Introduction to Remote Sensing

P. CHANDRASEKHAR
Training & Education Group,
TEOG, MSA, NRSC/ISRO

THE STORY BEGINS

FIRS
1963

"THERE ARE SOME WHO QUESTION THE RELEVANCE OF SPACE ACTIVITIES IN A DEVELOPING NATION …..

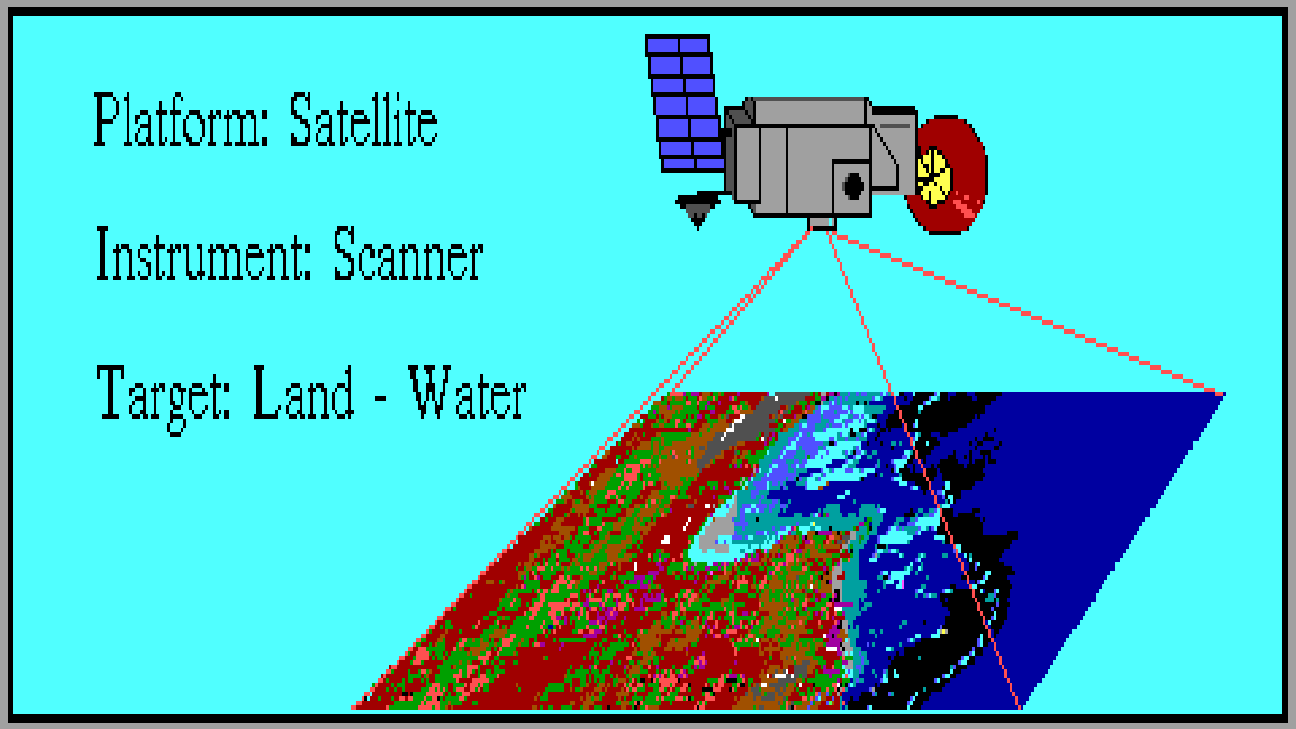
…….IF WE ARE TO PLAY A MEANINGFUL ROLE NATIONALLY, AND IN THE COMITY OF NATIONS, WE MUST BE SECOND TO NONE IN THE APPLICATION OF ADVANCED TECHNOLOGIES TO THE REAL PROBLEMS OF MAN AND SOCIETY"

THUMBA

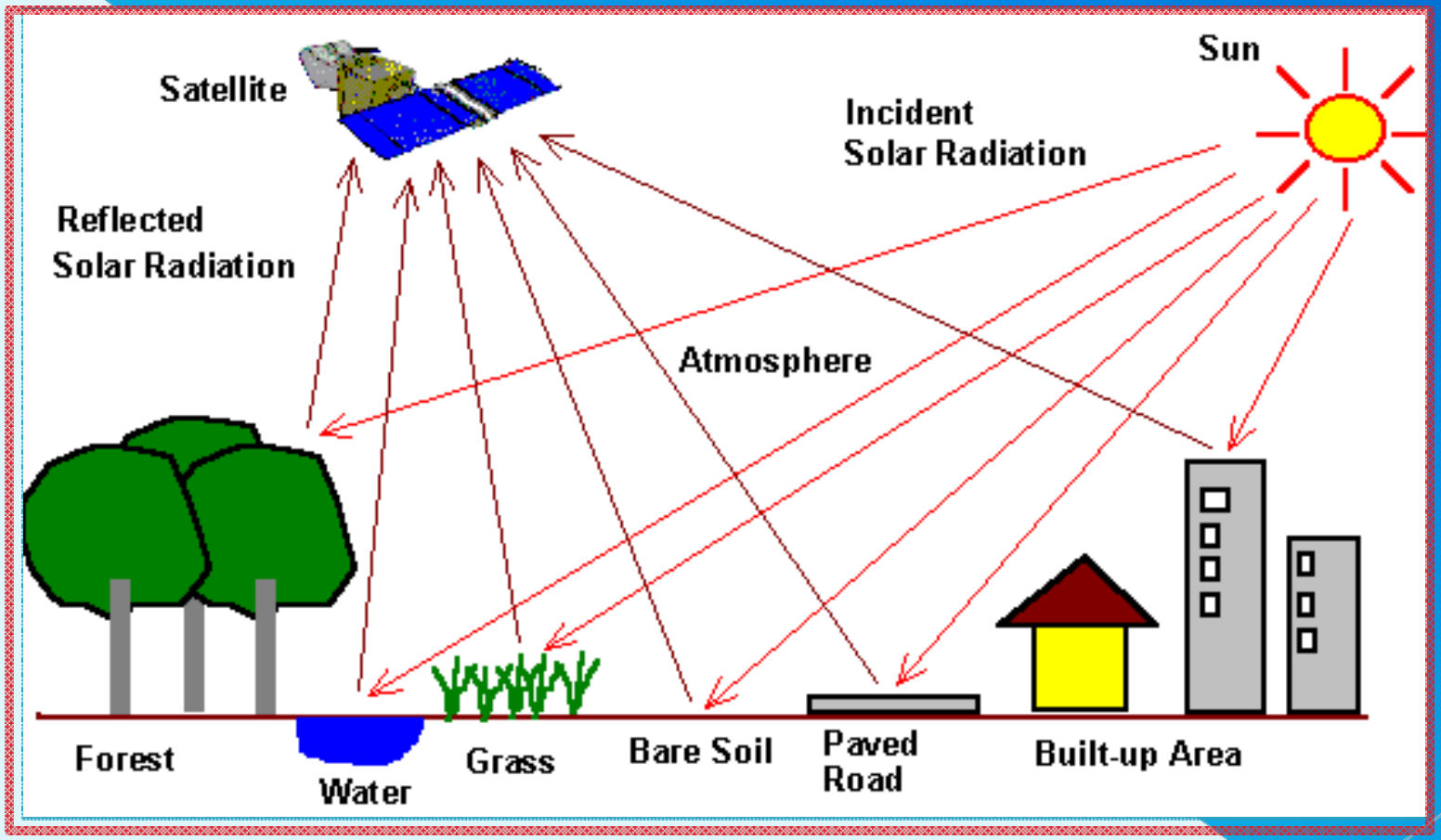
AND THE VISION…

What is Remote Sensing ?

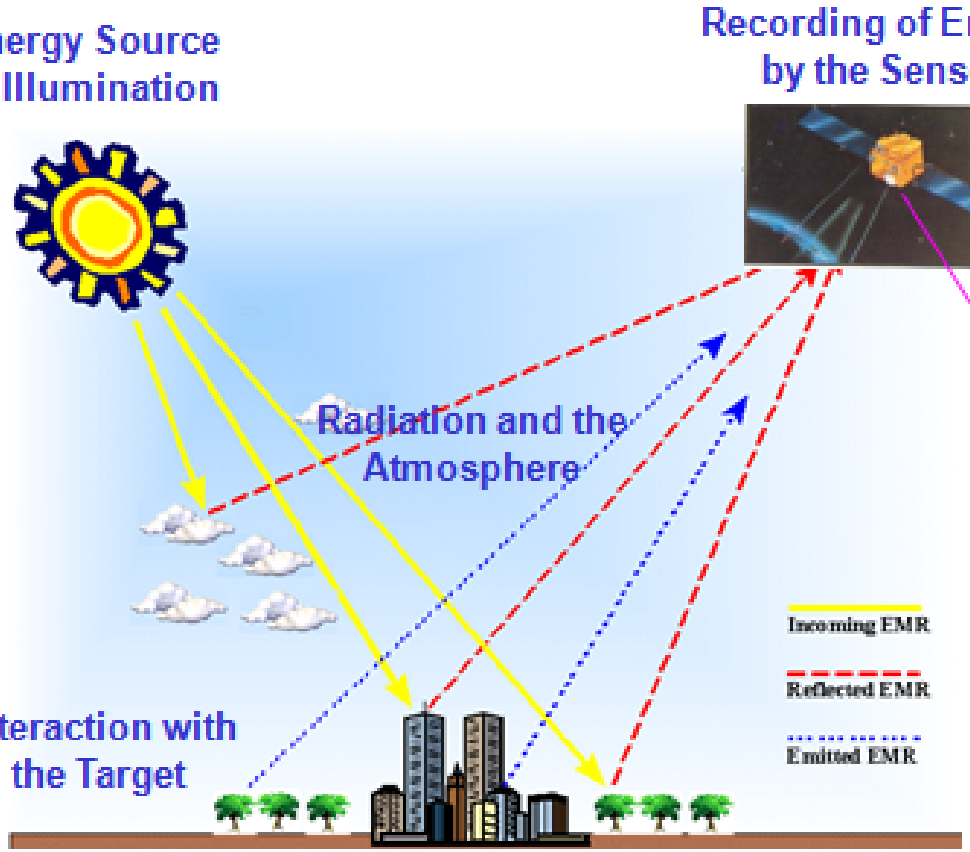
Information is gathered by instruments carried on suitable platforms. The information is used to study targets of interest on the Earth's surface.



Introduction to Remote Sensing



The process of Remote Sensing



Transmission

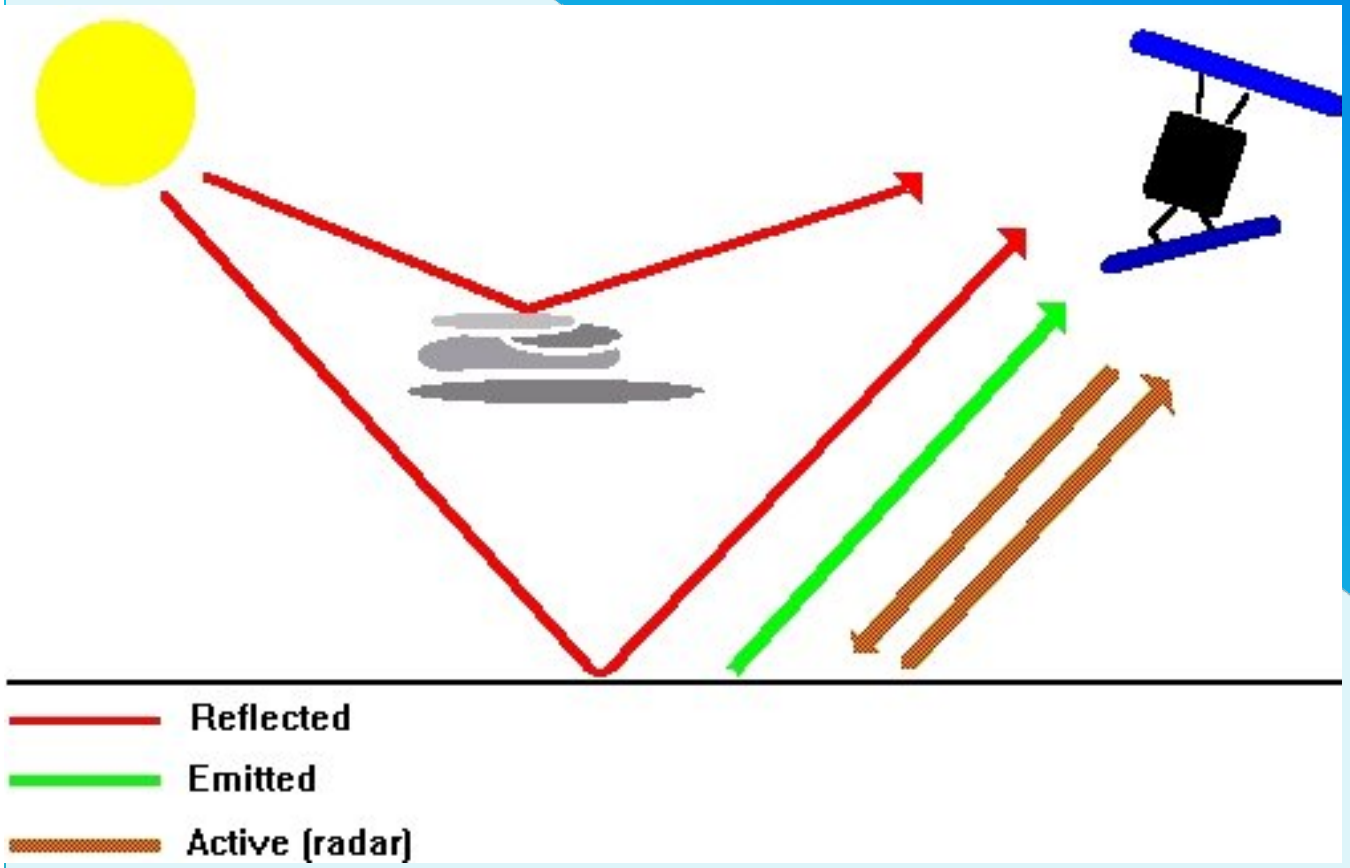
Interpretation, Analysis & Application

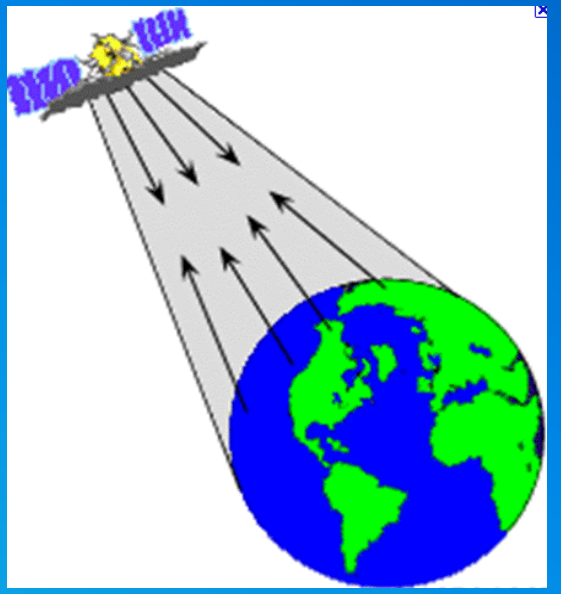
Reception & Processing

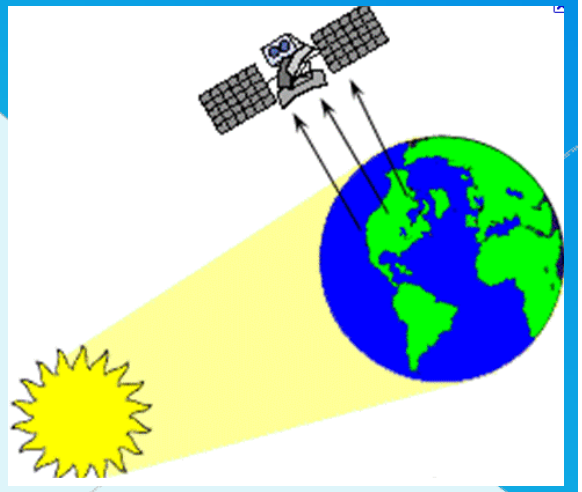
Advantages:

- Ability to provide data of inaccessible areas
- Provides global coverage
- Repetitive coverage of same area that helps study on temporal scale
- Helps to derive precise information
- Thematic maps such as Land Use/Land Cover, Forest type, Agriculture, Soil, Geology maps could be derived from Satellite data

Remote Sensing is of two types- Active and Passive Remote Sensing

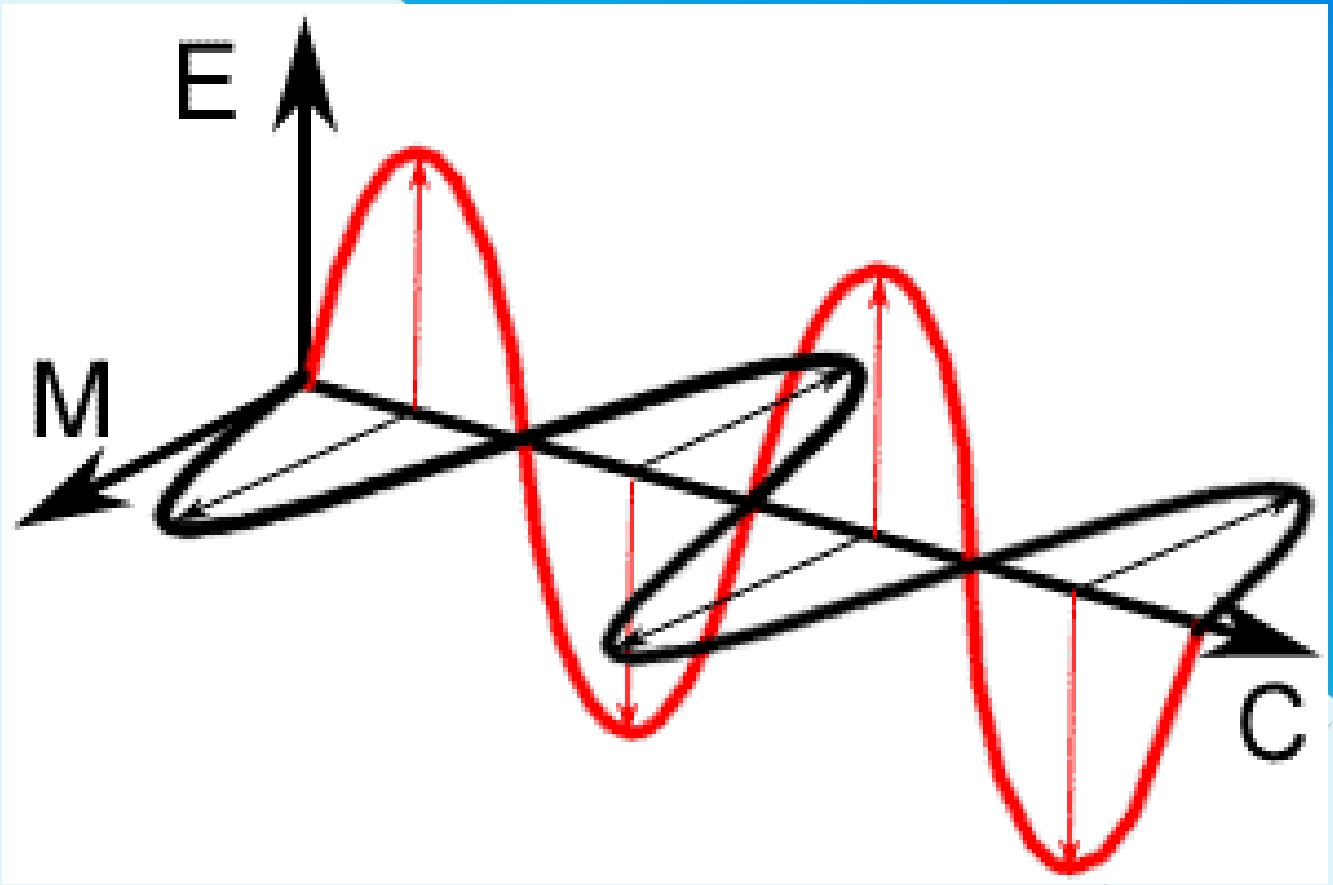




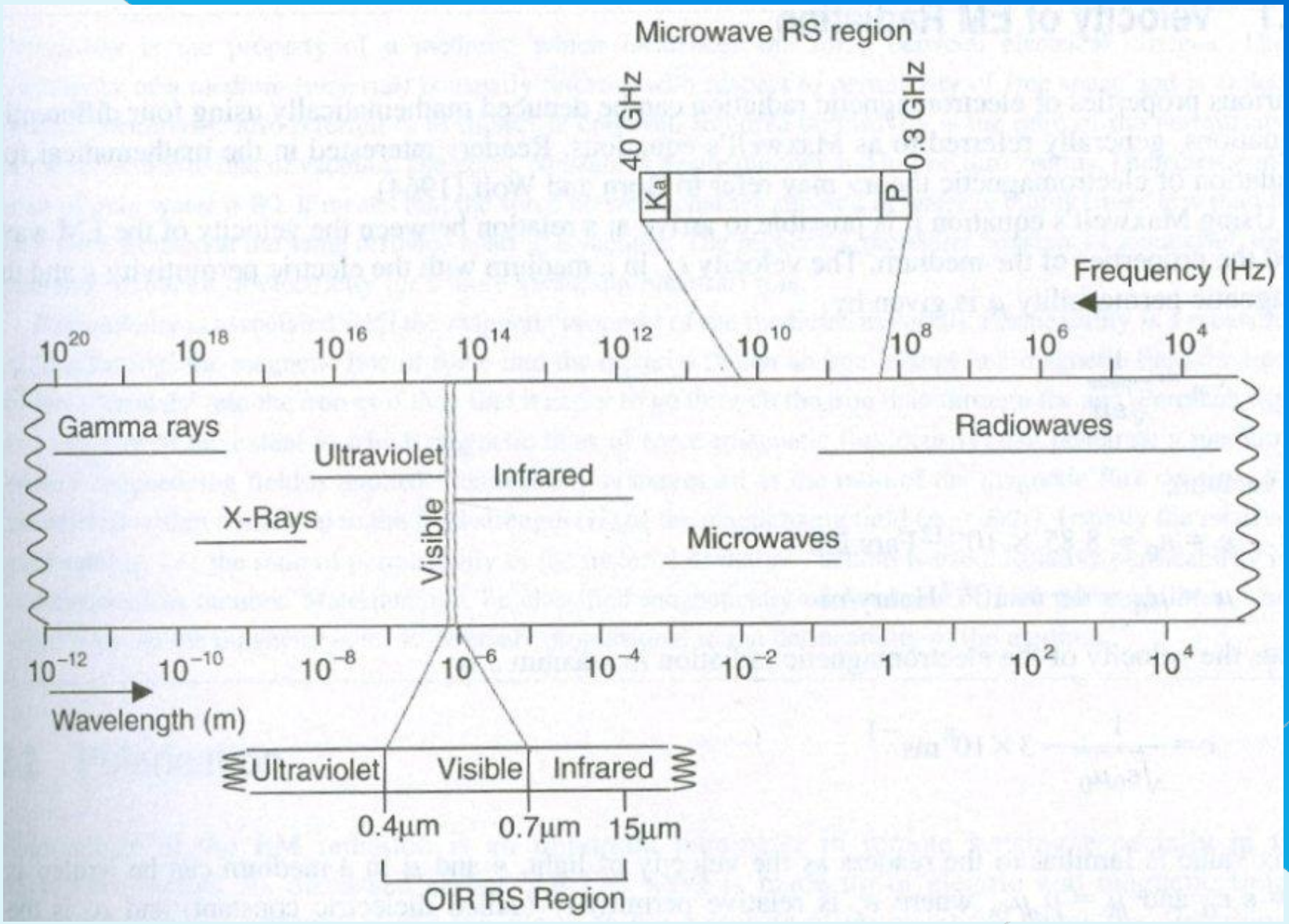


Electromagnetic (EM) Radiation

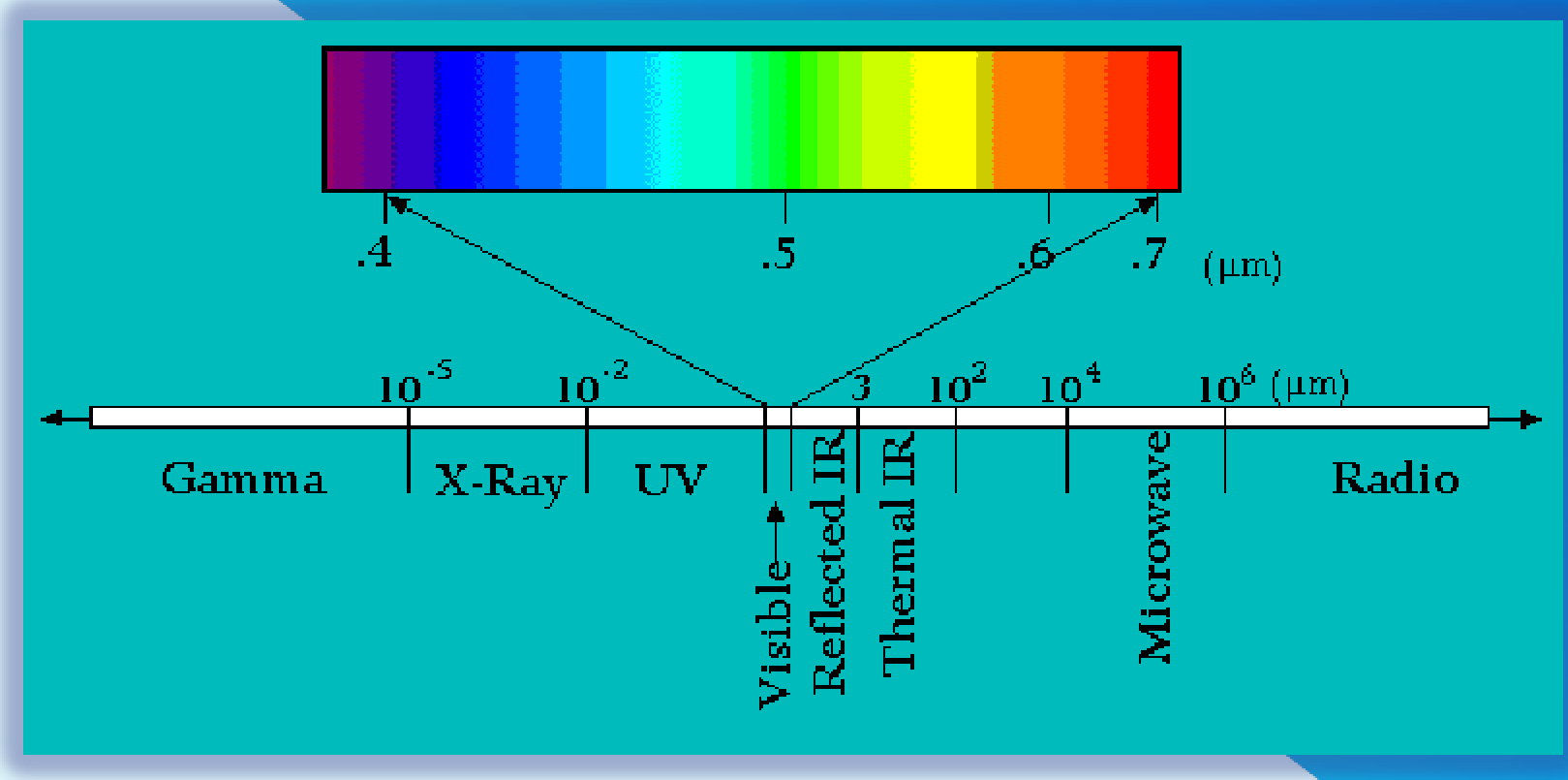
Motion of charged particles produce EM waves.
Changing electric fields are set up by the oscillation of charged particles. Changing electric fields induce changing magnetic fields. Changing magnetic fields in turn set up more changing fields and so on.



THE ELECTROMAGNETIC SPECTRUM



What can satellites see?



Satellite electromagnetic sensors let us "see" beyond the visible...

Optical Infrared (OIR) Region

Visible		0.4 – 0.7 µm
Near Infrared (NIR)	Reflective OIR	0.7 – 1.5 µm
Shortwave Infrared (SWIR)		1.5 – 3 µm
Mid-wave Infrared (MWIR)		3 – 8 µm
Long wave Infrared (Thermal Infrared (TIR))		8 – 15 µm
Far Infrared (FIR)		Beyond 15 µm

Microwaves

P band	0.3 – 1 GHz (30 – 100 cm)
L band	1 – 2 GHz (15 – 30 cm)
S band	2 – 4 GHz (7.5 – 15 cm)
C band	4 – 8 GHz (3.8 – 7.5 cm)
X band	8 – 12.5 GHz (2.4 – 3.8 cm)
Ku band	12.5 – 18 GHz (1.7 – 2.4 cm)
K band	18 – 26.5 GHz (1.1 – 1.7 cm)
Ka band	26.5 – 40 GHz (0.75 – 1.1 cm)

Three forms of interaction

I=A+R+T or A/I+R/I+T/I=1 (100%)

ENERGY INTERACTION

Conservation of Energy

When EM energy is incident on any given earth surface feature, three fundamental energy interactions are possible. A fraction of incident energy is reflected, absorbed and / or transmitted.

"Energy is neither created nor destroyed."

Incident energy = reflected energy + transmitted energy + absorbed energy

Energy Interaction

Conservation of Energy

Two points about the conservation of energy relationship:

- The proportions of energy reflected, absorbed and transmitted will vary for different earth features depending on their material type and condition.
- The wavelength dependency. That is, even within a given feature type, the proportion of reflected, absorbed and transmitted energy will vary at different wavelengths.

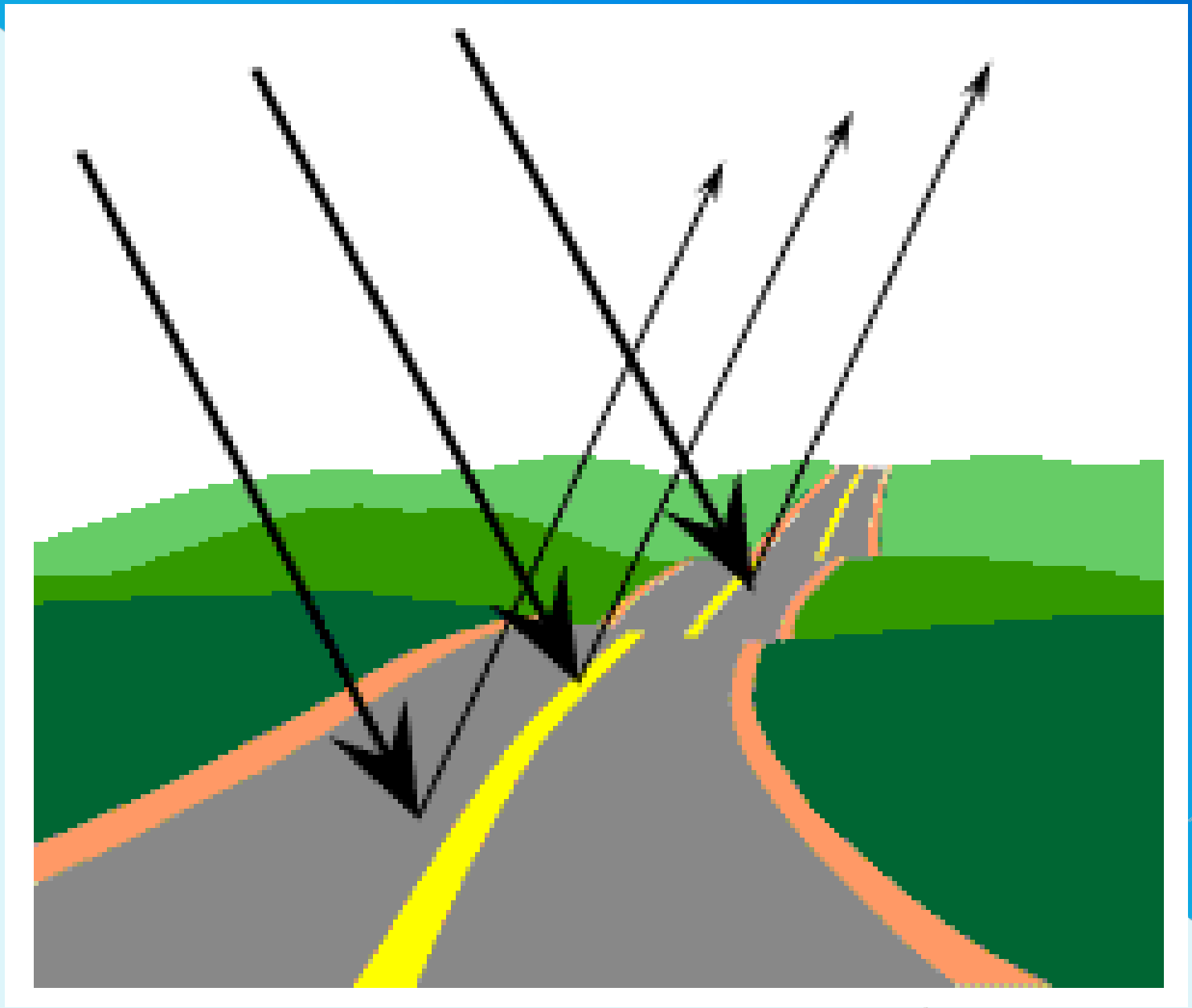
Two features may be distinguishable in one spectral band but not in another wavelength region. That's why we go for multi-spectral coverage.

Energy Interaction

Reflection

- Many remote sensing systems operate in Visible and NIR regions in which reflected energy is more. Hence, the reflectance properties of objects are more important.
- The reflectance is a function of surface roughness (or smoothness) of an object.
- Based on surface roughness, objects are categorized into two classes, 'specular' and 'diffused' reflectors.

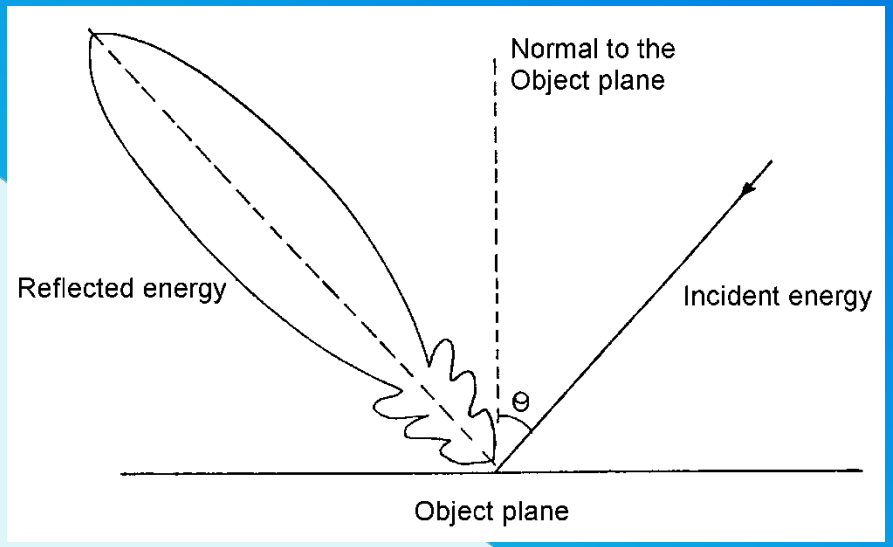
Specular Reflection



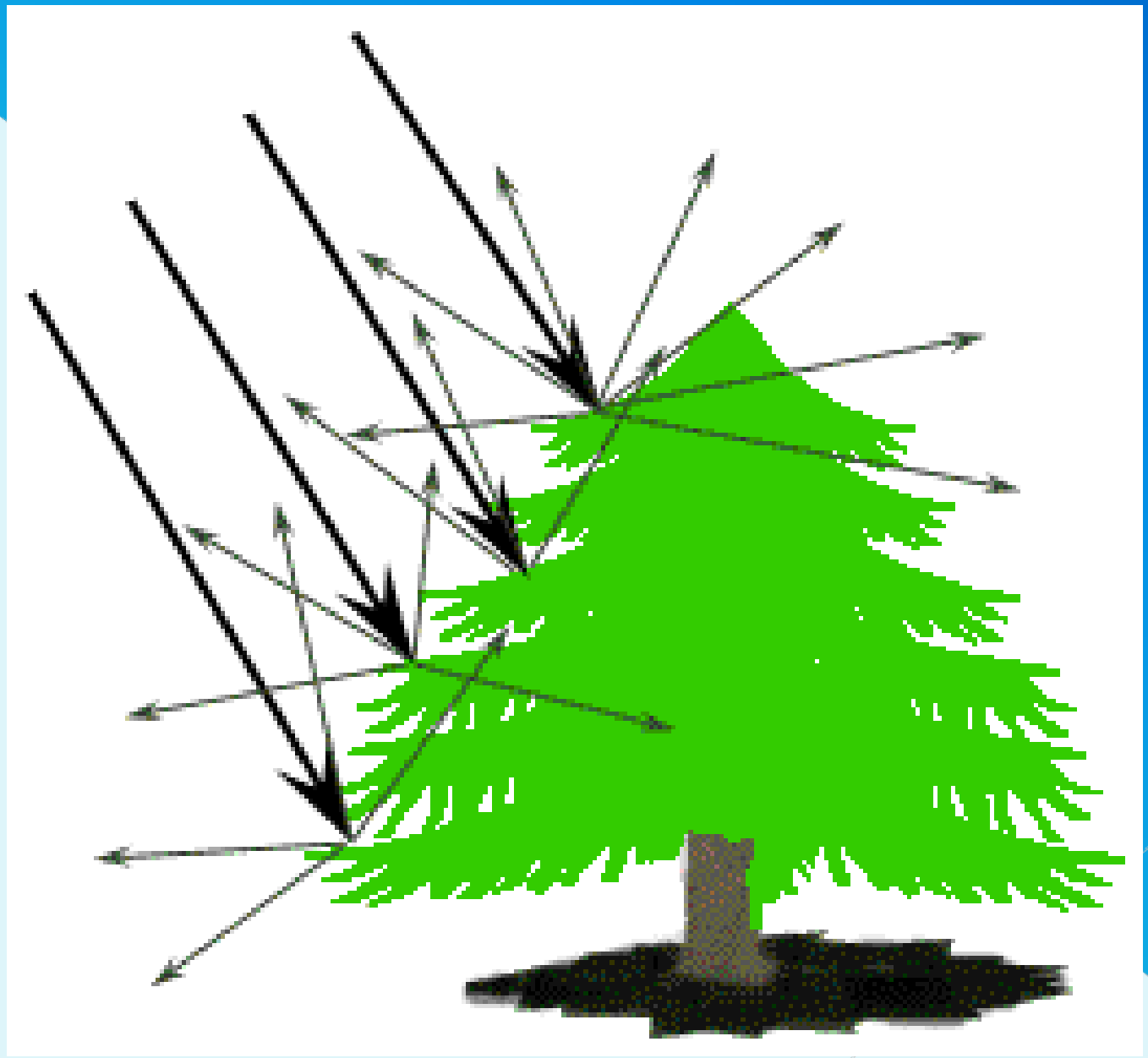
Energy Interaction

Specular reflectors

Objects which produce mirror like reflection are called Specular reflectors.



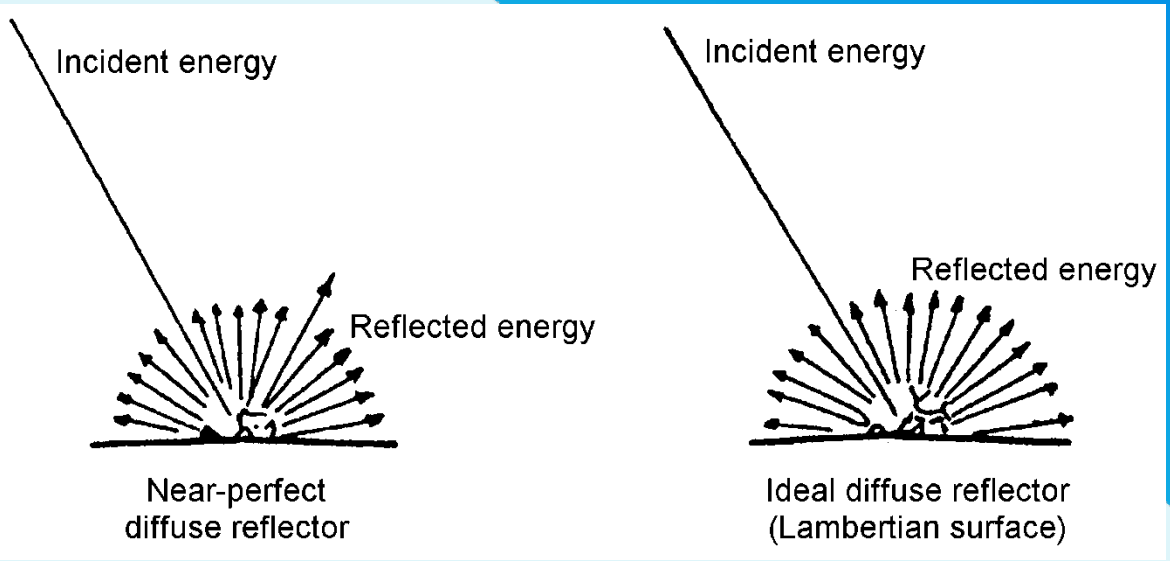
Diffuse Reflection



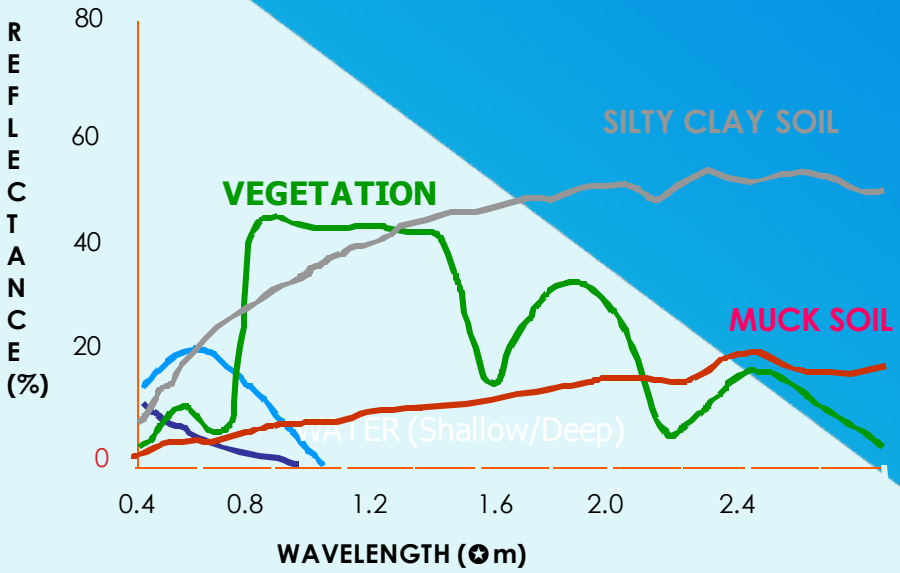
Energy Interaction

Diffuse reflectors

Rough surfaces that reflect uniformly in all directions independent of the angle of incidence are called Diffuse or Lambertian reflectors.

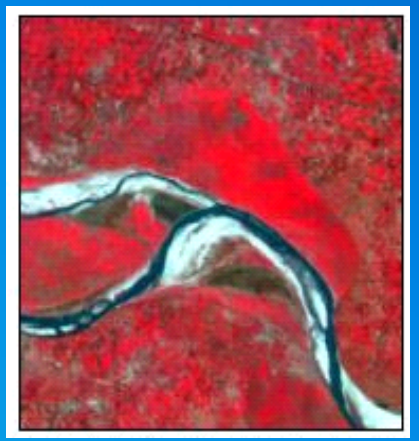


SPECTRAL RESPONSE OF EARTH SURFACE FEATURES

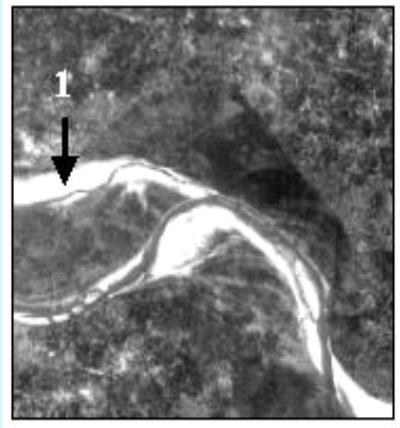


TRUE COLOR COMPOSITE

FALSE COLOR COMPOSITE



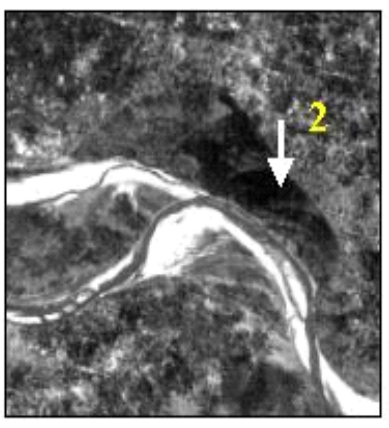
BLUE BAND (0.4-0.5 ✪m)



1- SAND

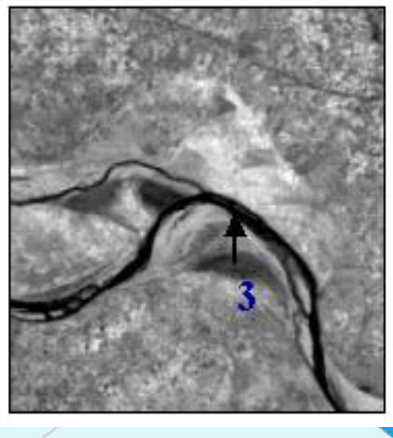
GREEN BAND (0.5-0.6 µm)

RED BAND (0.6-0.7 µm)



2-VEGETATION

NEAR IR (0.7-0.9 µm)



3-WATER

Resolutions in Remote Sensing

Spatial

Spectral

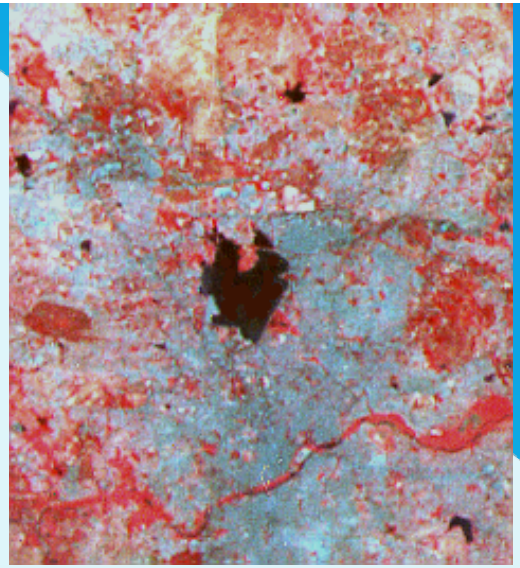
Radiometric

Temporal

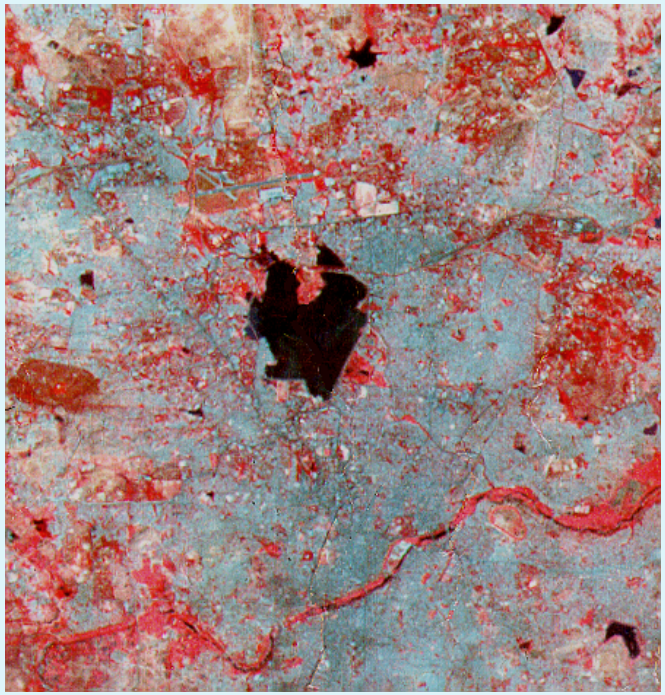
Mission/Sensor specific, cannot be changed during the mission

IRS-LISS-I/LISS-II and LISS-III Images Showing Part of Hyderabad

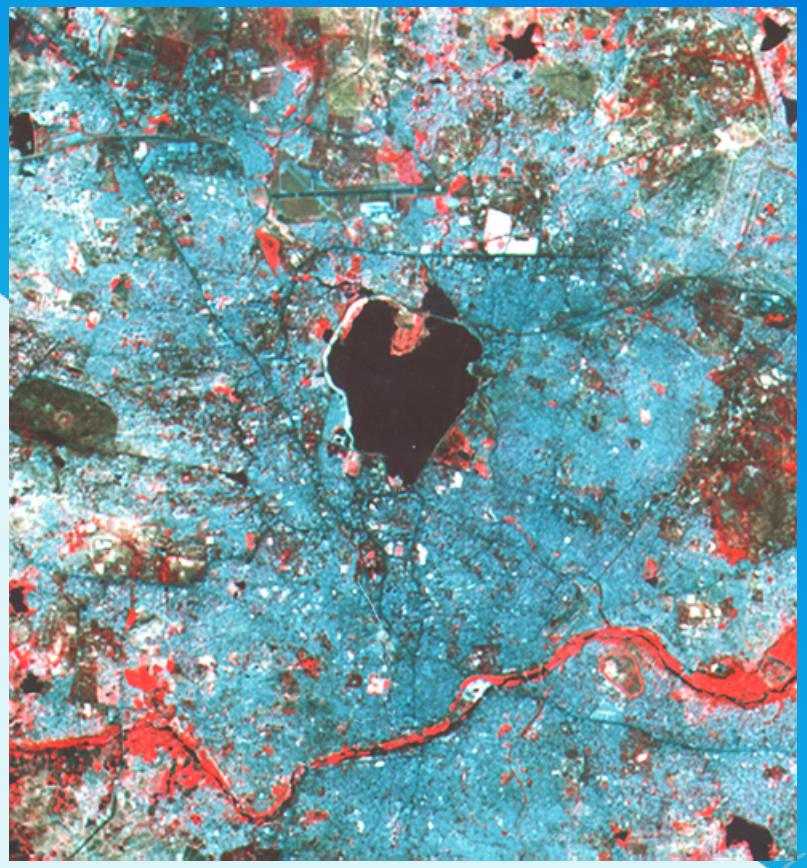
Effect of Spatial Resolution on Image contrast and clarity of features



LISS-I (72m)



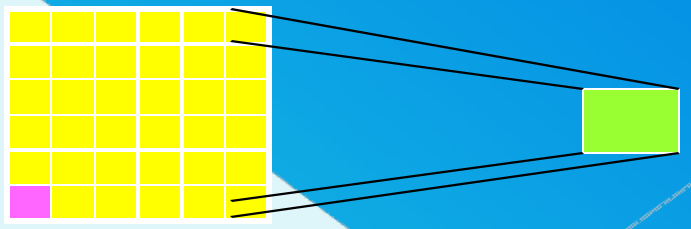
LISS-II (36m)



LISS-III (23m)

IRS – 5.8 m

IKONOS

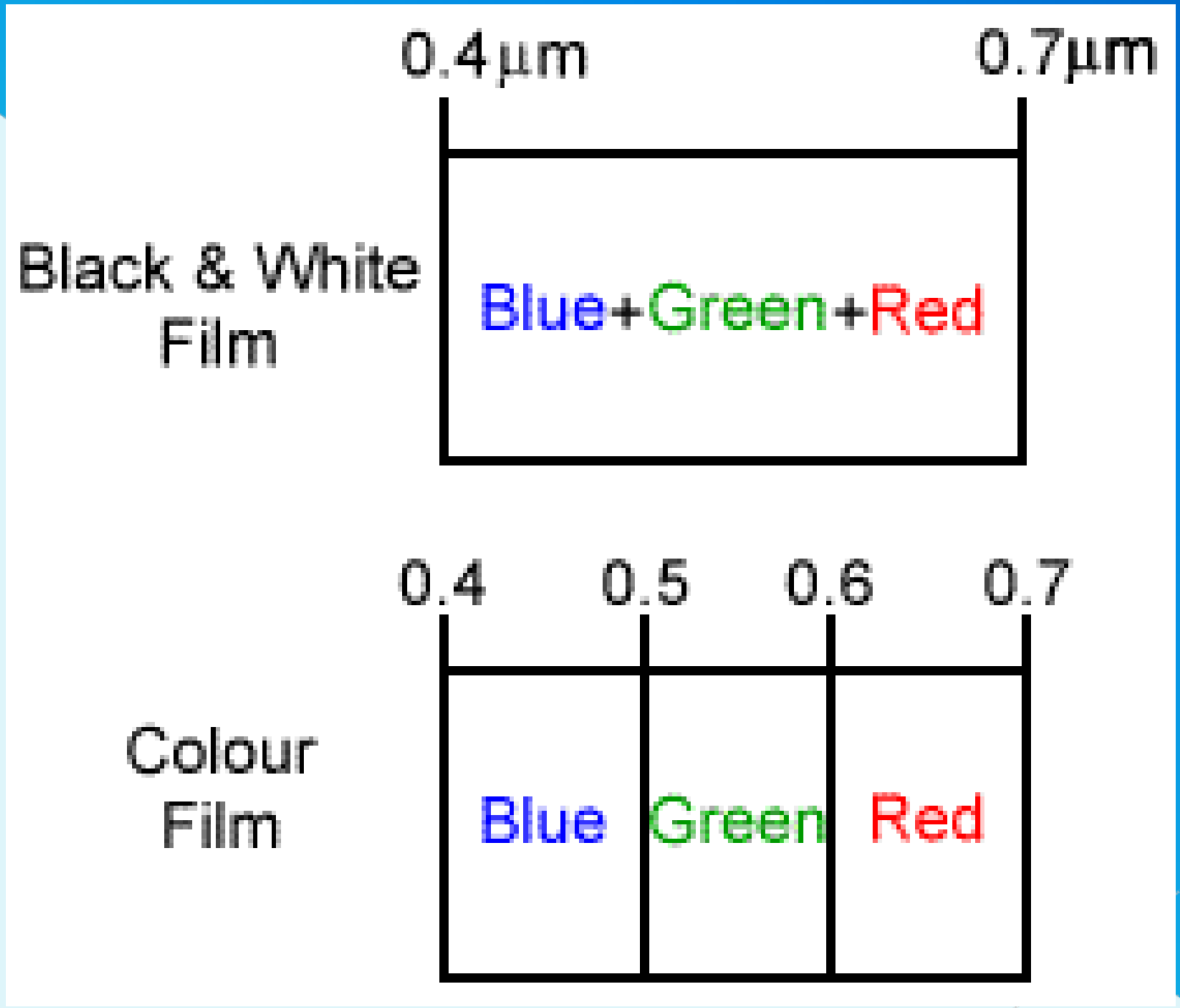


1 m x 1 m

6 m x 6 m

Rashtrapati Bhavan, New Delhi

Spectral Resolution



Radiometric Resolution

Refers to the number of possible brightness values in each band of data and is determined by the number of bits into which the recorded energy is divided.

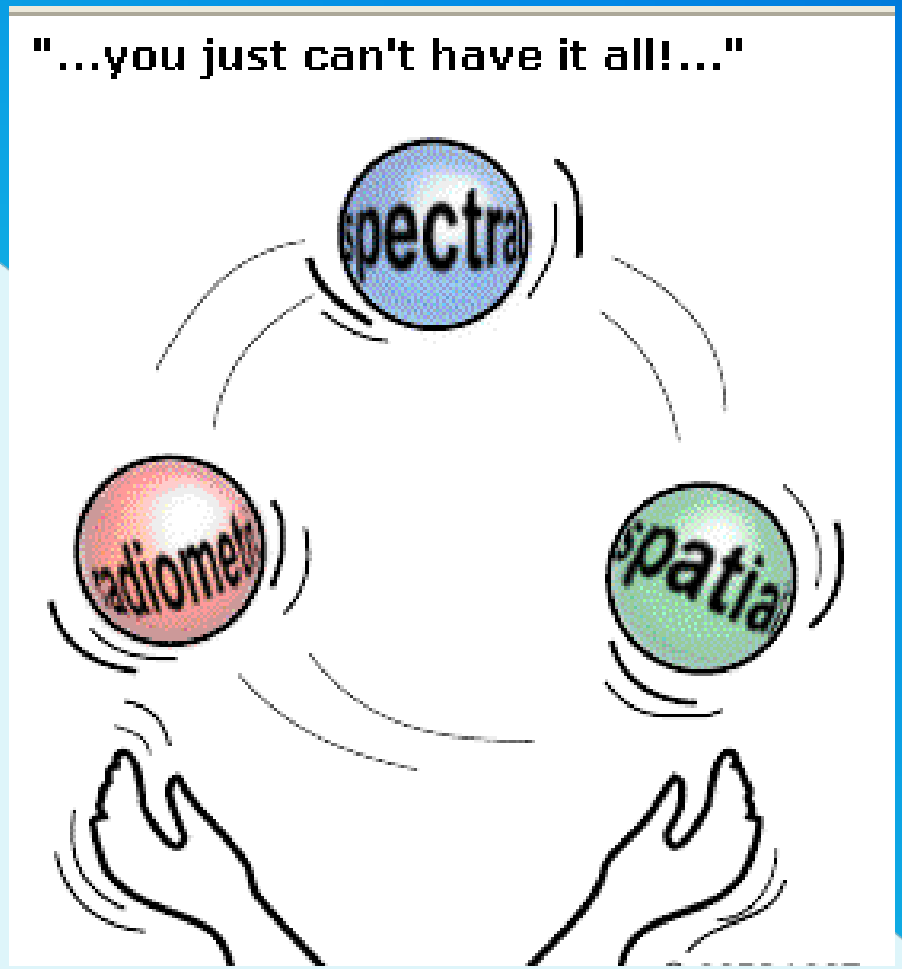
In 8-bit data, the brightness values can range from 0 to 255 for each pixel (256 total possible values).

In 7-bit data, the values range from 0 to 127, or half as many possible values.

For comparison across bands, all the bands should have same radiometric resolution.

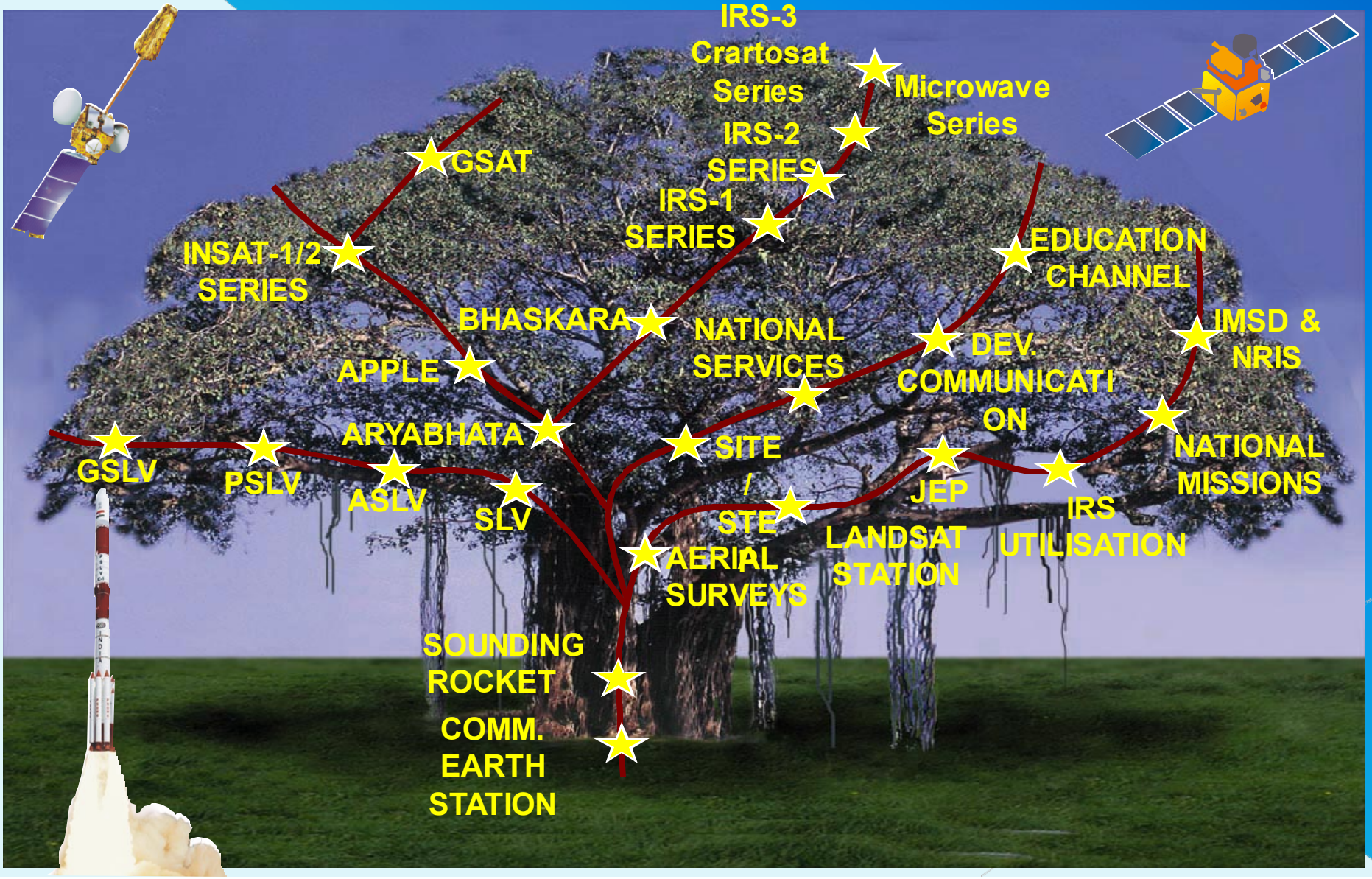
A 2-bit image

An 8-bit image



The three types of resolution must be balanced against the desired capabilities and objectives of the sensor.

The Evolution ..



Multiple Dimensions of Space

INDUSTRIES

- NATIONAL RESOURCES MANAGEMENT
- NATIONAL RESOURCES INFO SYSTEM
- SPECIAL NATIONAL NEEDS

- TELCOMMUNICATIONS
- BROADCASTING (TV, RADIO)
- SEARCH & RESCUE
- METEOROLOGY
- SPECIAL NATIONAL NEEDS

ACADEMIA

- SOCIO-ECONOMIC DEVELOPMENT
- STRATEGIC TECHNOLOGY CAPACITY
- INTERNATIONAL COOPERATION
- POLICY AND FRAMEWORK

- SPACE SCIENCE RESEARCH
- ATMOSPHERIC STUDIES

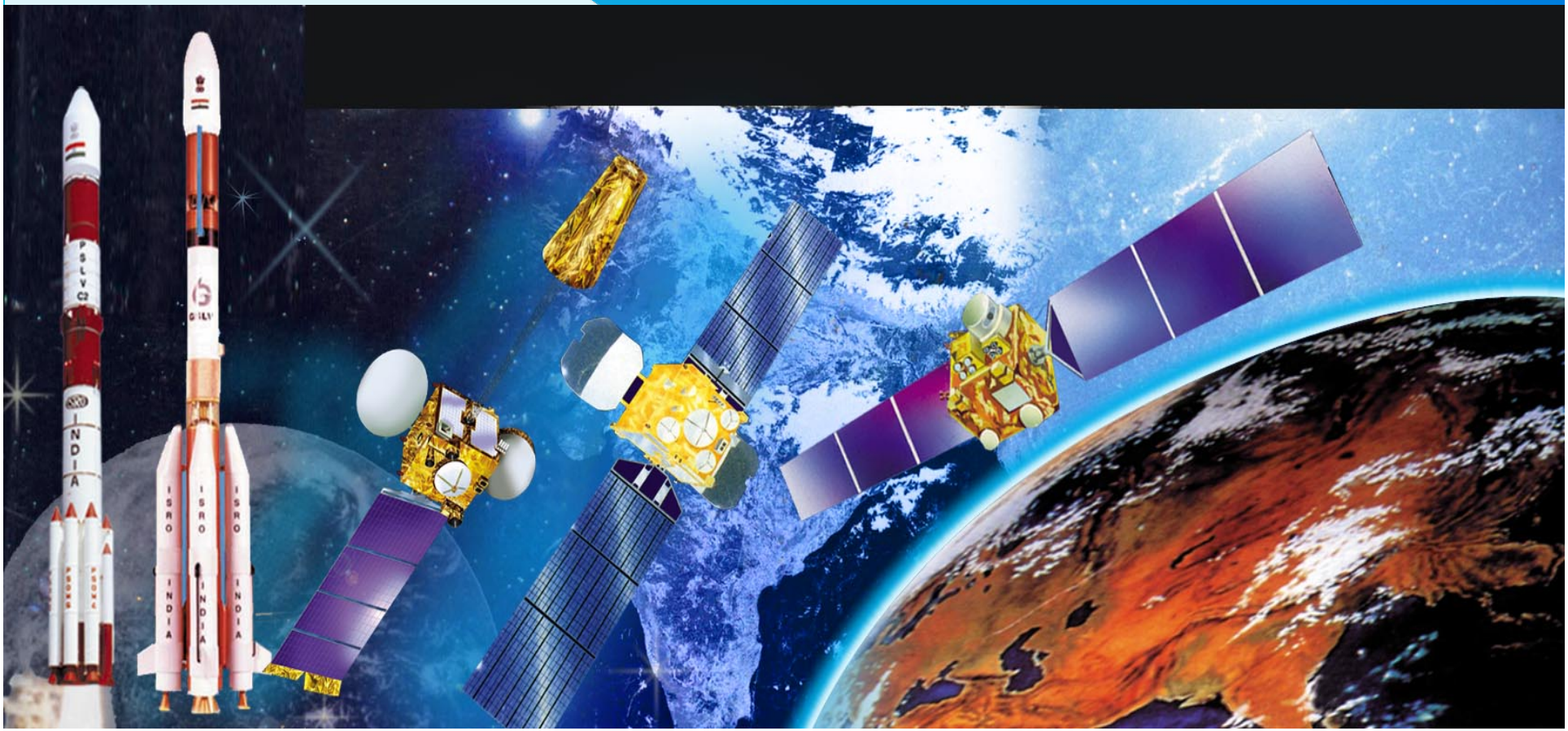
NATIONAL/STATE AGENCIES

NATIONAL SPACE SYSTEMS

LAUNCH VEHICLES

INSAT

IRS



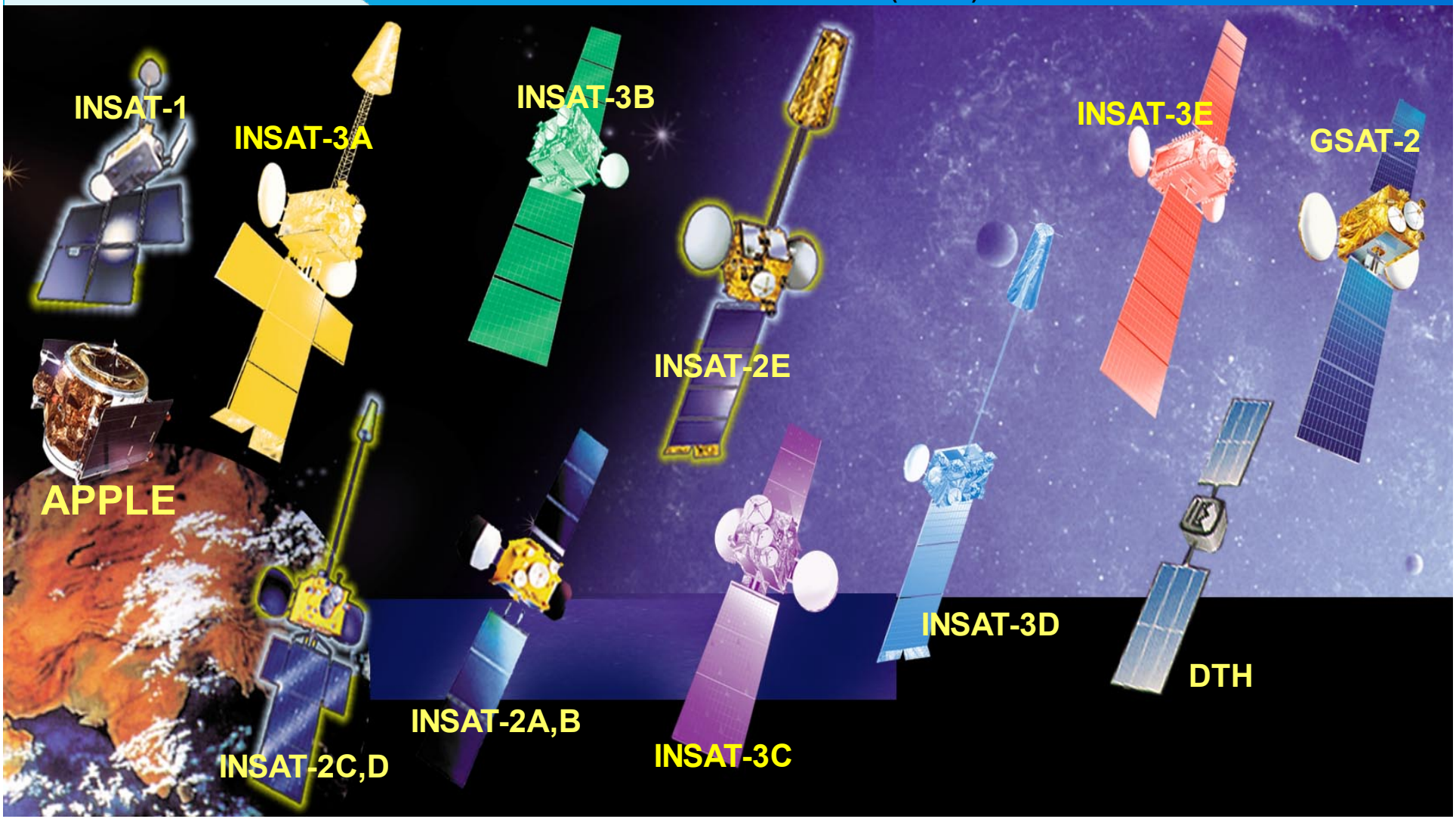
INSAT FAMILY

APPLE
- SPIN STABILISED
- 1 TRANSPONDER

INSAT-1
- 3-AXIS STABILISED
- 12C, 2S
- 32 dbw (1 kw)

INSAT-2
- 3-AXIS STABILISED
- 12C, 6-ExtC,2S, MSS, Ku
- 36 dbw (1.5 kw)

INSAT-2E
- 3-AXIS STABILISED
- 17C, GLOBAL
- 36 dbw (2.5 kw)

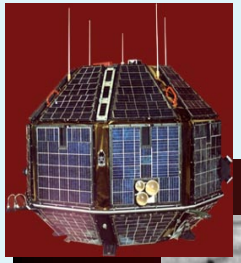


INSAT APPLICATIONS

- SPEECH CIRCUITS ON TRUNK ROUTES
- TV BROADCASTING
- BUSINESS COMMUNICATIONS
- MOBILE SATELLITE SERVICES
- RADIO NETWORKING
- SEARCH AND RESCUE SERVICES
- VSAT CONNECTIVITY
- DATA COLLECTION PLATFORMS
- METEOROLOGY IMAGING
- DISASTER WARNING SYSTEM
- DATA COLLECTION PLATFORMS

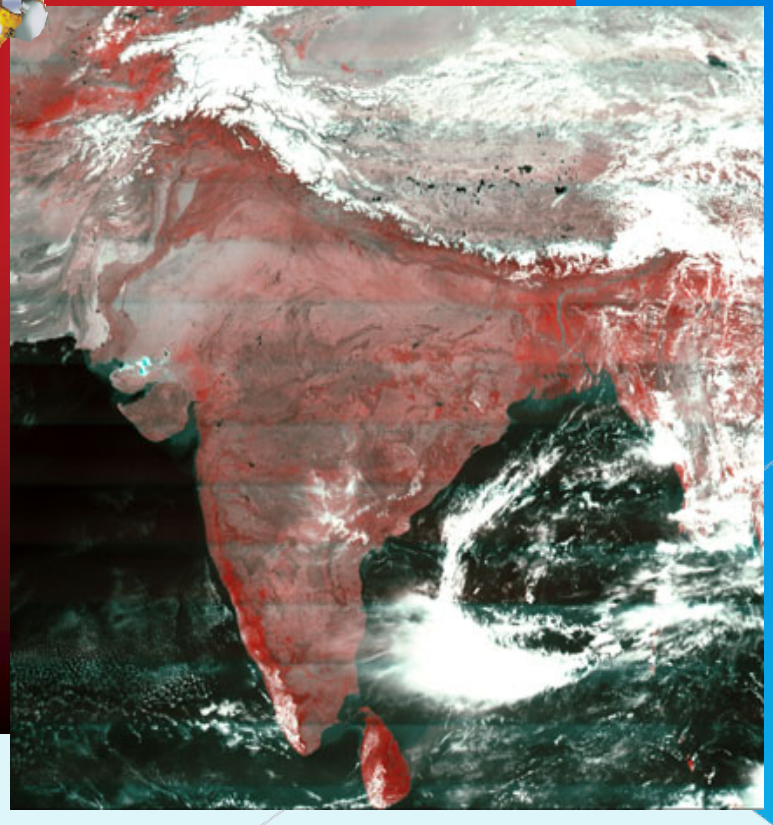
DEVELOPMENTAL COMMUNICATIONS TRAINING AND EDUCATION

BHASKARA TO INSAT



THEN ...

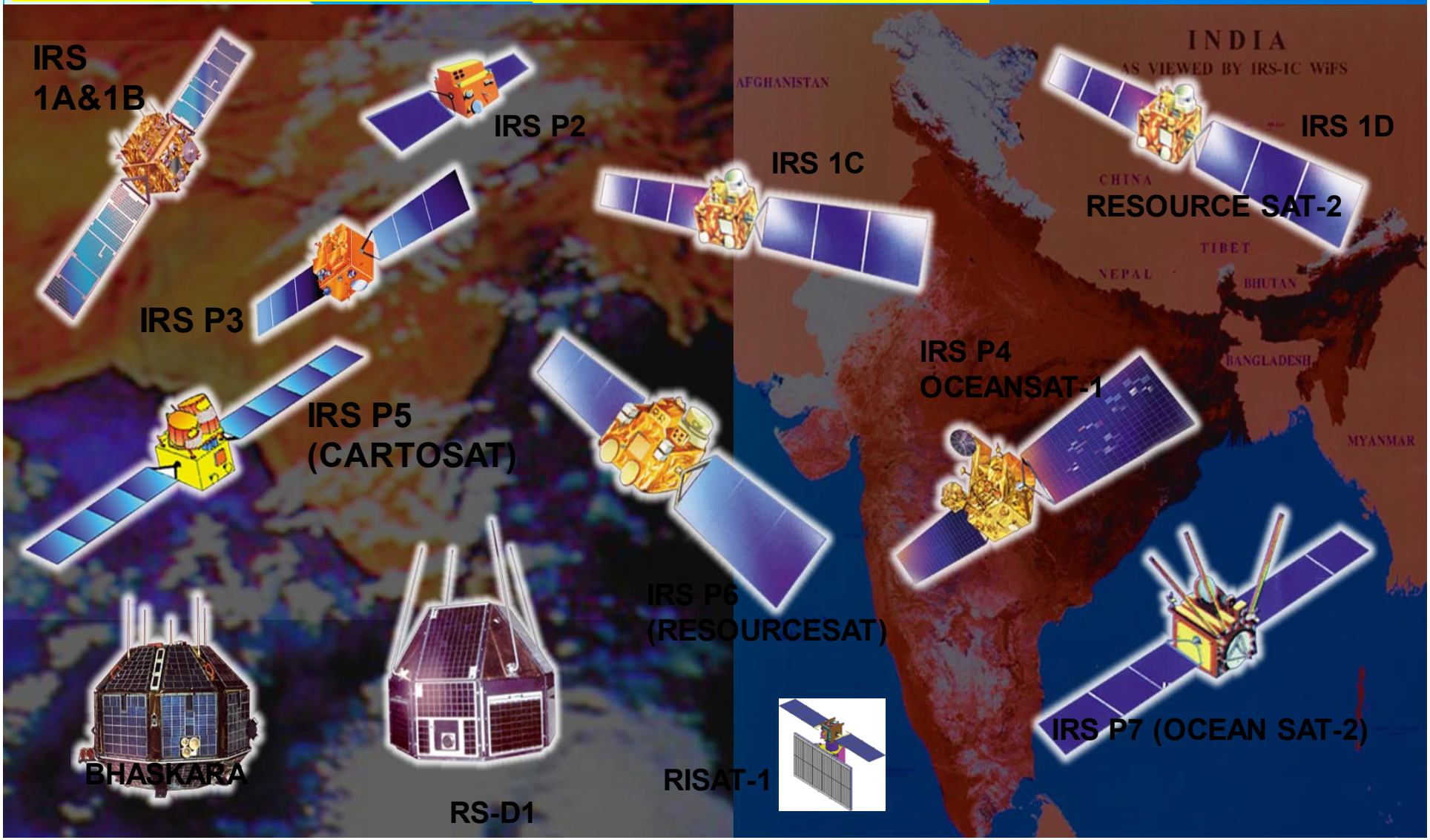
NOW ...



IRS SERIES

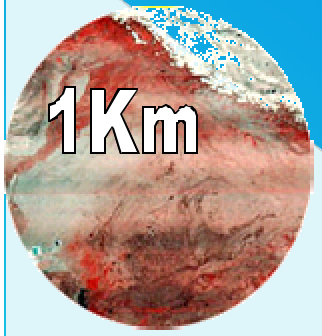
IMAGING IMPROVEMENTS
- 1 km to 1 m RESOLUTION

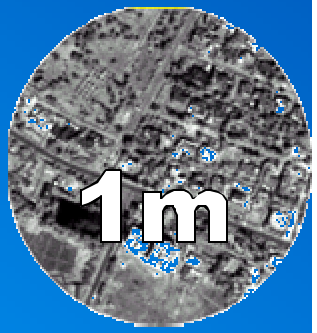
GLOBAL COVERAGE
APPLICATION-SPECIFIC

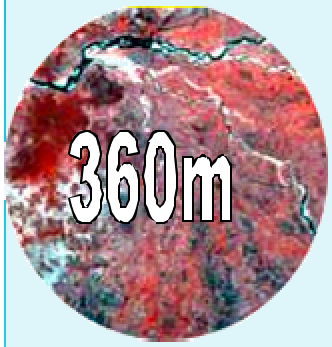


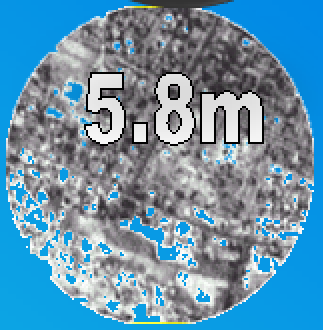
Indian Imaging Capability

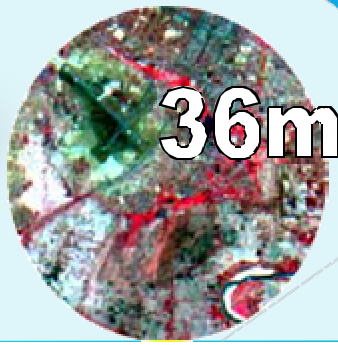
- 1 km to 0.65 m spatial resolution
- 24 days to every 1 day repetivity
- 1 million scale to cadastral level



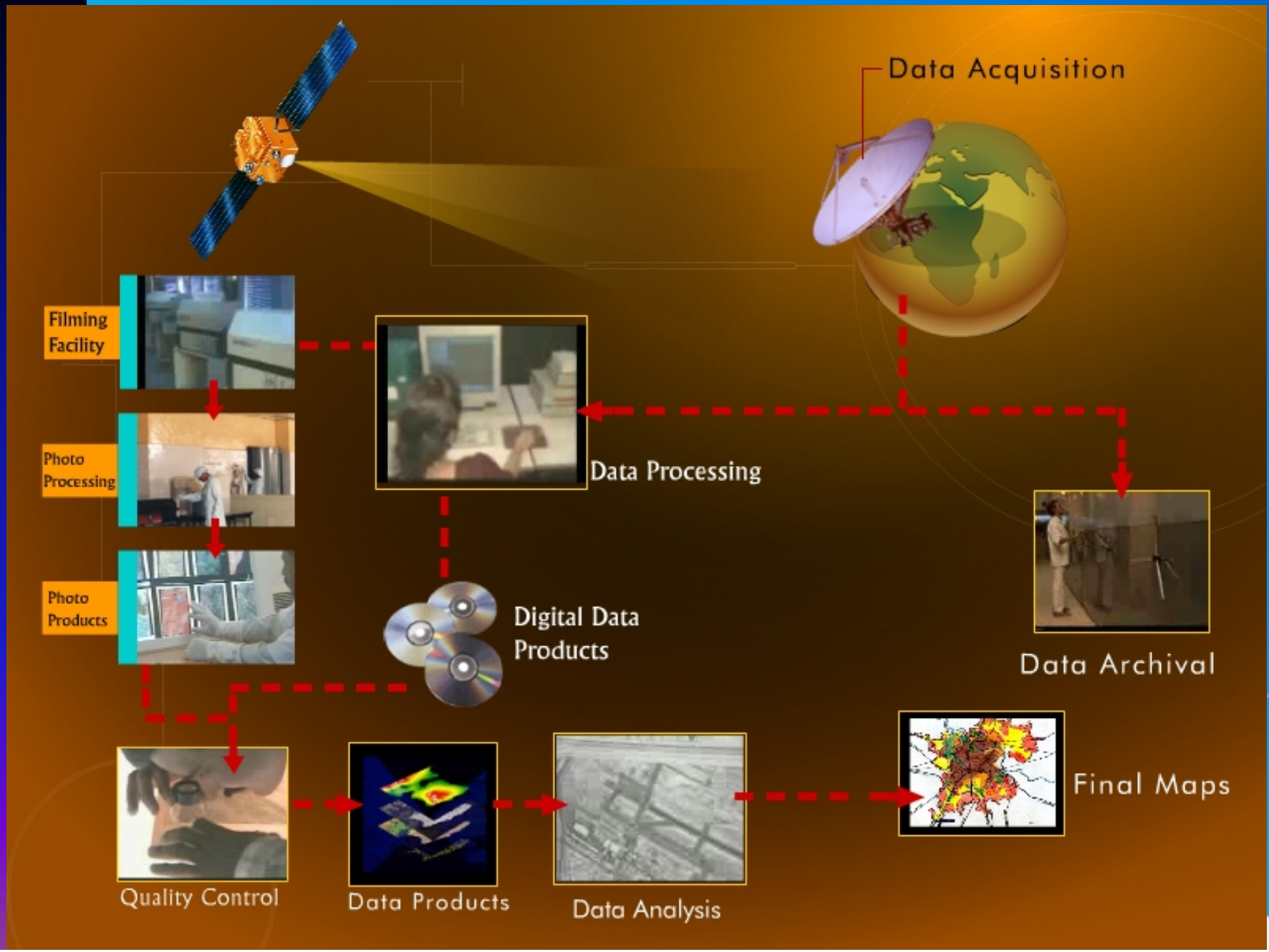




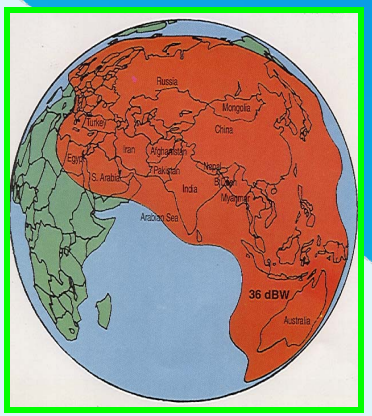




Data Products generation flow

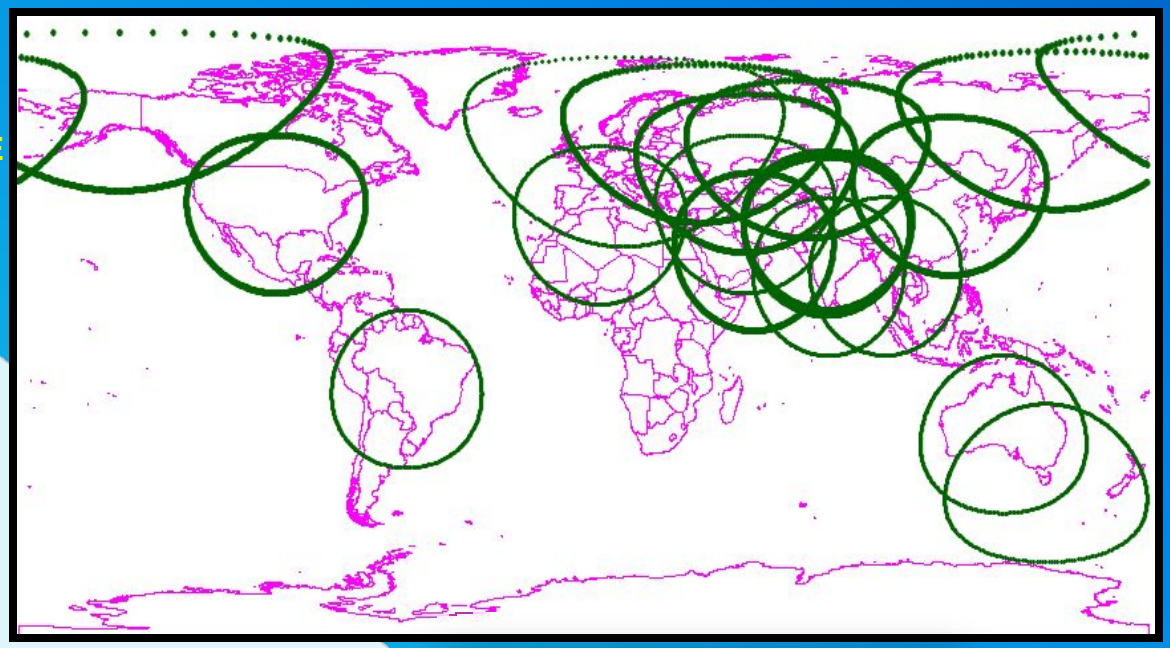


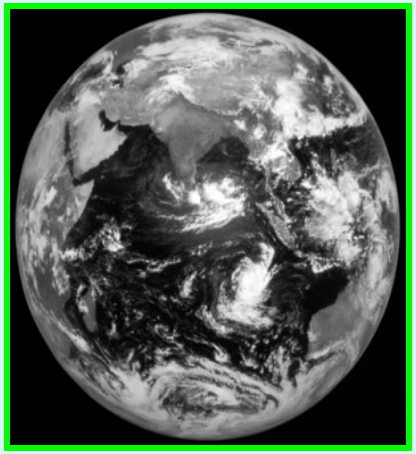
INTERNATIONAL DIMENSIONS



INSAT-2E WIDE BEAM COVERAGE

International Ground Stations



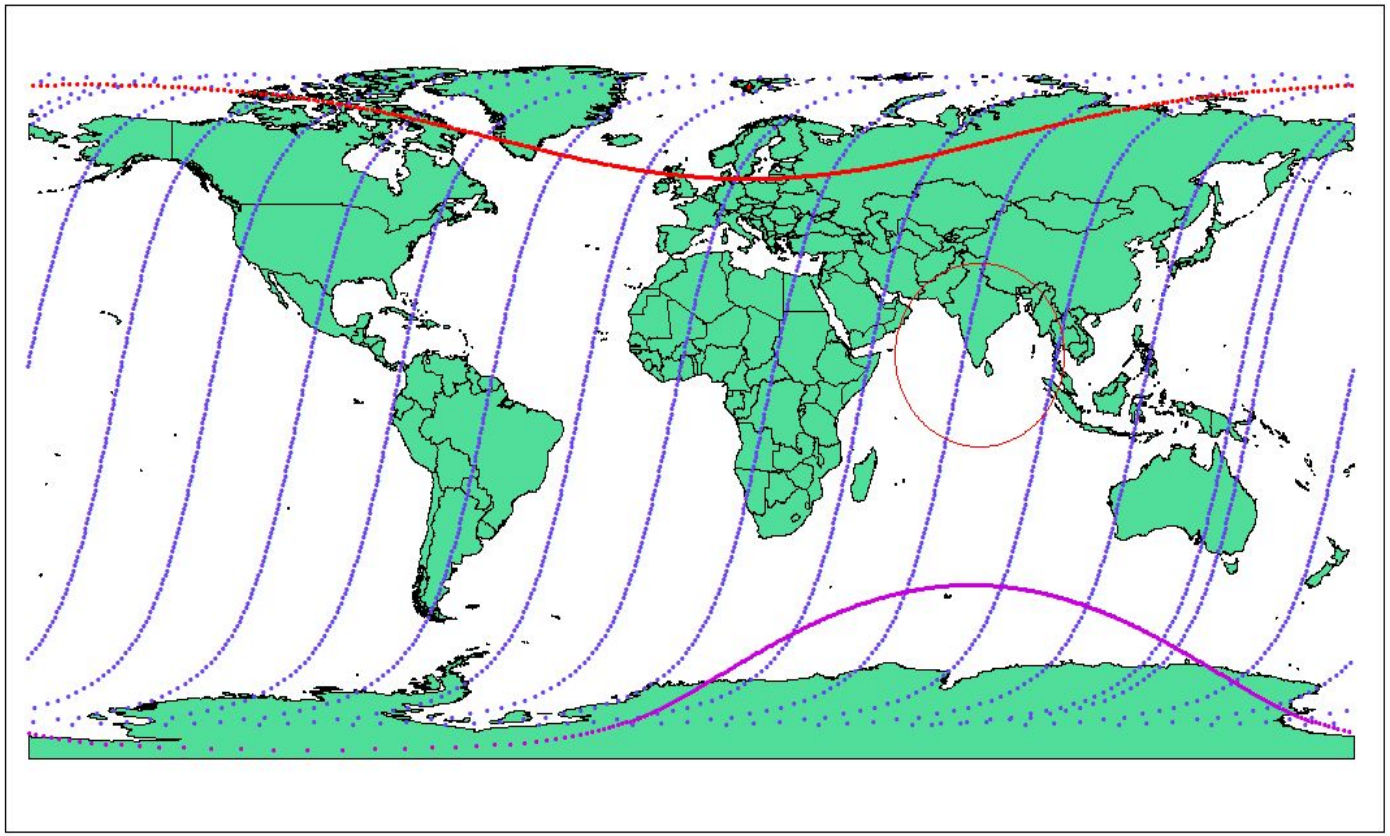


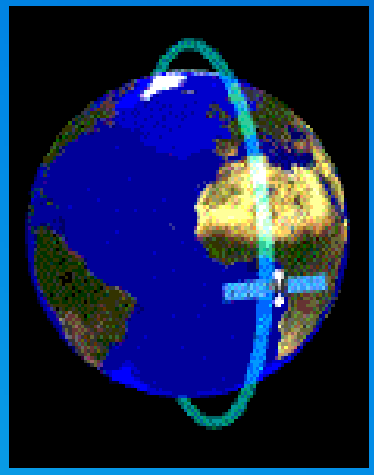
INSAT 2E-VHRR COVERAGE

PAN IMAGE OF ALEXANDRIA

Neighboring countries

Satellite Orbits Around The Globe





- All the satellites orbit 14/15 times around the globe in 24 h
- The satellites have to be tasked for imaging based on the power and other satellite capacities
- Data downlink is always governed by the visibility of the station

Satellite Data Reception..

- EARTH STATION AT SHADNAGAR, ABOUT 60 KMS FROM HYDERABAD

1st 10 Meter Antenna 1980

1st 7.5 Meter Antenna 2003

3.7mtr Antenna-2008

- DEDICATED DATA RECEPTION AND TRACKING, ARCHIVAL AND REAL TIME QUICK-LOOK FACILITY

Mobile Ground Station-2010

4.5 Meter Antenna-2012

2.7 Meter Antenna-2014

- GENERATION OF BROWSE DATA
- DATA RECEPTION STARTED WITH LANDSAT SATELLITE OF USA - 1979
- MULTI-MISSION CAPABILITY (INDIA'S IRS SERIES, USA'S LANDSAT-5, NOAA-14 & 15 AND EUROPEAN ERS-1 & 2)

IRS IMAGES – what can be seen …

Cape town

IRS images in True color

Mangalore

Remote Sensing Applications

INFORMATION TO SOLUTIONS

- AGRICULTURE & CROPS
- FOREST & BIO-RESOURCES
- WATER RESOURCES
- GEOLOGY
- OCEAN/COASTAL
- ENVIRONMENT
- RURAL DEVELOPMENT
- URBAN MANAGEMENT
- CARTOGRAPHY/MAPPING
- CLIMATE MODELLING
- GLOBAL CHANGE

INTEGRATED MISSION FOR SUSTAINABLE DEVELOPMENT

NATIONAL (NATURAL) RESOURCES INFORMATION SYSTEMS


Thank you