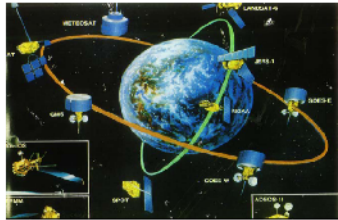


# Introduction to Remote sensing and applications



อ.ดร.วีระเกษมทร สวนผลา

D.Eng(RS&GIS)

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## What is Remote Sensing ?

“Remote Sensing is defined as the science and technology by which *characteristics* of objects of interest can be identified without direct contact”

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## Contents

- **Concept of Remote Sensing**
- **Overview of Remote Sensing Technology**
- **Application of Remote Sensing**

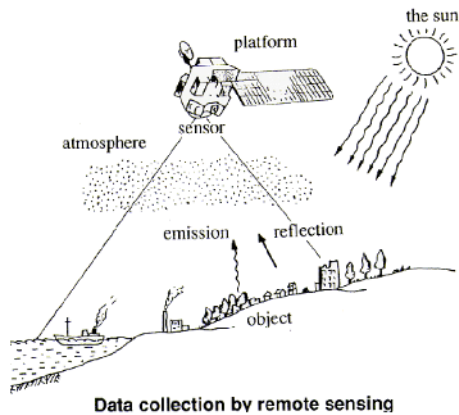
2

## Type of remote sensing

- Optical remote sensing
  - High resolution (Quick bird, IKONOS, LANDSAT, SPOT, **THEOS (Thailand Earth Observation System)** )
  - Moderate or Low resolution (Terra-MODIS,NOAA)
- Non Optical remote sensing (Microwave)
  - Passive Sensor
  - Active Sensor
    - Synthetic Aperture Radar (SAR)
    - Real Aperture Radar (RAR)
    - Synthetic Aperture Radar Interferometry (InSAR)

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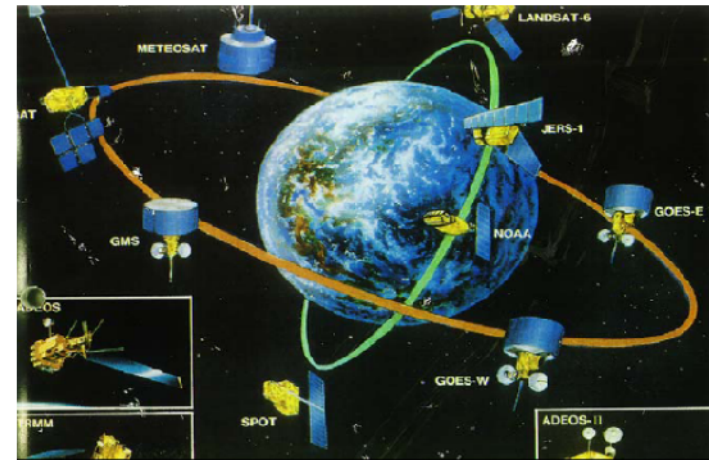
# Remote Sensing System



**Satellite Remote Sensing - Earth Observation**  
**Broad Area**

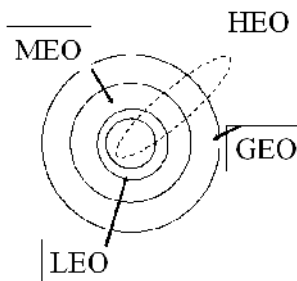
**Quick,**  
**180 km x 180 km**  
**30 sec**  
**Repetitive**

# Polar Orbit Satellite and Geostationary Satellite

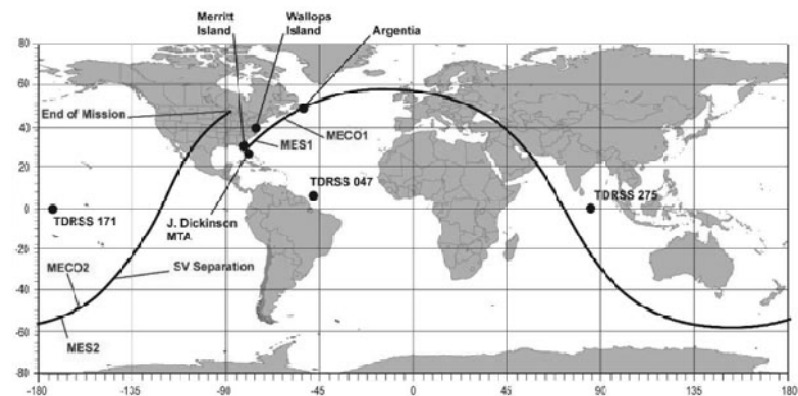


# Architecture of orbital system

- **Low earth orbit (LEO)**  
 →  $T < 25 \text{ min}$ ,  $h < 6,000 \text{ km}$   
 → Earth sensing, some communication Human space flight
- **Medium earth orbit (MEO)**  
 →  $225 \text{ min} < T < 24 \text{ hr}$ ,  $6,000 \text{ km} < h < 36,000 \text{ km}$   
 → some earth sensing, navigation (military)
- **Geo-stationary orbit (GEO)**  
 →  $T = 24 \text{ hr}$ ,  $h = 36,000 \text{ km}$   
 → geosynchronous, geostationary
- **Higher Earth orbit (HEO)**  
 →  $T > 24 \text{ hr}$ ,  $h > 36,000 \text{ km}$   
 → moninya orbit (military, communication)

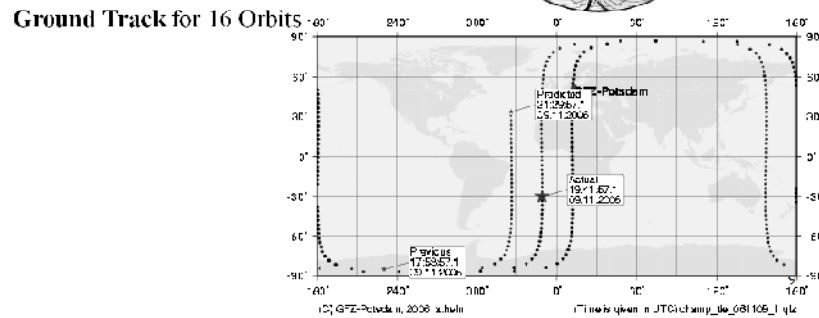
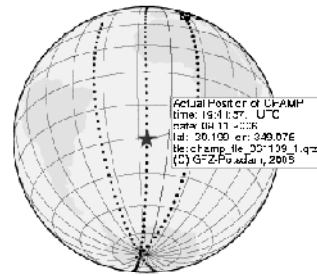
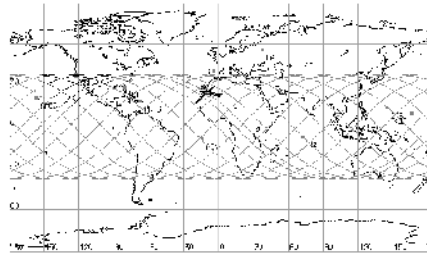


# Ground track

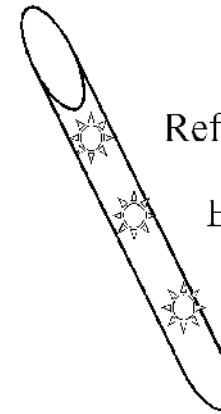


How height you can go?

launch site



## What Does a Sensor Measure?



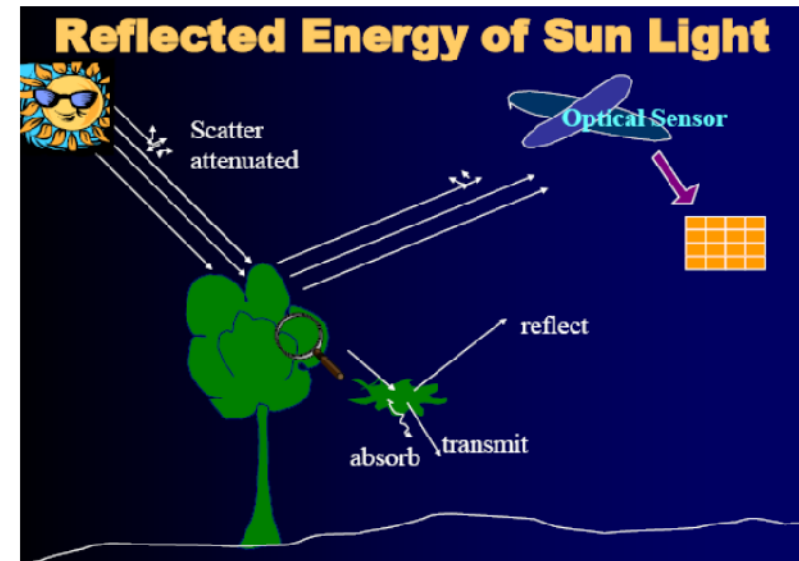
Reflected energy from the Earth

Emitted energy from the Earth

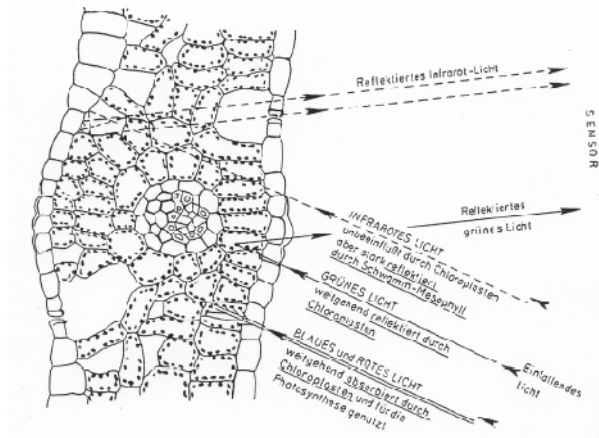
Scattered Energy from the Earth

## Several Important Numbers

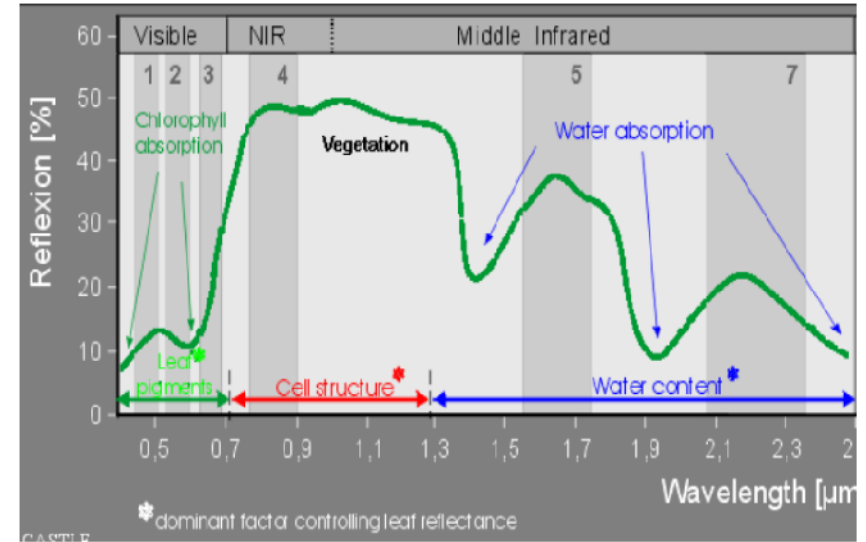
- Radius of Earth approx. 6,300km  
( $a=6377$ ,  $b=6356$ , Bessel)
- Altitude of Polar Orbit Satellite •300km - 900km
- Landsat 705km, JERS-1 568km, SPOT 822km, NOAA 833-870km
- Altitude of Geo-stationary Satellite 35,800km
- Speed of light 300,000km/sec
- Speed of Satellite ( relative to the earth )
- 6.5km/sec = 23,400km/hour, Jet Passenger Aircraft 900km/h



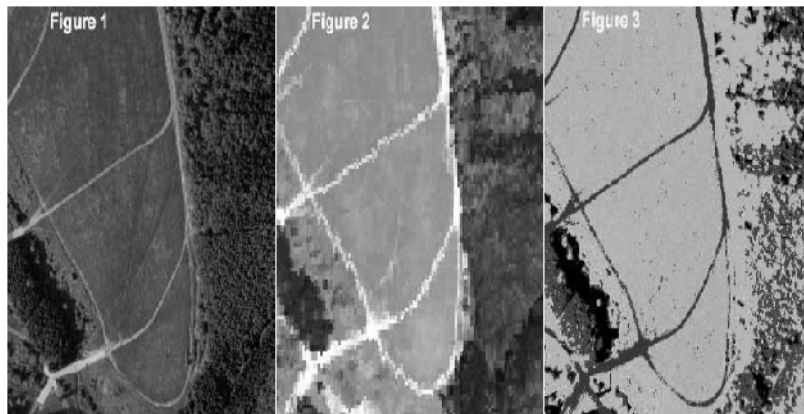
## Reflexionseigenschaften von Vegetation



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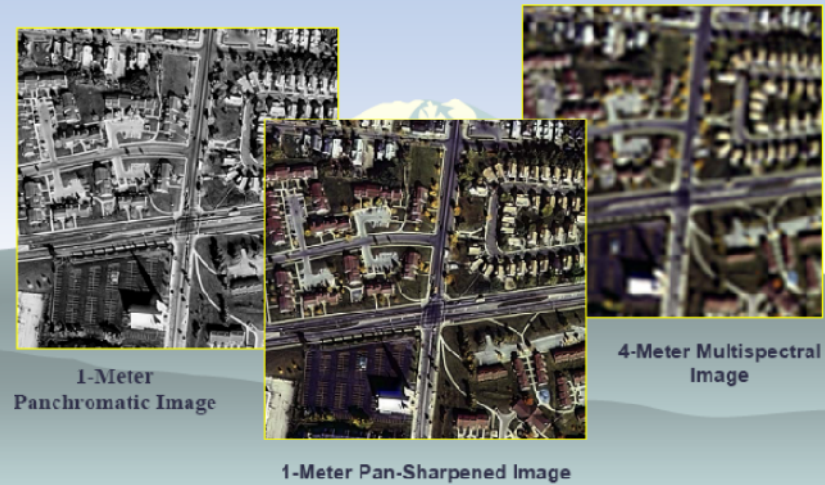
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## Optical Remote sensing

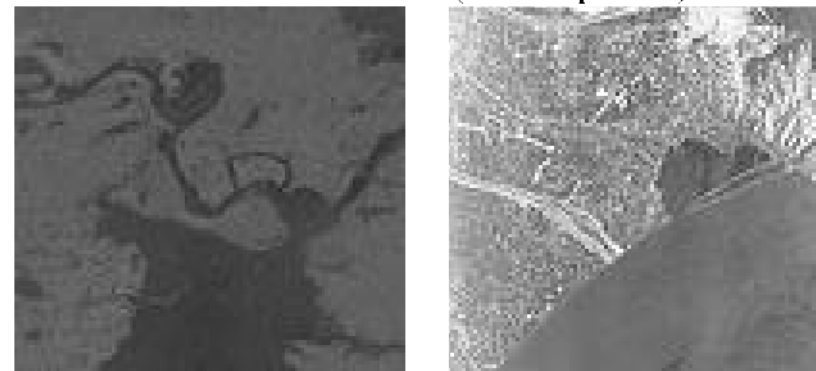


Landsat 7 ETM+ Image around Lake Titicaca, Bolivia/Peru

## Pan-sharpened imagery – Ikonos example

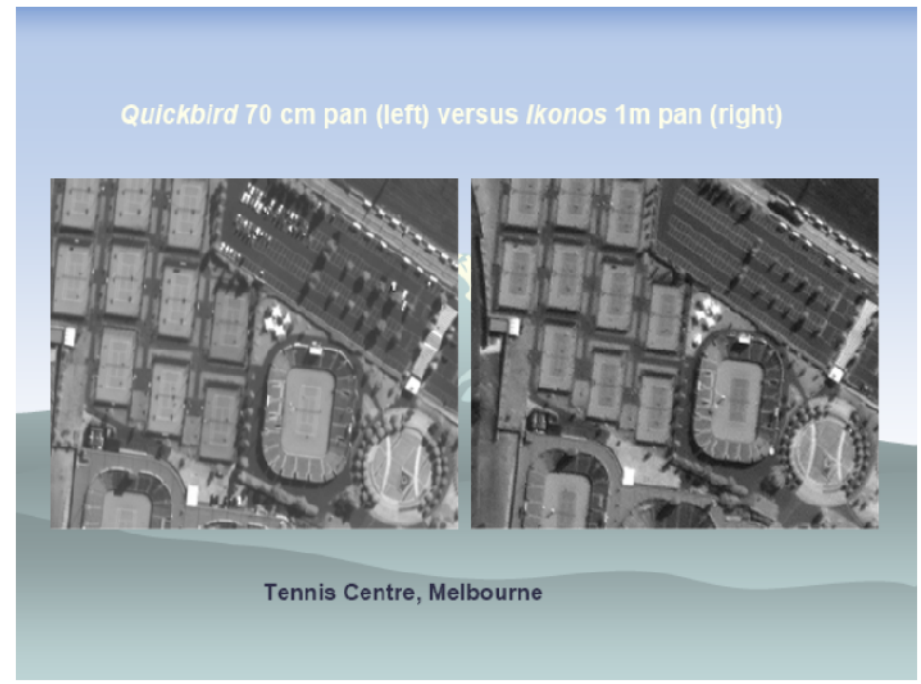
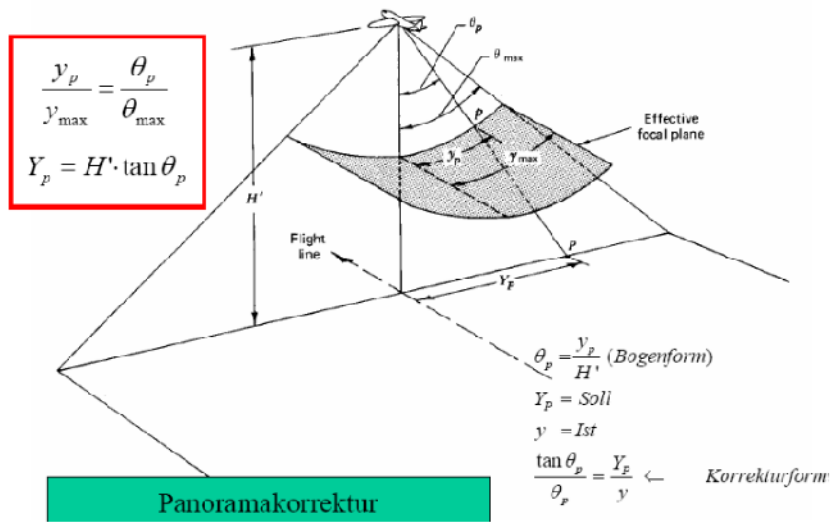
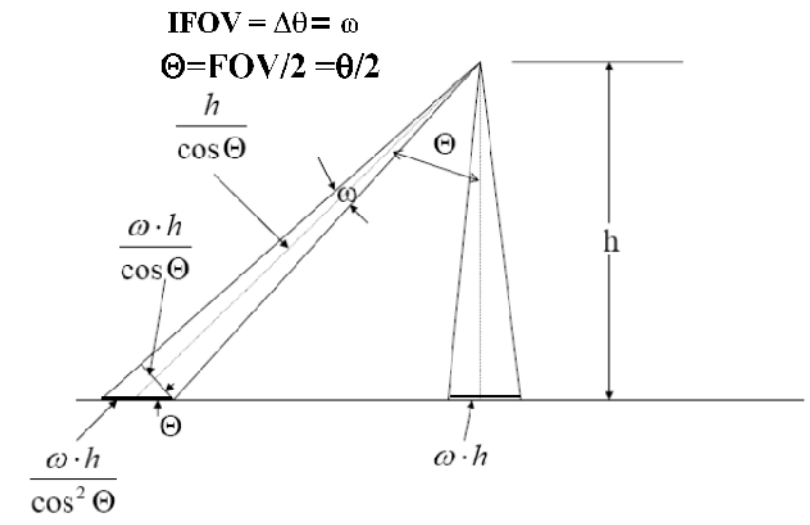
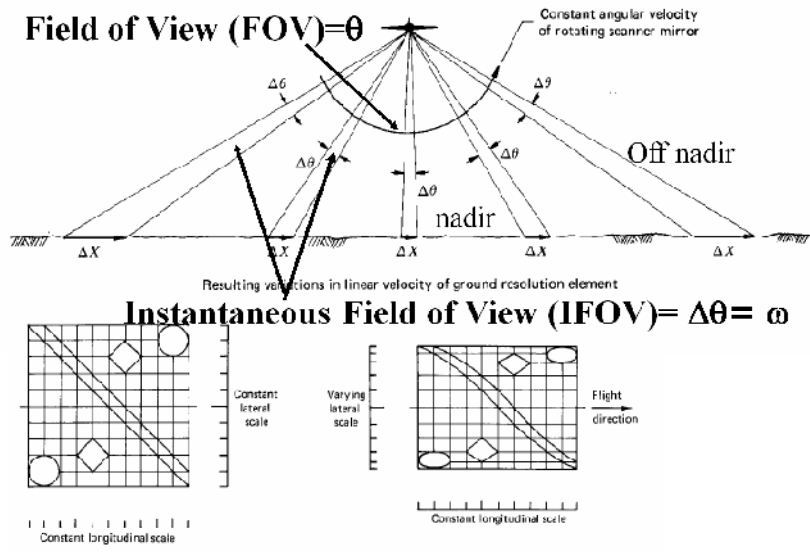


## Microwave-RS (Non optical)



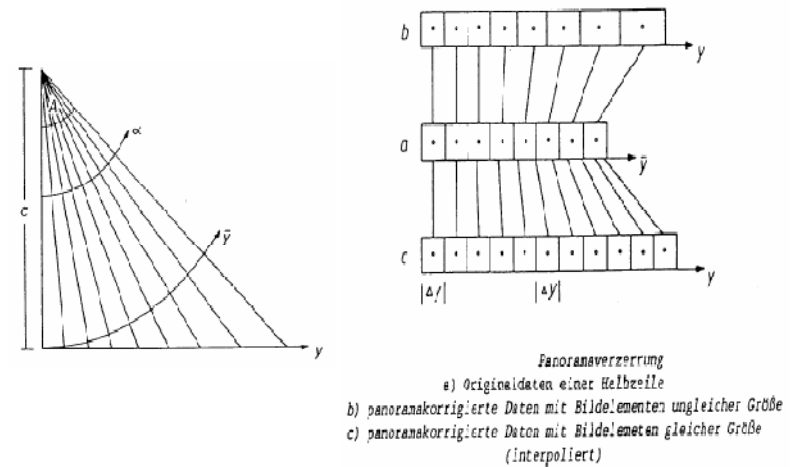
JERS1-OPS  
(Optical sensor)

JERS1-sar  
(active microwave sensor)



## Comparison between IKONOS and Quickbird

◆ Item	IKONOS	Quickbird
◆ Focal Length	10m	9m
◆ Altitude	680km	450km
◆ No of pixel/l	13,800	27,500
◆ FOV	0.93deg.	2.1deg.
◆ Resolution	0.82m	0.61m
◆ Coverage	11x11km	16.5x16.5km
•IFOV	1.206 $\mu$ rad.	1.356 $\mu$ rad.



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## Example

1. ถ้าต้องการถ่ายภาพให้ได้ความชัดถึง 10 cm (nadir). จะต้องให้ดาวเทียม quick bird ถ่ายภาพที่ระดับความสูงเท่าใด ถ้าปัจจุบัน sensor altitude = 450 km. Res.=0.60 m

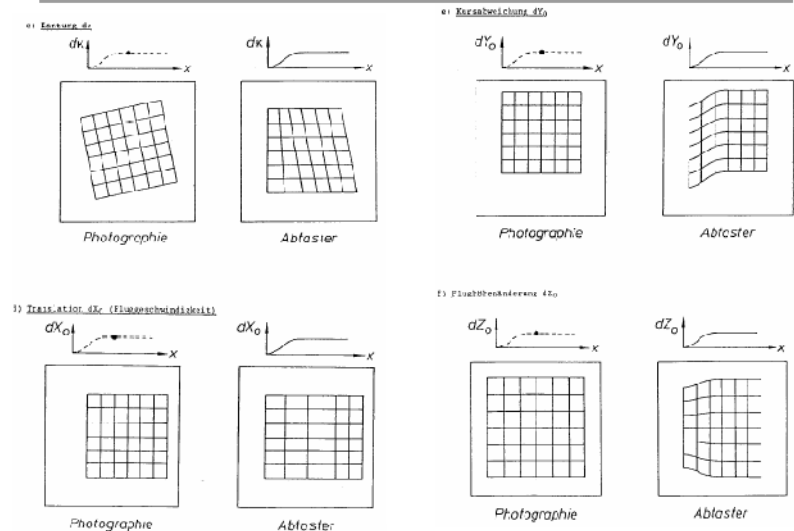
Ans. 75 km impossible.

2. ดาวเทียมดวงหนึ่งถ่ายได้ละเอียดที่ 80 cm (nadir). sensor อยู่สูงเท่าใดและบริเวณไกลสุด off nadir จะถ่ายภาพของวัตถุได้อย่างชัดที่สุดเมื่อวัตถุมีขนาดเท่าใด ถ้าปัจจุบัน IFOV=1.0  $\mu$ rad. FOV =90  $^{\circ}$

Ans.  $h=0.8/1 \times 10^{-6}=800,000$  m. = 800 km  
 $Res' = 0.8 / \cos^2(90/2) = 1.6$  m.

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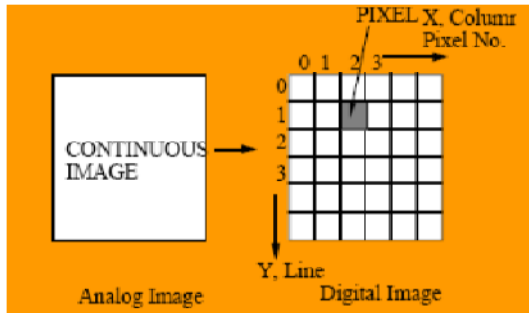
## Parametrische Entzerrung (Forts.)



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# Digital Image Data Pixel

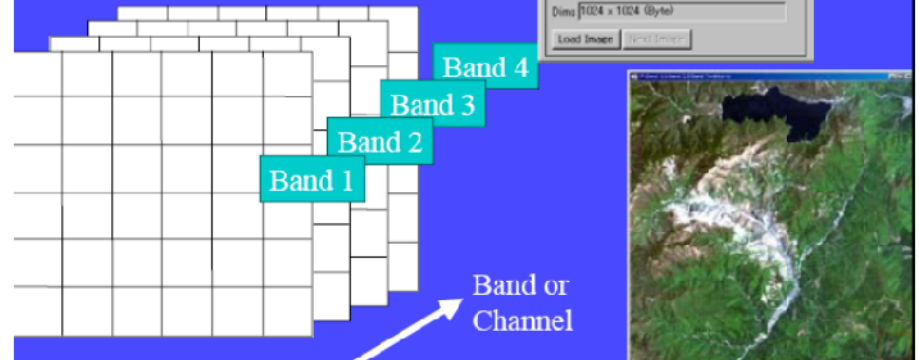
Pixel (Picture Element) ,pixel has a value  $f(x,y)$   
 $x,y$ :integer,  $f$ : brightness in most case, integer



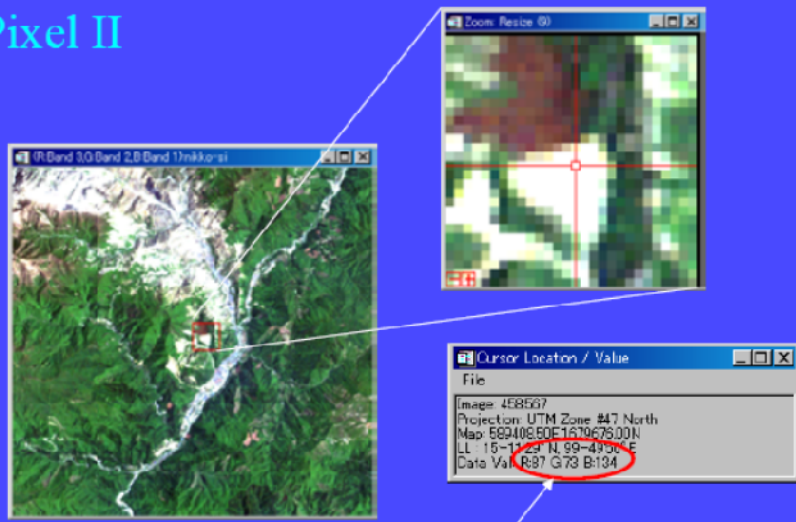
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# Multi Channel Image

Color Image: 3 channel for R,G,B  
 Landsat TM 7 Channel



# Pixel II



Pixel Value

# Bit and Binary System

- The gray level of each pixel is recorded and stored as finite number of bits
- If there are  $k$  bits/pixel, total of  $2^k$  gray levels over the range 0 to  $2^k-1$
- Example of 3 bits image

Bit2	Bit1	Bit0	Gray level	Bit2	Bit1	Bit0	Gray level
0	0	0	0	1	0	0	4
0	0	1	1	1	0	x	5
0	1	0	2	1	0	0	x
0	1	1	x	1	1	x	7

If  $k=8$ , the group of bits is called "byte".

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# Binary system in computer memory

Pixel value is stored in limited space in a computer memory, 1 unit = 1 byte = 8 bits  
 8 bits has  $2^8 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 256$   
 Combinations of on/off at bits.

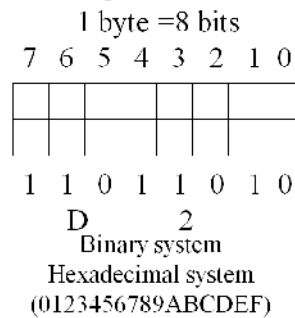
Thus k bits unsigned integer has 0 to  $2^k - 1$  of data range.

8 bits(1 byte)/ pixel 0 to 255  
 16 bits(2 bytes)/pixel 0 to 65535

1024 bytes = 1kB  
 1024 kB = 1MB  
 1024 MB = 1GB  
 1024 GB = 1TB

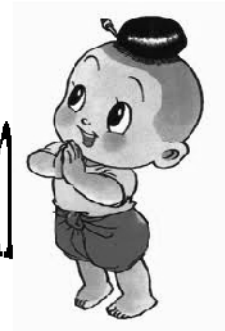
Image size in Bytes

1024 width x 1024 height x 7 bands/1 byte/pixel → 7 MB



Question?

Thank you for your kind attention



## Reference:

Assoc.Prof.Dr.HONDA Kiyoshi, Lecture Note .School of Engineering and Technology ,AIT Thailand.

### Suggested Web Sites:

- AUSLIG (<http://www.auslig.gov.au/>)
- Space Imaging (<http://www.spaceimage.com/>)
- Australian Bureau of Meteorology  
 (<http://www.bom.gov.au/sat/intro/paper1intro.shtml>)
- JPL Radar Site (<http://www.jpl.nasa.gov/radar/sircxsar/>)
- Australian geological Survey Organization  
 (<http://www.agso.gov.au/>)