission, reflection, scattering, and absorption



Atmospheric windows (transmission bands)

-The wavelength ranges in which the atmosphere is particularly transmissive



Atmospheric Windows

- The windows:
  UV & visible: 0.30-0.75 mm
  Near infrared: 0.77-0.91 mm
  Mid infrared: 1.55-1.75mm, 2.05-2.4 mm
  Far infrared: 3.50-4.10 mm, 8.00- 9.20 mm,
  10.2-12.4 mm
  Microwave: 7.50-11.5 mm, 20.0+mm
- X-Rays and UV are very strongly absorbed and Gamma Rays and IR are somewhat less strongly absorbed.
- The atmospheric windows are important for RS sensor design

Energy Interactions with Earth Surface Features

Reflection, absorption, and transmission

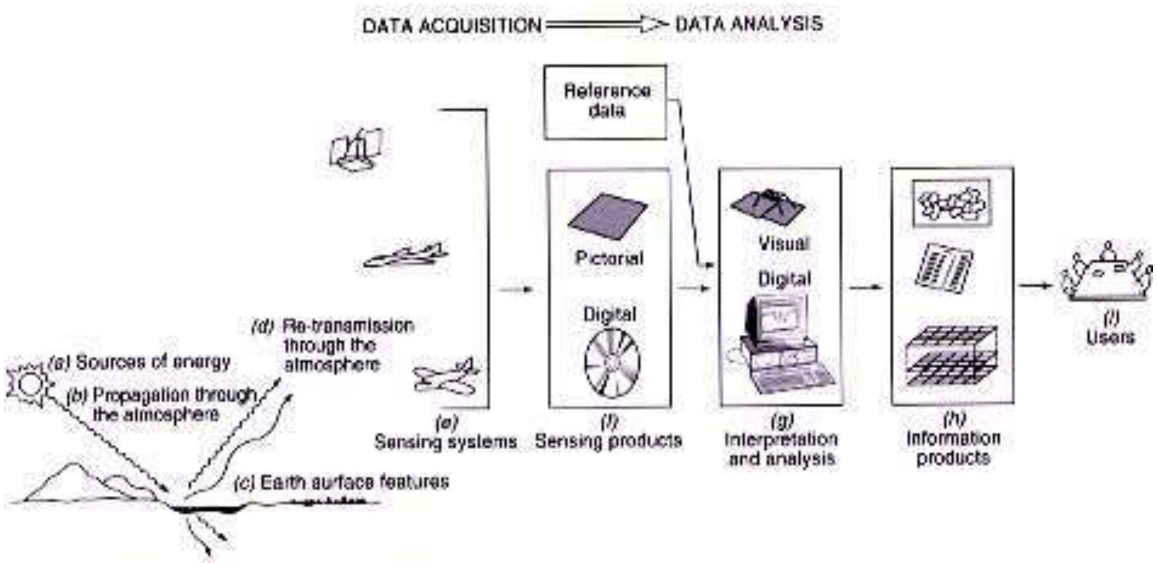
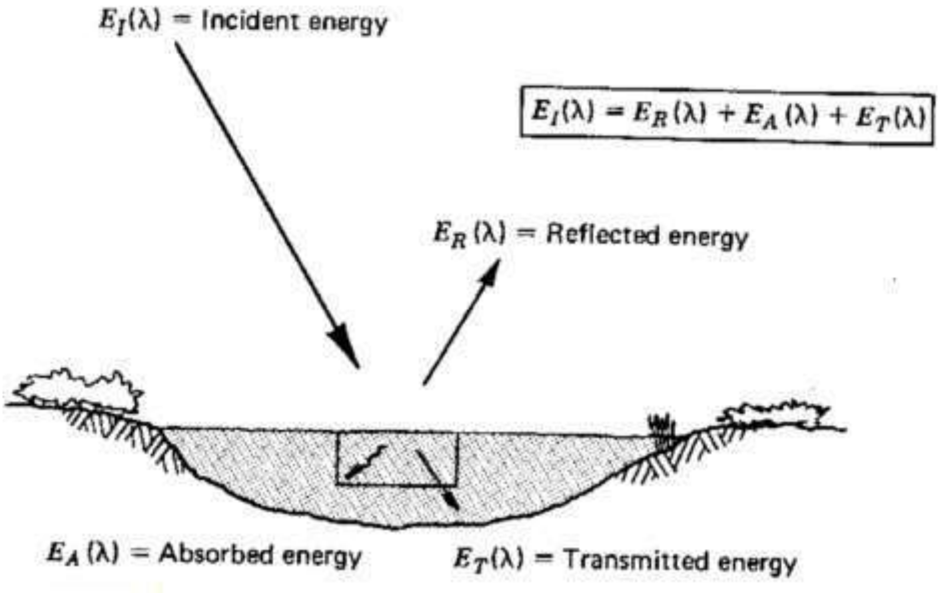


Figure 1.1 Electromagnetic remote sensing of earth resources.

Energy Interactions with Earth Surface Features

- All EM energy reaches earth's surface must be reflected, absorbed, or transmitted
- The proportion of each depends on:
  - the spectral reflectance properties of the surface materials
  - the surface smoothness relative to the radiation wavelength
  - wavelength
  - angle of illumination

Energy Interactions with Earth Surface Features



Energy Interactions with Earth Surface Features

- Light ray is redirected as it strikes a nontransparent surface
- Albedo - Spectral reflectance R (λ): the average amount of incident radiation reflected by an object at some wavelength interval

$$R(\lambda) = ER(\lambda) / EI(\lambda) \times 100$$

Where

$ER(\lambda)$ = reflected radiant energy

$EI(\lambda)$ = incident radiant energy

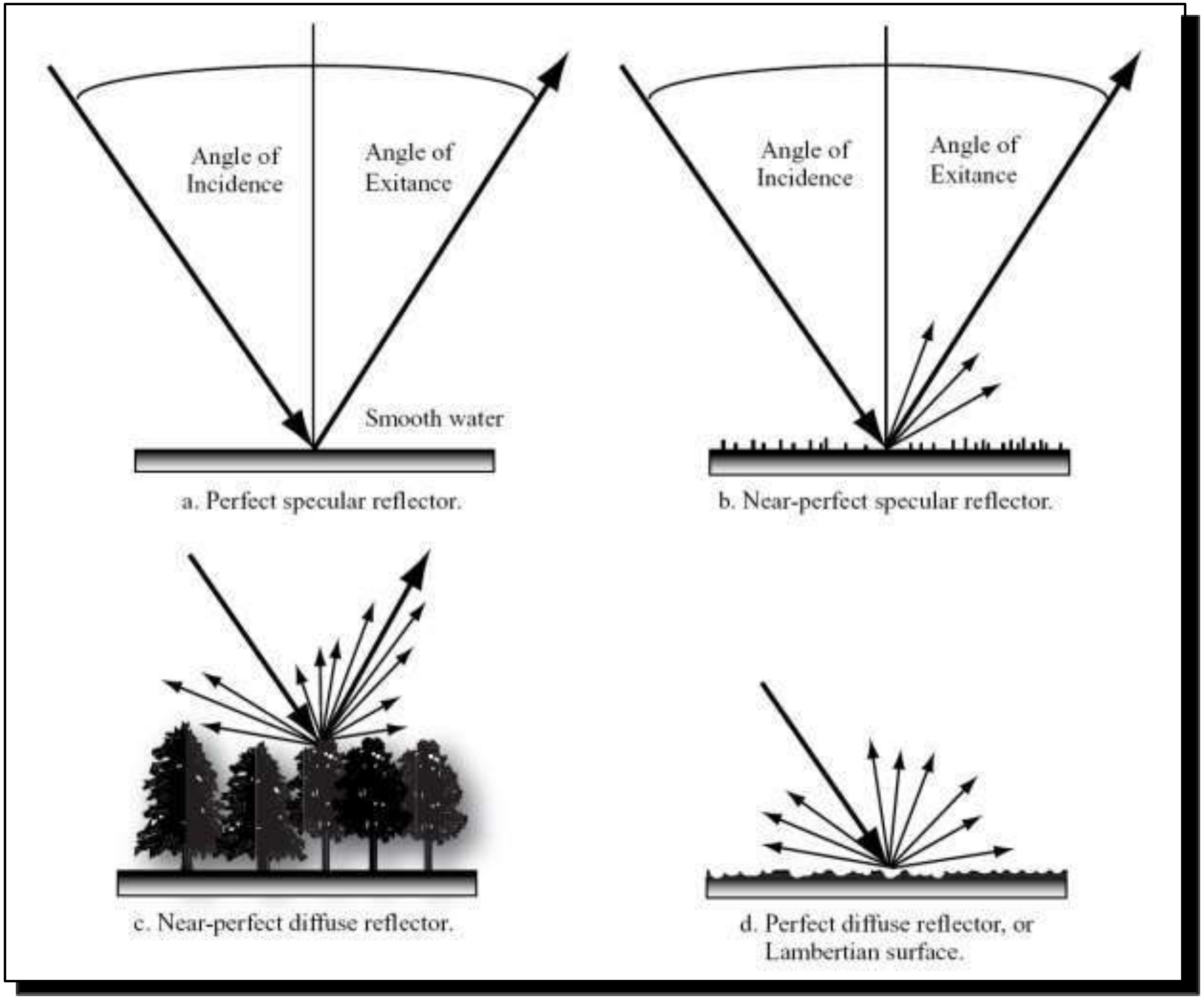
Specular versus diffuse reflectance

- Specular reflectors are flat surfaces that manifest mirrolike reflections. The angle of reflection equals the angle of incident.

- Diffuse (or Lambertian) reflectors are rough surfaces that reflect uniformly in all the directions
  - If the surface is rough, the reflected rays go in many directions, depending on the orientation of the smaller reflecting surfaces
- Diffuse contain spectral information on the color of the reflecting surface, whereas specular reflections do not.

- In remote sensing we are often interested in measuring the diffuse reflectance of objects.

Specular versus diffuse reflectance



Transmission

- Radiation passes through a substance without significant attenuation

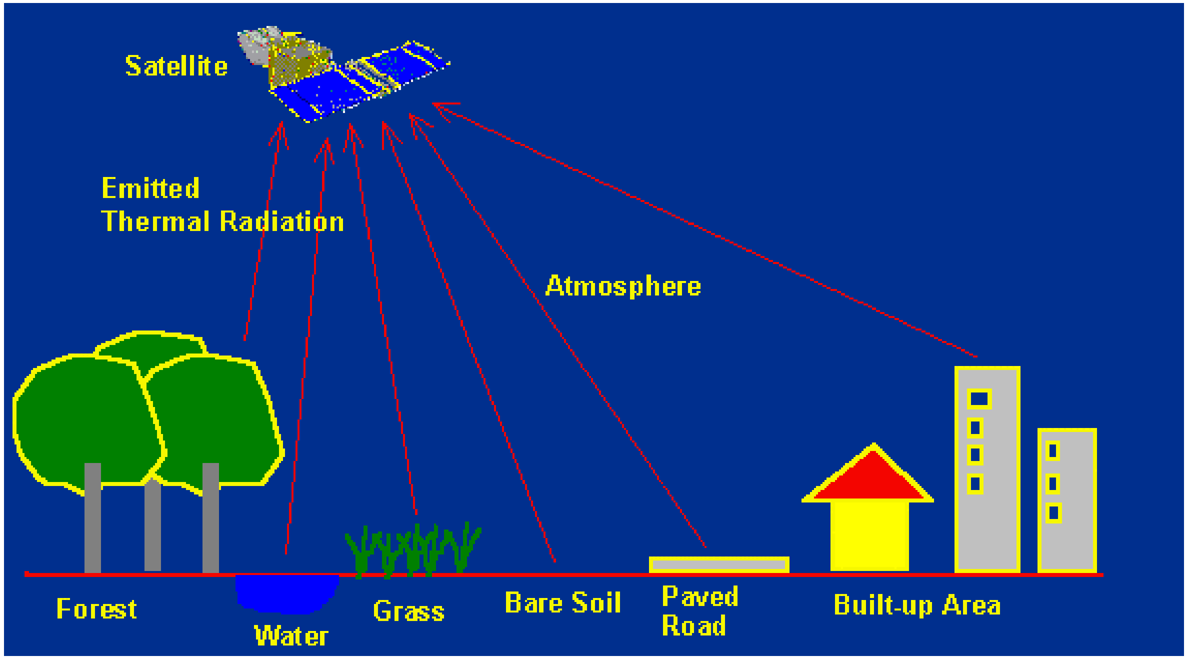
- Transmittance (t):

$$t = \frac{\text{transmitted radiation}}{\text{incident radiation}}$$

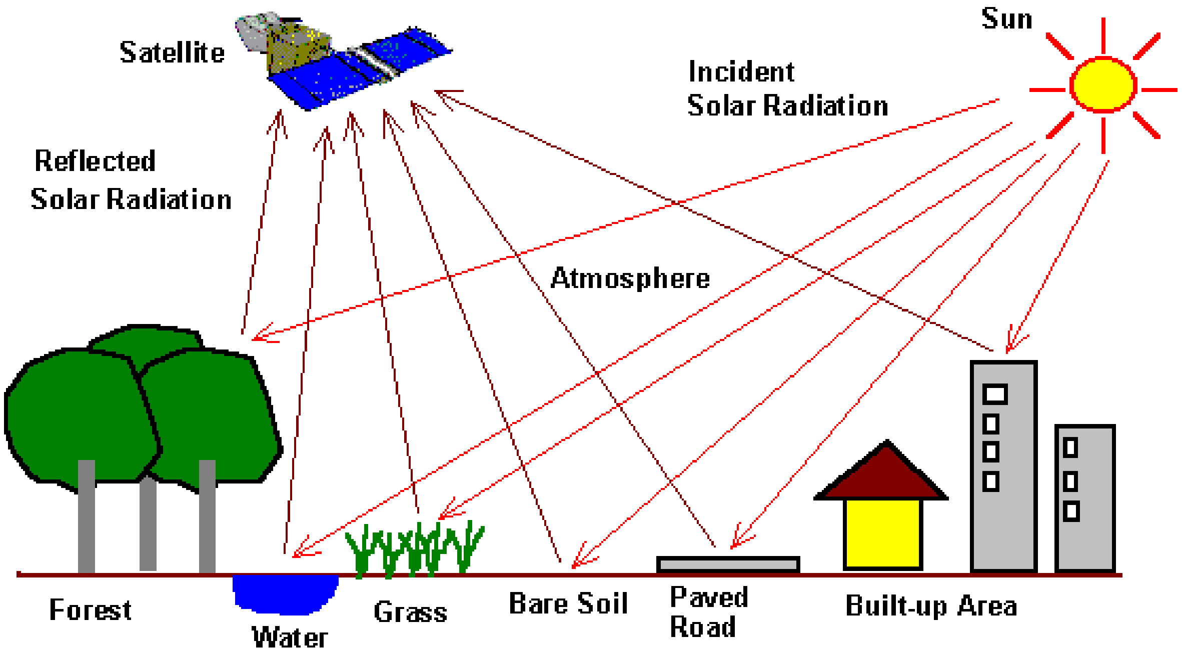
Absorption

Reflection + Transmission + Absorption = 100%

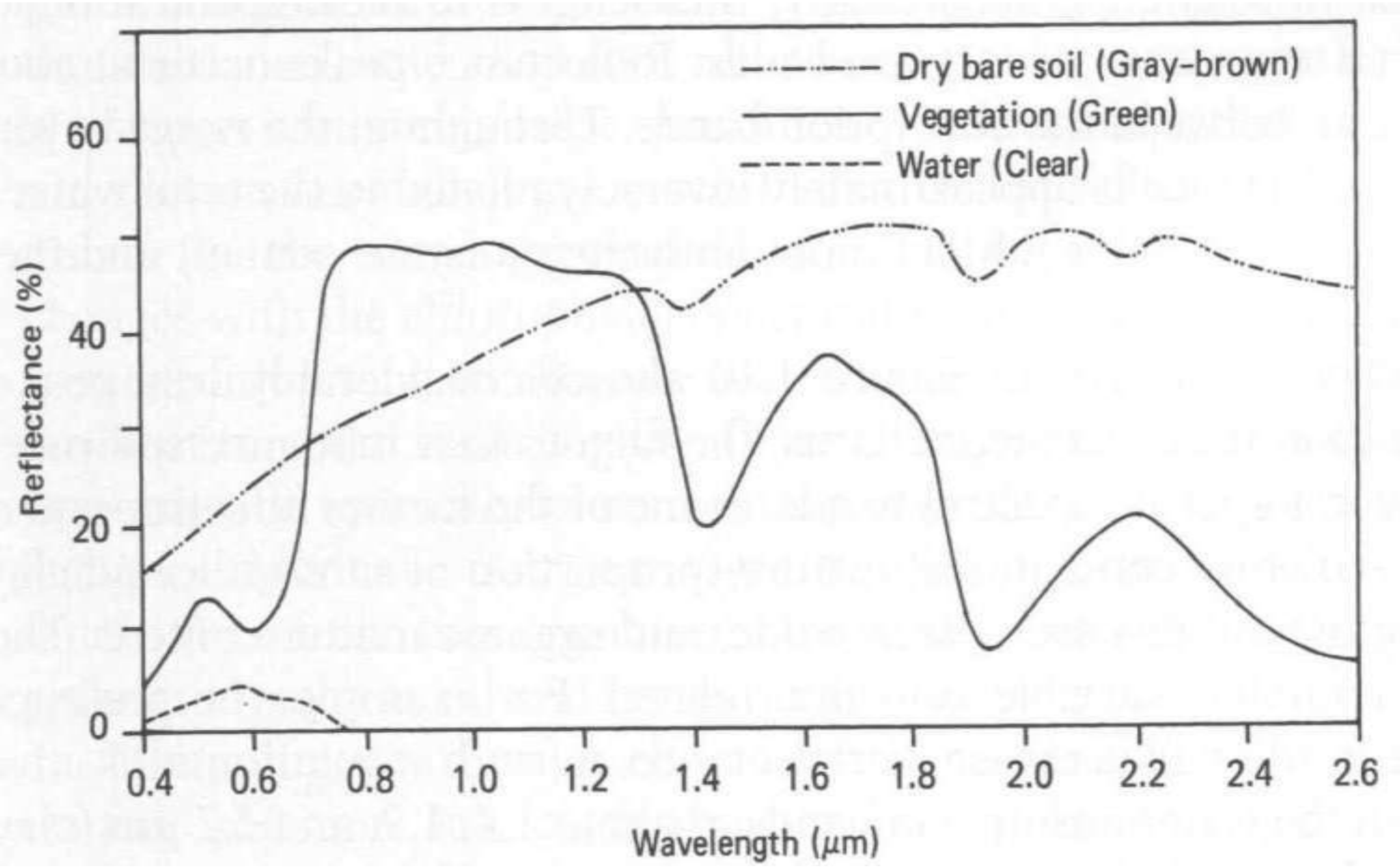
Emission


Satellite
Emitted
Thermal Radiation
Atmosphere
Forest
Water
Grass
Bare Soil
Paved
Road
Built-up Area

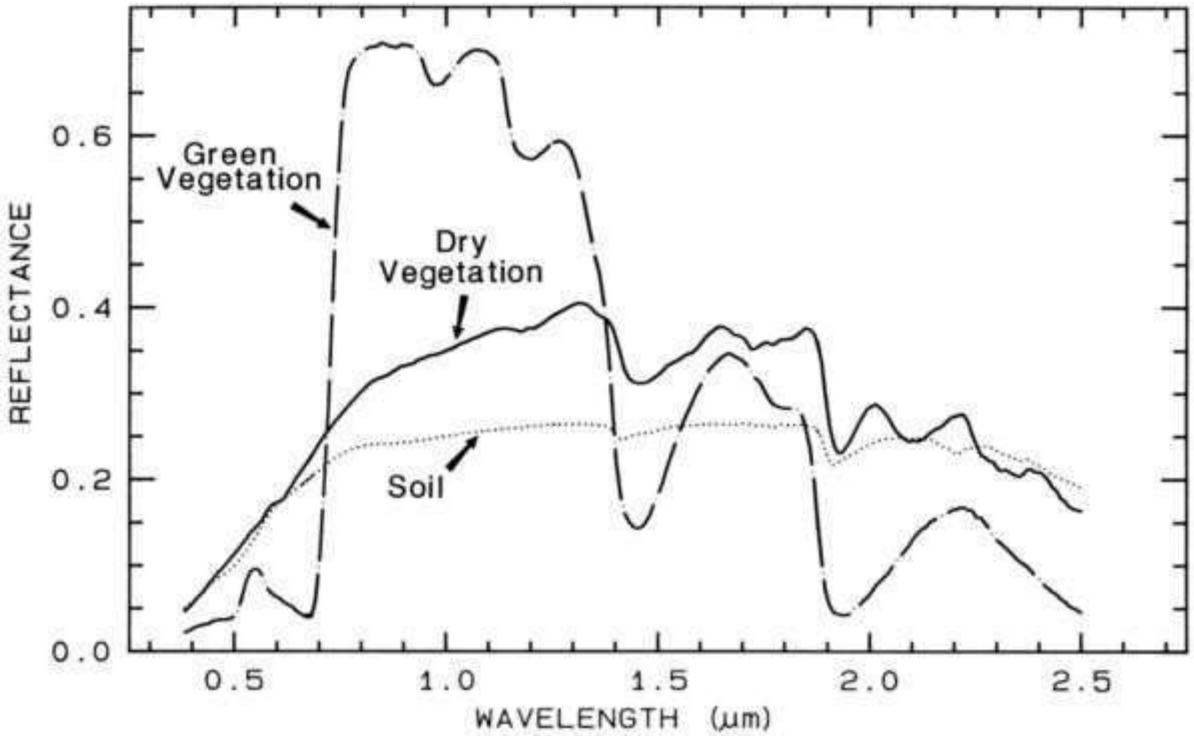
Spectral Characteristics of Features



Spectral reflectance curves for vegetation, soil, and water

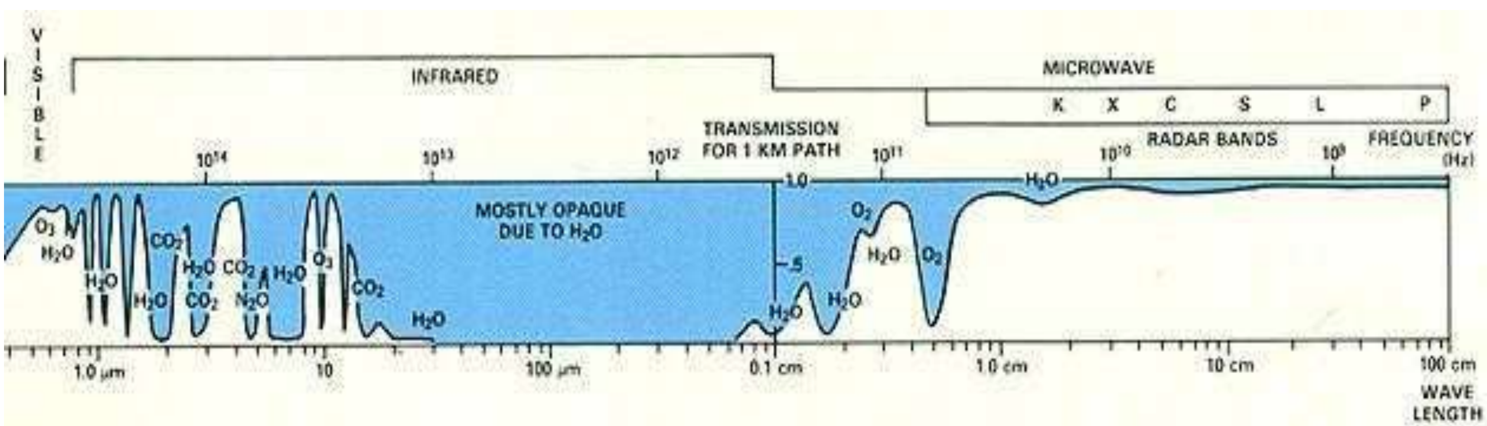


Identification of Surface Materials Based on Spectral Reflectance

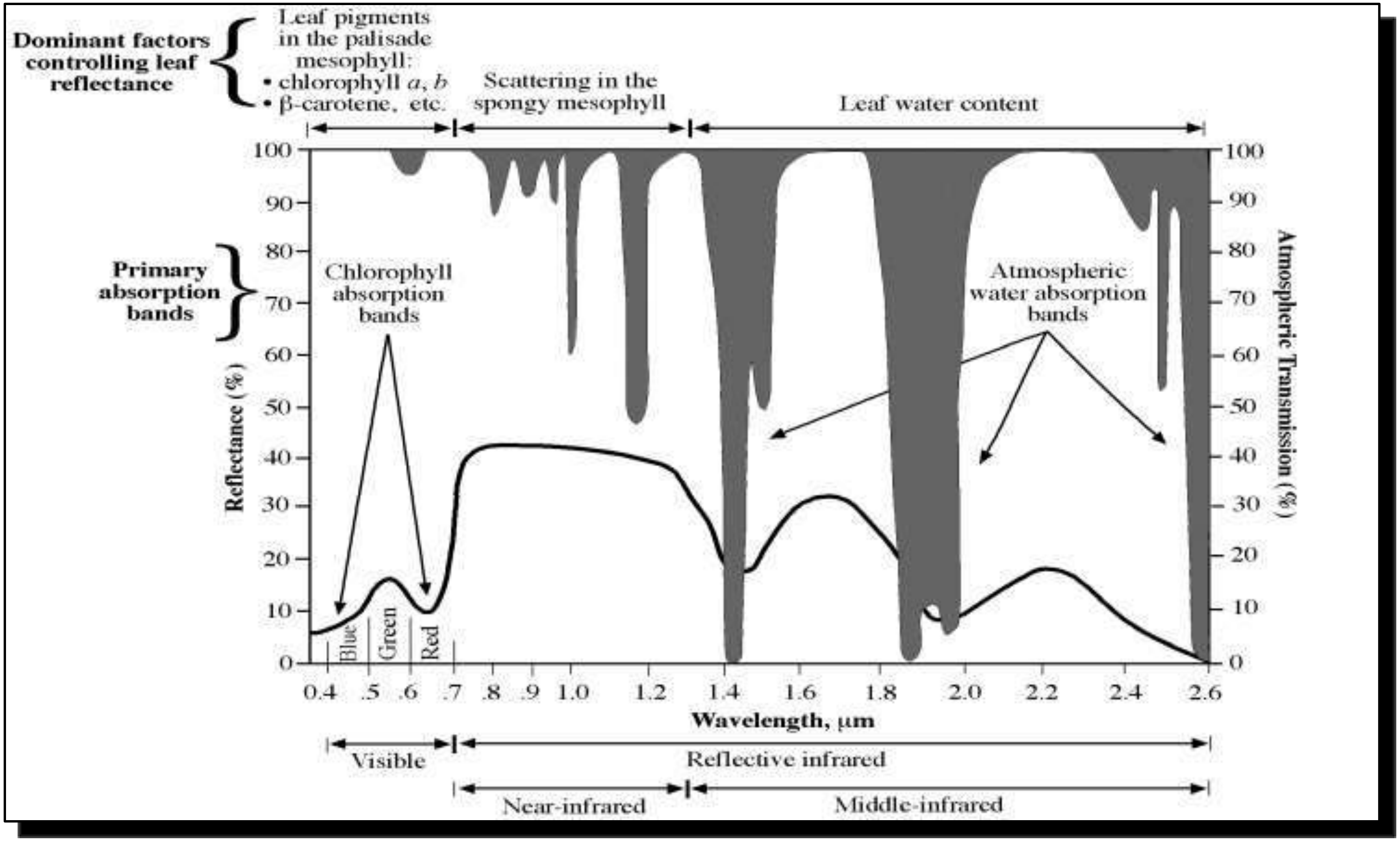


Spectra of vegetation

- Chlorophyll absorbs blue and red, reflects green
- Vegetation has a high reflection and transmission at NIR wavelength range
- Reflection or absorption at MIR range, the water absorption bands



Spectra of vegetation



Absorption is dominant process in **visible**
Scattering is dominant process in **near infrared**
Water absorption is increasingly important with increasing wavelength in the infrared.

Spectra of soil

- What are the important properties of a soil in an RS image

  -Soil texture (proportion of sand/silt/clay)

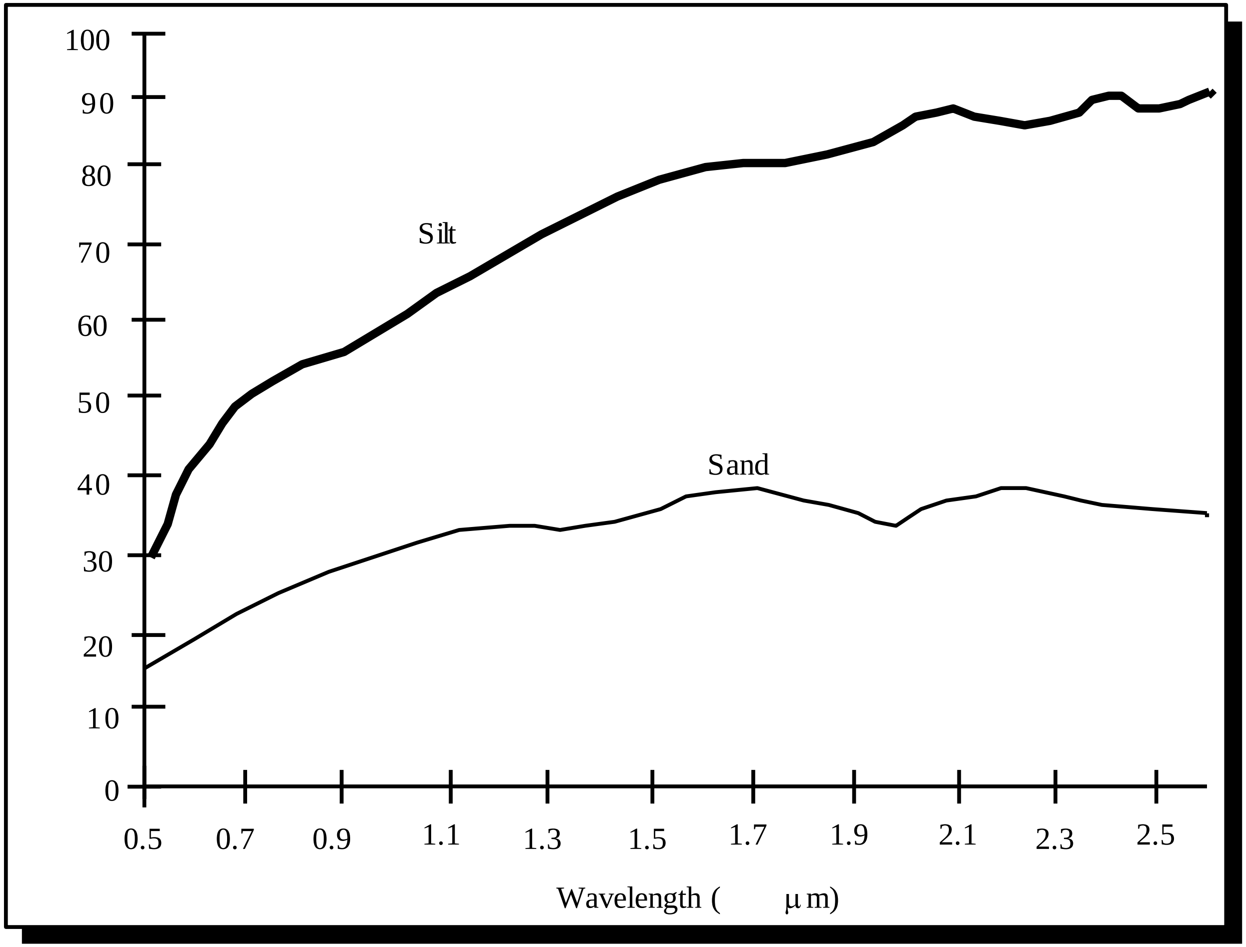
  -Soil moisture content

  -Organic matter content

  -Mineral contents, including iron-oxide and carbonates

  -Surface roughness

Dry soil spectrum

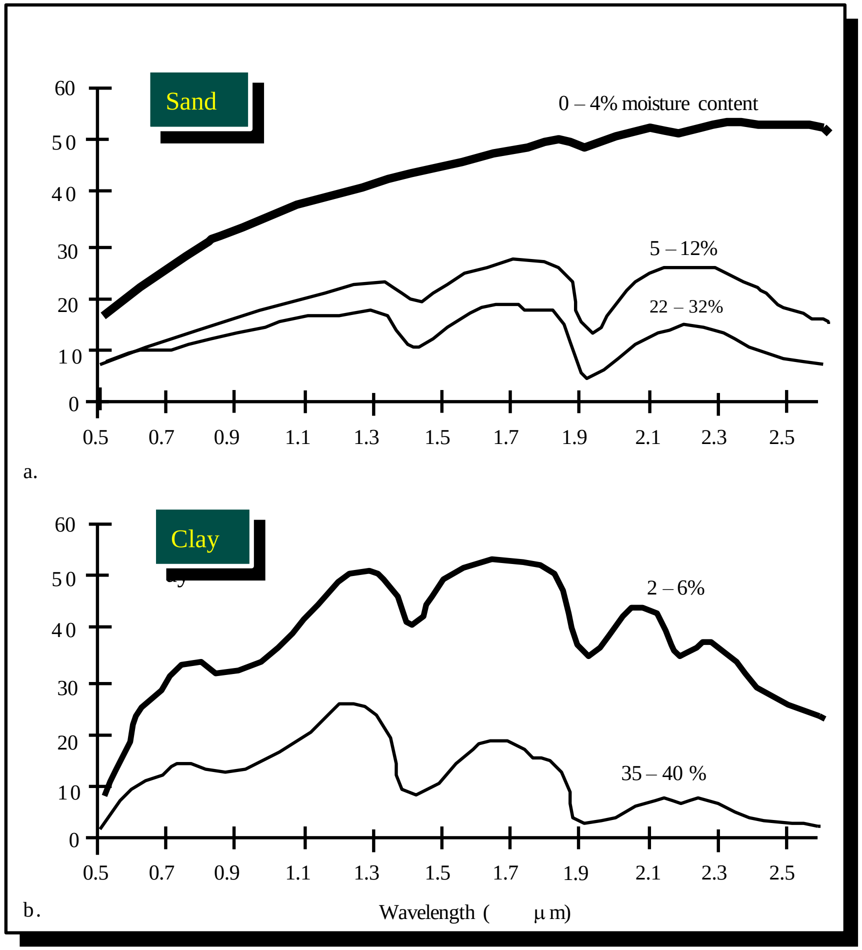


- **Coarse soil (dry) has relatively high reflectance**
- **Increasing reflectance with increasing wavelength through the visible, near and mid infrared portions of the spectrum**

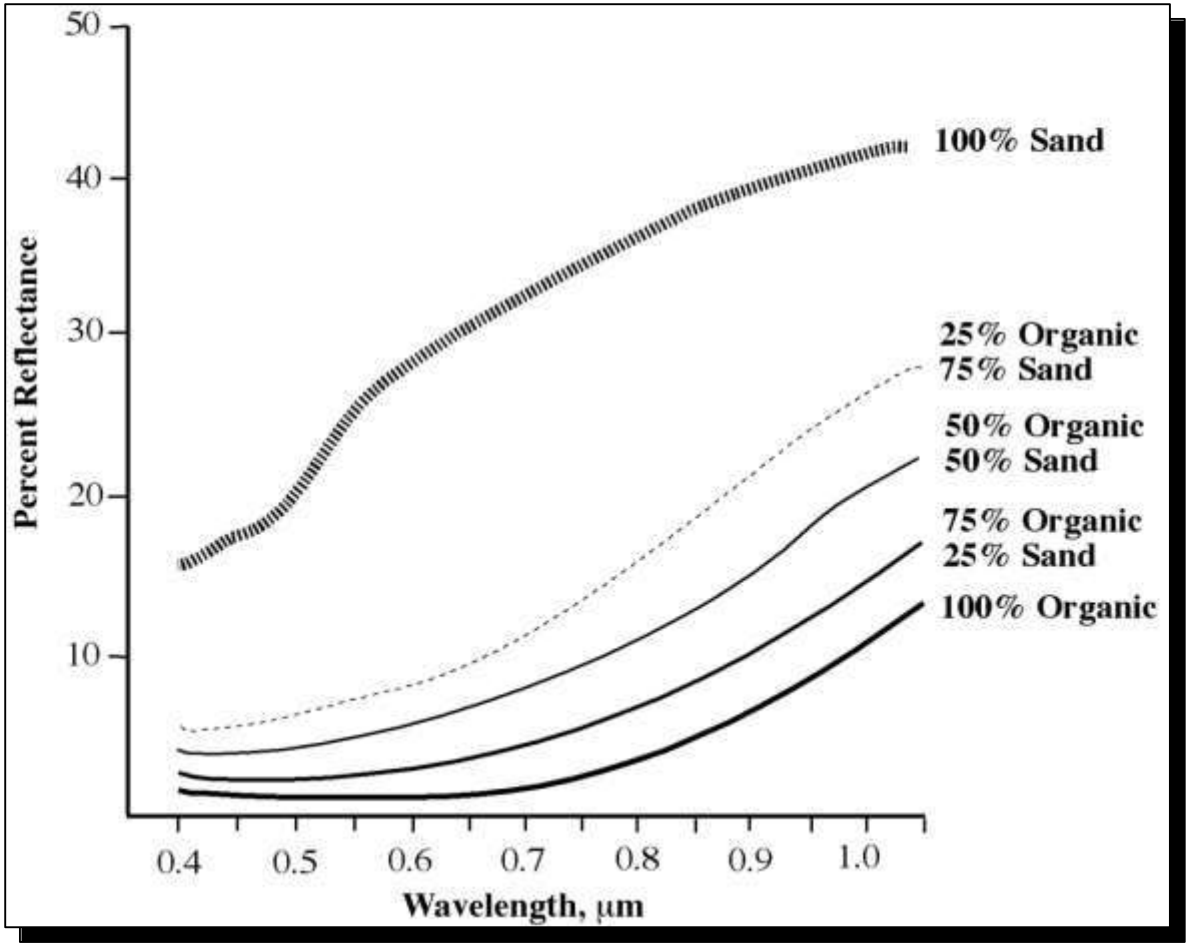
Soil moisture and texture

- Soil moisture decreases reflectance
- Clays hold more water more „tightly‟ than sand.
- Thus, clay spectra display more prominent water absorption bands than sand spectra

Soil moisture and texture

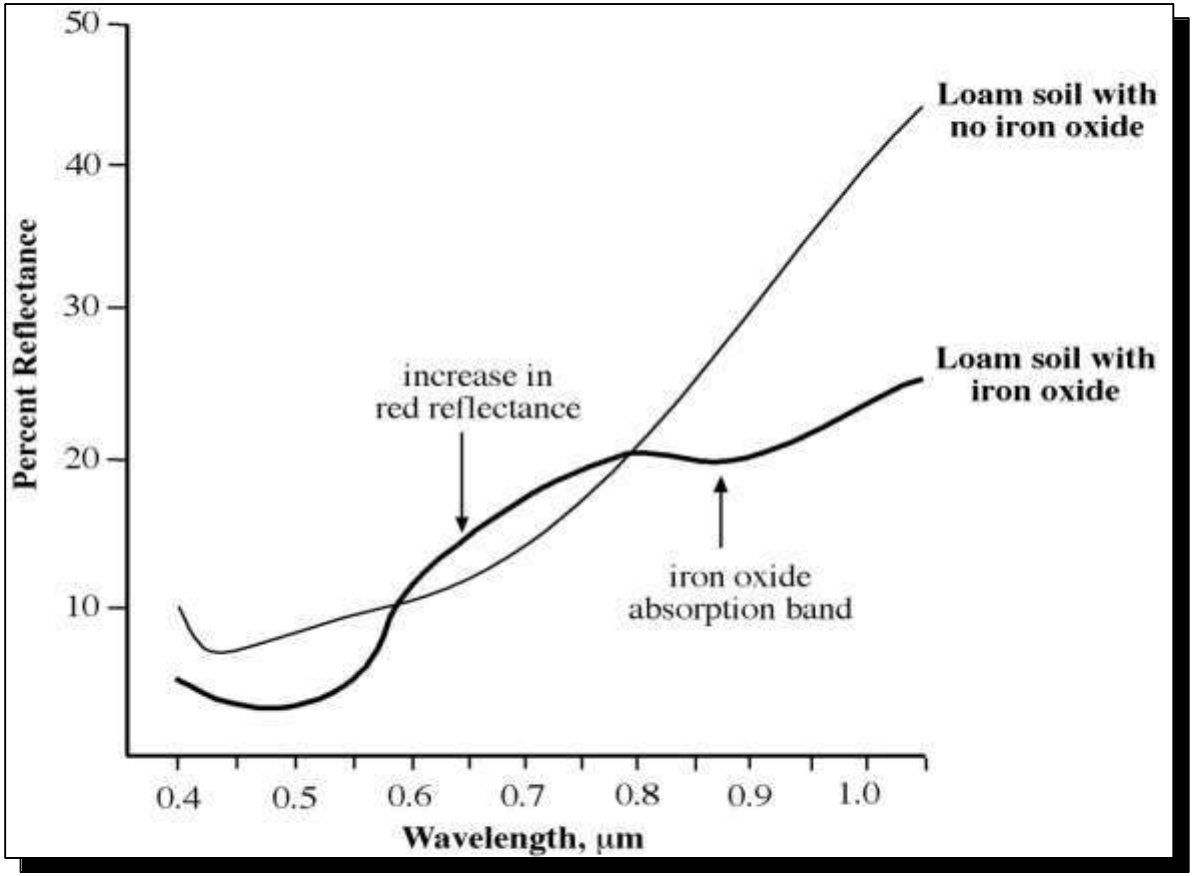


Soil Organic Matter



Organic matter is a strong absorber of EMR, so more organic matter leads to darker soils (lower reflectance curves).

Iron Oxide



Recall that iron oxide causes a charge transfer absorption in the UV, blue and green wavelengths, and a crystal field absorption in the NIR (850 to 900 nm). Also, scattering in the red is higher than soils without iron oxide, leading to a red color.

Surface Roughness

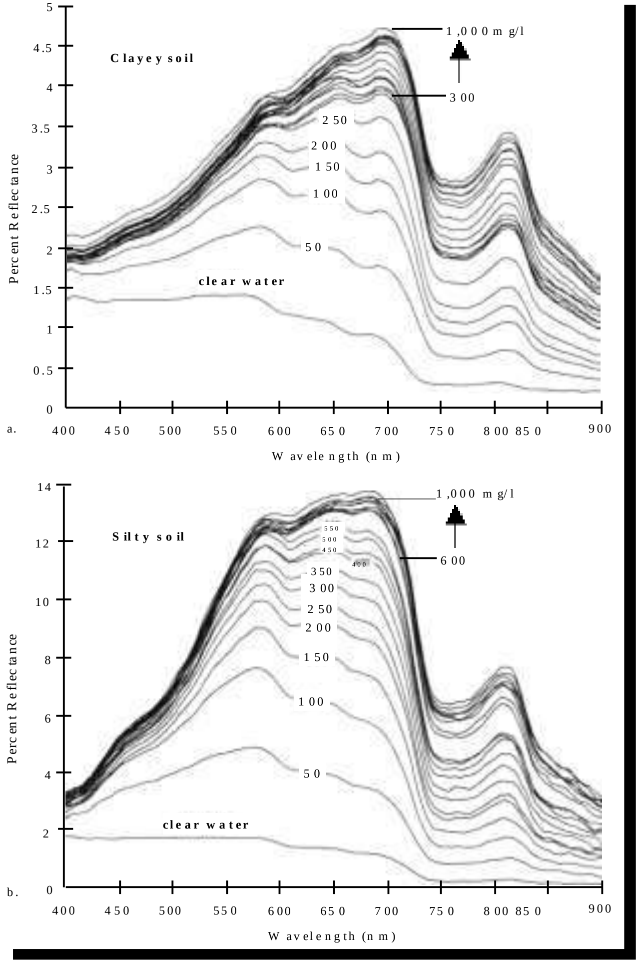
- Smooth surface appears black.
- Smooth soil surfaces tend to be clayey or silty, often are moist and may contain strong absorbers such as organic content and iron oxide.
- Rough surface scatters EMR and thus appears bright.

Spectra of water

- Transmission at visible bands and a strong absorptionat NIR bands

- Water surface, suspended material, and bottom of water body can affect the spectral response

Spectra of water



Reflectance peak shifts toward longer wavelengths as more suspended sediment is added

UNIT-3

FUNDAMENTALS OF

GEOGRAPHIC INFORMATION SYSTEMS

Mapping Concepts, Features & Properties

A map represents

- Geographic features or other spatial phenomena by graphically conveying information about locations and attributes.
- Locational information describes the position of particular geographic features on the Earth's surface, as well as the spatial relationship between features,
- Attribute information describes characteristics of the geographic features represented, such as the feature type, its name or number and quantitative information

- Thus the basic objective of mapping is to provide
  - descriptions of geographic phenomenon
  - spatial and non spatial information

Geomatics, also known as Geoinformatics, is the science and technology of : gathering, analyzing, interpreting, distributing and using geographic information.

Geomatics encompasses a broad range of disciplines including surveying and mapping,, geographic information systems (GIS), and the GPS.

Geographic information systems are among the most exciting and powerful geo matics decision-making tools in the world.

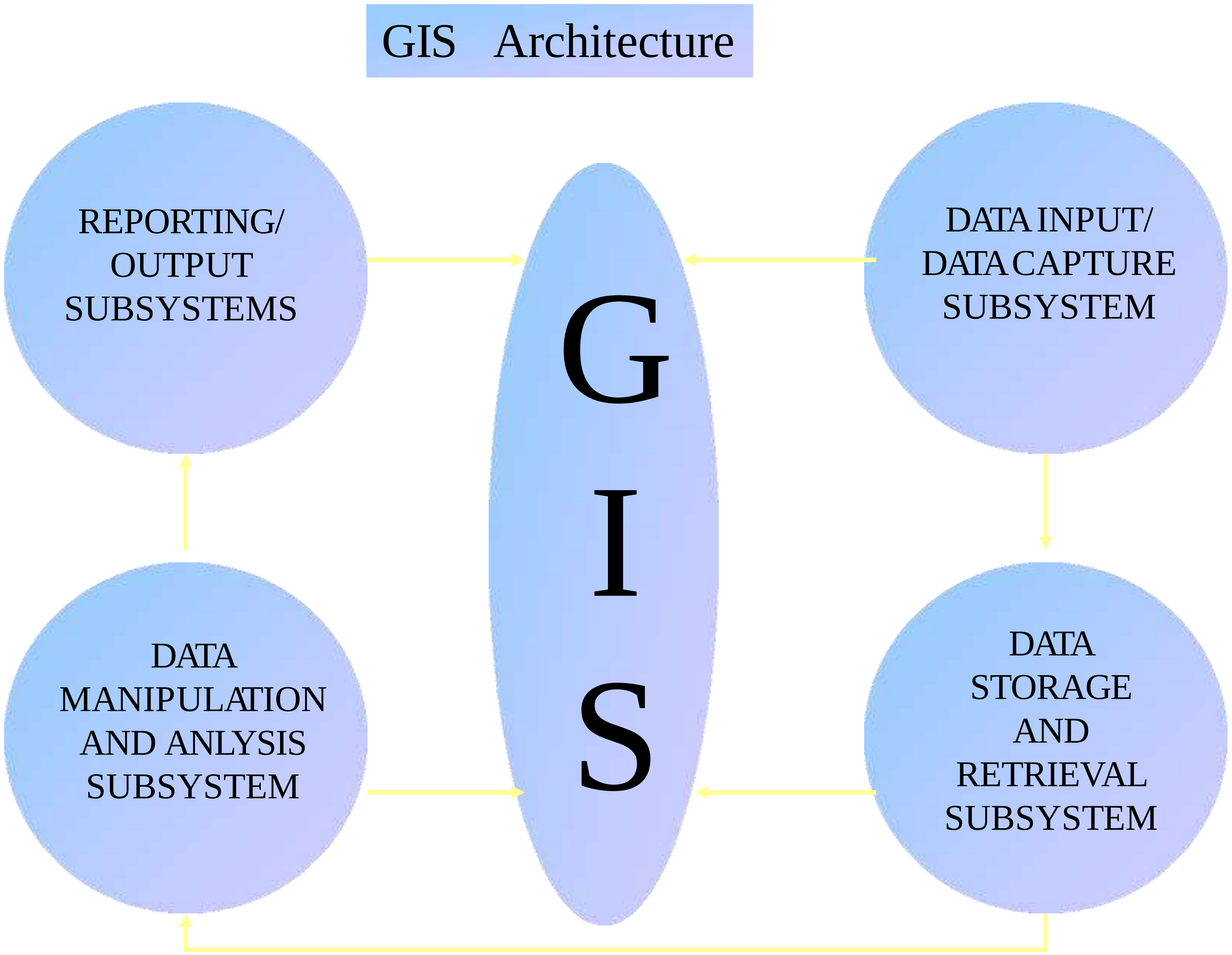
A GIS uses computer technology to integrate, manipulate and display a wide range of information to create a picture of an area's geography, environment and socio-economic characteristics.

Definition of GIS

An organized collection of computer hardware, software, Geographical data and personnel designed to efficiently capture, store, update, manipulate, analyze & display all forms of Geographically referenced information is called GIS.

Application areas of GIS

- Agricultural applications
- Forestry applications
- Rangeland applications
- Water resources applications
- Urban and regional planning applications
- Wetland mapping
- Land use/ Land cover mapping
- Geologic and soil mapping
- Wildlife ecology applications
- Archaeological applications
- Environmental assessment, monitoring and management


GIS Architecture
REPORTING/ OUTPUT SUBSYSTEMS
DATA INPUT/ DATA CAPTURE SUBSYSTEM
G I S
DATA MANIPULATION AND ANLYSIS SUBSYSTEM
DATA STORAGE AND RETRIEVAL SUBSYSTEM

DATA INPUT/DATA CAPTURE SUBSYSTEM →

- Key board entry
- Manual Digitizing
- Scanning and automatic digitizing

DATA STORAGE AND RETRIEVAL SUBSYSTEM →

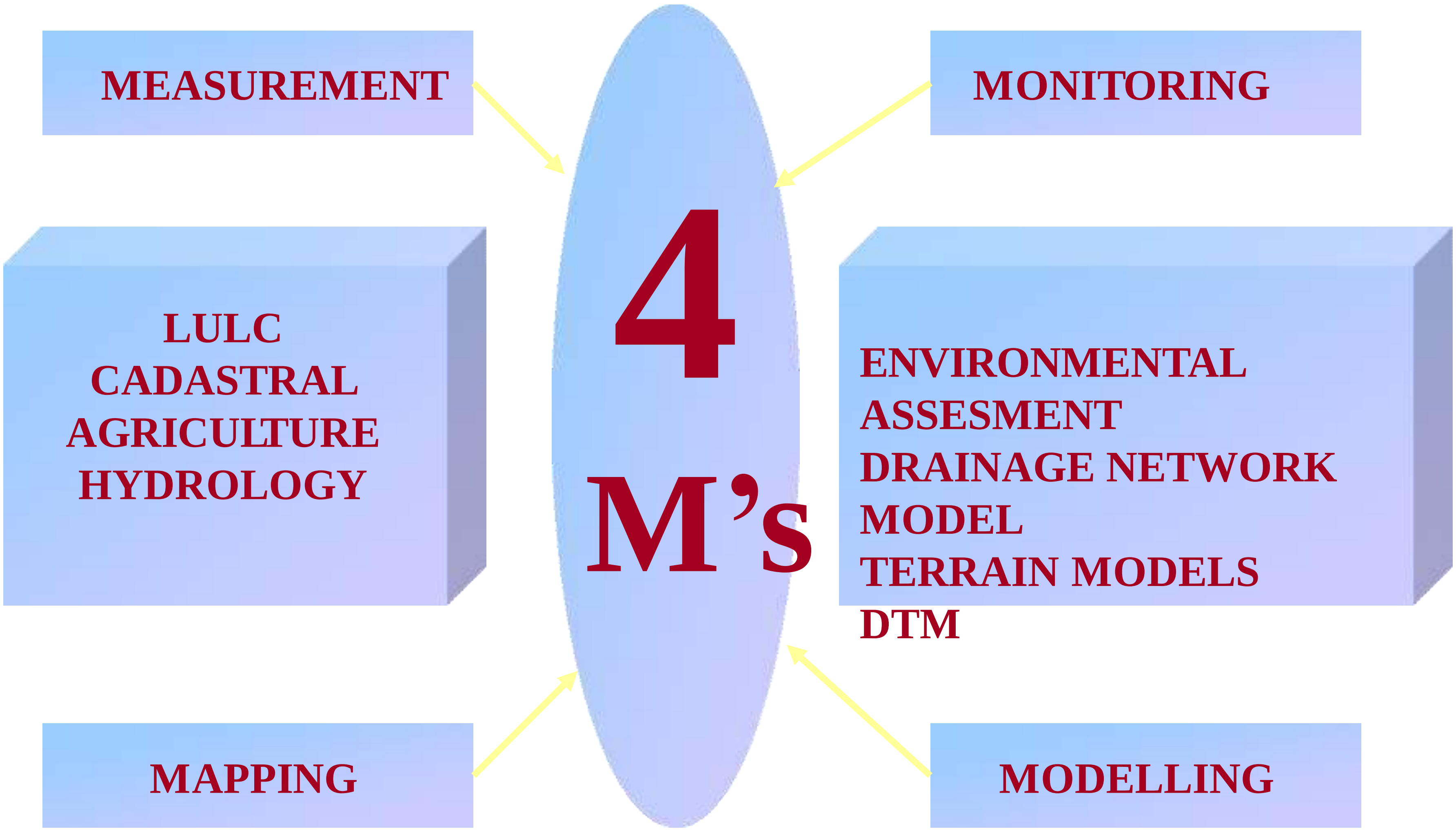
- DBMS

DATA MANIPULATION AND ANLYSIS SUBSYSTEM →

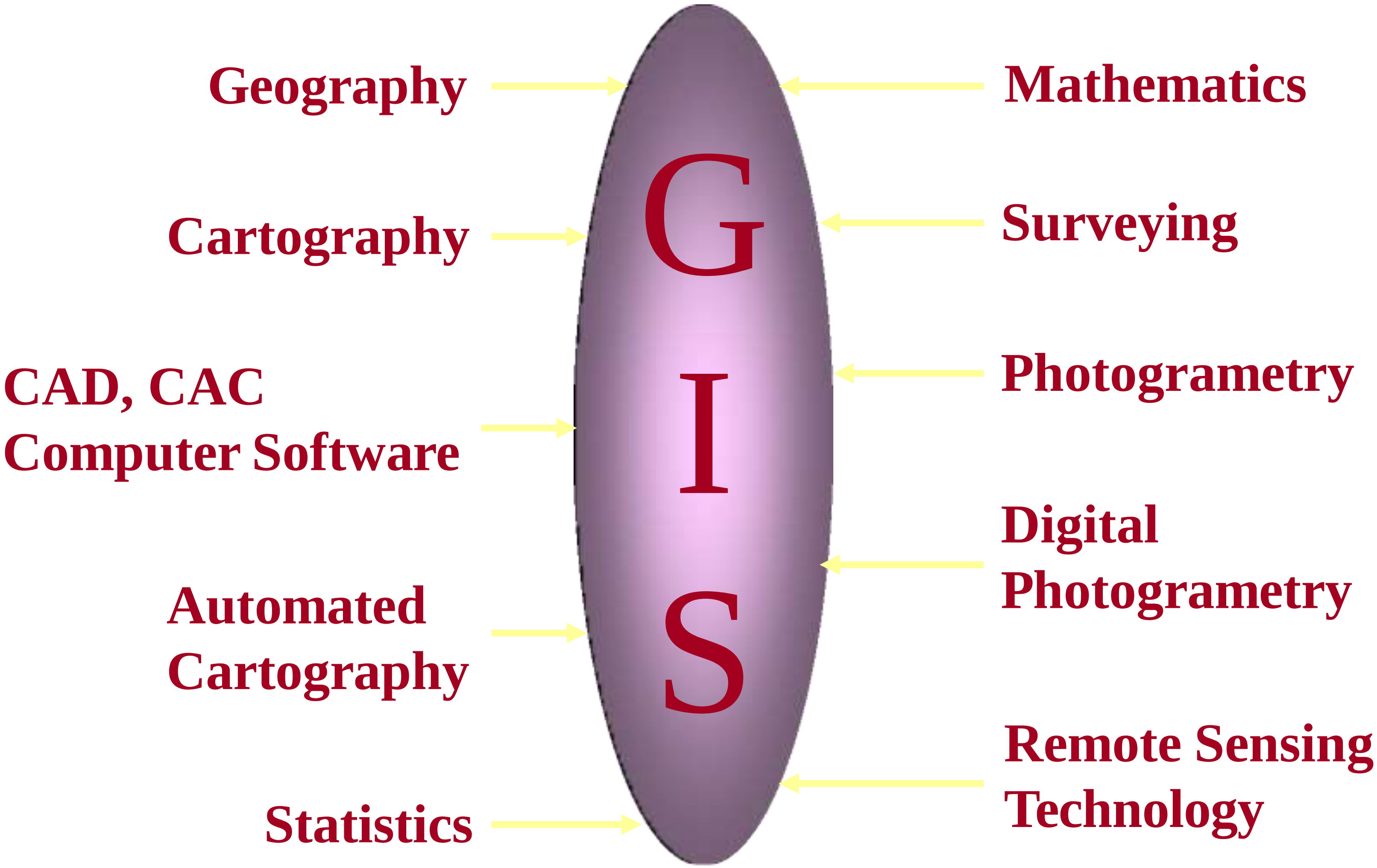
- Format conversion
- Data medium conversion
- Spatial measurements
- Reclassification
- Buffering
- Overlay
- Modelling surfaces

REPORTING/ OUTPUT SUBSYSTEMS →

- Maps
- Graphical outputs

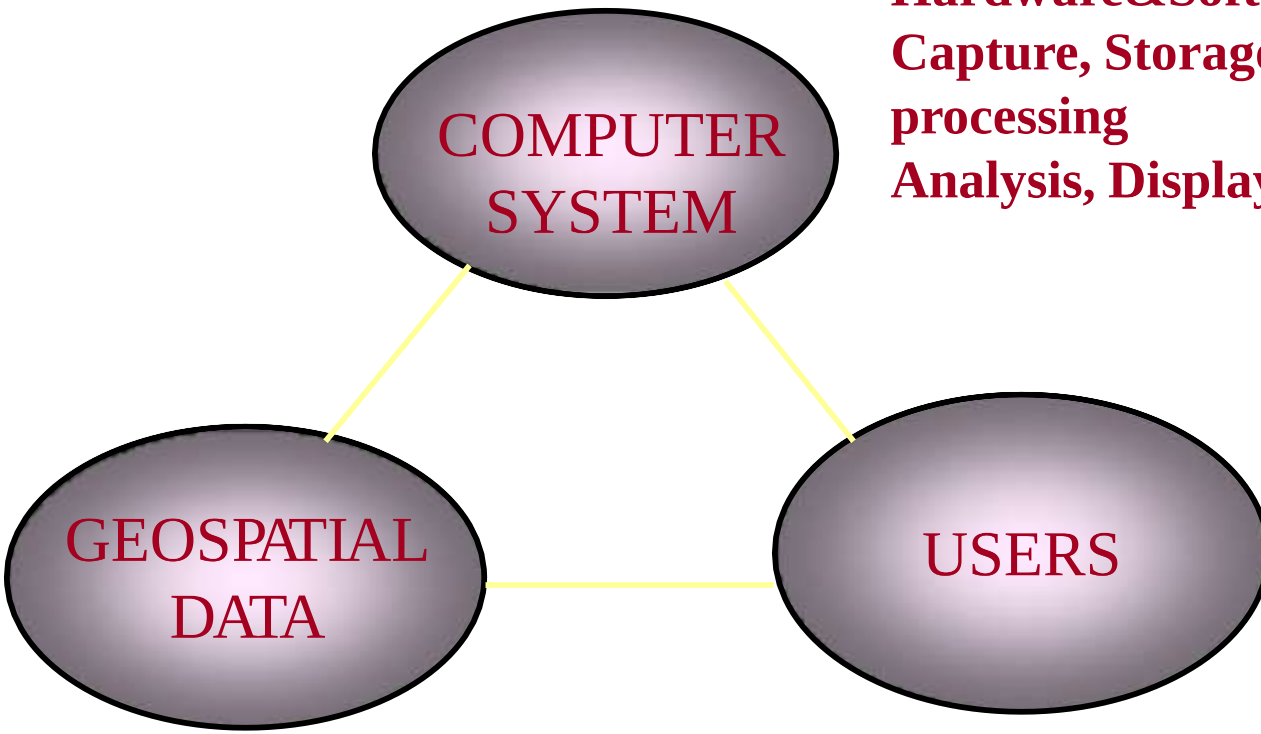

MEASUREMENT
MONITORING
LULC
CADASTRAL
AGRICULTURE
HYDROLOGY
4
M's
ENVIRONMENTAL
ASSESMENT
DRAINAGE NETWORK
MODEL
TERRAIN MODELS
DTM
MAPPING
MODELLING

Contribution Disciplines



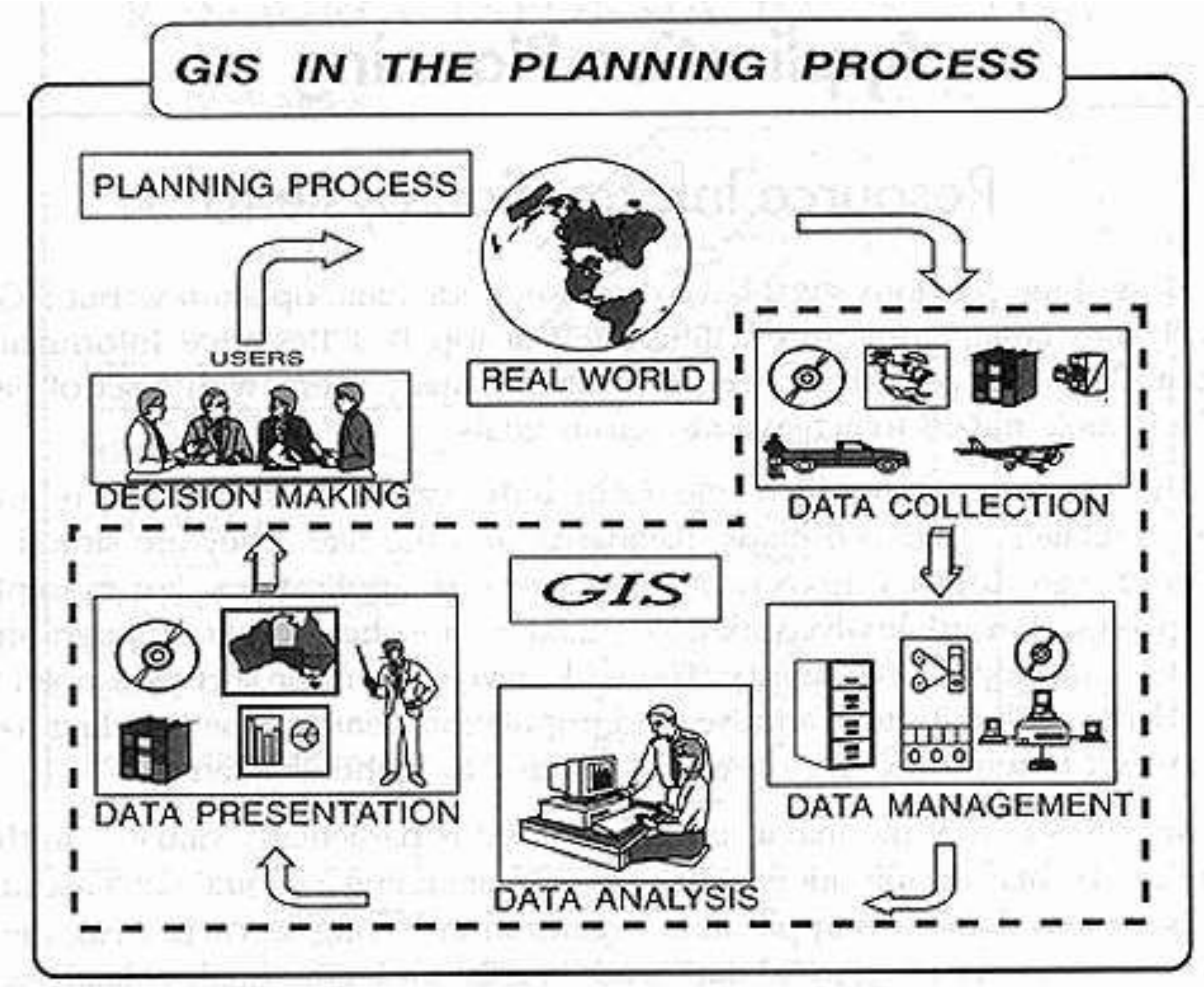
KEY COMPONENTS OF GIS

Hardware&Software
Capture, Storage, processing
Analysis, Display etc.,

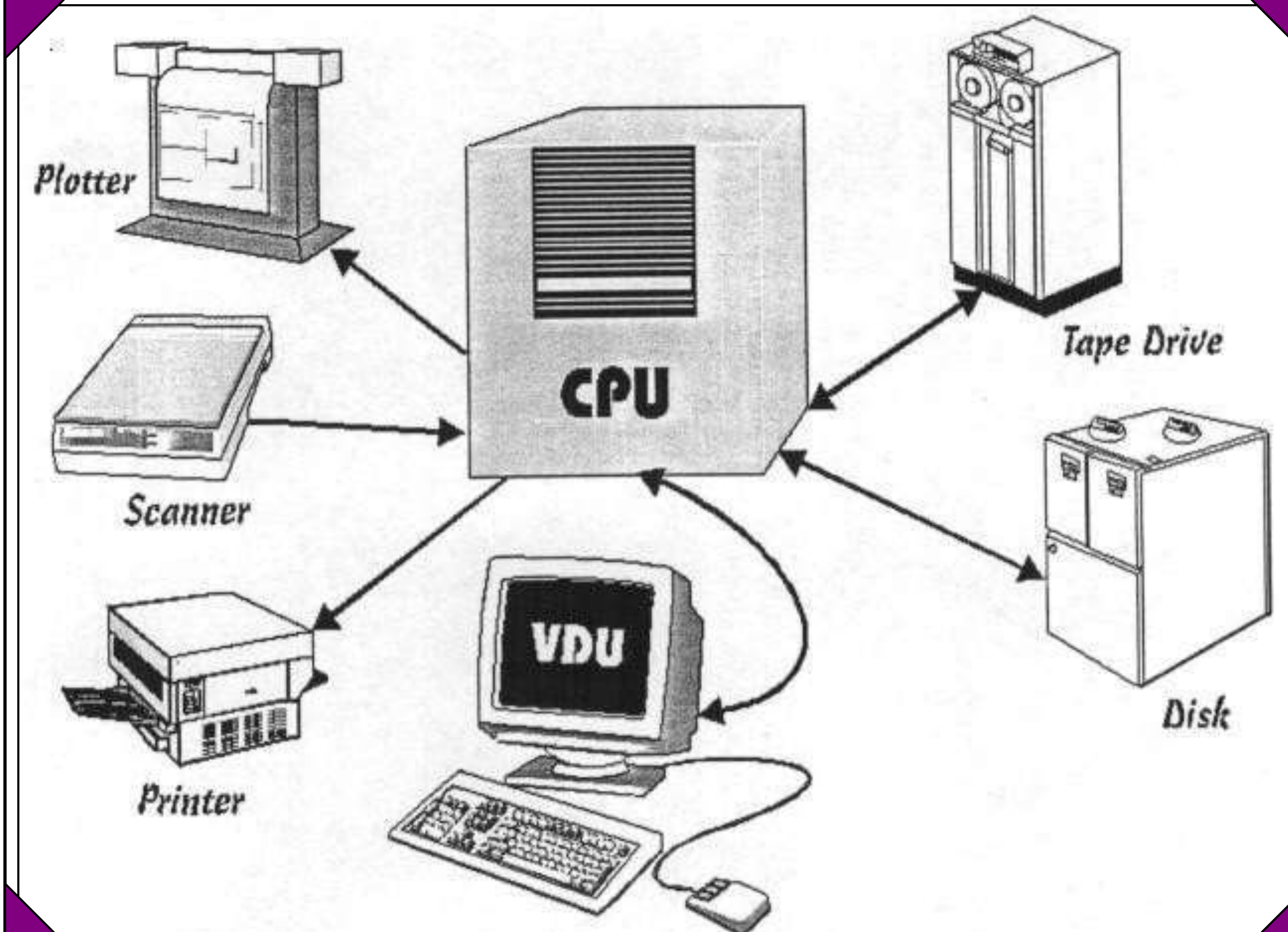


Maps, Aerial photographs, Satellite Images, Statistic Tables etc,

Design of Standards, Updating, Analysis and Implementations


GIS IN THE PLANNING PROCESS
PLANNING PROCESS
USERS
REAL WORLD
DECISION MAKING
DATA COLLECTION
GIS
DATA PRESENTATION
DATA MANAGEMENT
DATA ANALYSIS

HARDWARE COMPONENTS



GIS Software...

- Arc/Info
- ArcView
- SpansGIS
- PAMAP GIS
- GENA GIS
- INTERGRAPH
- NIC ATLAS

Data Capture Sources

- Digitizing from paper maps
- Scanning
- Traditional surveying techniques
- Paper records & field notes
- Photogrammetry
- Remote sensing
- GPS

UNIT-4

Vector Data Model

Geographic information systems rely on two interrelated types of databases:

•***<u>The Spatial Database</u>***

•**Describes the location and shape of geographic features, and their spatial relationship to other features.**

•**The information contained in the spatial database is held in the form of digital co-ordinates, which describe the spatial features.**

•**These can be points (for example, hospitals), lines (for example, roads), or polygons (for example, administrative districts).**

•***<u>The Attribute Database</u>***

•**The attribute database is of a more conventional type; it contains data describing characteristics or qualities of the spatial features (i.e., descriptive information):**

•GIS links spatial data with geographic information about a particular feature on a map. The information is stored as „attributes‟ of the graphically represented feature.

DATA

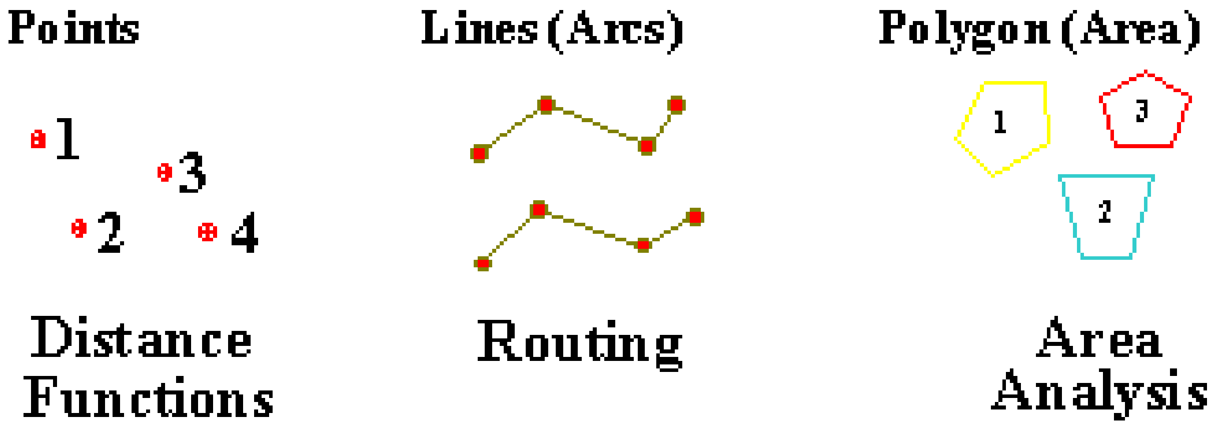
1. SPATIAL DATA

2. ATTRIBUTE DATA


Software
Hardware
GIS
Data
People
Methods


Land Use
Streets
Districts
Parcels
Parks
River
Discharge Point
Sand and Gravel
Sandstone Aquifer
Water Table
Shale

GIS attempts to describe all features in geometric terms.



•**Point:** discrete location represented as a co-ordinate pair (e.g., sampling locations, disease cases, hospitals, and town centroids).

•**Line (Arc):** set of ordered co-ordinates represented by a string of co-ordinates (e.g., streams, power and pipelines, and transportation routes).

•**Polygon (Area):** closed feature whose boundary encloses a homogeneous area represented by a closed string of co-ordinates which encompass an area (e.g., land use, lakes, census tracts, hospital catchment area, and town boundaries).

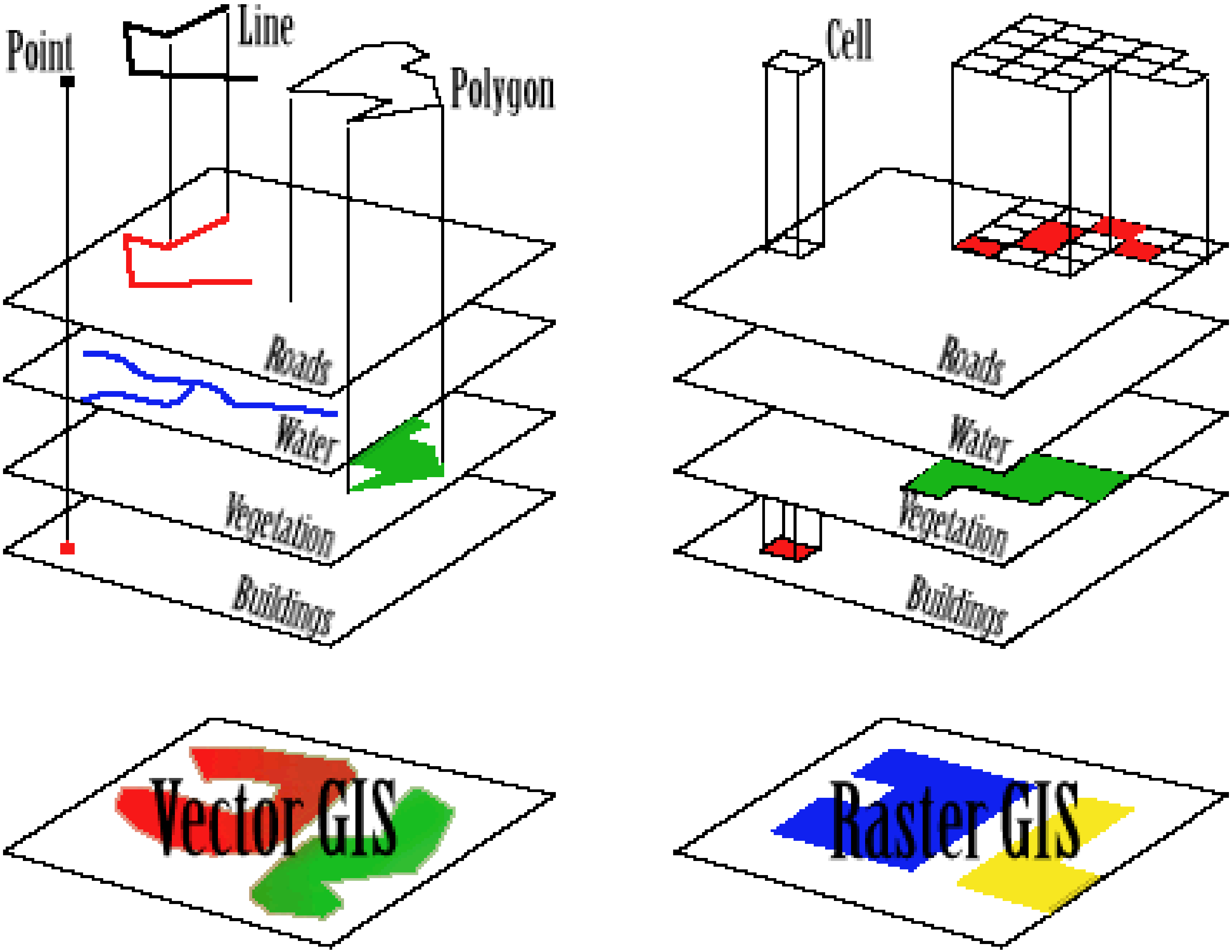
ATTRIBUTE DATA

<u>Attributes</u> can be numeric or alphaanumeric data that is assigned to a point, line or area spatial features

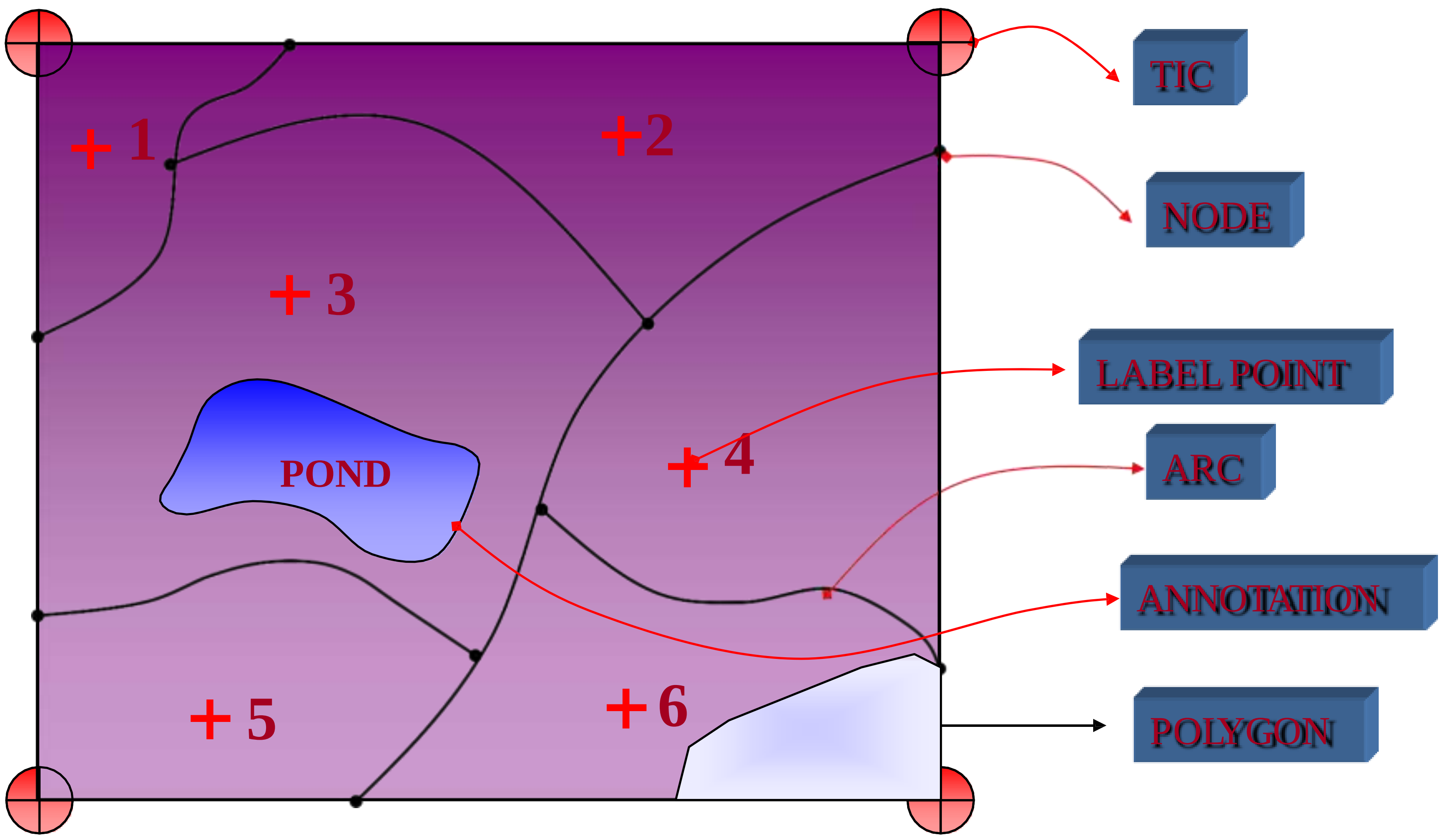
Example Attributes…

Stand ID, Compartment no, Vegetation type, Name of the Forest Block, Type of road, VSS code etc.,

Vector and Raster



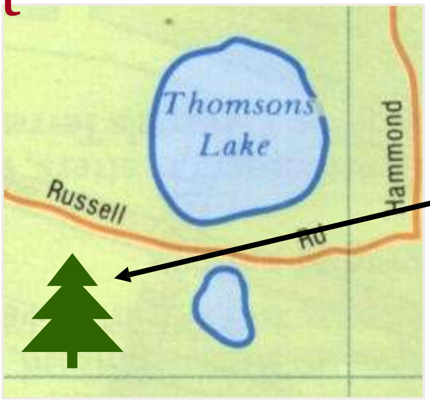
FEATURES OF A COVERAGE



Point Features

Spatially distributed entities, activities or events

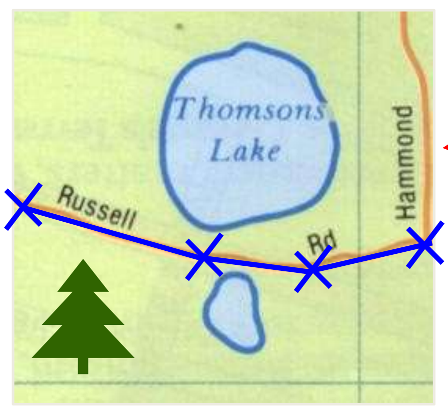
- Points have a single geographic coordinate such as:
  - Tree
  - Traffic accident
  - Lamp post



Line Features

Spatially distributed entities, activities or events

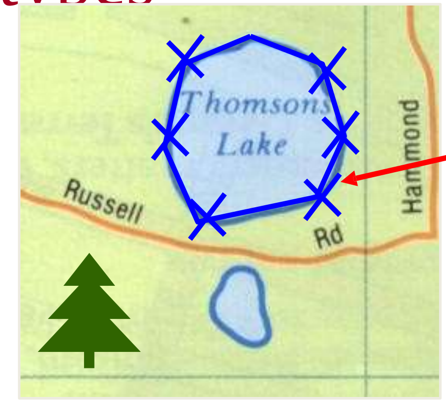
- Lines (Arcs) are a series of geographic coordinates joined to form a line such as:
  - Road
  - Stream
  - Railway



Area Features

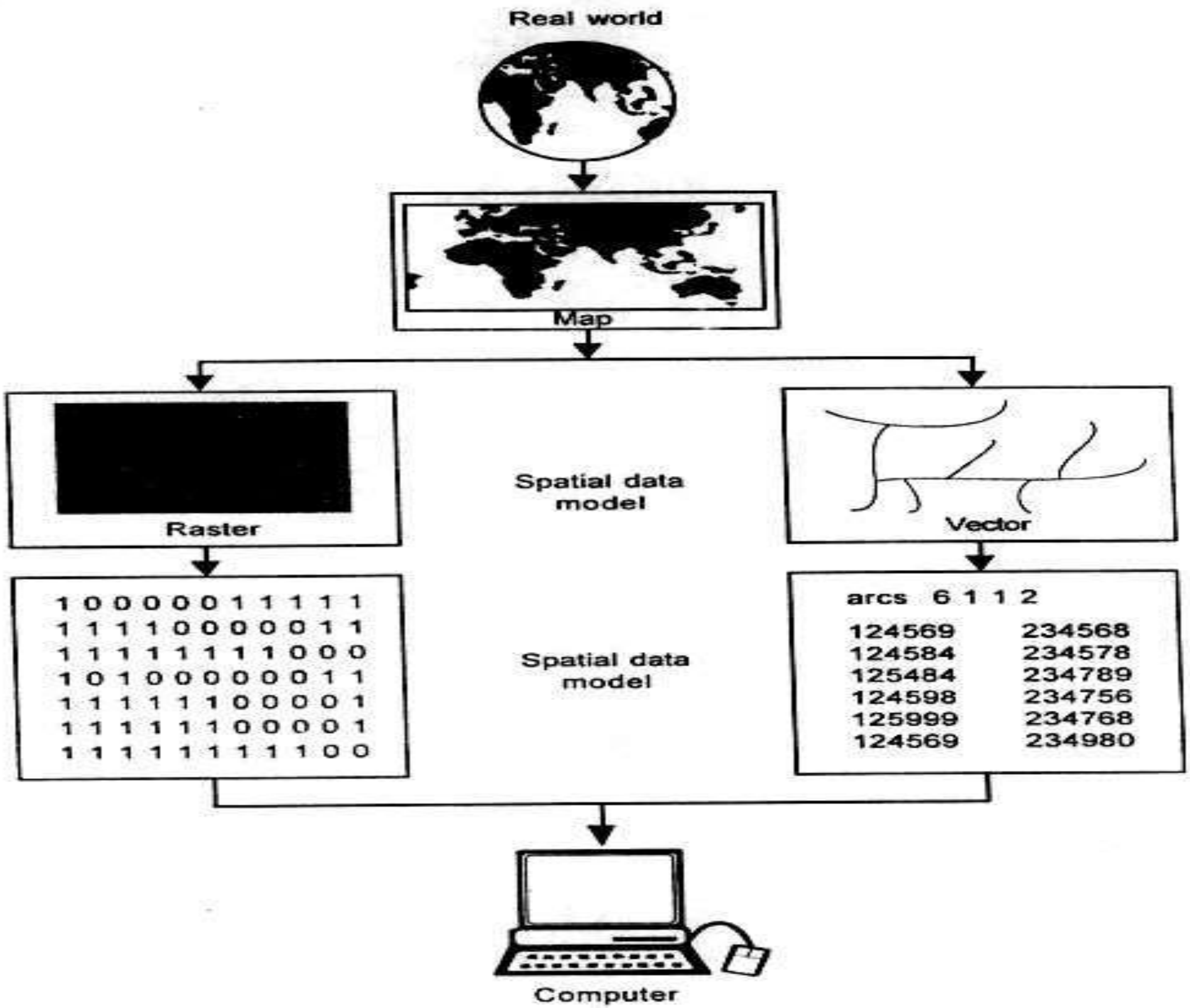
Spatially distributed entities, activities or events

- Areas (Polygons) are a series of geographic coordinates joined together to form a boundary such as:
  - Lake
  - Soil types



GIS DATA STRUCTURES

Stages in creating a GIS data model

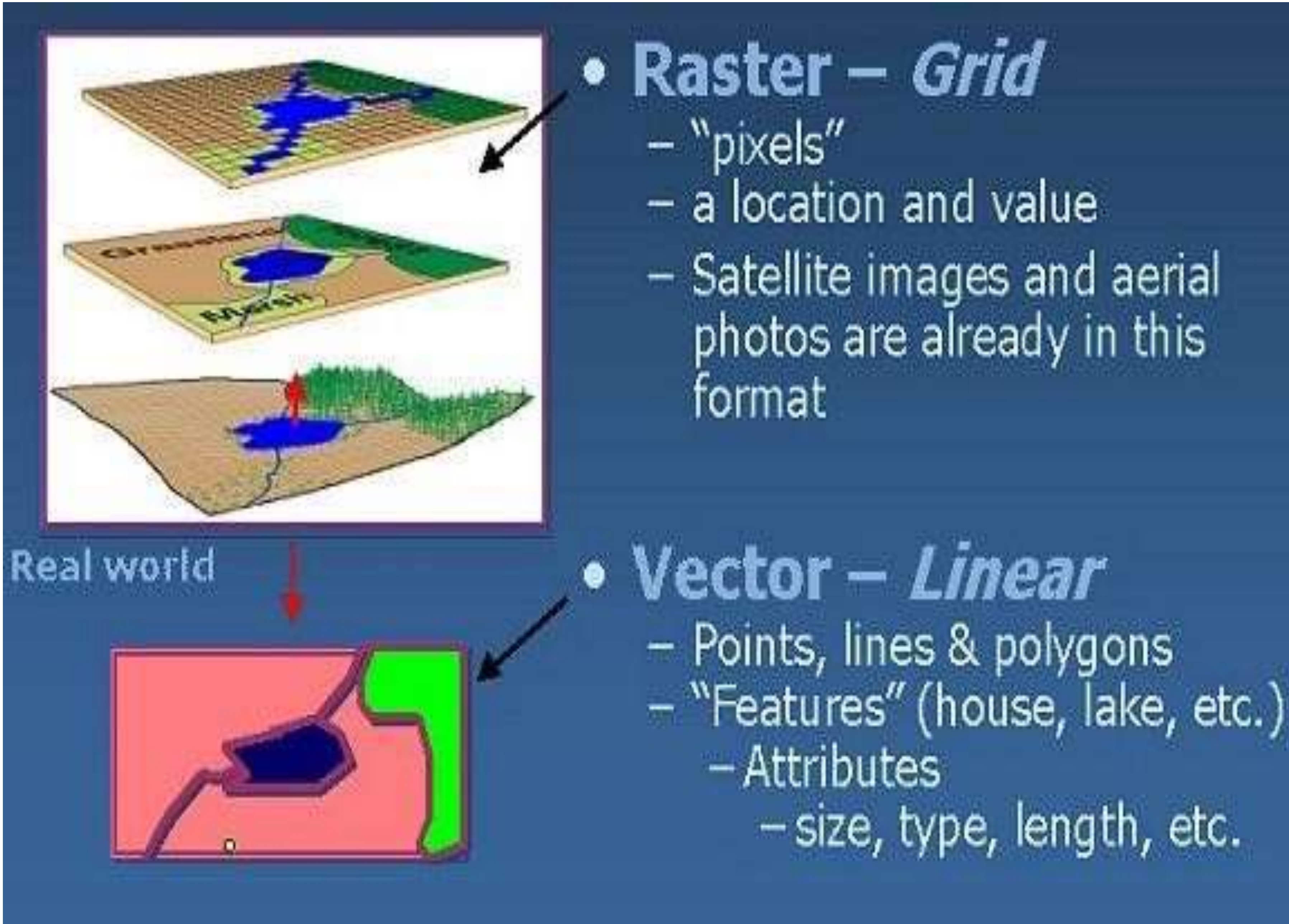


GIS Data and Structures

- SPATIAL DATA
  - RASTER DATA
  - VECTOR DATA
- NONSPATIAL DATA / ATTRIBUTE DATA
- THE RELATIONSHIP BETWEEN SPATIAL DATA AND NON-SPATIAL DATA IS TOPOLOGY

UNIT-5

Raster Data Model



• Raster – Grid
– "pixels"
– a location and value
– Satellite images and aerial photos are already in this format
Marsh
Real world
• Vector – Linear
– Points, lines & polygons
– "Features" (house, lake, etc.)
–Attributes
–size, type, length, etc.

- Raster Geographic Information Systems, which store map features in raster or grid format,
- generalise the location of features to a regular matrix of cells.

- Raster GIS data structures are preferred for digital elevation modelling

- In raster-based analysis, the areas of analysis are divided into squares of uniform size (cells).

- Each cell characterises the feature of interest within this area with a single value.

- Digital image data, including aerial photos and satellite imagery, are stored in raster format (as pixels).

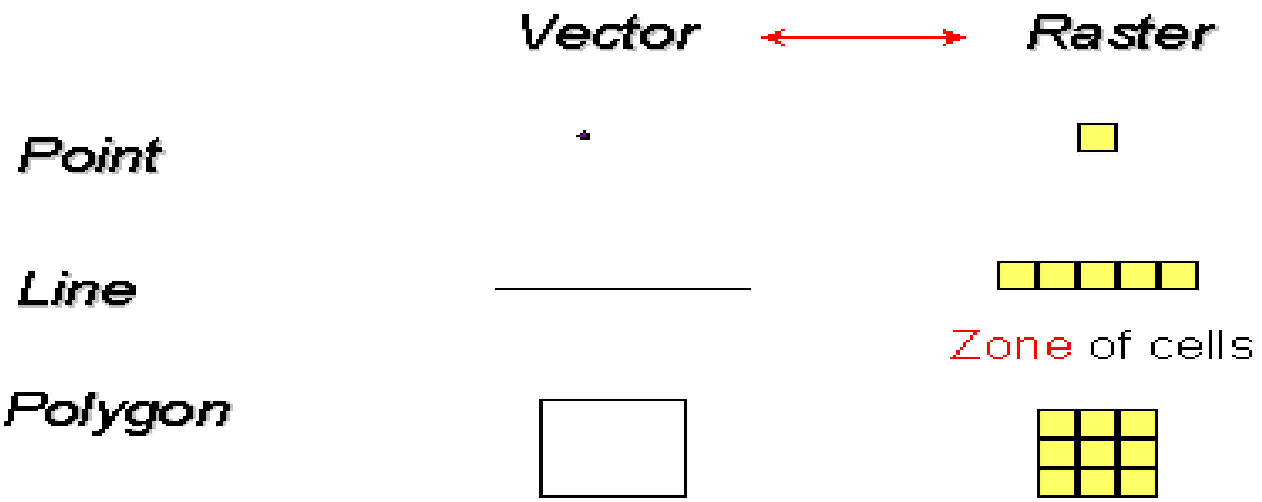
- GRID cell-based modelling uses the raster format to determine routing patterns and terrain.

Vector data on the other hand, are coordinate-based data structures commonly used to represent linear features (polygons can be formed by closed strings of co-ordinates).

Each feature in this format is represented as a list of ordered x,y co-ordinates.

Raster and Vector Data

Raster data are described by a cell grid, one value per cell



Data Layers in the Database

- Organize by feature type
  - point
  - line
  - polygon
- Organize by thematic grouping
  - roads (lines)
  - land use (polygons)
  - soils (polygons)
  - wells (points)

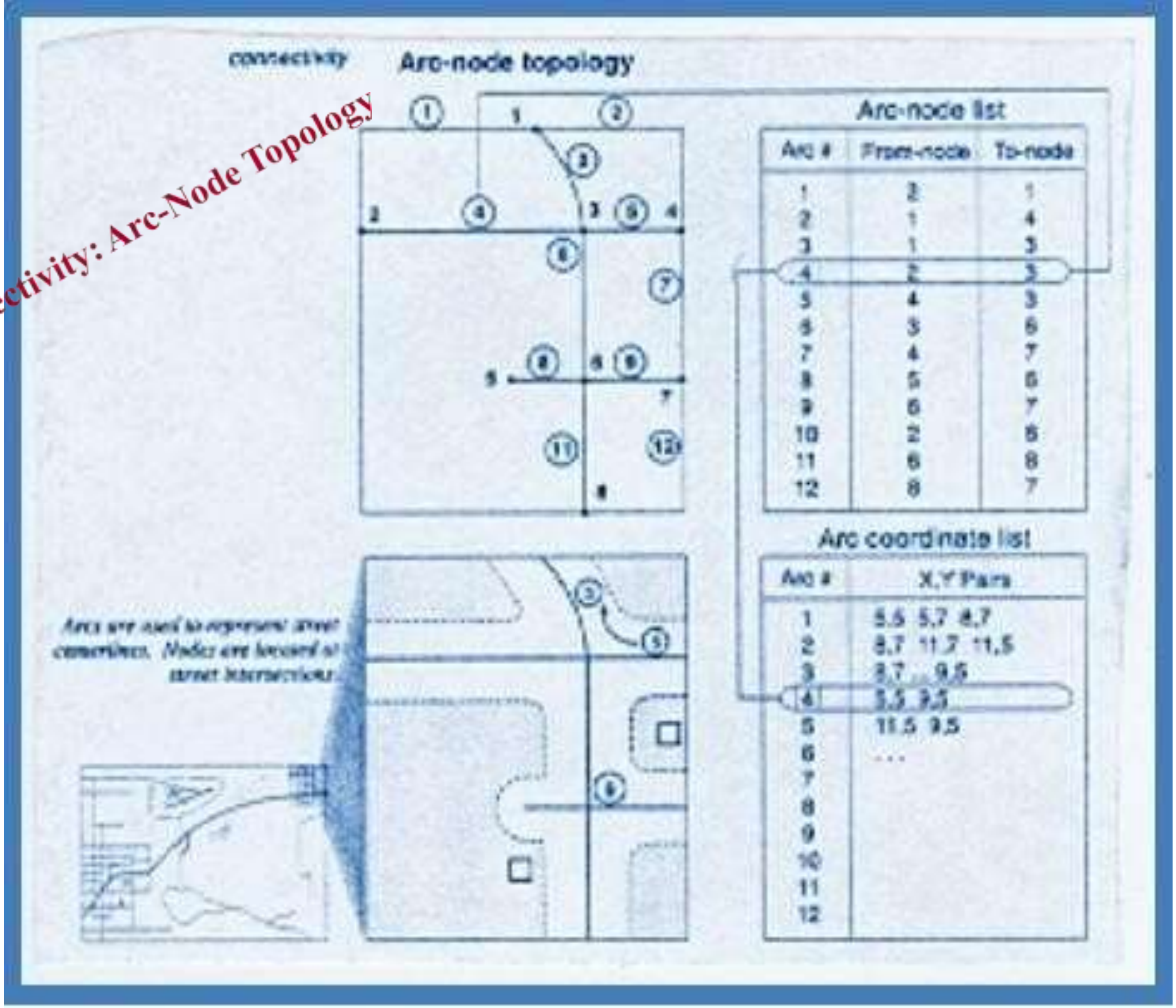
TOPOLOGY

- ***Topology*** **- mathematical representation of geographic features(arcs, nodes, polygons and points)**
- **When topology is built, it creates spatial relationship among the features**
- **Topology can be very important for certain types of analysis.**

Topology

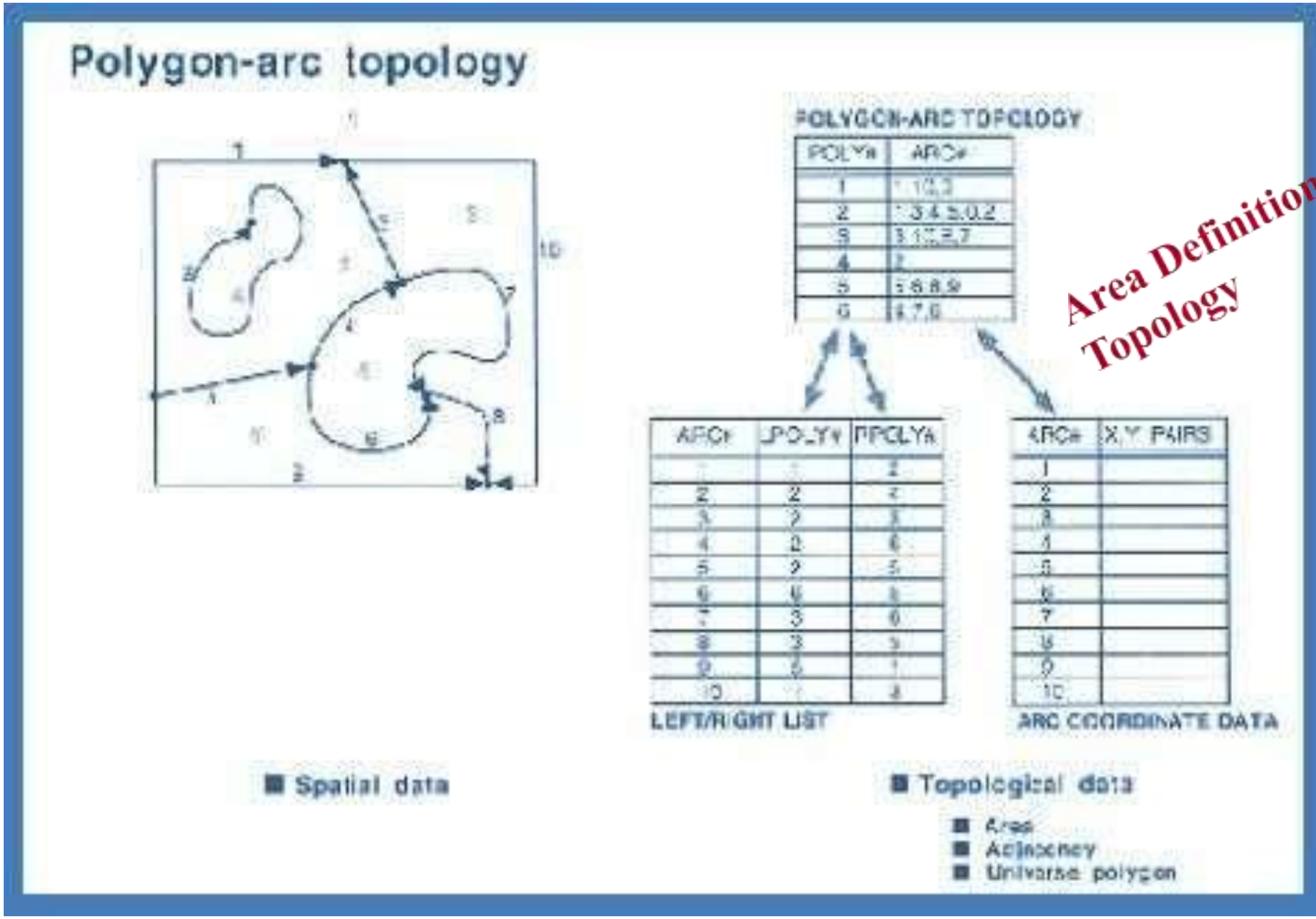
- **Topology is a mathematical procedure for explicitly defining** *spatial relationships*.
- Arcs connect to each other at nodes (*connectivity*),
- Arcs that connect to surround an area define a polygon (*area definition*), and
- Arcs have direction and right and left sides (*contiguity*).

Connectivity: Arc-Node Topology



- Points along the arc that define its shape are called *vertices*.
- Endpoints of arcs are called *nodes*.
- Arcs join *only at nodes*.

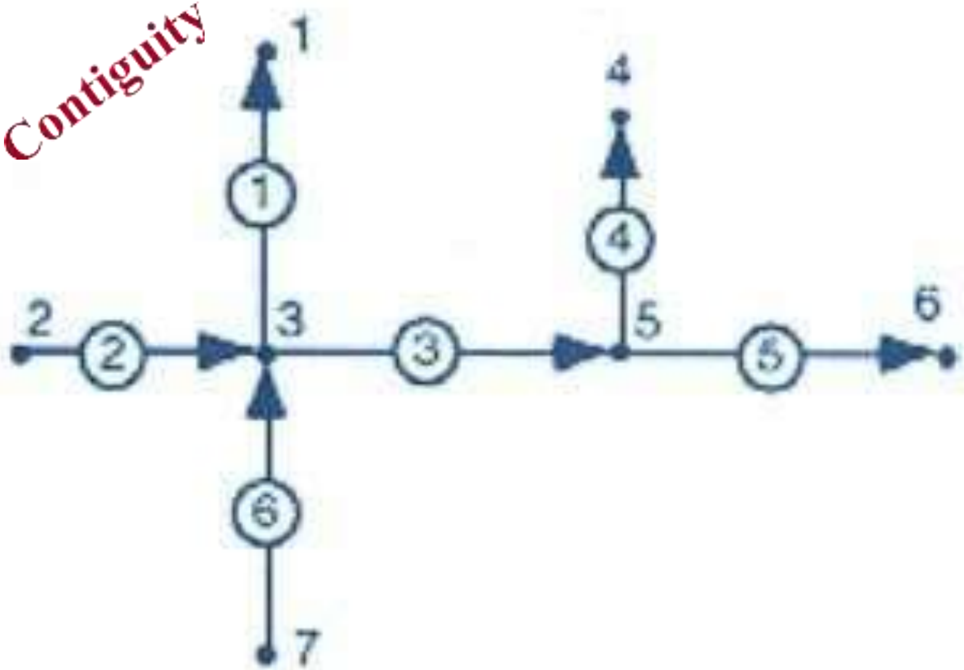
Area Definition: Polygon-Arc Topology



Polygons are represented as a series of x,y co-ordinates that connect to define an area.

The GIS also stores the list of arcs that make up the polygon.

Contiguity



Arc	From node	To node
1		
2		
3		
4		
5		
6		

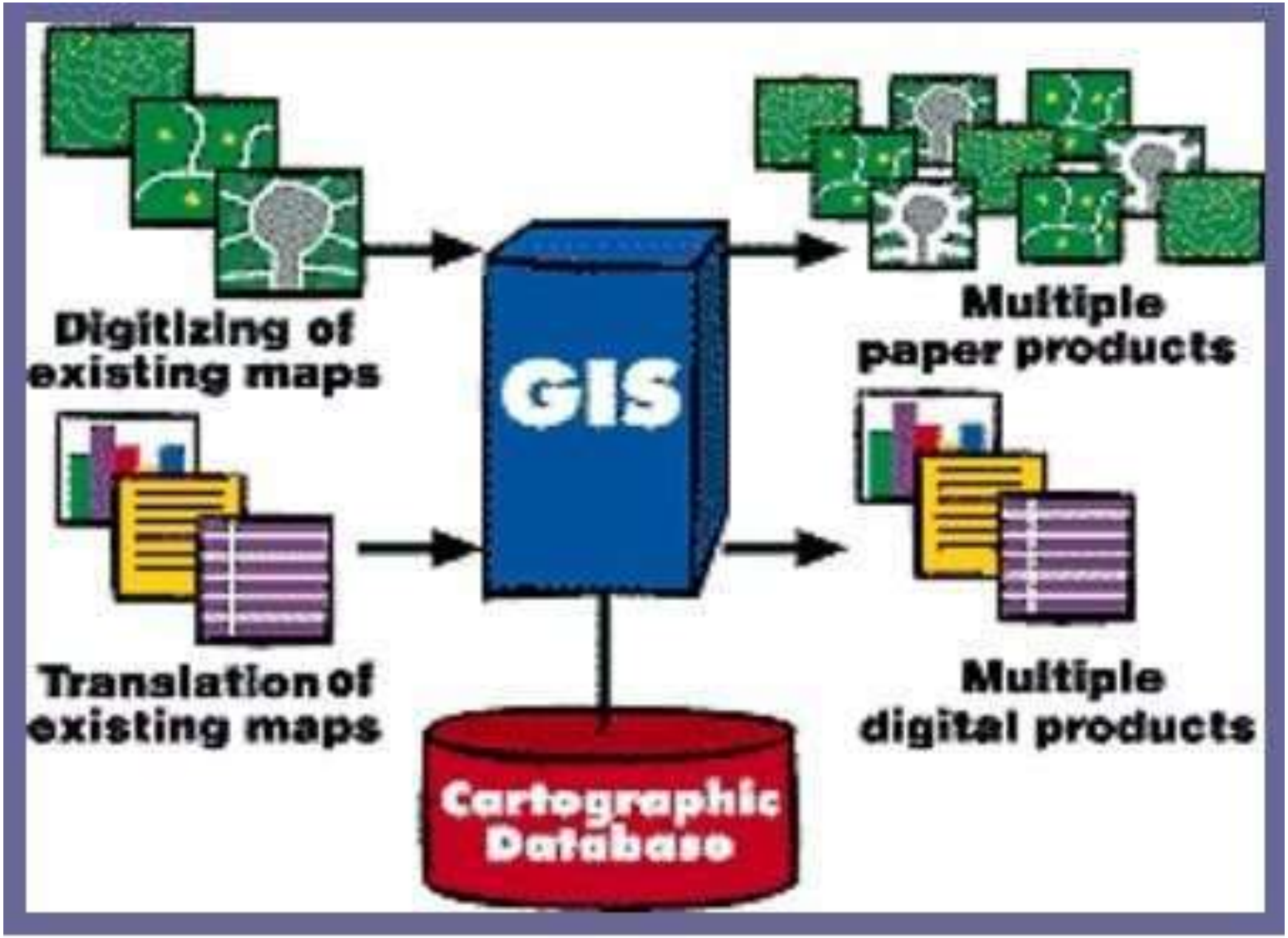
Path from Node 6 to Node 1

Arc #	5				
Direction	–				

Every arc has a direction.
The GIS maintains a list of polygons on the left and right side of each arc.

The computer uses this information to determine which features are next to one another.

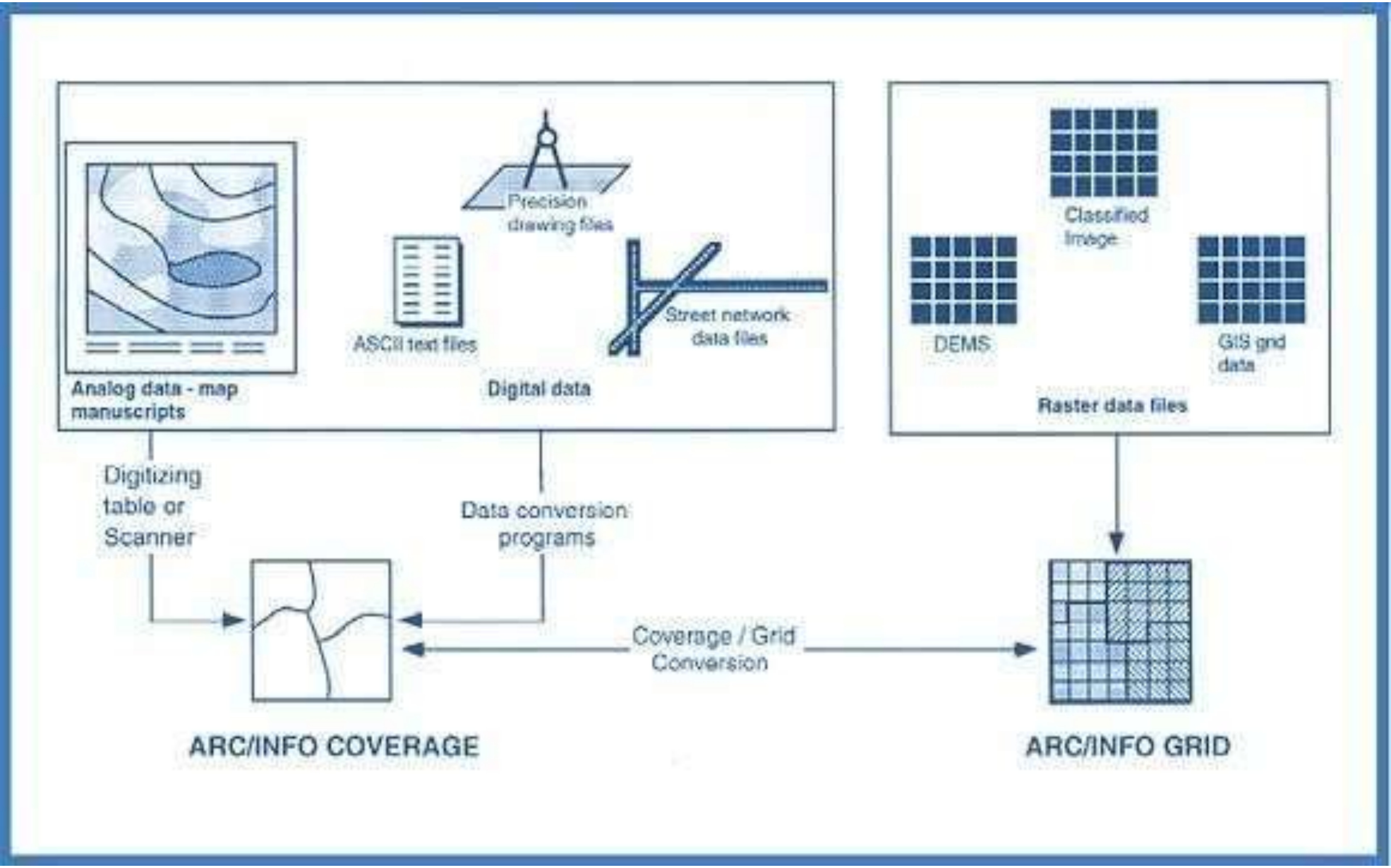
Getting Data into a GIS – Sources of Electronic Data Files


Digitizing of
existing maps
Translation of
existing maps
GIS
Cartographic
Database
Multiple
paper products
Multiple
digital products

This can be done by:

- **Digitising hard copy maps**
- **Keyboard entry of co-ordinate data (co-ordinates are added as a series of numbers defining the location of a point, the shape of a line, or**
- **Electronic entry using a data file;**
- **Scanning a map manuscript; and**
- **Converting or reformatting existing data.**

Electronic data files are the easiest way to get data into a GIS. Ready-to-use data sources.


Precision drawing files
ASCII text files
Street network data files
Analog data - map manuscripts
Digital data
Classified Image
DEMS
GIS grid data
Raster data files
Digitizing table or Scanner
Data conversion programs
Coverage / Grid Conversion
ARC/INFO COVERAGE
ARC/INFO GRID

•A digitiser converts spatial features on a hard copy map into digital format.

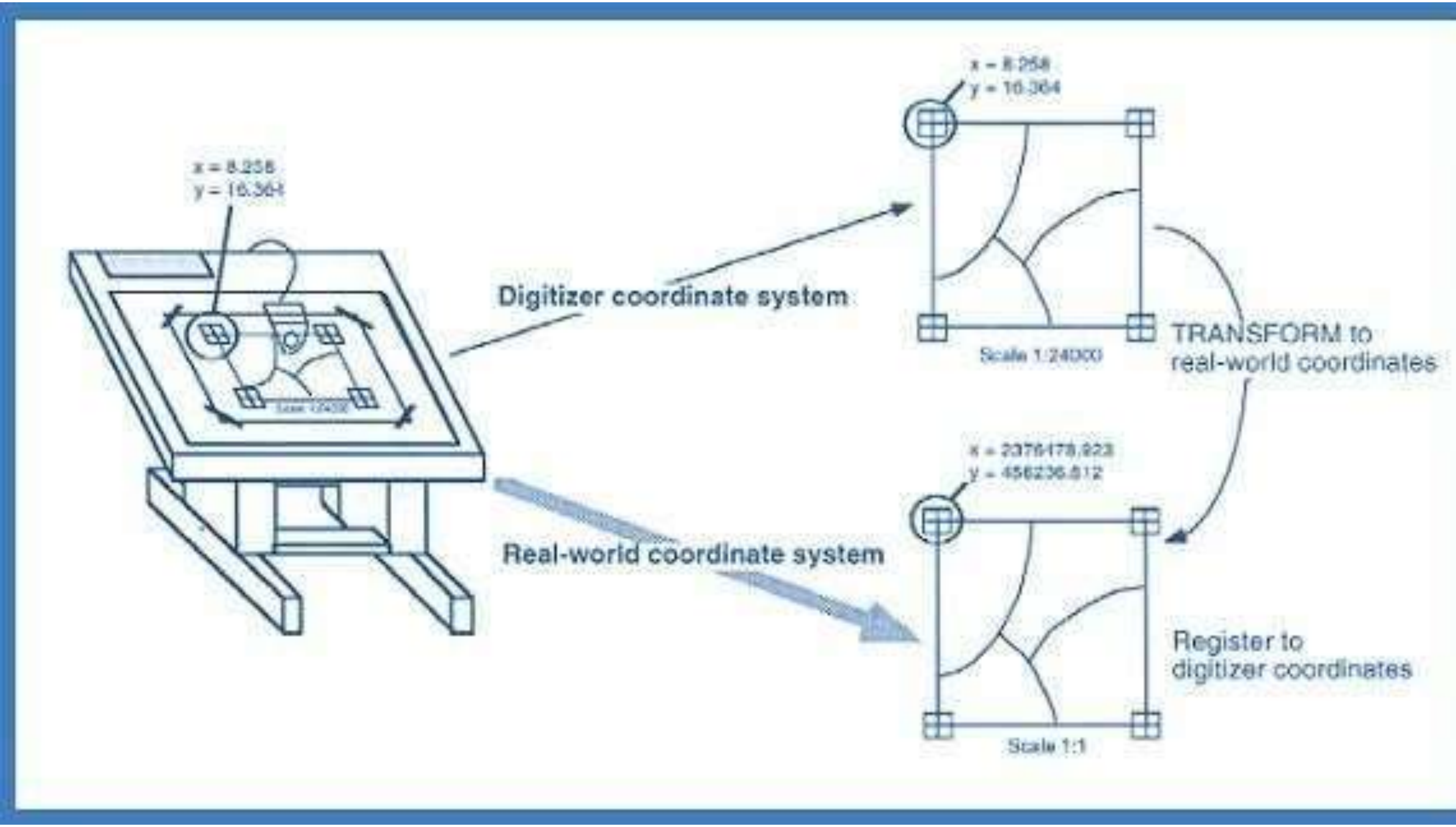
•Point, line and area features are converted into x,y co-ordinates.

•The process involves manually tracing all features of interest using an electronic stylus.

Good base maps must be used.

After digitising, a procedure known as *transformation* converts digitiser units to a real-world co-ordinate system.

Tics are used to provide the relationship between the two co-ordinate systems.



x = 8.258
y = 16.364
Digitizer coordinate system
x = 8.258
y = 16.364
Scale 1:24000
TRANSFORM to
real-world coordinates
x = 2376178.923
y = 456236.812
Real-world coordinate system
Register to
digitizer coordinates
Scale 1:1

Techniques For Spatial Representation

- feature data (point feature, linear feature, homogenous polygon)
- areal units (boundaries, areal polygon)

- network topology (node, link, polygon)
- sampling records (stations, lines, plots)

- surface data (elevations, contours, proximal polygons)

- label/text data (place names, linear feature names, polygon labeling)

- graphic/symbol data (point symbols, line type, polygon shading)

Topological Relationships

- basic point: node
- basic line: node, line, node
- basic polygon: node1, line, node2, line, node3, line, node4, line, node1
- *topological relationships can be linked to a geographic reference system*

Processing of Geographic Data

- removal of duplicates
- arc to polygon conversion
- edge-matching
- editing of x,y coordinates for entry errors
- base file creation & update
- file management
- basic search & retrieval
- query of selected attributes

Data Retrieval

- •browsing
- •windowing (zoom-in & zoom-out)
- •query window generation (retrieval of certain, selected features)
- •multiple map sheet observation
- •Boolean logic functions (meeting specific rules)

Map Generalization

- •line coordinate thinning of nodes
- •polygon coordinate thinning of nodes
- •drop lines
- •edge-matching

Map Abstraction

•calculation of centroids

•visual editing & checking

•automatic contouring from randomly spaced points

•generation of Thiessen/proximity polygons

•reclassification of polygons

•raster to vector/vector to raster conversion

Map Sheet Manipulation

•changing scales

•distortion removal/rectification

•changing projections

•rotation of coordinates/registration

Buffer Generation

- generation of zones around certain objects

Polygon Enhancement Techniques

- polygon overlay
- polygon dissolve

Measurements

- points - total number or number within an area
- lines - distance along a straight or curvilinear line
- polygons - area or perimeter
- volumes - measure cross-sections or differences between overlays

Raster/Grid Analysis

- grid cell overlay
- area calculation
- search radius
- distance calculations
- optimum corridor selection

Digital Terrain Analysis

- slope/aspect analysis
- watershed calculation
- contour generation

Graphical Manipulation Techniques

- variable symbols
- variable text fonts
- variable line thickness
- variable colors

GIS Output Formats

- hard copy maps
- tabular outputs
- visual display
- data tapes/CDs

Several Approaches To GIS Development

- process-orientated approach
- application approach
- toolbox approach
- database approach
- Computer-Aided Design (CAD) approach

Several Approaches To GIS Development

Process-Orientated Approach

- GIS converts geographic data into useful information
- the system should include: inputs, storage, retrieval, analysis, output

❑ Application Approach

- GIS designed to meet the standards of the data
- each application will need a unique GIS

❑ Toolbox Approach

- a set of procedures and algorithms run together
- unique bundling must be present to be considered a GIS

- Database Approach
  - •a DBMS that allows unique spatial queries into its databases
  - •retrieval, analysis, and display should be part of the system
- CAD Approach
  - •electronically drafting tools with spatial referencing
  - •needs to have graphical output

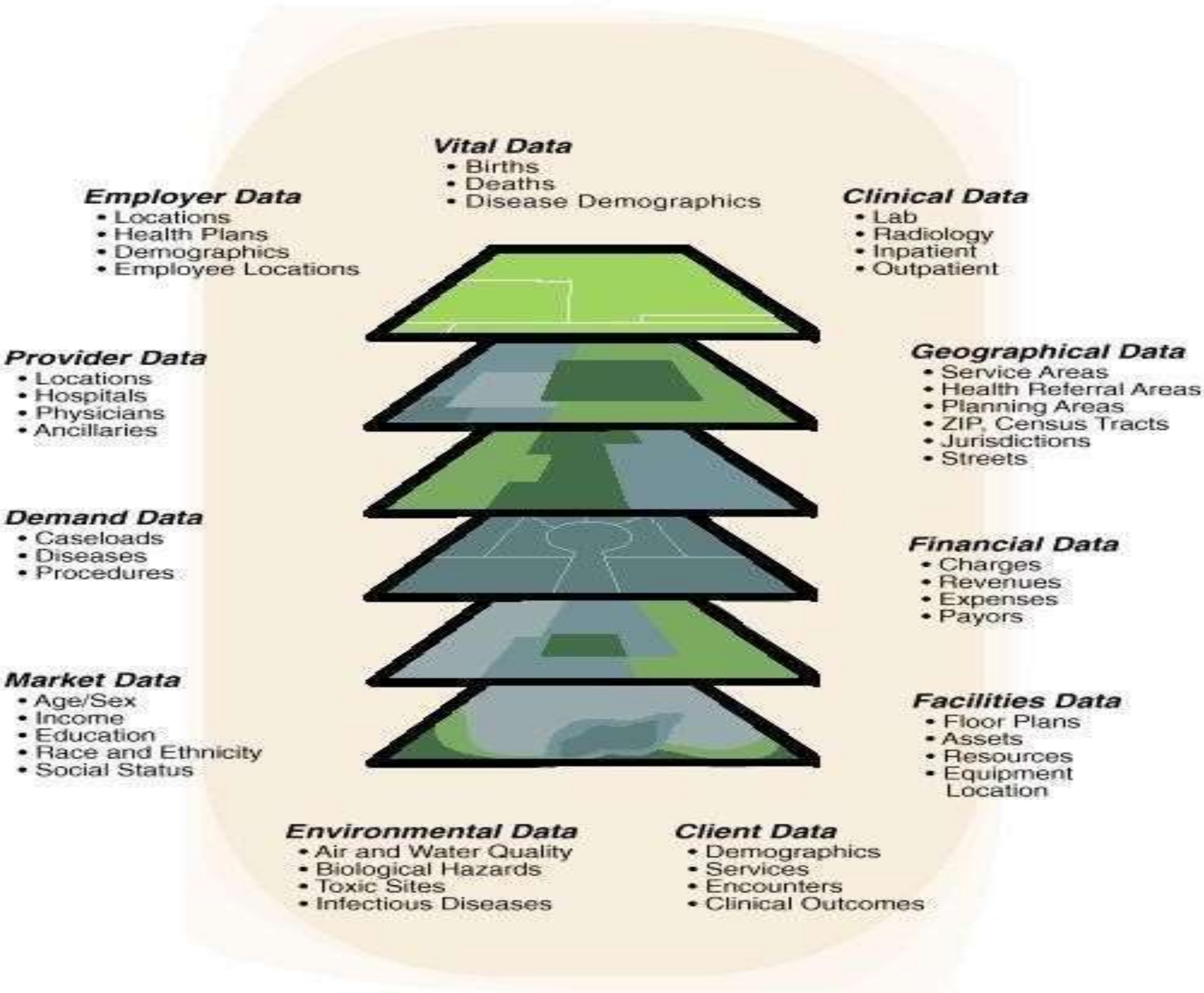
Four Main Types of Maps/Data Exist:

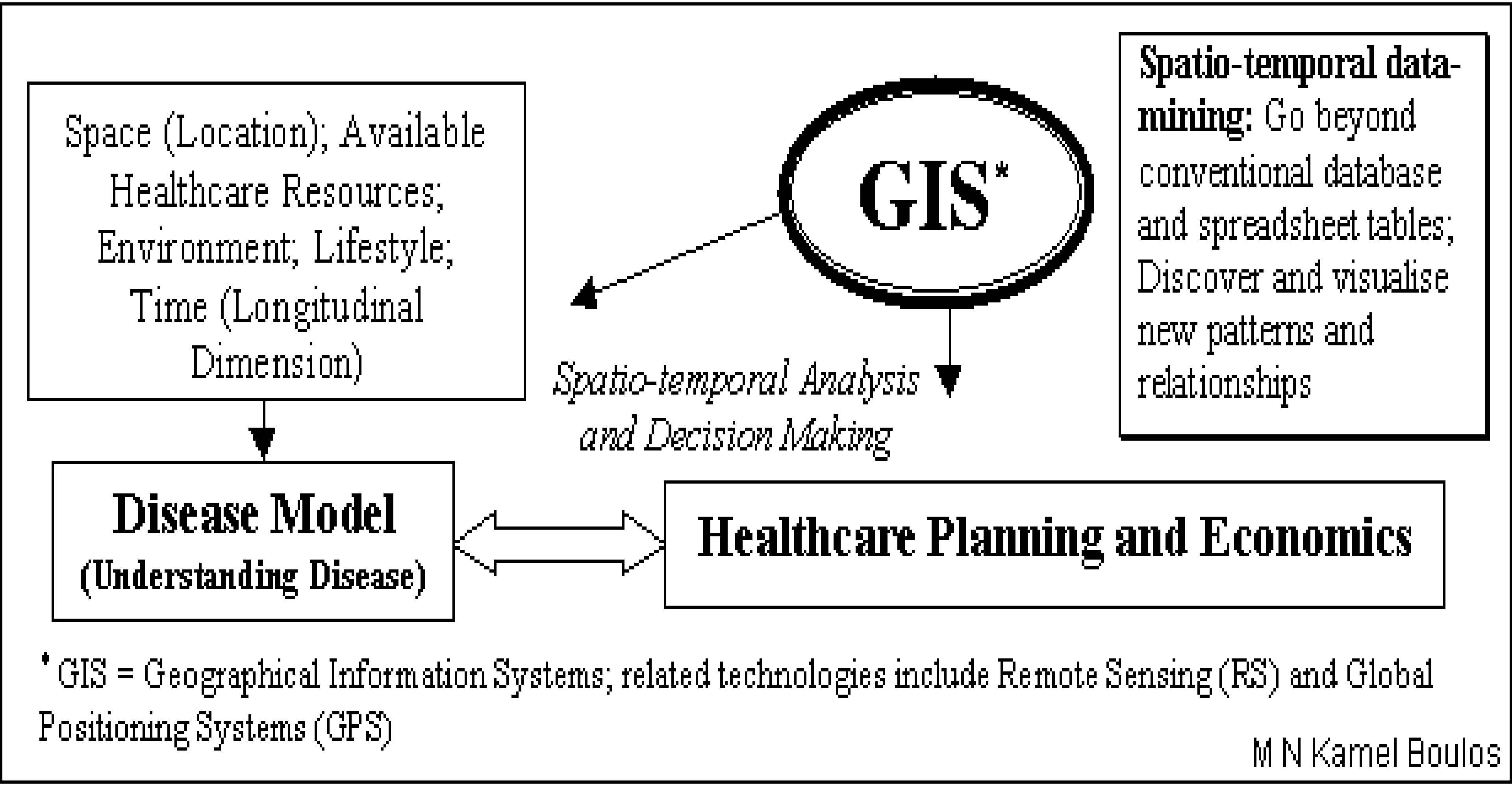
Base Maps: include streets and highways; boundaries for census, postal, and political areas; rivers and lakes; parks and landmarks; place names;

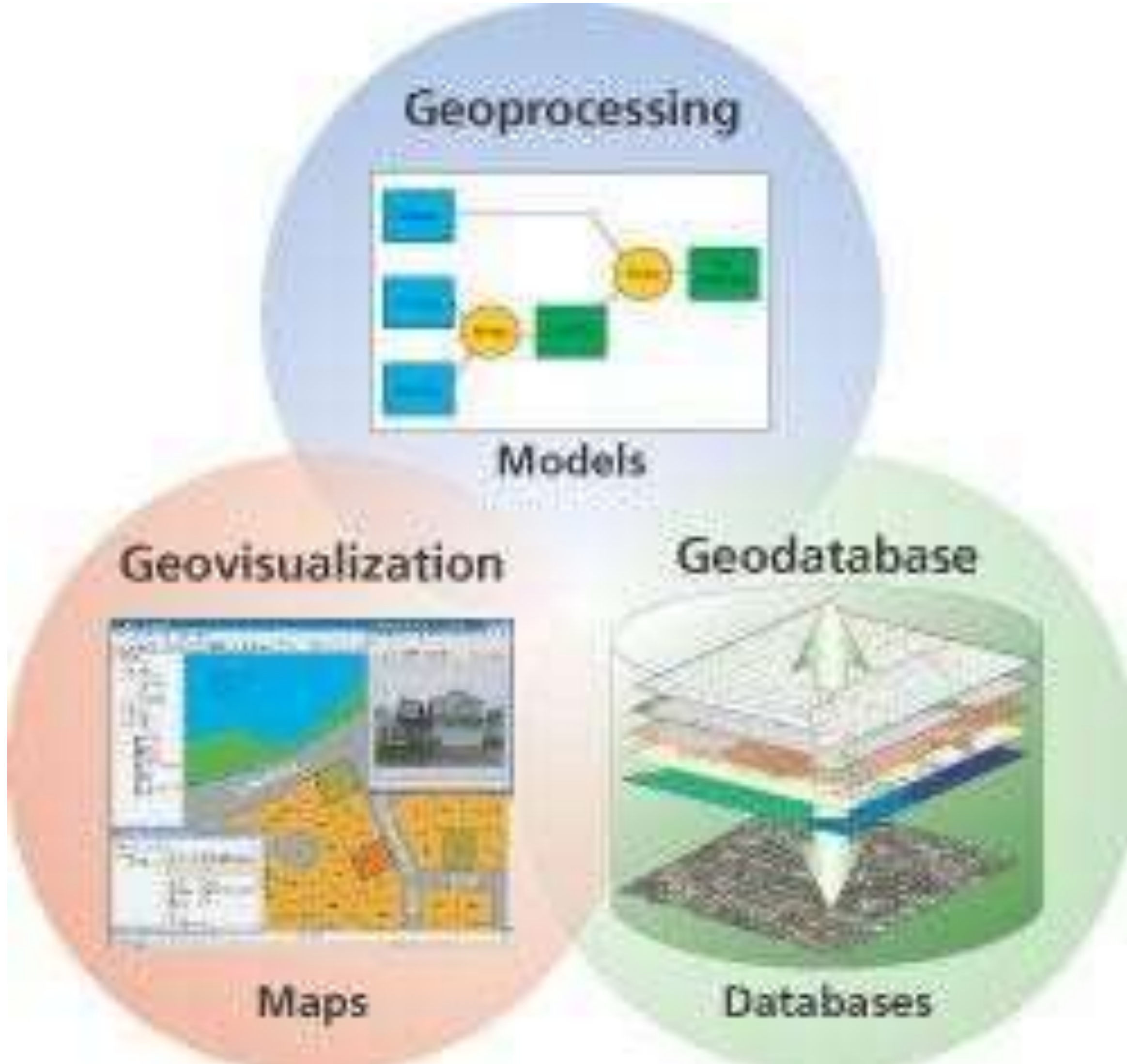
Business Maps and Data: include data related to census/demography, consumer products, financial services, healthcare, real estate, telecommunications, emergency preparedness, crime, advertising, business establishments, and transportation.

Environmental Maps and Data: include data related to the environment, weather, environmental risk, satellite imagery, topography, and natural resources.

General Reference Maps: world and country maps and data that can be a foundation for a GIS database.


Vital Data
• Births
• Deaths
• Disease Demographics
Employer Data
• Locations
• Health Plans
• Demographics
• Employee Locations
Clinical Data
• Lab
• Radiology
• Inpatient
• Outpatient
Provider Data
• Locations
• Hospitals
• Physicians
• Ancillaries
Geographical Data
• Service Areas
• Health Referral Areas
• Planning Areas
• ZIP, Census Tracts
• Jurisdictions
• Streets
Demand Data
• Caseloads
• Diseases
• Procedures
Financial Data
• Charges
• Revenues
• Expenses
• Payors
Market Data
• Age/Sex
• Income
• Education
• Race and Ethnicity
• Social Status
Facilities Data
• Floor Plans
• Assets
• Resources
• Equipment Location
Environmental Data
• Air and Water Quality
• Biological Hazards
• Toxic Sites
• Infectious Diseases
Client Data
• Demographics
• Services
• Encounters
• Clinical Outcomes


Space (Location); Available Healthcare Resources; Environment; Lifestyle; Time (Longitudinal Dimension)
GIS*
Spatio-temporal data-mining: Go beyond conventional database and spreadsheet tables; Discover and visualise new patterns and relationships
Spatio-temporal Analysis and Decision Making
Disease Model (Understanding Disease)
Healthcare Planning and Economics
* GIS = Geographical Information Systems; related technologies include Remote Sensing (RS) and Global Positioning Systems (GPS)
M N Kamel Boulos


Geoprocessing
Models
Geovisualization
Maps
Geodatabase
Databases

Scales and Maps

Prepared By:

JHARANARANI SENAPATI

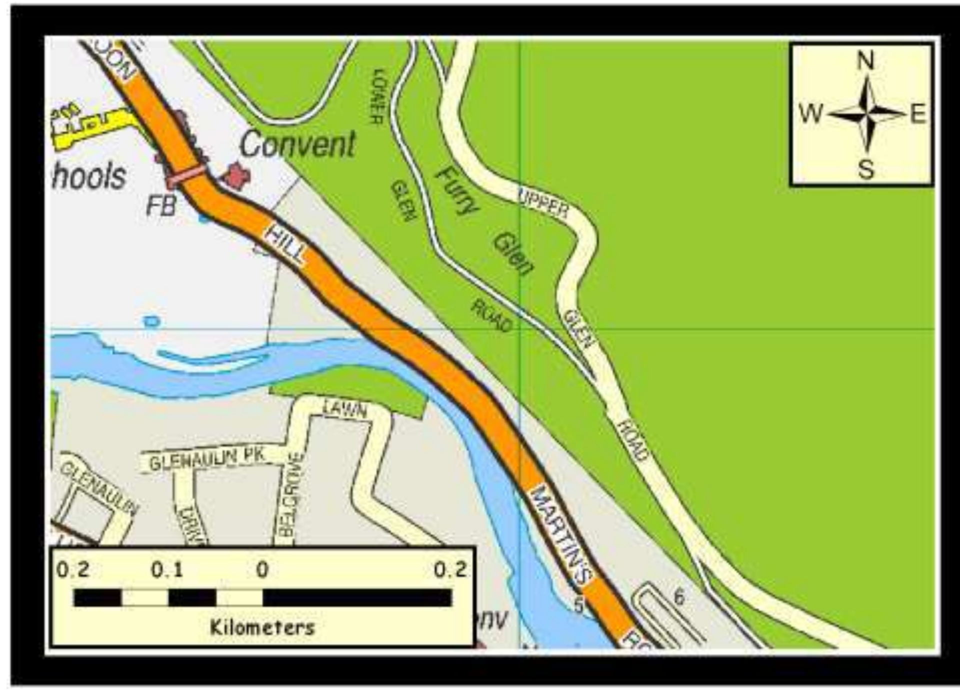
Asst. Professor

Department of Civil Engineering

What is Scale?

- A scale on a map is the relationship between the physical object and the feature that represents it on a map.
- An example of this would be the length of a road on the ground and the way that the road is represented on a map.

Representing features on Maps.

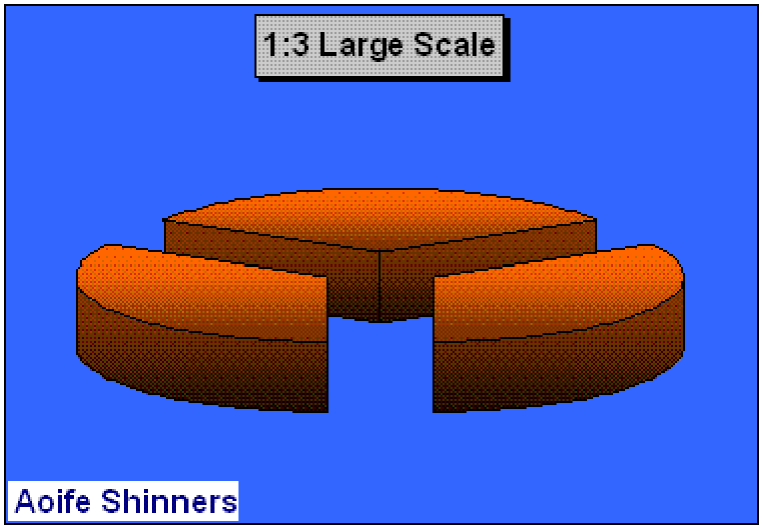


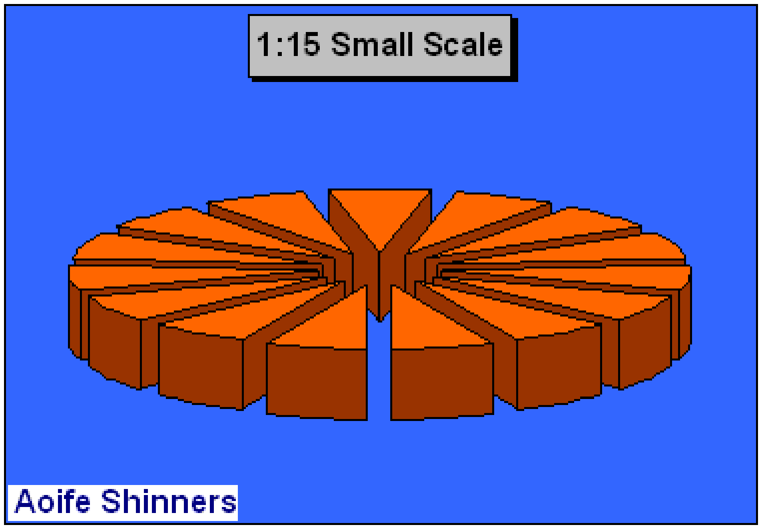
The Upper Glen Road, the first image, on the ground is displayed clearly on the map, the second image.

How to represent features correctly!

- If, for example, the length of a road is 1cm on a map and it measures 2500cm (or 0.025km) on the ground, the scale of the map is 1:2500.
- This would be called a large scale map as it can be represented as a very large fraction i.e. 1/2500.
- A smaller scale map would be 1:450,000 as its fraction is much smaller 1/450,000. 1cm on this map would represent 4.5km on the ground.

Large Scale Vs Small Scale





The slice of the first cake represents:

A large slice

A large fraction

A large amount of data and information on a map

The slice of the second cake represents:

A small slice

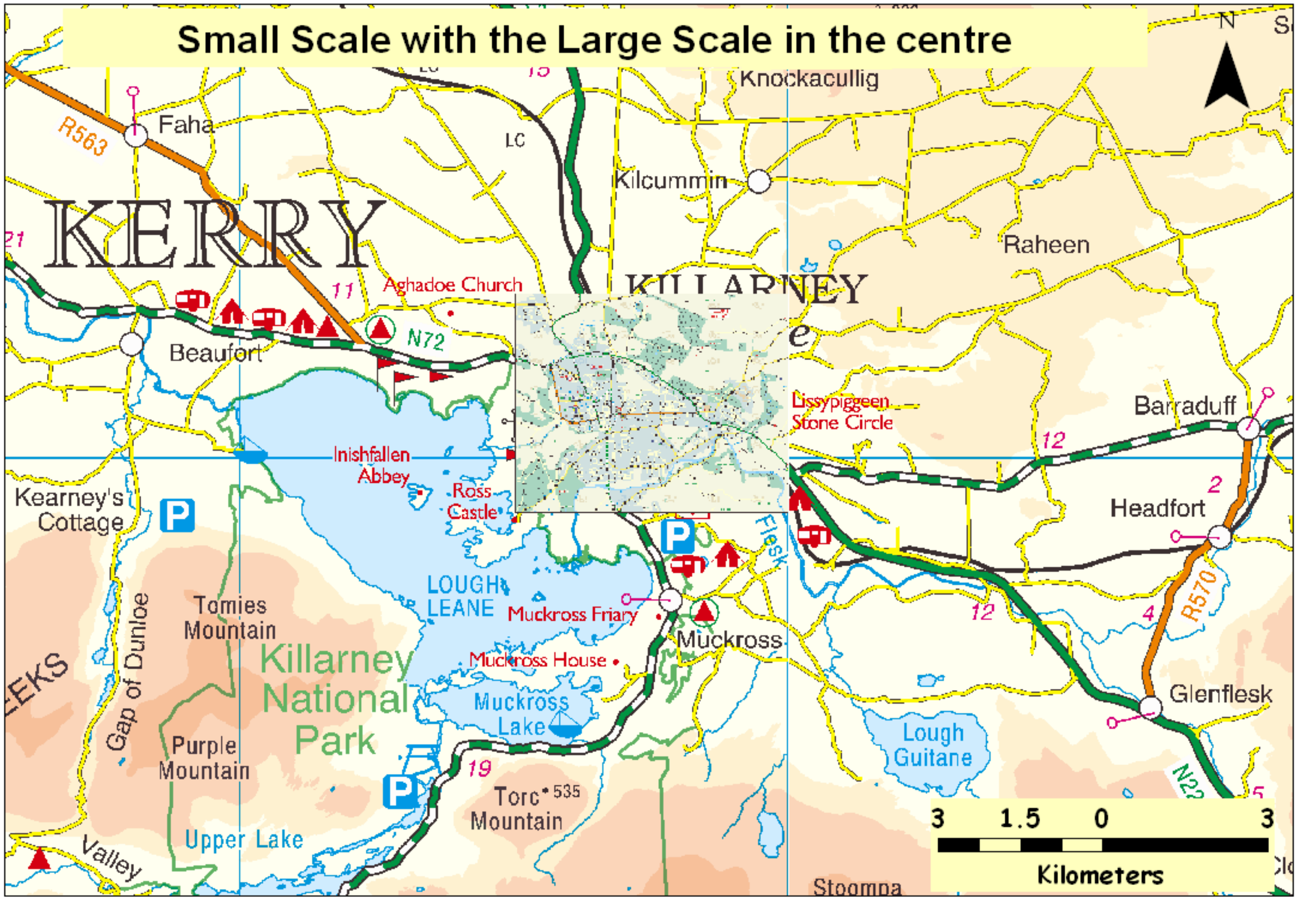
A small fraction

A small amount of data and information on a map

Small Scale

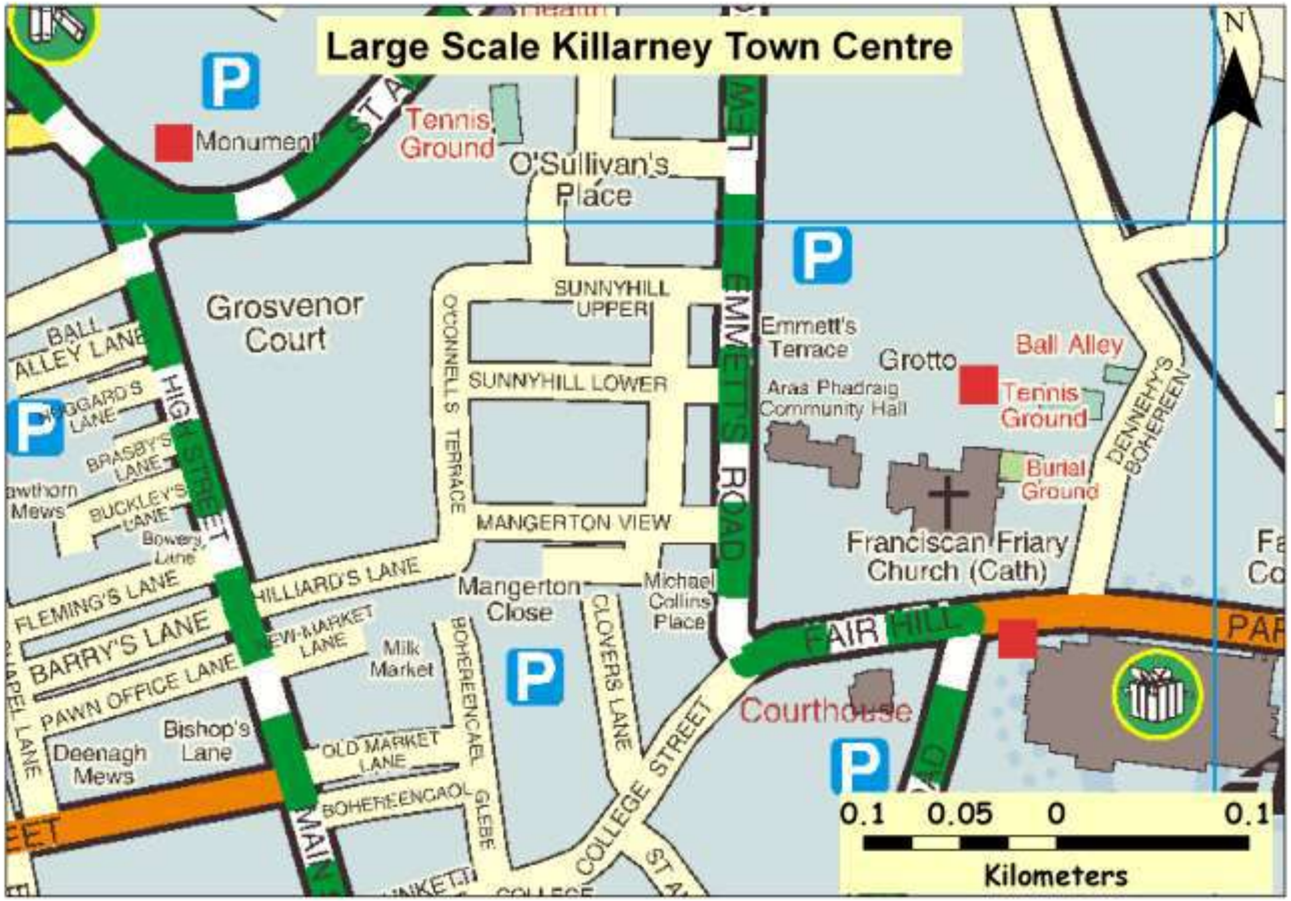
The small scale map above shows the town of Killarney and the surrounding area. It is an ideal map for somebody who wants to travel through and outside the town.

How does Small Scale Compare to a Large Scale Map?



The large scale map looks very hard to read as it contains an awful lot of detail and information. Large scale is best for concentrating on a small area like Killarney

Large Scale



This type of map would be ideal if you wanted to see how to get from High Street to the train station. So, it is a good scale map to use if you wanted to have a lot of detail for a local neighbourhood.

The main points about large and small scale.

- It is important to note the following:
  - Large fraction=large scale=covering a small area.
  - Small fraction=small scale=covering a large area.

How representative fractions of scales are created…

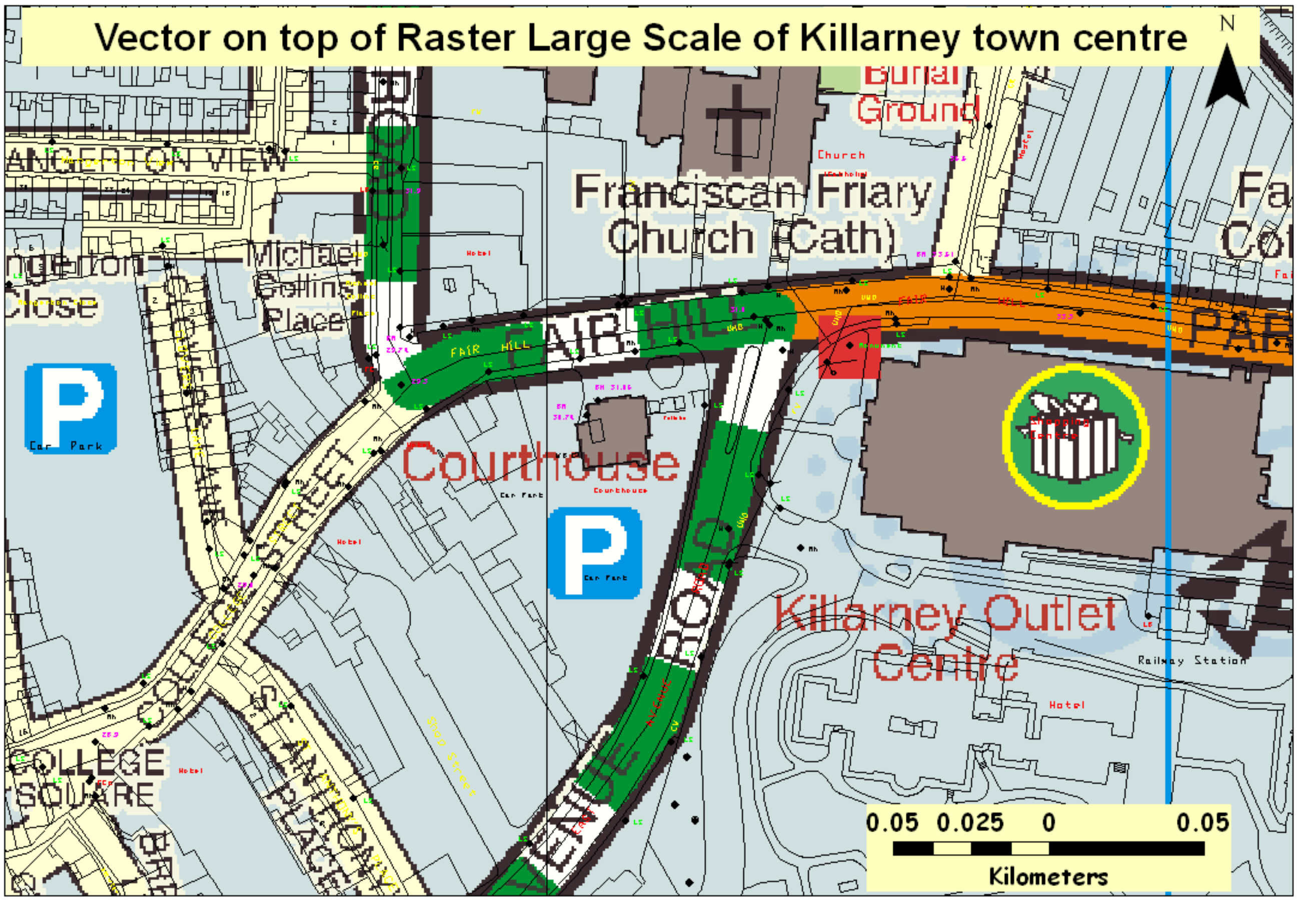
- The method in which a scale is represented on a map originates from comparing the inches on a map to its mile equivalent on the ground.
- 1 inch on a map = 1 mile on the ground.
- As there are 63,360 inches in 1 mile the above can be displayed as the representative fraction 1:63,360.

Various names for a sample of map scales

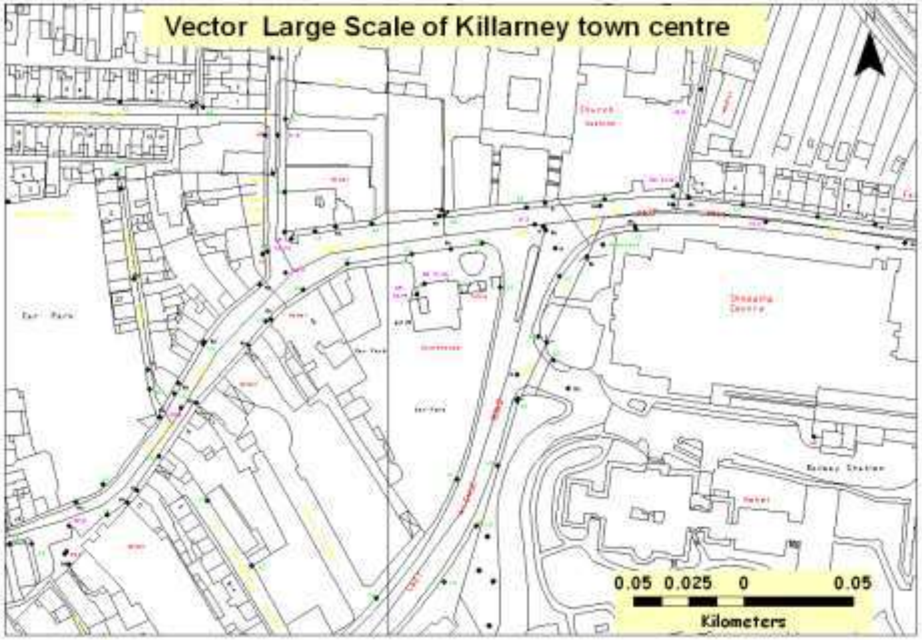
Past	Scale Type
• ¼ inch = 1 mile	
1:253,440	Small Scale
• ½ inch = 1 mile	
1:126,720	Small Scale
• 6 inch = 1 mile	
1:10,560	Large Scale
Present	
• 1:250,000	Small Scale
• 1:50,000	Small Scale
• 1:1,000	Large Scale

6inch maps are still presently available.

What do Vector and Raster look like on Large Scale Maps?



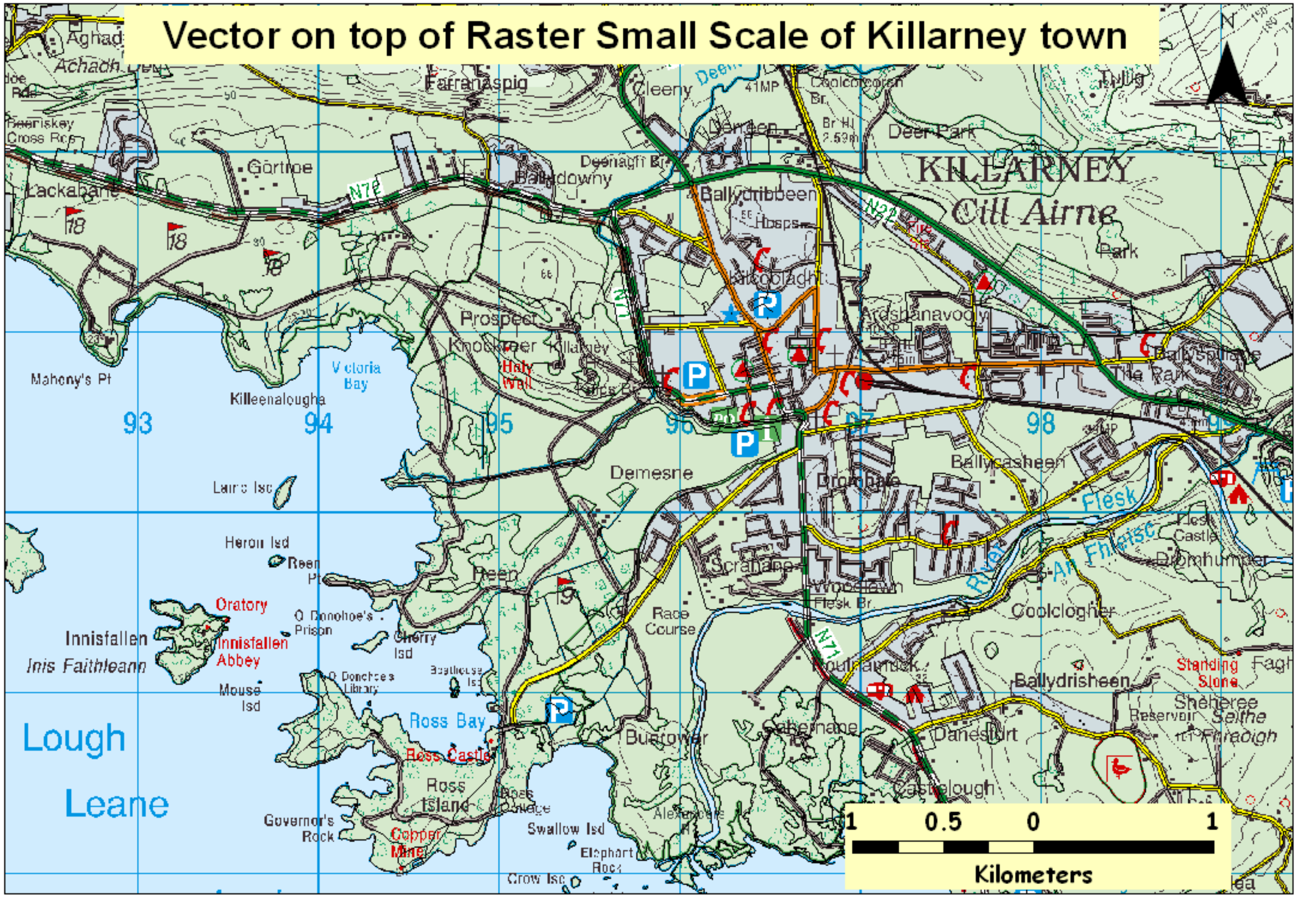
Here the vector is placed over the raster. Raster is the chunky part of the maps and the vector is the combination of points, edges and faces.



Vector maps show a great amount of detail. Vector can also be manipulated into looking more reader friendly as well as being more intelligent than raster.

Raster Maps are visually more attractive.

What do Vector and Raster look like on Small Scale Maps?



Raster Small Scale of Killarney town