A Non-Technical Overview of Satellite Remote SensingRobert J. Farrell, PE &Michael R. Courneen16th Annual New York StateGIS ConferenceLiverpool, NY Sept. 20-21, 2000

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Table of Contents


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Robert J. Farrell, PE &
Michael R. Courneen
16th Annual New York State GIS Conference
Liverpool, NY
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Slide 1 of 39


Goal of This Session
The goal of this session is to provide you with a non-technical introduction to the basics of satellite remote sensing, including:
* Terms & Definitions
* Satellite Platforms
* Applications
* Example Imagery
* Sample Ordering Information
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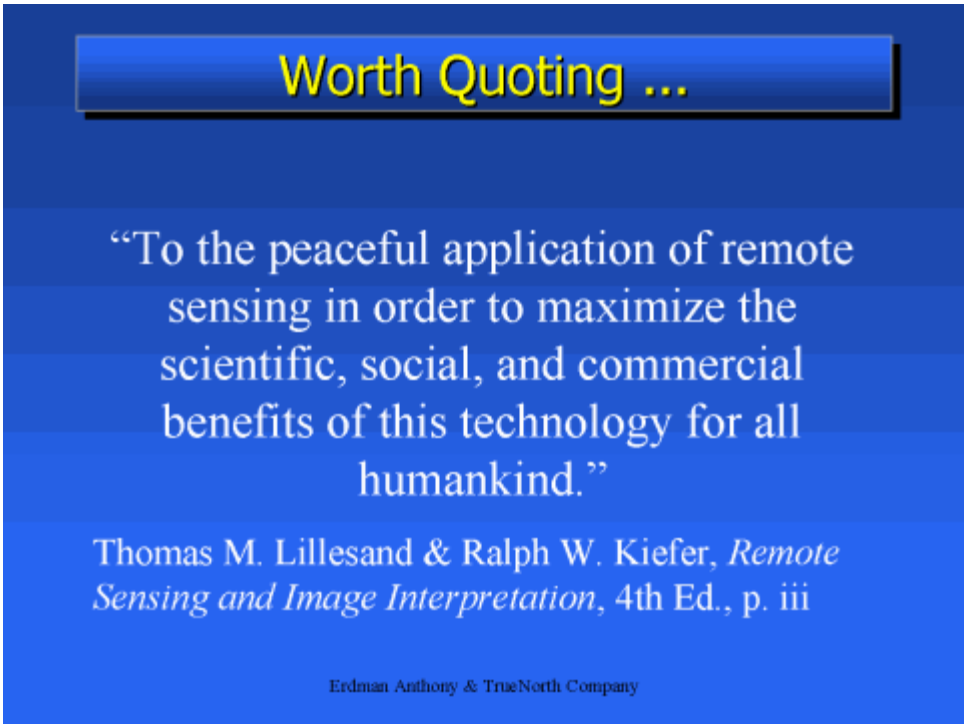
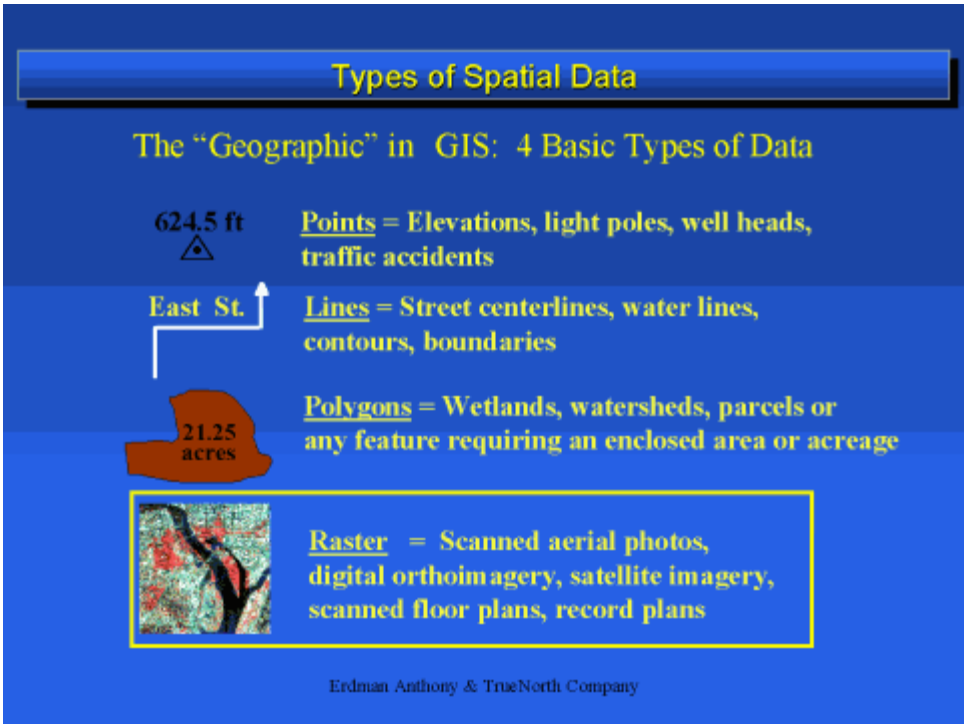

Worth Quoting ...
"To the peaceful application of remote sensing in order to maximize the scientific, social, and commercial benefits of this technology for all humankind."
Thomas M. Lillesand & Ralph W. Kiefer, *Remote Sensing and Image Interpretation*, 4th Ed., p. iii
Erdman Anthony & TrueNorth Company


Types of Spatial Data
The "Geographic" in GIS: 4 Basic Types of Data
624.5 ft
Points = Elevations, light poles, well heads, traffic accidents
East St.
Lines = Street centerlines, water lines, contours, boundaries
21.25 acres
Polygons = Wetlands, watersheds, parcels or any feature requiring an enclosed area or acreage
Raster = Scanned aerial photos, digital orthoimagery, satellite imagery, scanned floor plans, record plans
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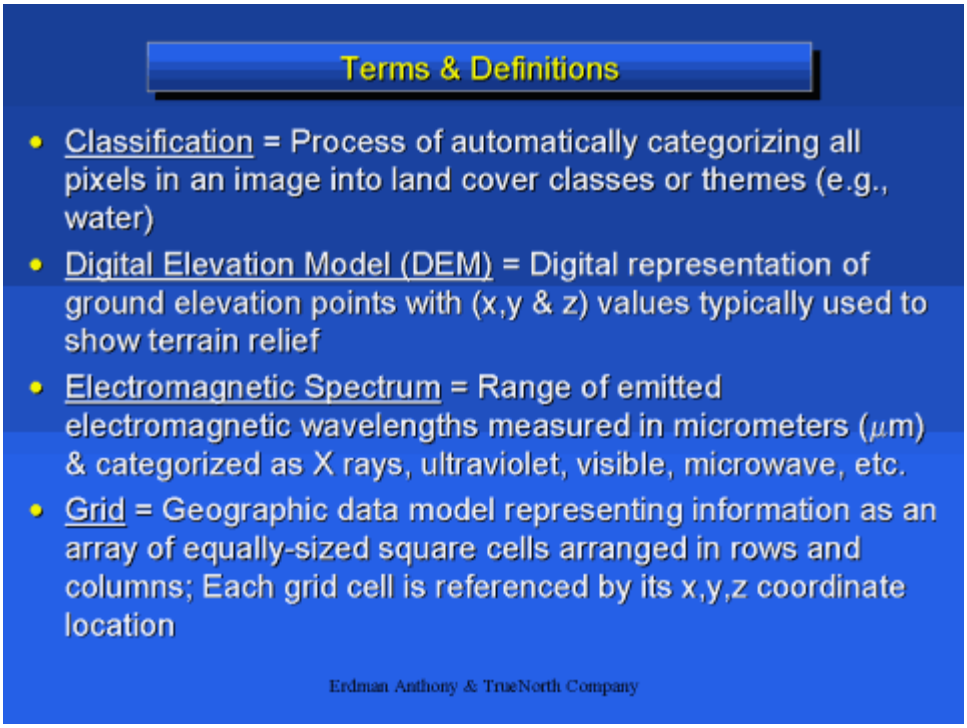
Terms & Definitions
• Classification = Process of automatically categorizing all pixels in an image into land cover classes or themes (e.g., water)
• Digital Elevation Model (DEM) = Digital representation of ground elevation points with (x,y & z) values typically used to show terrain relief
• Electromagnetic Spectrum = Range of emitted electromagnetic wavelengths measured in micrometers (μm) & categorized as X rays, ultraviolet, visible, microwave, etc.
• Grid = Geographic data model representing information as an array of equally-sized square cells arranged in rows and columns; Each grid cell is referenced by its x,y,z coordinate location
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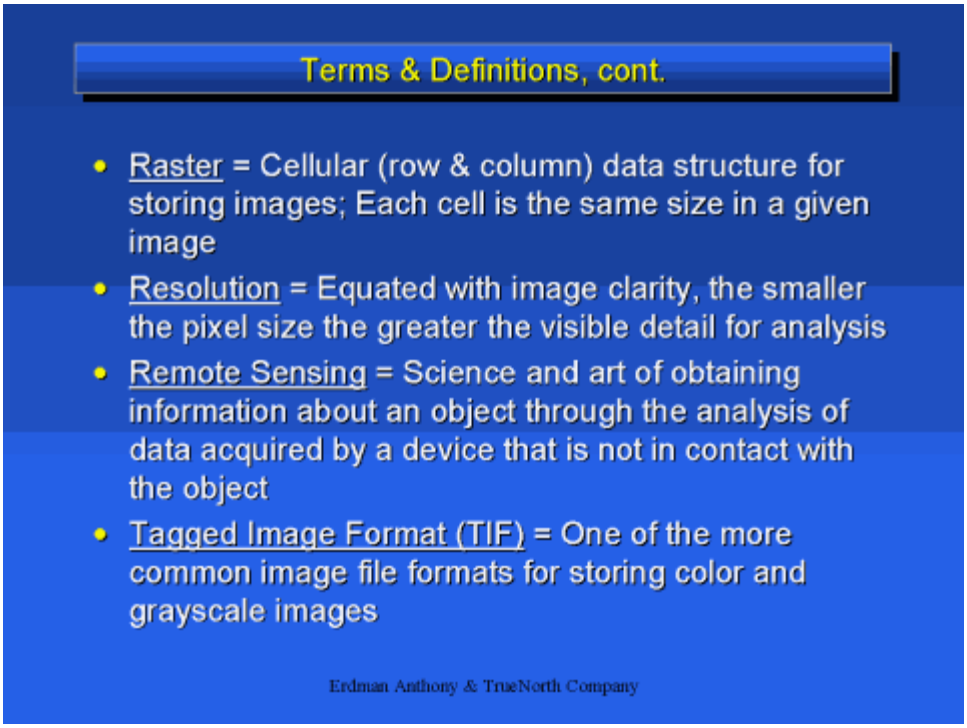
Terms & Definitions, cont.
Raster = Cellular (row & column) data structure for storing images; Each cell is the same size in a given image
Resolution = Equated with image clarity, the smaller the pixel size the greater the visible detail for analysis
Remote Sensing = Science and art of obtaining information about an object through the analysis of data acquired by a device that is not in contact with the object
Tagged Image Format (TIF) = One of the more common image file formats for storing color and grayscale images
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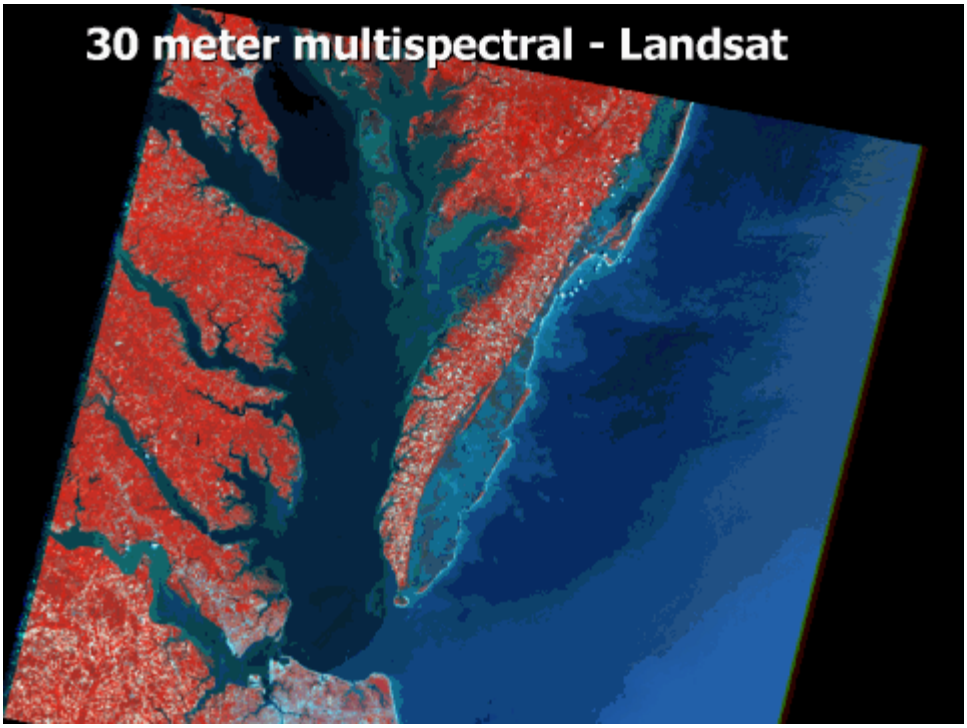
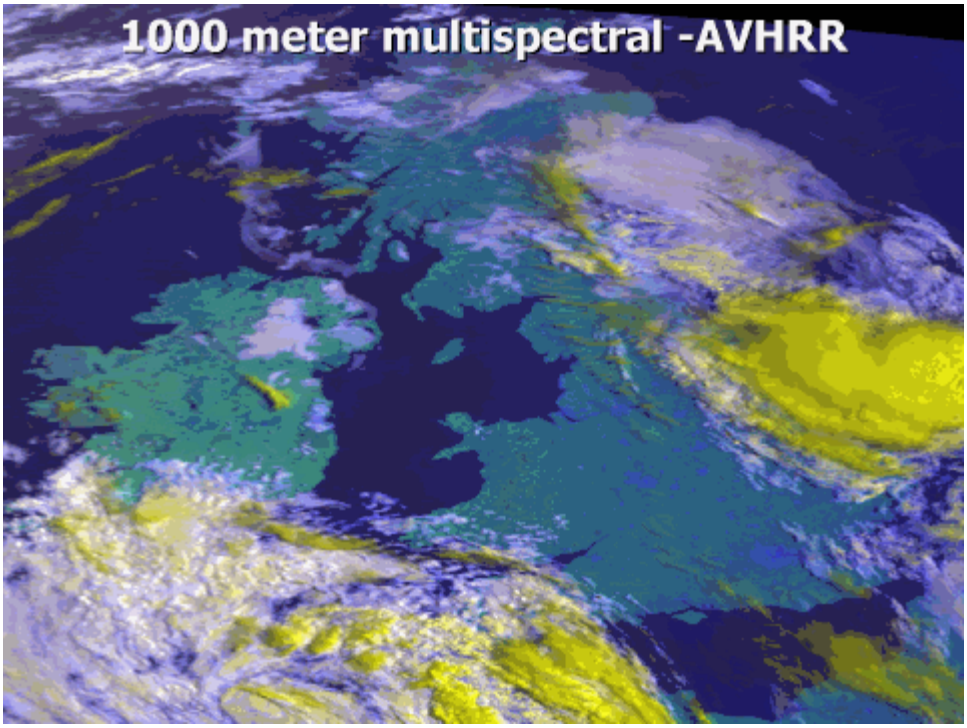
Slide 7 of 39

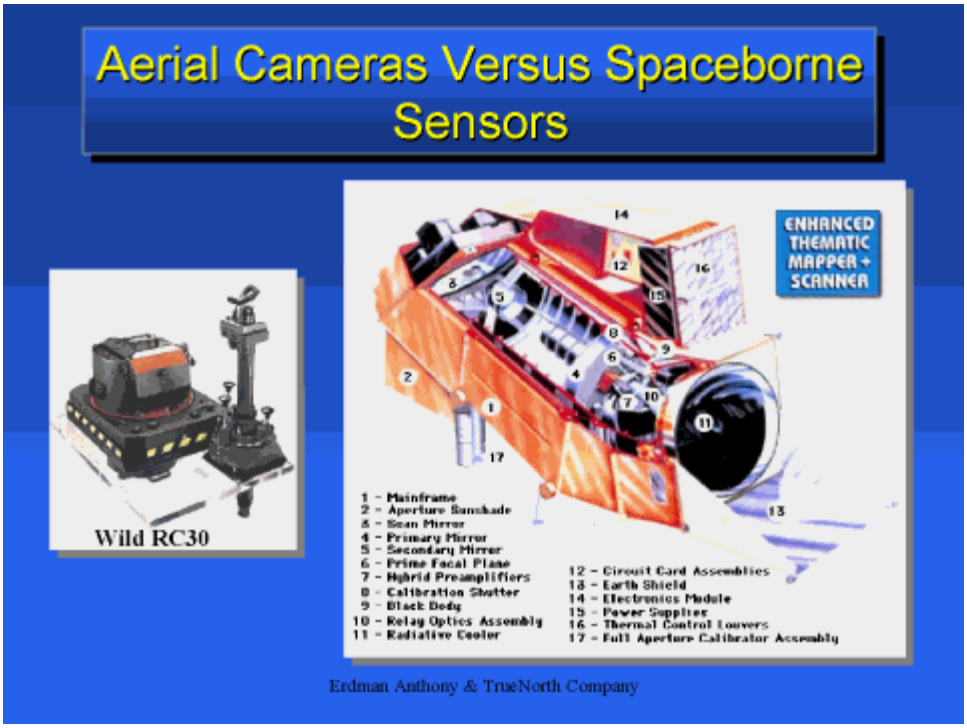

4 meter multispectral - Ikonos



Slide 9 of 39



Slide 10 of 39


Aerial Cameras Versus Spaceborne Sensors
Wild RC30
ENHANCED THEMATIC MAPPER + SCANNER
1 - Mainframe
2 - Aperture Sunshade
3 - Scan Mirror
4 - Primary Mirror
5 - Secondary Mirror
6 - Prime Focal Plane
7 - Hybrid Preamplifiers
8 - Calibration Shutter
9 - Black Body
10 - Relay Optics Assembly
11 - Radiative Cooler
12 - Circuit Card Assemblies
13 - Earth Shield
14 - Electronics Module
15 - Power Supplies
16 - Thermal Control Louvers
17 - Full Aperture Calibrator Assembly
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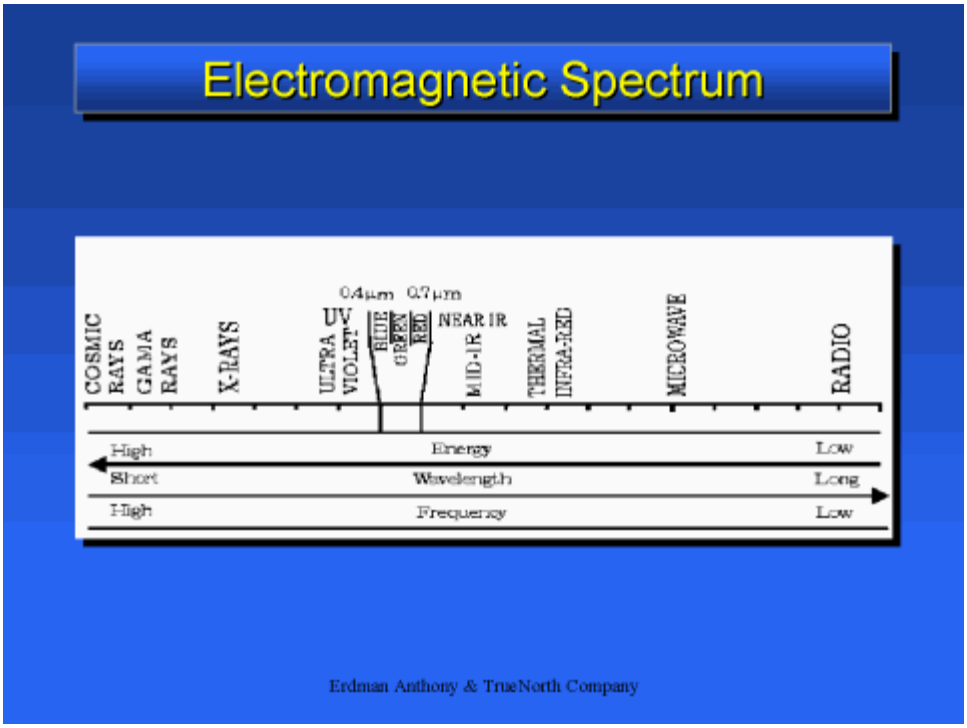
Electromagnetic Spectrum
0.4µm
0.7µm
COSMIC RAYS
GAMA RAYS
X-RAYS
ULTRA VIOLET
UV
BLUE
GREEN
RED
NEAR IR
MID-IR
THERMAL INFRA-RED
MICROWAVE
RADIO
High
Energy
Low
Short
Wavelength
Long
High
Frequency
Low
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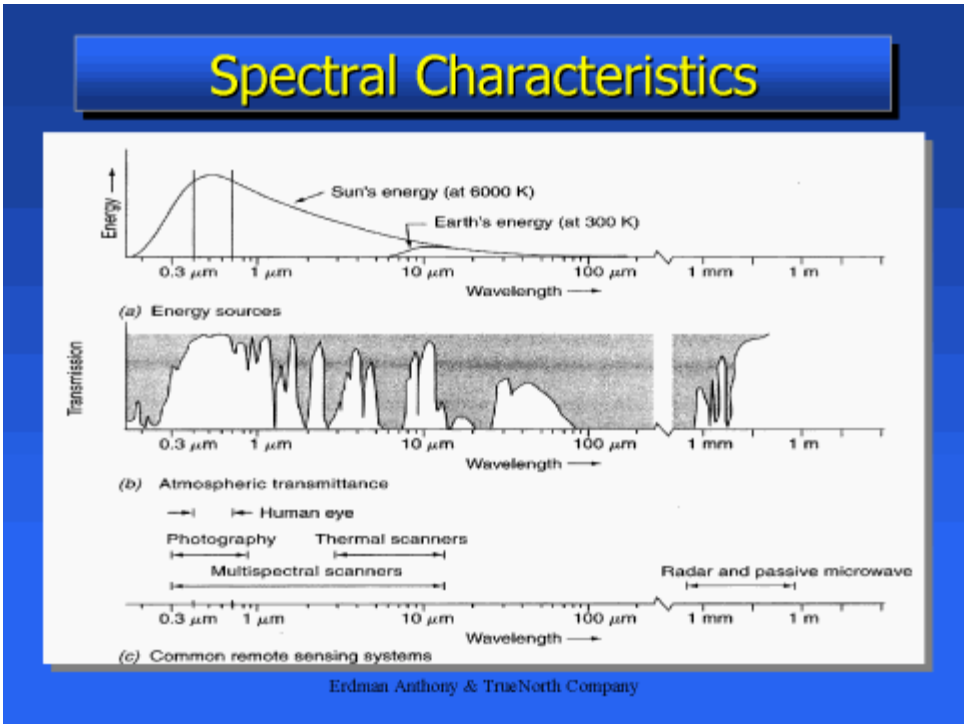
Spectral Characteristics
Energy
Sun's energy (at 6000 K)
Earth's energy (at 300 K)
0.3 μm
1 μm
10 μm
100 μm
1 mm
1 m
Wavelength
(a) Energy sources
Transmission
(b) Atmospheric transmittance
Human eye
Photography
Thermal scanners
Multispectral scanners
Radar and passive microwave
(c) Common remote sensing systems
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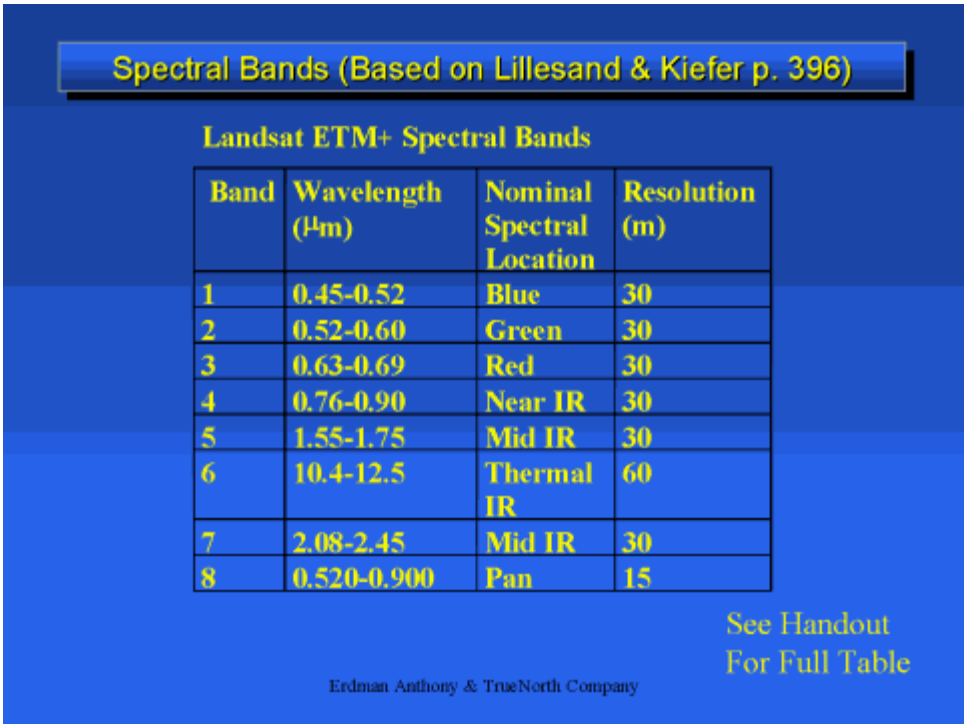
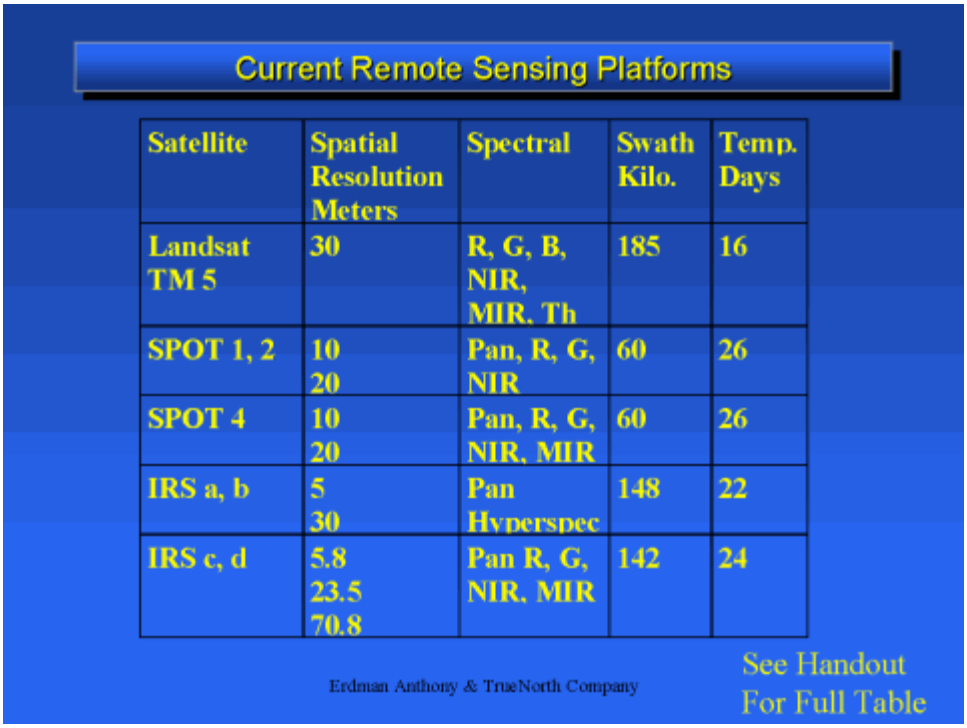


Slide 14 of 39


Current Remote Sensing Platforms
Satellite
Spatial Resolution Meters
Spectral
Swath Kilo.
Temp. Days
Landsat TM 5
30
R, G, B, NIR, MIR, Th
185
16
SPOT 1, 2
10 20
Pan, R, G, NIR
60
26
SPOT 4
10 20
Pan, R, G, NIR, MIR
60
26
IRS a, b
5 30
Pan Hyperspec
148
22
IRS c, d
5.8 23.5 70.8
Pan R, G, NIR, MIR
142
24
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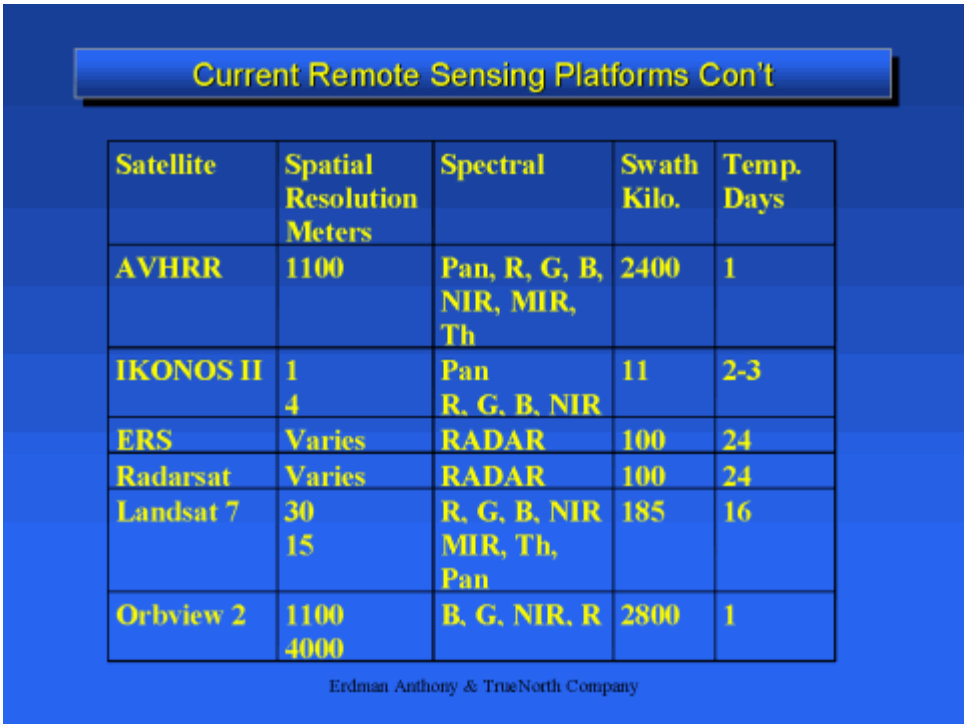
See Handout For Full Table


Current Remote Sensing Platforms Con't
Satellite
Spatial Resolution Meters
Spectral
Swath Kilo.
Temp. Days
AVHRR
1100
Pan, R, G, B, NIR, MIR, Th
2400
1
IKONOS II
1
4
Pan
R, G, B, NIR
11
2-3
ERS
Varies
RADAR
100
24
Radarsat
Varies
RADAR
100
24
Landsat 7
30
15
R, G, B, NIR MIR, Th, Pan
185
16
Orbview 2
1100
4000
B, G, NIR, R
2800
1
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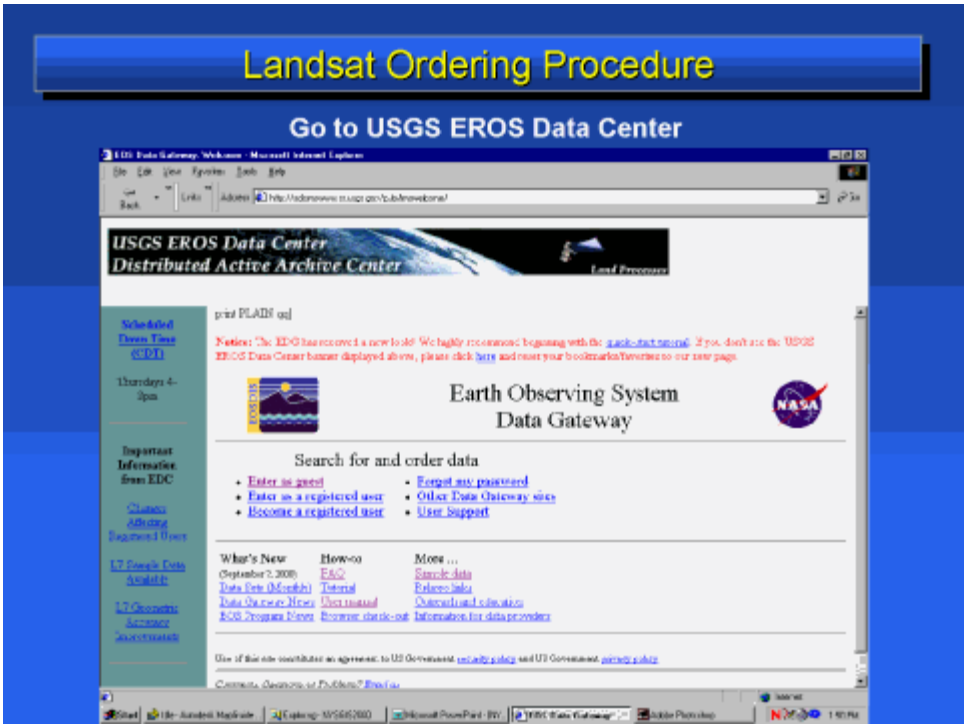
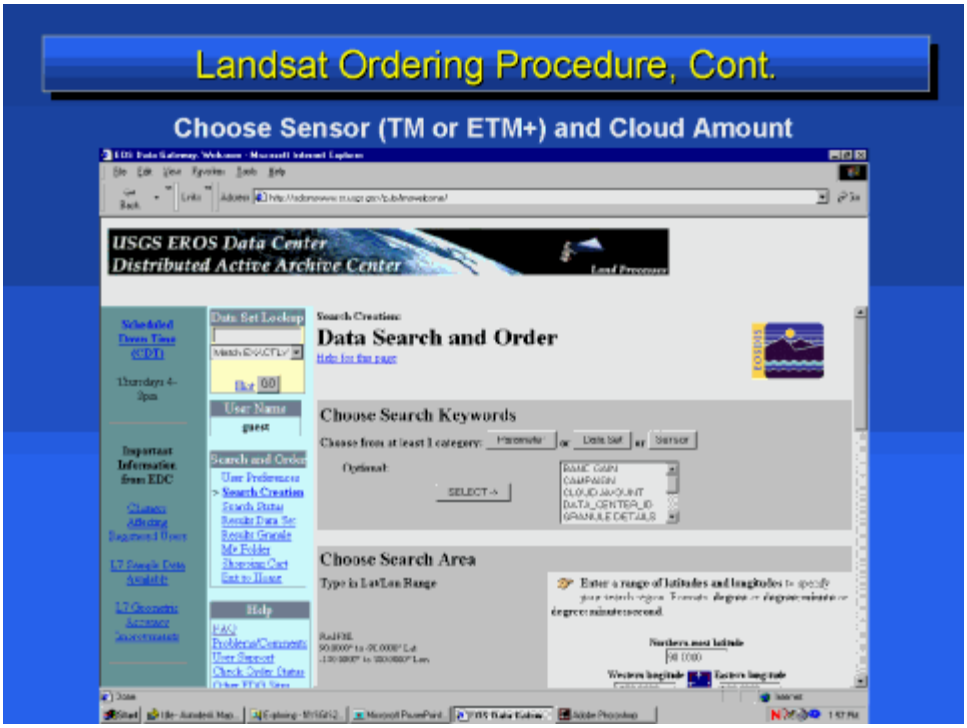
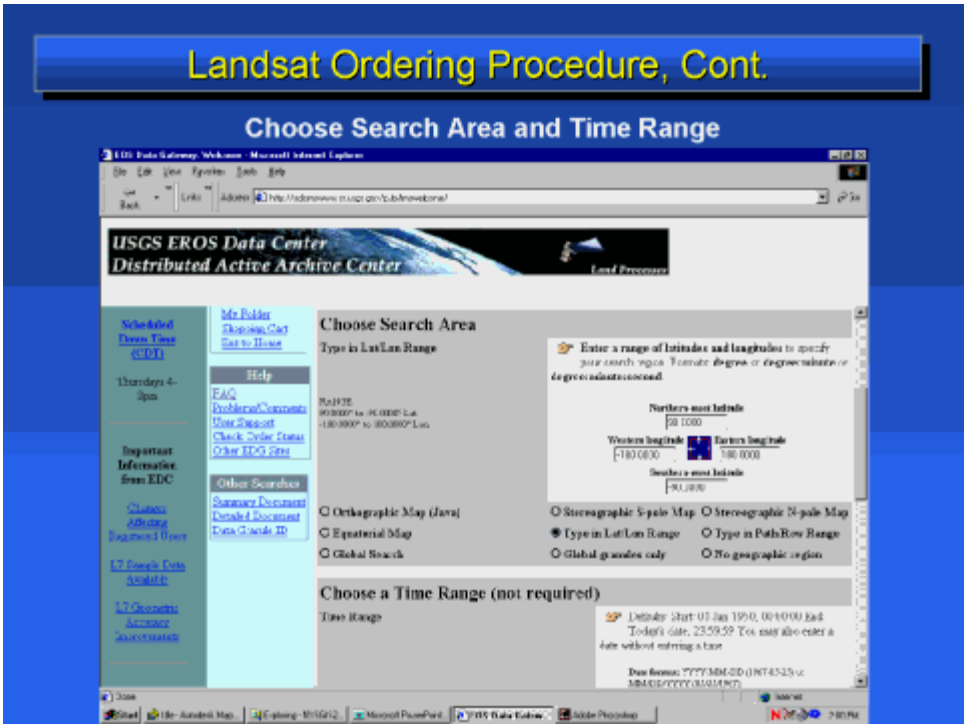

Landsat Ordering Procedure
Go to USGS EROS Data Center
USGS EROS Data Center
Distributed Active Archive Center
Earth Observing System
Data Gateway
Search for and order data
Enter as guest
Enter as a registered user
Become a registered user
Forget my password
Other Data Gateway sites
User Support
What's New
How-to
More ...


Landsat Ordering Procedure, Cont.
Choose Sensor (TM or ETM+) and Cloud Amount
USGS EROS Data Center
Distributed Active Archive Center
Data Search and Order
Choose Search Keywords
Choose Search Area


Landsat Ordering Procedure, Cont.
Choose Search Area and Time Range
USGS EROS Data Center
Distributed Active Archive Center
Choose Search Area
Choose a Time Range (not required)


Landsat Ordering Procedure, Cont.
Add results to your folder
USGS EROS Data Center
Distributed Active Archive Center
My Folder:
Listing
Help for this page
Search and Order
Help


Landsat Ordering Procedure, Cont.
Review Scenes
USGS EROS Data Center
Distributed Active Archive Center
Other Searches


Landsat Ordering Procedure, Cont.
Add scenes that meet your criteria to your basket
Checkout
Select Media Options: CD, 8mm tape, FTP Download
Select Format: FASTL7A, HDF or GEOTIFF
Select Processing: Level 0R, 1R or 1G
Pay (Purchase Orders, Standing Account, Credit Card)
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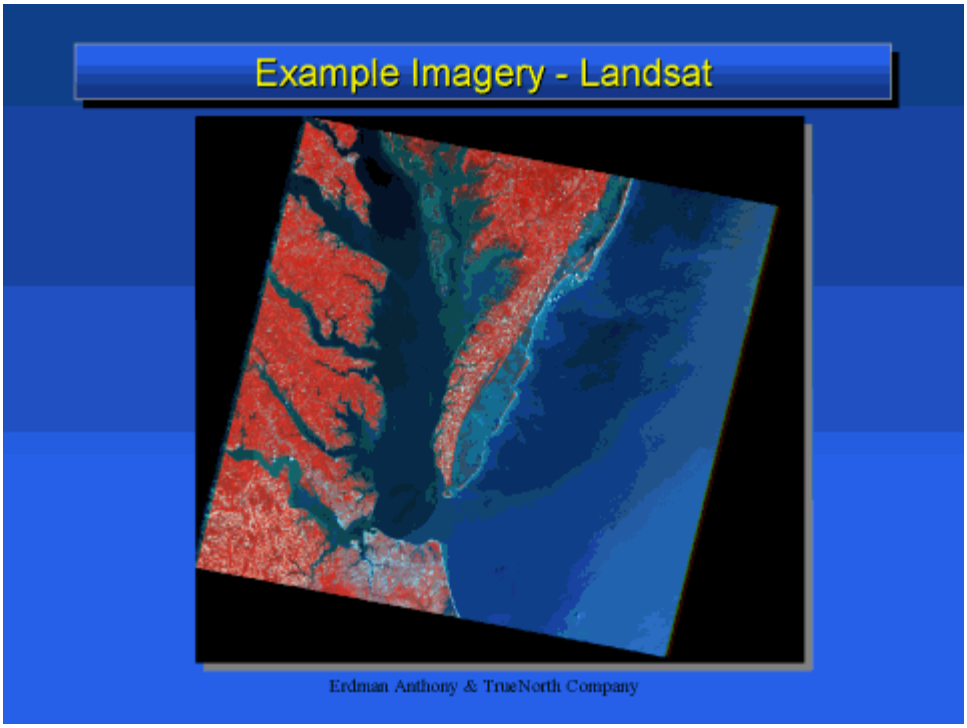
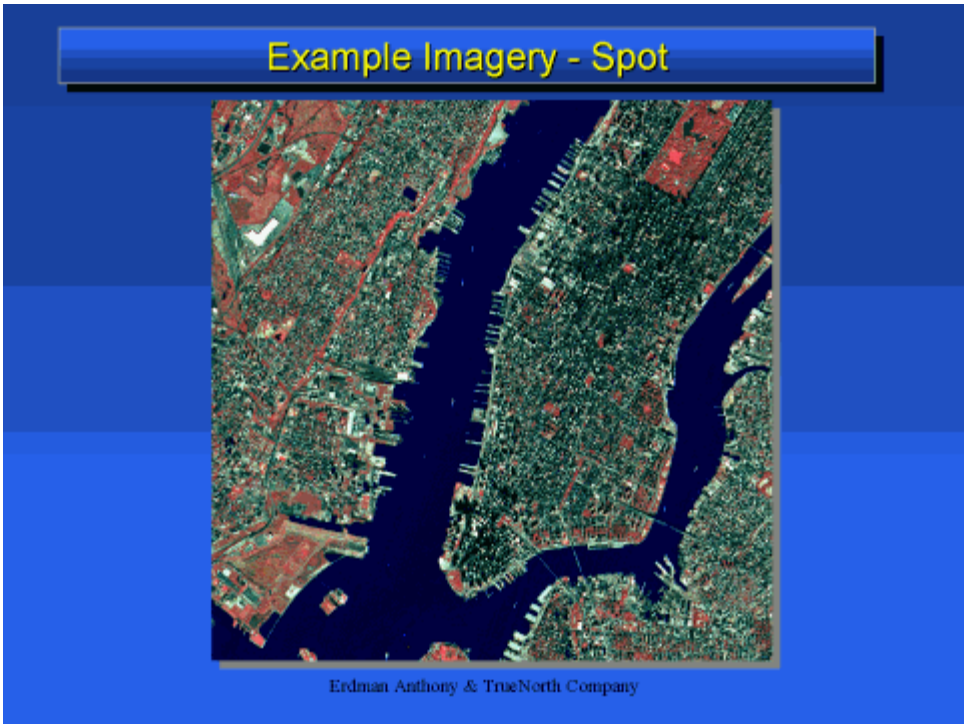


Slide 23 of 39


Example Imagery - Spot
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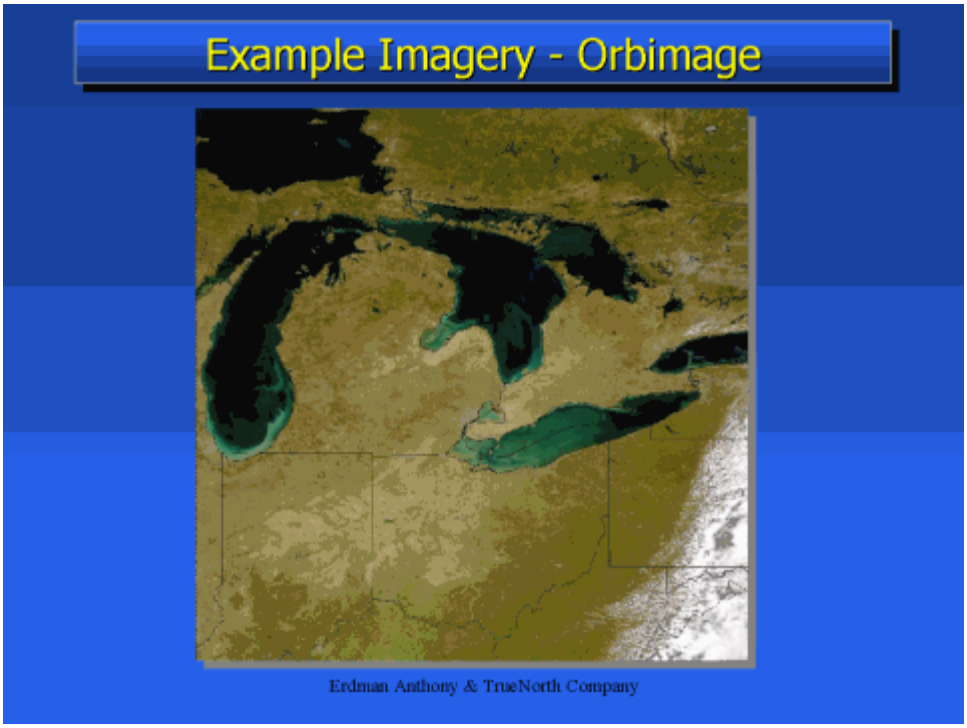
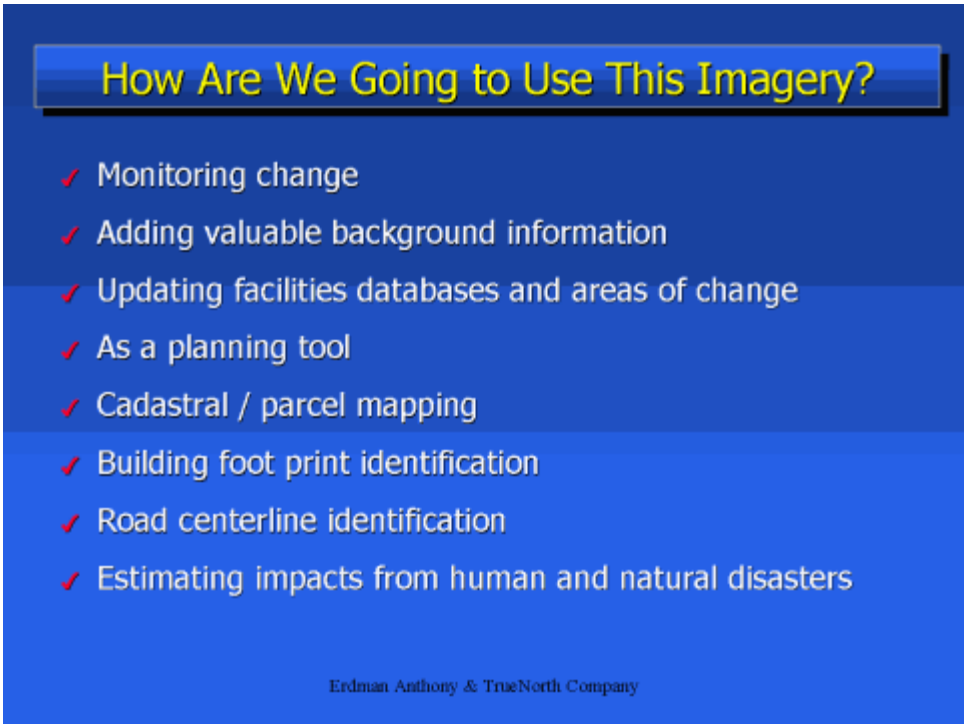


Slide 25 of 39


How Are We Going to Use This Imagery?
Monitoring change
Adding valuable background information
Updating facilities databases and areas of change
As a planning tool
Cadastral / parcel mapping
Building foot print identification
Road centerline identification
Estimating impacts from human and natural disasters
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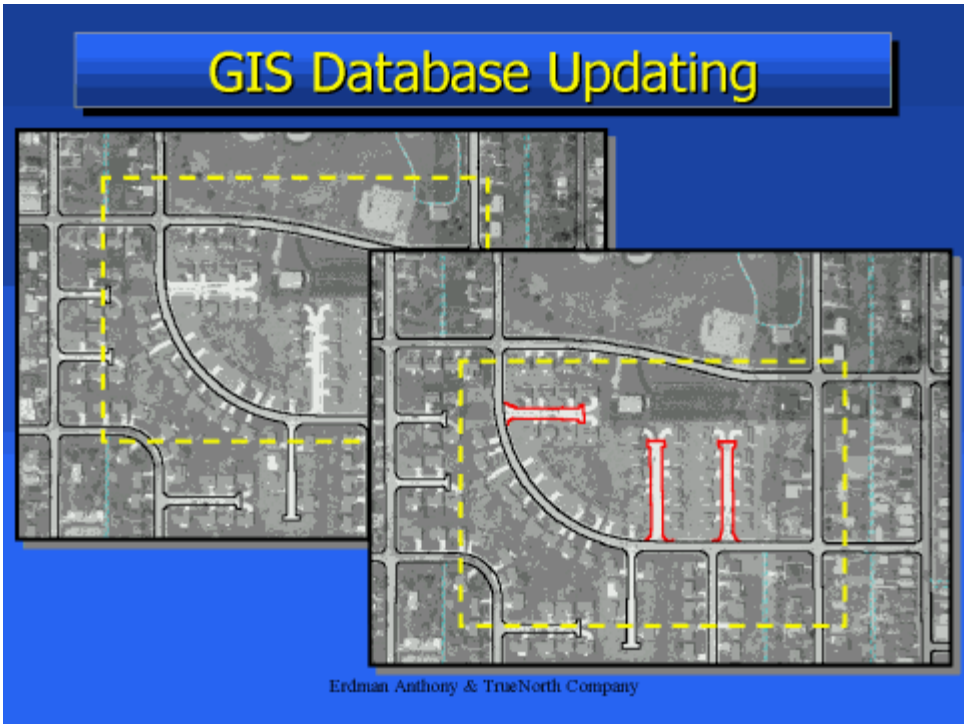
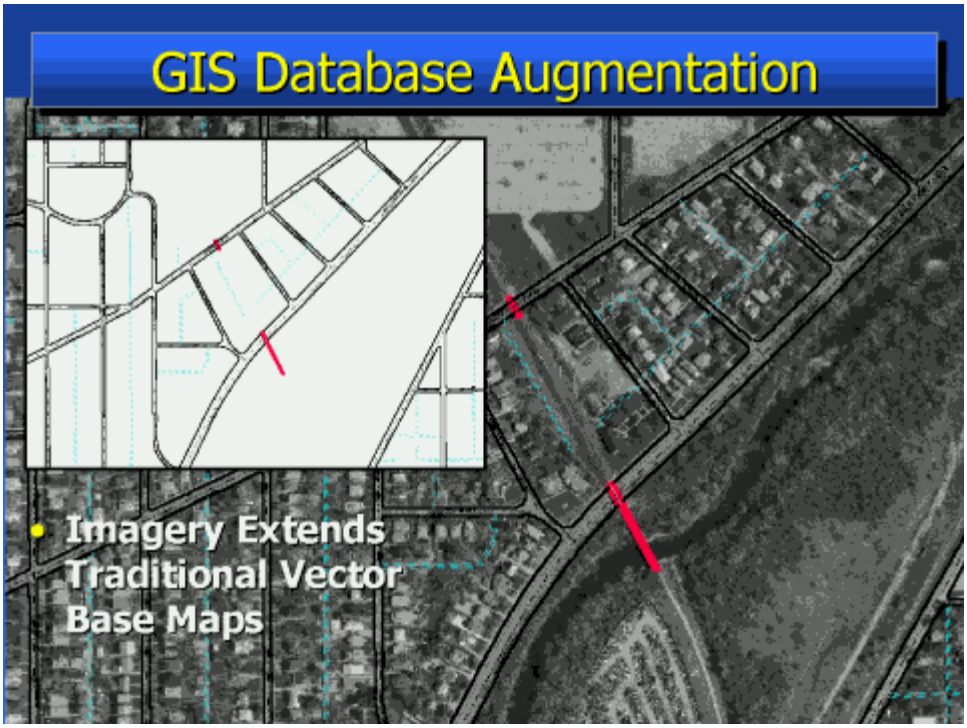
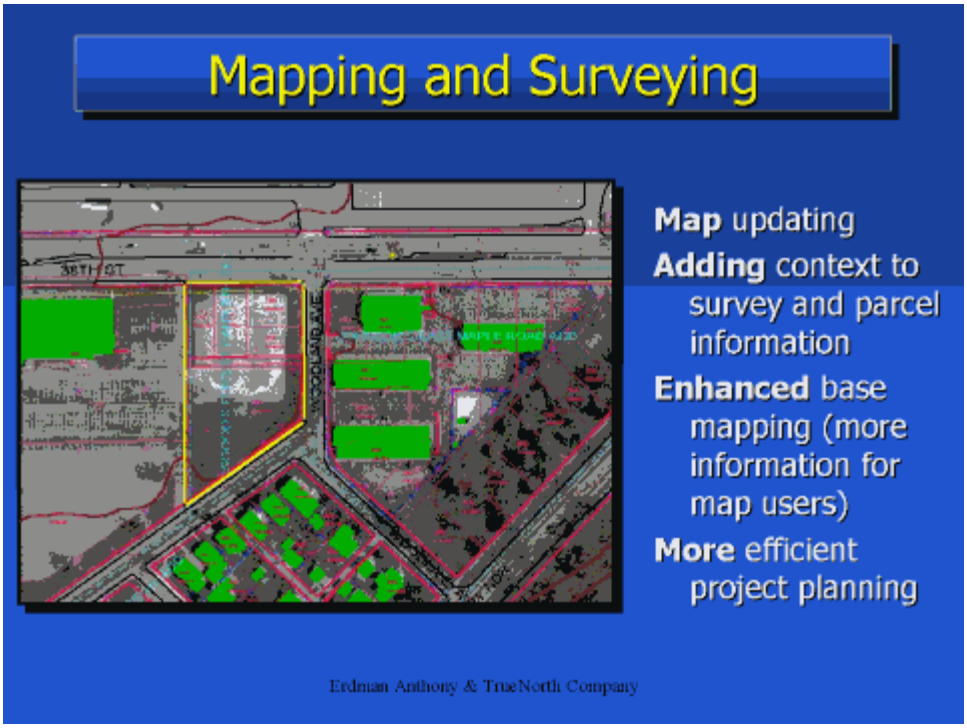
Slide 27 of 39



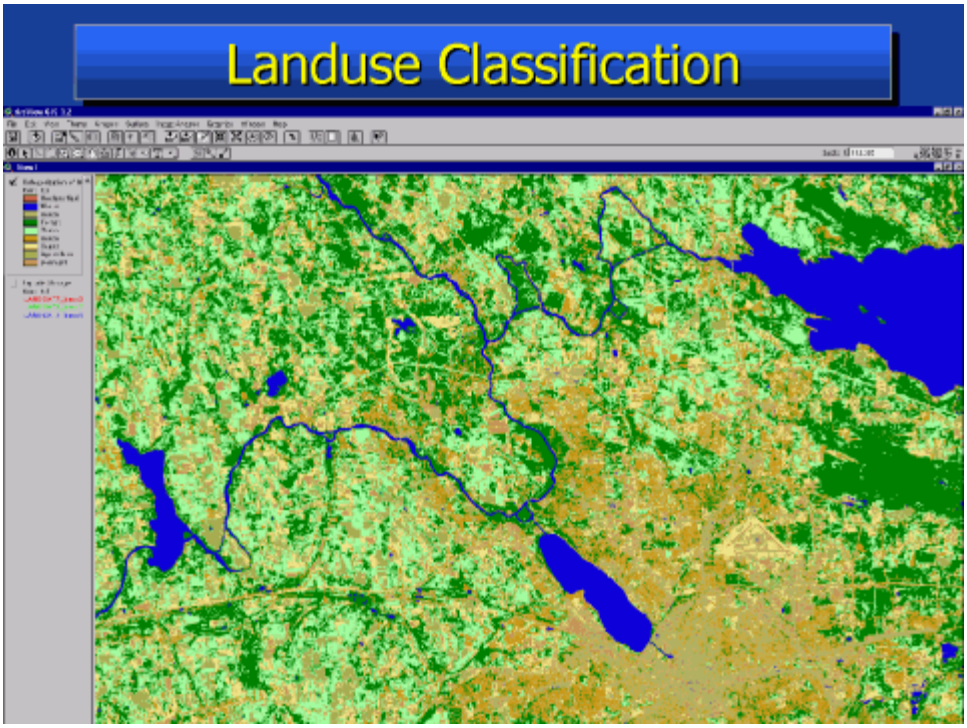
Slide 28 of 39



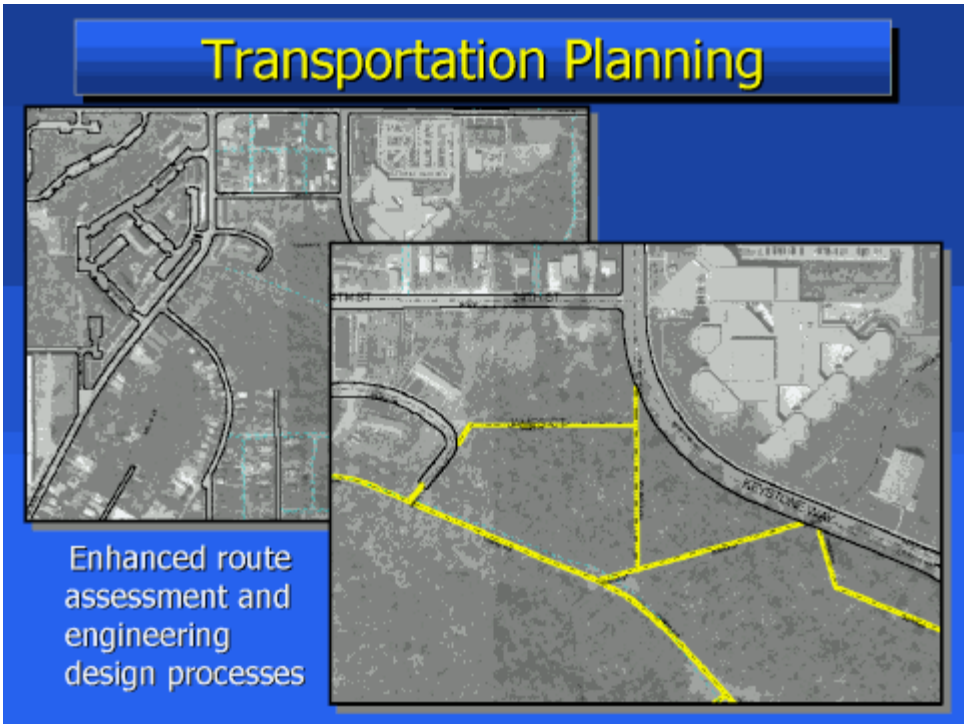
Slide 29 of 39



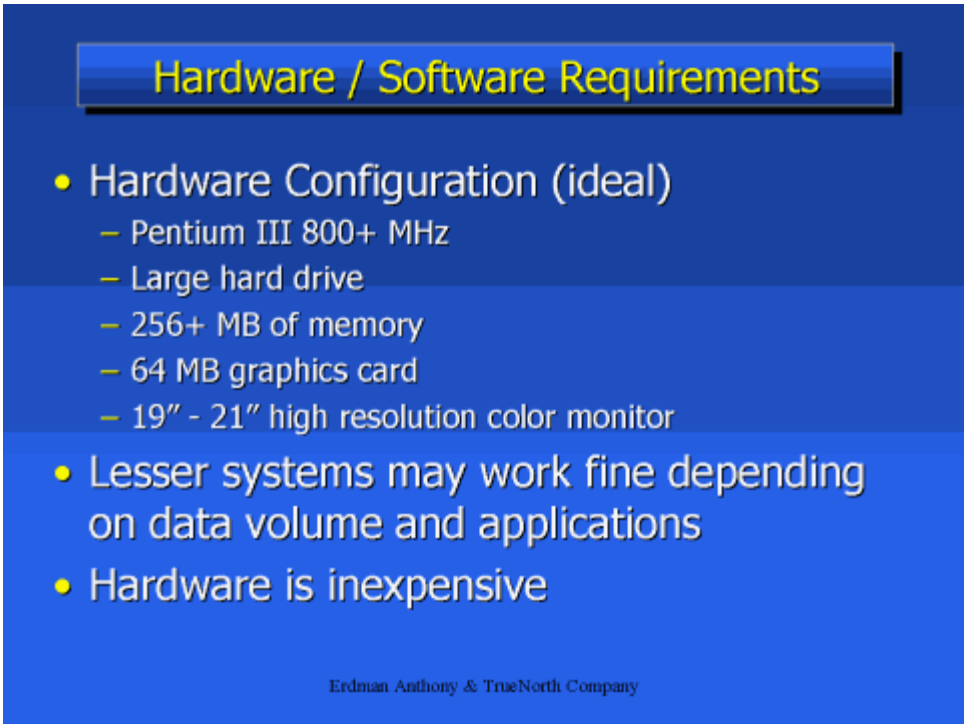
Slide 30 of 39



Slide 31 of 39



Slide 32 of 39


Hardware / Software Requirements
• Hardware Configuration (ideal)
– Pentium III 800+ MHz
– Large hard drive
– 256+ MB of memory
– 64 MB graphics card
– 19″ - 21″ high resolution color monitor
• Lesser systems may work fine depending on data volume and applications
• Hardware is inexpensive
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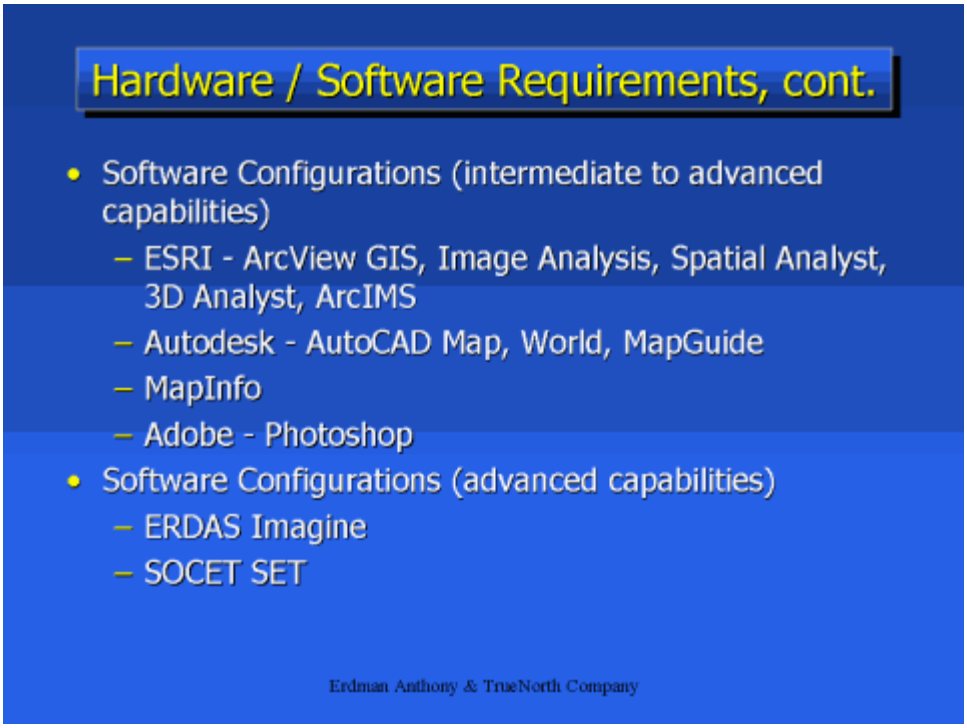
Hardware / Software Requirements, cont.
• Software Configurations (intermediate to advanced capabilities)
– ESRI - ArcView GIS, Image Analysis, Spatial Analyst, 3D Analyst, ArcIMS
– Autodesk - AutoCAD Map, World, MapGuide
– MapInfo
– Adobe - Photoshop
• Software Configurations (advanced capabilities)
– ERDAS Imagine
– SOCET SET
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Products and Pricing Information
Price depends on resolution, processing, date acquired, quantity
Imagery Formats: GeoTIFF, BIL, EROS, Acres, Spot, others
Media Options: CD, DAT cartridge, 8mm cartridge tape, FTP
Terms and copyright restrictions vary
Processing Options:
radiometric correction
geometric correction
basic georeferencing
enhanced georeferencing and geo-coding
ortho-rectification
Landsat $475 - $600 per scene
Spot $750 - $1,000 per scene
Ikonos II $12 to $44 per sq. kilometer
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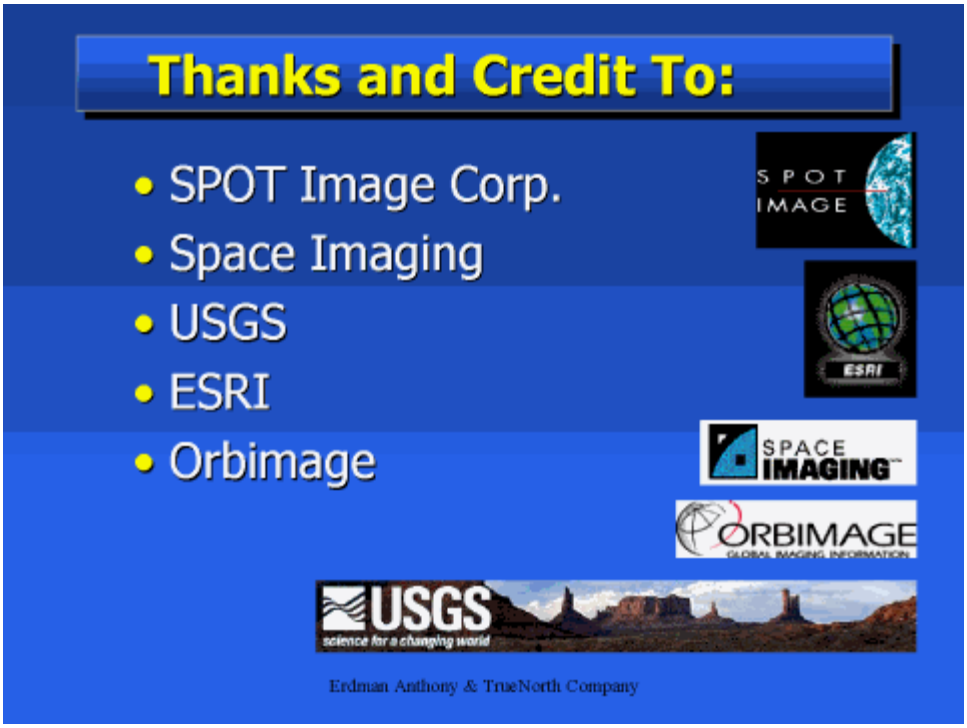
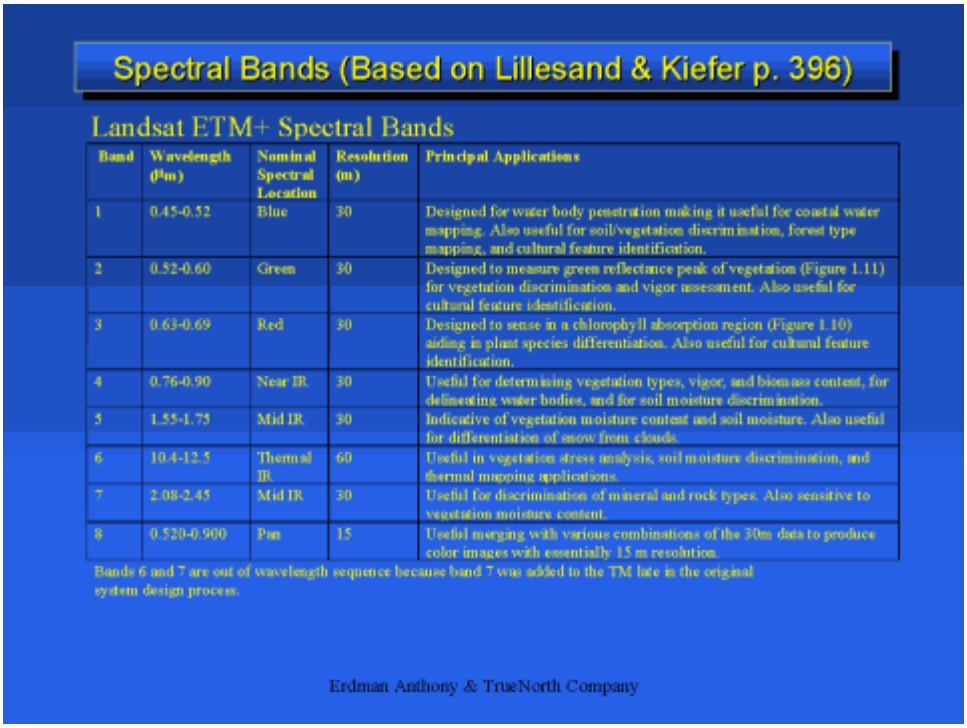
Questions/Discussion


Thanks and Credit To:
• SPOT Image Corp.
• Space Imaging
• USGS
• ESRI
• Orbimage
SPOT IMAGE
ESRI
SPACE IMAGING
ORBIMAGE
USGS
science for a changing world
Erdman Anthony & TrueNorth Company


Spectral Bands (Based on Lillesand & Kiefer p. 396)
Landsat ETM+ Spectral Bands
Band | Wavelength (μm) | Nominal Spectral Location | Resolution (m) | Principal Applications
1 | 0.45-0.52 | Blue | 30 | Designed for water body penetration making it useful for coastal water mapping. Also useful for soil/vegetation discrimination, forest type mapping, and cultural feature identification.
2 | 0.52-0.60 | Green | 30 | Designed to measure green reflectance peak of vegetation (Figure 1.11) for vegetation discrimination and vigor assessment. Also useful for cultural feature identification.
3 | 0.63-0.69 | Red | 30 | Designed to sense in a chlorophyll absorption region (Figure 1.10) aiding in plant species differentiation. Also useful for cultural feature identification.
4 | 0.76-0.90 | Near IR | 30 | Useful for determining vegetation types, vigor, and biomass content, for delineating water bodies, and for soil moisture discrimination.
5 | 1.55-1.75 | Mid IR | 30 | Indicative of vegetation moisture content and soil moisture. Also useful for differentiation of snow from clouds.
6 | 10.4-12.5 | Thermal IR | 60 | Useful in vegetation stress analysis, soil moisture discrimination, and thermal mapping applications.
7 | 2.08-2.45 | Mid IR | 30 | Useful for discrimination of mineral and rock types. Also sensitive to vegetation moisture content.
8 | 0.520-0.900 | Pan | 15 | Useful merging with various combinations of the 30m data to produce color images with essentially 15 m resolution.
Bands 6 and 7 are out of wavelength sequence because band 7 was added to the TM late in the original system design process.
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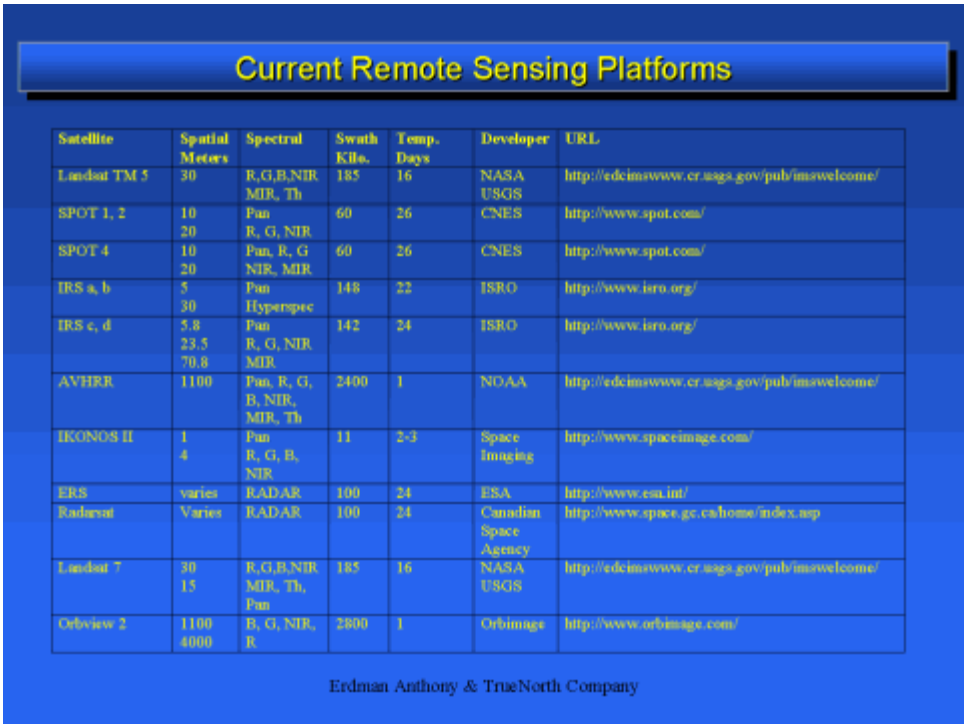
Current Remote Sensing Platforms
Satellite | Spatial Meters | Spectrul | Swath Kilo. | Temp. Days | Developer | URL
Landsat TM 5 | 30 | R,G,B,NIR MIR, Th | 185 | 16 | NASA USGS | http://edcimswww.cr.usgs.gov/pub/imswelcome/
SPOT 1, 2 | 10 20 | Pan R, G, NIR | 60 | 26 | CNES | http://www.spot.com/
SPOT 4 | 10 20 | Pan, R, G NIR, MIR | 60 | 26 | CNES | http://www.spot.com/
IRS a, b | 5 30 | Pan Hyperspec | 148 | 22 | ISRO | http://www.isro.org/
IRS c, d | 5.8 23.5 70.8 | Pan R, G, NIR MIR | 142 | 24 | ISRO | http://www.isro.org/
AVHRR | 1100 | Pan, R, G, B, NIR, MIR, Th | 2400 | 1 | NOAA | http://edcimswww.cr.usgs.gov/pub/imswelcome/
IKONOS II | 1 4 | Pan R, G, B, NIR | 11 | 2-3 | Space Imaging | http://www.spaceimage.com/
ERS | varies | RADAR | 100 | 24 | ESA | http://www.esa.int/
Radarsat | Varies | RADAR | 100 | 24 | Canadian Space Agency | http://www.space.gc.ca/home/index.asp
Landsat 7 | 30 15 | R,G,B,NIR MIR, Th, Pan | 185 | 16 | NASA USGS | http://edcimswww.cr.usgs.gov/pub/imswelcome/
Orbview 2 | 1100 4000 | B, G, NIR, R | 2800 | 1 | Orbimage | http://www.orbimage.com/
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