

The American Society for Photogrammetry
and Remote Sensing (ASPRS)

GUIDE TO LAND IMAGING SATELLITES

Special Edition Prepared for

PECORA 16

**GLOBAL PRIORITIES IN
LAND REMOTE SENSING
OCTOBER 23-27 2005 SIOUX FALLS S.D.**

**W. E. Stoney
Mitretek Systems
Wstoney@mitretek.org**

INTRODUCTION

Purpose

- This report is posted to make the ASPRS members and the broader remote sensing user community aware of just how ubiquitous imaging the Earth from space has become due to the technical advances that have enabled the creation of multispectral mid resolution satellites for as little as \$10 to 20 Million.
 - 13 countries have mid to hi resolution satellites in orbit
 - By the end of the decade there will be 20

Background

- This survey was initiated under MITRE/Mitretek contracts with NASA and the USGS in support of the 1995 ASPRS Satellite Conference. NOAA supported development of a data base web site and an updating in the 2002 period.

Sources

- All of the data are from open sources, all of the systems are defined as civil; the majority of the systems have web sites that contain detailed descriptions of the satellites and their sensors. Googling will find them and locate relevant news items.
- While the system definitions remain constant once announced the launch dates are highly volatile . History has shown that few satellites launch within 6 months of their initial launch date.

Data Availability

- Data availability is provided on the web sites. There is no central source that provides meta data on the scenes that have been acquired.

Note

- In comparing systems be aware that the quality of the radiometry is usually not available and is a variable that may be important for specific uses.

Corrections and/or additions will be gratefully accepted

OVERVIEW

- **This guide includes all civil land imaging satellites with resolutions equal to or better than 36 meters in orbit or currently planned to be in orbit by 2010.**
 - **Optical, 26 in orbit, 25 planned**
 - **Radar, 3 in orbit, 9 planned,**
- **There are two major resolution groups**
 - **18 high resolution systems (0.5 to 1.8 meter)**
 - **44 mid resolution systems (2.0 to 36 meter)**
- **They have greatly different coverage capabilities.**
 - **Hi-res swaths are in the 8 to 28 kilometer range**
 - **Mid-res swaths are generally between 70 to 185 kilometers except for the DMC's 600 Km swaths**
- **There are four privately funded systems in orbit, 3 US and 1 Israeli, all focused on the hi-res military market. A 5th commercial system, RapidEye of Germany, plans to serve a broad area of applications with a 5 microsatellite constellation**
- **The planned European satellites are labeled “Dual Purpose” meaning that their data will serve both military and civil users.**

A GUIDE TO THE CHARTS

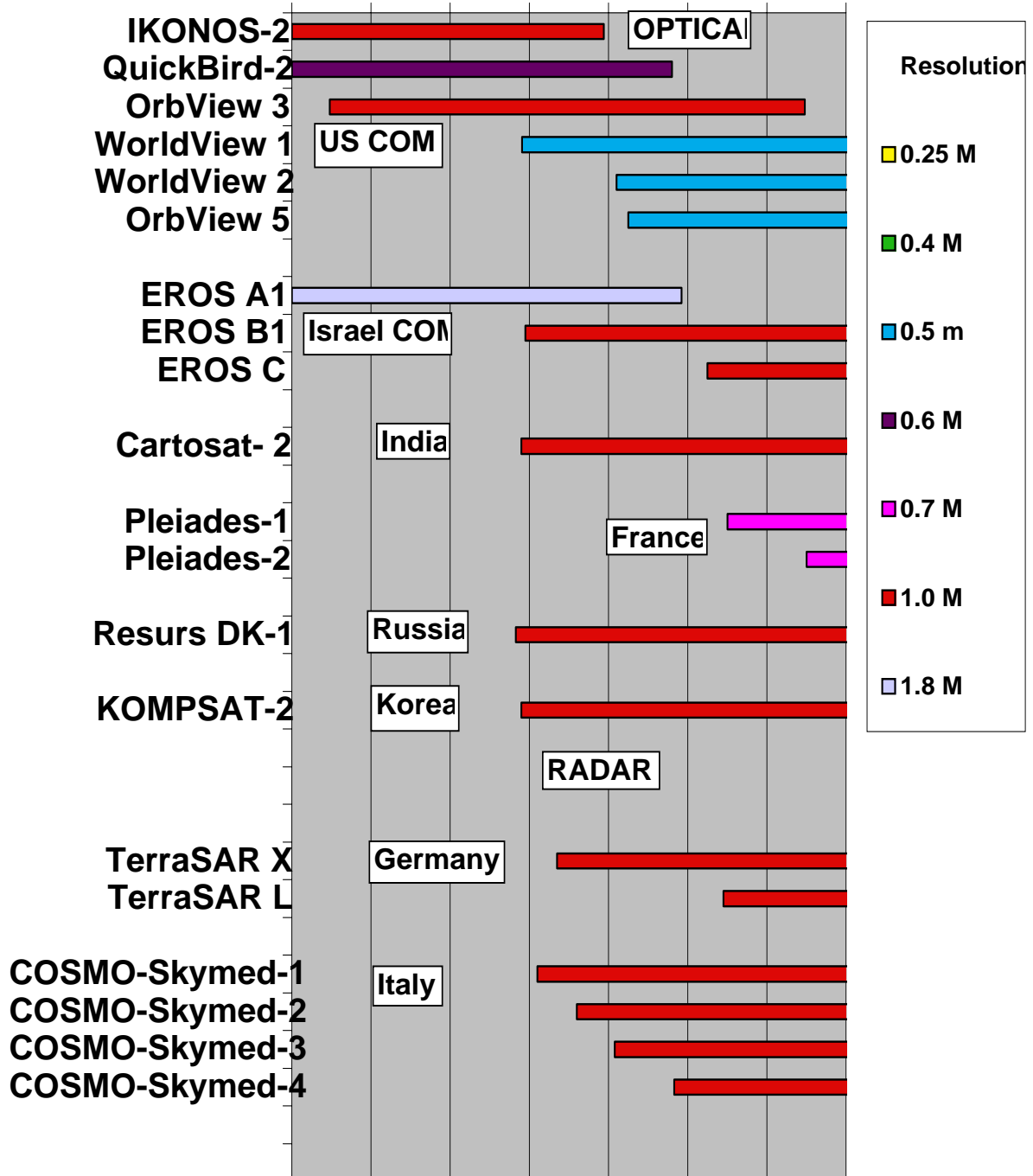
- **Table by country**
 - Note the number of small countries paying to play
 - Note that there are no US radar satellites
- **History of the number of satellites since 1999**
 - Shows the rapid increase due to the microsat constellations of DMC and RapidEye
- **Hi-Res schedule**
 - Note that 7 countries are involved and the very aggressive plans for 1 meter radar in Europe
- **Mid-Res schedule**
 - There are 18 countries funding satellites.
 - Germany's RapidEye is the only commercial system.
- **Sensor characteristics (as of 11/04 but still usefull)**
 - Provides the number, location and resolution and swaths of the optical sensor bands and the resolution, swath ranges and bands of the radars
 - Note that most of the foreign Landsat-like systems carry 2 or more sensors, one of which is wide field of view
- **Spatial coverage**
 - Illustrates the scene coverage relative to Landsat's 185 x 170 Km scene. Chart courtesy of the USGS
- **Spectral coverage**
 - Shows the spectral location and range of the bands. Note the similarity of the spectral band widths

CURRENT AND PLANNED, 36 M & BETTER, LAND IMAGING SATELLITES

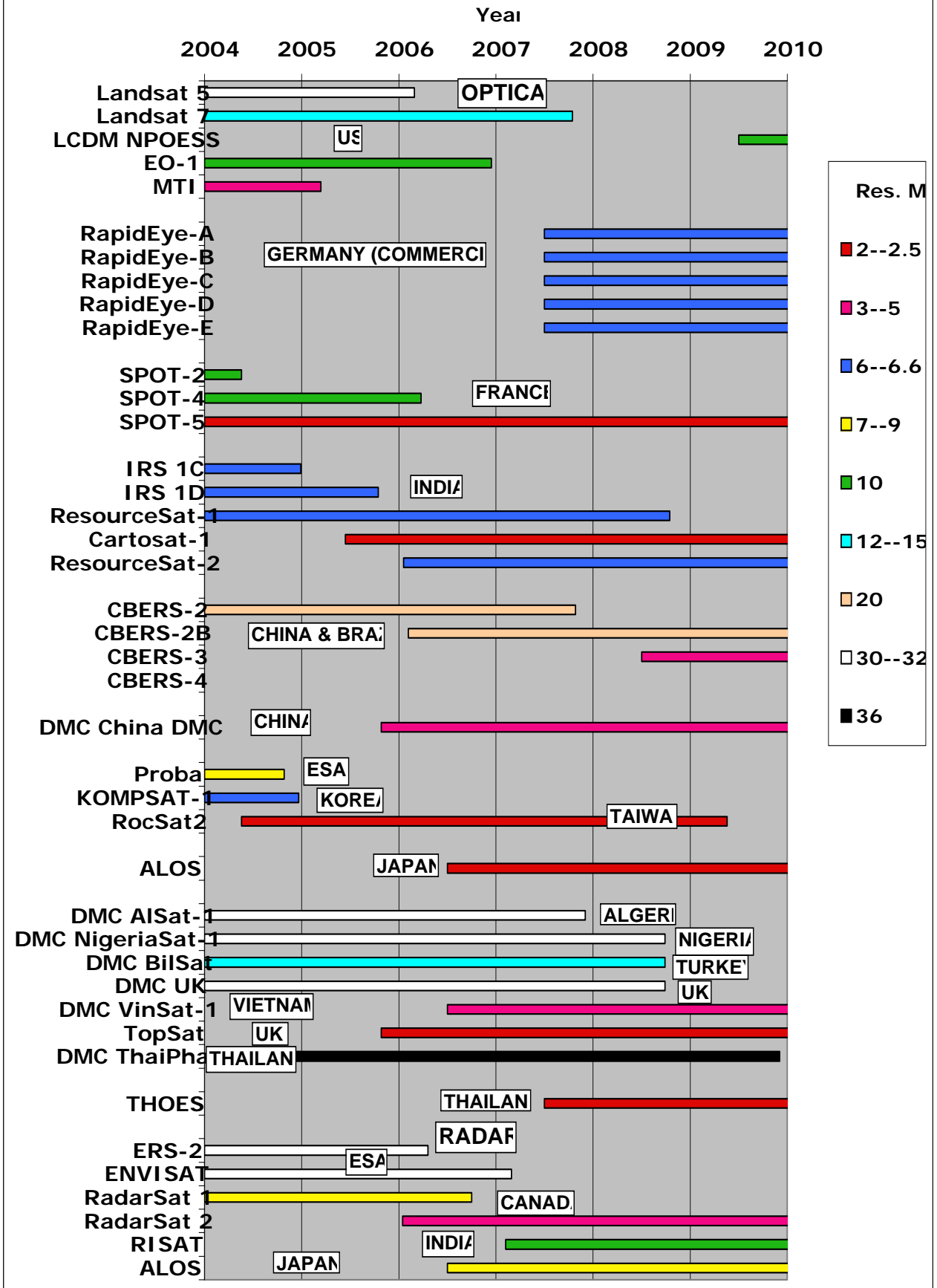
| SATELLITE | COUNTRY | LAUNCH | PAN RES. M | MS RES. M | SWATH KM |
|----------------------------|---------------------|-----------------|-------------|------------------|---------------------|
| OPTICAL | | | | | |
| DMC AISat-1(SSTL) | Algeria | 11/28/02 | | 32 | 600 |
| Tsinghua-1 (SSTL) | China | 06/28/00 | | 39 | 600 |
| DMC China DMC | China | 10/27/05 | 4.0 | 32 | 600 |
| CBERS-2 | China/Brazil | 10/21/03 | 20.0 | 20 | 113 |
| CBERS-2B | China/Brazil | 01/15/06 | 20.0 | 20 | 113 |
| CBERS-3 | China/Brazil | 05/01/08 | 5.0 | 20 | 60, 120 |
| CBERS-4 | China/Brazil | 06/01/10 | 5.0 | 20 | 60, 120 |
| Proba | ESA | 10/22/01 | 8.0 | 18, 36 | 14 |
| SPOT-2 | France | 01/22/90 | 10.0 | 20 | 120 |
| SPOT-4 | France | 03/24/98 | 10.0 | 20 | 120 |
| SPOT-5 | France | 05/04/02 | 2.5 | 10 | 120 |
| Pleiades-1 | France | 07/01/08 | 0.7 | 2.8 | 20 |
| Pleiades-2 | France | 07/01/09 | 0.7 | 2.8 | 20 |
| RapidEye-A | Germany* | 06/01/07 | | 6.5 | 78 |
| RapidEye-B | Germany* | 06/01/07 | | 6.5 | 78 |
| RapidEye-C | Germany* | 06/01/07 | | 6.5 | 78 |
| RapidEye-D | Germany* | 06/01/07 | | 6.5 | 78 |
| RapidEye-E | Germany* | 06/01/07 | | 6.5 | 78 |
| IRS 1C | India | 12/28/95 | 6.0 | 23 | 70, 142 |
| IRS 1D | India | 09/29/97 | 6.0 | 23 | 70, 142 |
| IRS ResourceSat-1 | India | 10/17/03 | 6.0 | 6, 23, 56 | 24, 140, 740 |
| IRS Cartosat 1 | India | 05/04/05 | 2.5 | | 30 |
| IRS Cartosat 2 | India | 12/10/05 | 1.0 | | 10 |
| IRS ResourceSat-2 | India | 01/15/06 | 6.0 | 6, 23, 56 | 24, 140, 740 |
| EROS A1 | Israel* | 12/05/00 | 1.8 | | 14 |
| EROS B1 | Israel* | 12/05/05 | 0.7 | | 7 |
| EROS C | Israel* | 03/01/08 | 0.7 | 2.5 | 16 |
| TERRA (ASTER) | Japan/US | 12/15/99 | | 15, 30, 90 | 60 |
| ALOS | Japan | 07/01/06 | 2.5 | 10 | 35, 70 |
| KOMPSAT-1 | Korea | 12/20/99 | 6.6 | | 17 |
| KOMPSAT-2 | Korea | 11/20/05 | 1.0 | 4 | 15 |
| RazakSat | Malaysia | 02/01/06 | 2.5 | 5 | ? |
| DMC NigeriaSat-1 (SSTL) | Nigeria | 09/27/03 | | 32 | 600 |
| MONITOR-E -1 | Russia | 08/26/05 | 8.0 | 20 | 94, 160 |
| Resurs DK-1 (01-N5) | Russia | 10/31/05 | 1.0 | 3 | 28 |
| X-Sat | Singapore | 01/15/06 | | 10 | 50 |
| R26m | South Africa | 09/01/06 | | 7.5 | ? |
| RocSat2 | Taiwan | 04/20/04 | 2.0 | 8 | 24 |
| DMC ThaiPhat (SSTL) | Thailand | 12/01/04 | | 36 | 600 |
| THOES | Thailand | 06/30/07 | 2.0 | 15 | 22, 90 |
| DMC BilSat (SSTL) | Turkey | 09/27/03 | 12.0 | 26 | 52 |
| DMC UK (SSTL) | UK | 09/27/03 | | 32 | 600 |
| TopSat (SSTL) | UK | 10/27/05 | 2.5 | 5 | 10, 15 |
| Landsat 5 | US | 03/01/84 | | 30.0 | 185 |
| Landsat 7 | US | 04/15/99 | 15.0 | 30 | 185 |
| IKONOS-2 | US* | 09/24/99 | 1.0 | 4 | 11 |
| MTI | US | 03/12/00 | | 5, 20 | 12 |
| EO-1 | US | 12/07/00 | 10.0 | 30 | 37 |
| QuickBird-2 | US* | 10/18/01 | 0.6 | 2.5 | 16 |
| OrbView 3 | US* | 06/26/03 | 1.0 | 4 | 8 |
| OrbView5 | US* | 03/16/07 | 0.41 | 1.64 | 15 |
| WorldView -1 | US* | 11/11/05 | 0.5 | | 16 |
| WorldView -2 | US* | 07/01/08 | 0.5 | 1.8 | 16 |
| LDCM (NPOES) | US | 06/30/09 | 10.0 | 30 | 177 |
| DMC VinSat-1 | Vietnam | 05/01/06 | 4.0 | 32 | 600 |
| RADAR | | | | | |
| RadarSat 1 | Canada | 11/04/95 | 8.5 | | |
| RadarSat 2 | Canada | 01/15/06 | 3.0 | | |
| ERS-2 | ESA | 04/21/95 | 30.0 | | |
| ENVISAT | ESA | 03/01/02 | 30.0 | | |
| TerraSAR X | Germany | 04/15/06 | 1.0 | | |
| TerraSAR L | Germany | 06/15/08 | 1.0 | | |
| RISAT | India | 01/30/07 | 3.0 | | |
| COSMO-Skymed-1 | Italy | 02/01/06 | 1.0 | | |
| COSMO-Skymed-2 | Italy | 08/01/06 | 1.0 | | |
| COSMO-Skymed-3 | Italy | 02/01/07 | 1.0 | | |
| COSMO-Skymed-4 | Italy | 10/01/07 | 1.0 | | |
| ALOS | Japan | 07/01/06 | 10.0 | | |

Hi-Res Land Imaging Satell

2003 2004 2005 2006 2007 2008 2009 2010



Mid-Res Land Imaging Satc



SENSOR CHARACTERISTICS

| OPTICAL SATELLITE | Sensor | Resolution Meters & (# bands) | | | | | Swath Kilometers |
|----------------------------|------------------------------|-------------------------------|---------------------------------|----------|---------|---------|---------------------|
| | | PAN | VNIR | SWIR | MWIR | TIR | |
| ALOS | AVNIR PRISM | | 10 (4) | | | 70 | |
| | | 2.5 | (simultaneous fore, nadir, aft) | | | 35, 70 | |
| CBERS-1, 2 & 2A | CCD | 20.0 | 20 (4) | | | 113 | |
| | IRMSS | 80.0 | | 80 (2) | 160 (1) | 120 | |
| | WFI-1 | | 240 (3) | | | 885 | |
| CBERS-3 & 4 | IRMSS | | 40 (1) | 40 (2) | 80 (1) | 120 | |
| | MUXCAM | | 20 (4) | | | 120 | |
| | PANMUX | 5.0 | 10 (3) | | | 60 | |
| | WFI-2 | | 73 (3) | 73 (1) | | 866 | |
| DMC AISat-1 | MSDMC | | 32 (3) | | | 600 | |
| DMC BiSat | MST | | 26 (4) | | | 52 | |
| | PANT | 12.0 | | | | | |
| DMC China DMC | MSDMC | | 32 (3) | | | 600 | |
| | PDMC | 4.0 | | | | | |
| DMC NigeriaSat-1 | MSDMC | | 32 (3) | | | 600 | |
| DMC ThaiPhat | TMS | | 36 (3) | | | 600 | |
| DMC UK | MSDMC | | 32 (3) | | | 600 | |
| DMC VinSat-1 | MSDMC | | 32 (3) | | | 600 | |
| | PDMC | 4.0 | | | | | |
| EO-1 | ALI | 10.0 | 30 (6) | 30 (3) | | 37 | |
| | HYPERION | | 30 (230) | | | 7.5 | |
| | LAC | | 250 (256) | | | 250 | |
| EROS A1 | PIC | 1.8 | | | | 14 | |
| EROS B | PIC-3 | 0.7 | | | | 7 | |
| EROS C | PIC-2 | 0.7 | 2.8 (4) | | | 11 | |
| IKONOS-2 | OSA | 1.0 | 2.5 (4) | | | 11.3 | |
| IRS 1C & 1D | LISS-III | | 23.5 (3) | 70.5 (1) | | 142 | |
| | PAN | 6.0 | | | | 70 | |
| | WiFS | | 188 (2) | | | 810 | |
| IRS Cartosat 1 | HR-PAN | 2.5 | | | | 30 | |
| IRS Cartosat 2 | HR-PAN-2 | 1.0 | | | | 10 | |
| IRS ResourceSat-1 | AWiFS | | 56 (2) | 56 (1) | | 740 | |
| IRS ResourceSat-2 | LISS-III + | | 23.5 (3) | 23.5 (1) | | 140 | |
| | LISS-IV | 6.0 | 6 (3) | | | 70/23.9 | |
| KOMPSAT-1 | EOC | 6.6 | | | | 17 | |
| | OSMI | | 1000 (6) | | | 800 | |
| KOMPSAT-2 | MSC | 1.0 | 4 (4) | | | 15 | |

Note: Black = Operational. Red = Planned

Revised 11/8/04

W.E.S.

SENSOR CHARACTERISTICS (continued)

| OPTICAL SATELLITE | Sensor | Resolution Meters & (# bands) | | | | | Swath Kilometers |
|-------------------------|--------------|-------------------------------|---------------|-------------------------|--------|---------|---------------------|
| | | PAN | VNIR | SWIR | MWIR | TIR | |
| Landsat 5 | MSS | | 80 (4) | | | | 185 |
| | TM | | 30 (4) | 30 (2) | | 120 (1) | 185 |
| Landsat 7 | ETM+ | 15.0 | 30 (4) | 30 (2) | | 60 (1) | 185 |
| LDCM | OLI | 10.0 | 30 (5) | 30 (3) | | | 177 |
| MONITOR-E #1 | PANIMAGER | 8.0 | | | | | 94 |
| | MS DA | | 20 (3) | (40 TO DIST SITES) | | | 160 |
| MTI | MTI | | 5 (4), 20 (3) | 20 (3) | 20 (2) | 20 (3) | 12 |
| OrbView 3 | OHRIS | 1.0 | 4 (4) | | | | 8 |
| OrbView 5 | OHRIS+ | 0.4 | 1.64 (4) | | | | ? |
| Pleiades-1 & 2 | OHRI | 0.7 | 2.8 (4) | | | | 20 |
| Proba | CHRIS | | 18/36 (63) | | | | 14 |
| | HRC | 8.0 | | | | | |
| QuickBird-2 | BGIS 2000 | 0.6 | 2.5 (4) | | | | 16 |
| RapidEye-A, B, C, D & E | REIS | 6.5 | 6.5 (5) | | | | 158 |
| RazakSat | MAC | 2.5 | 5(?) | 7 deg. equatorial orbit | | | ? |
| Resurs DK-1 | HROI | 1.0 | 3 (3) | | | | 28 |
| RocSat2 | RSI | 2.0 | 8 (4) | | | | 24 |
| SICH-1M #1 | MSU-EU | | 24 (3) | | | | 48 |
| SPOT-1 & 2 | HRV | 10.0 | 20 (3) | | | | 120 |
| SPOT-4 | HRVIR | 10.0 | 20 (3) | 20 (1) | | | 120 |
| | VMI | | 1150 (3) | 1150 (1) | | | 2200 |
| SPOT-5 | HRG | 2.5 | 10 (3) | 20 (1) | | | 120 |
| | HRS | 10.0 | | | | | 120 |
| | VMI | | 1150 (3) | 1150 (1) | | | 2200 |
| Terra | ASTER (VNIR) | | 15 (3) | | | | 60 |
| | ASTER (SWIR) | | | 30 (9) | | | 60 |
| | ASTER (TIR) | | | | | 90 (5) | 60 |
| THOES | ? | 2.0 | ? | ? | | | ? |
| TopSat | HIROC | 2.5 | 5 (3) | | | | 15/10 |
| Tsinghua-1 (SSTL) | ? | | 39 (3) | | | | 600 |
| WorldView | ? | 0.5 | 4 (8) | | | | 16 |

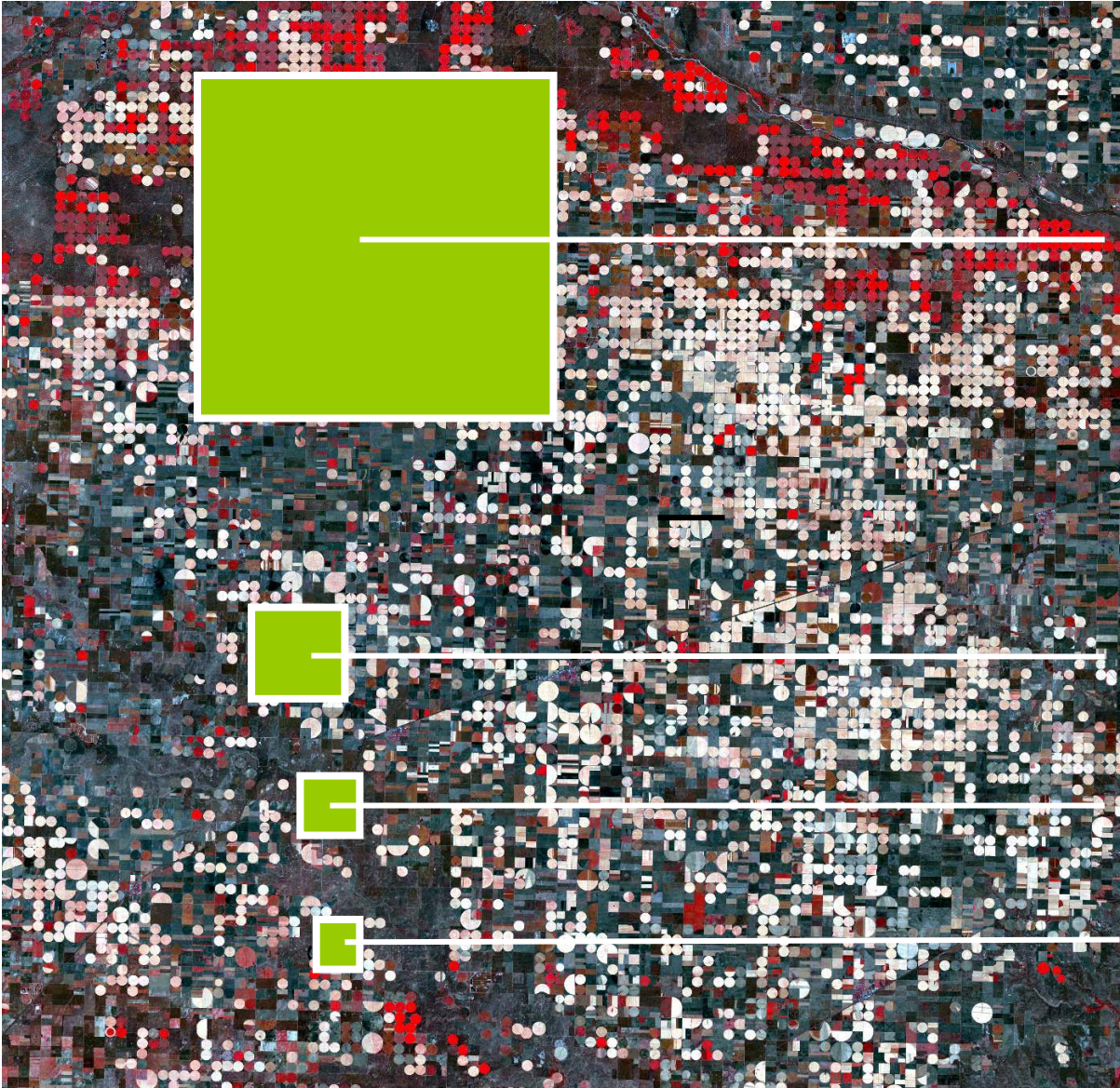
| RADAR SATELLITE | | Resolution Meters | (Band) | |
|----------------------|----------|-------------------|--------|--------------|
| ALOS | PALSAR | 10-20-100 | L | 35-50-70-250 |
| COSMO-Skymed-1,2,3,4 | SAR-2000 | 1.0 | X | |
| ENVISAT | ASAR | 30.0 | C | 60-100 |
| ERS-2 | GOME | 25.0 | C | 100 |
| RadarSat 1 | SAR | 8.5-100 | C | 50-500 |
| RadarSat 2 | SAR+ | 3-28-100 | C | 20-100-500 |
| RISAT | SAR | 10-50 | C | 10-240 |
| TerraSAR L | LSAR | 1.5-30 | L | 10-200 |
| TerraSAR X | XSAR | 1.5-30 | X | 10-200 |

Note: Black = Operational Red = Planned

Revised 11/8/04

W.E.S

Spatial Coverage



Landsat

ASTER,
1/2SPOT

QuickBird

IKONOS

OrbView-3

BAND LOCATIONS FOR 30 METER AND BETTER SATELLITES

