

# FOREIGN LAND IMAGING SATELLITE PROGRAMS

PRESENTATION TO  
NOAA'S ADVISORY COMMITTEE  
FOR COMMERCIAL REMOTE  
SENSING

11/14/03

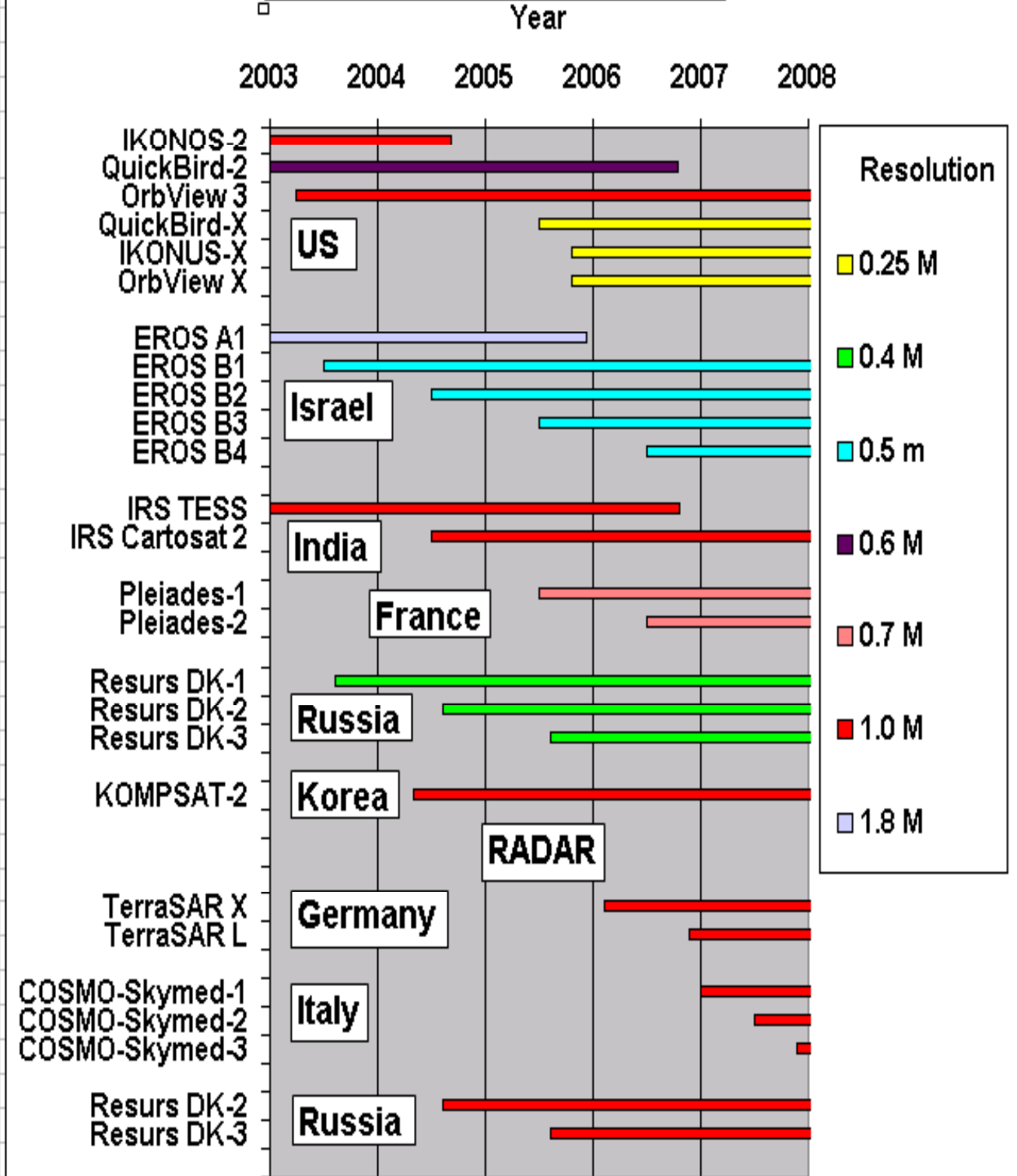
W. STONEY  
MITRETEK SYSTEMS

## LAND IMAGING SATELLITES: THE NEXT 5 YEARS???

Satellite	Country	Owner	Launch	Best Res
<b>IKONUS-X</b>	US	Com.	6/1/2005	<b>0.25</b>
<b>QuickBird-X</b>	US	Com.	6/1/2004	<b>0.25</b>
<b>OrbView X</b>	US	Com.	11/1/2005	<b>0.25</b>
<b>Resurs DK-1</b>	Russia	Gov.	9/1/2003	<b>0.4</b>
<b>Resurs DK-2</b>	Russia	Gov.	9/1/2004	<b>0.4</b>
<b>Resurs DK-3</b>	Russia	Gov.	9/1/2005	<b>0.4</b>
<b>EROS B1</b>	Israel	Com.	6/1/2003	<b>0.5</b>
<b>EROS B2</b>	Israel	Com.	6/1/2004	<b>0.5</b>
<b>EROS B3</b>	Israel	Com.	6/1/2005	<b>0.5</b>
<b>EROS B4</b>	Israel	Com.	6/1/2006	<b>0.5</b>
<b>QuickBird-2</b>	US	Com.	10/18/2001	<b>0.6</b>
<b>Pleiades-1</b>	France	Gov	6/1/2005	<b>0.7</b>
<b>Pleiades-2</b>	France	Gov	6/1/2006	<b>0.7</b>
<b>IKONOS-2</b>	US	Com.	9/24/1999	<b>1.0</b>
<b>EROS A1</b>	Israel	Com.	12/5/2000	<b>1.8</b>
<b>IRS TESS</b>	India	Gov.	10/22/2001	<b>1.0</b>
<b>OrbView 3</b>	US	Com.	3/15/2003	<b>1.0</b>
<b>KOMPSAT-2</b>	Korea	Gov.	1/1/2004	<b>1.0</b>
<b>IRS Cartosat 2</b>	India	Gov.	6/1/2004	<b>1.0</b>
<b>Resurs DK-2</b>	Russia	Gov.	9/1/2004	<b>1.0</b>
<b>TerraSAR X</b>	Germany	Gov	6/15/2005	<b>1.0</b>
<b>Resurs DK-3</b>	Russia	Gov.	9/1/2005	<b>1.0</b>
<b>TerraSAR L</b>	Germany	Gov	3/15/2006	<b>1.0</b>
<b>COSMO-Skymed-1</b>	Italy	Gov.	1/1/2007	<b>1.0</b>
<b>COSMO-Skymed-2</b>	Italy	Gov.	6/1/2007	<b>1.0</b>
<b>COSMO-Skymed-3</b>	Italy	Gov.	11/1/2007	<b>1.0</b>
<b>RocSat2</b>	Taiwan	Gov.	12/1/2003	<b>2.0</b>
<b>SPOT-5</b>	France	Gov.	5/4/2002	<b>2.5</b>
<b>TopSat</b>	UK	Gov.	11/15/2003	<b>2.5</b>
<b>ALOS</b>	Japan	Gov.	6/1/2004	<b>2.5</b>
<b>RadarSat 2</b>	Canada	Gov.	4/1/2004	<b>3.0</b>
<b>Ziyuan-ZY-2B</b>	China	Gov.	10/27/2002	<b>3.0</b>
<b>DMC China DMC</b>	China	Gov.	5/1/2004	<b>4.0</b>
<b>DMC VinSat-1</b>	Vietnam	Gov.	5/1/2004	<b>4.0</b>
<b>CBERS-3</b>	China/Brazil	Gov.	5/1/2005	<b>5.0</b>
<b>CBERS-4</b>	China/Brazil	Gov.	6/1/2008	<b>5.0</b>
<b>IRS 1C</b>	India	Gov	12/28/1995	<b>6.0</b>
<b>IRS 1D</b>	India	Gov.	9/29/1997	<b>6.0</b>
<b>IRS ResourceSat-1</b>	India	Gov.	6/1/2003	<b>6.0</b>
<b>IRS ResourceSat-2</b>	India	GOV	1/1/2006	<b>6.0</b>
<b>RapidEye-A</b>	Germany	Com.	10/1/2005	<b>6.5</b>
<b>RapidEye-B</b>	Germany	Com.	10/1/2005	<b>6.5</b>
<b>RapidEye-C</b>	Germany	Com.	10/1/2005	<b>6.5</b>
<b>RapidEye-C</b>	Germany	Com.	10/1/2005	<b>6.5</b>
<b>KOMPSAT-1</b>	Korea	Gov.	12/20/1999	<b>6.6</b>
<b>ALOS</b>	Japan	Gov.	6/1/2004	<b>7.0</b>
<b>LCDM-A</b>	US	Com.	12/1/2006	<b>7.5</b>
<b>LCDM-B</b>	US	Com.	12/1/2006	<b>7.5</b>
<b>Proba</b>	ESA	Gov.	10/22/2001	<b>8.0</b>
<b>RadarSat 1</b>	Canada	Gov.	11/4/1995	<b>8.5</b>
<b>Ziyuan-ZY-2A</b>	China	Gov.	9/1/2000	<b>9.0</b>
<b>SPOT-2</b>	France	Gov.	1/22/1990	<b>10.0</b>
<b>SPOT-4</b>	France	Gov.	3/24/1998	<b>10.0</b>
<b>UoSAT 12</b>	Singapore	Gov.	5/12/1999	<b>10.0</b>
<b>EO-1</b>	US	Gov.	12/7/2000	<b>10.0</b>
<b>DMC BilSat</b>	Turkey	Gov	7/15/2003	<b>12.0</b>
<b>Landsat 7</b>	US	Gov.	4/15/1999	<b>15.0</b>
<b>CBERS-1</b>	China/Brazil	Gov.	10/14/1999	<b>20.0</b>
<b>CBERS-2</b>	China/Brazil	Gov.	8/10/2003	<b>20.0</b>
<b>ERS-2</b>	ESA	Gov.	4/21/1995	<b>30.0</b>
<b>ENVISAT</b>	ESA	Gov.	3/1/2002	<b>30.0</b>
<b>DMC AISat-1</b>	Algeria	Gov.	11/28/2002	<b>32.0</b>
<b>DMC NigeriaSat-1</b>	Nigeria	Gov	7/15/2003	<b>32.0</b>
<b>DMC UK</b>	UK	Gov	7/15/2003	<b>32.0</b>
<b>DMC ThaiPhat</b>	Thailand	Gov	7/15/2003	<b>36.0</b>

# Hi-Res Land Imaging Satellites

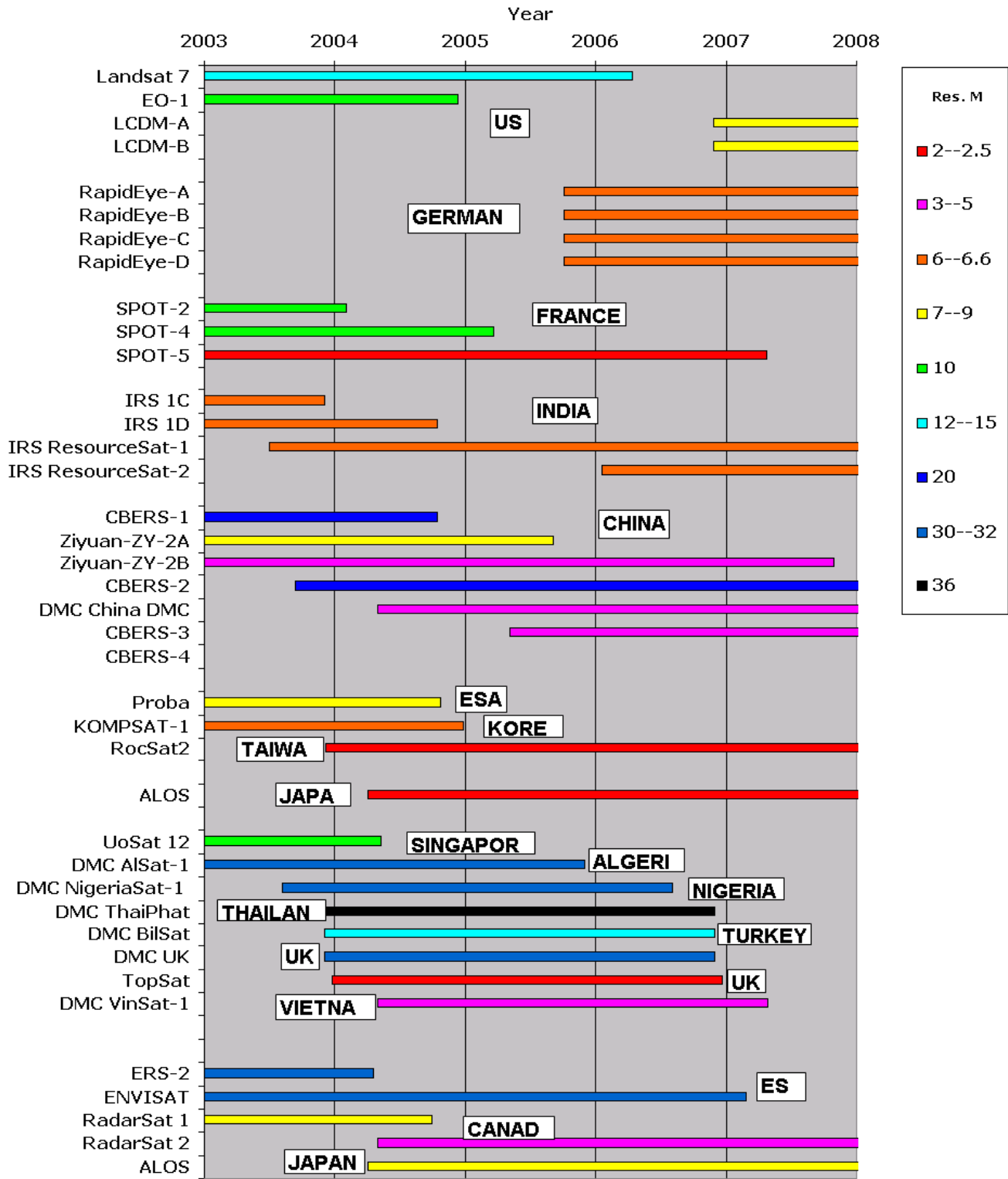
## The Next Five Years



## THE ONE METER AND BETTER CLUB

Satellite	Country	Owner	Launch	Best Res
<b>OPTICAL</b>				
<b>IKONOS-2</b>	US	Com.	9/24/1999	<b>1.0</b>
<b>QuickBird-2</b>	US	Com.	10/18/2001	<b>0.6</b>
<b>OrbView 3</b>	US	Com.	3/15/2003	<b>1.0</b>
<b>QuickBird-X</b>	US	Com.	6/1/2004	<b>0.25</b>
<b>IKONOS-X</b>	US	Com.	6/1/2005	<b>0.25</b>
<b>OrbView X</b>	US	Com.	11/1/2005	<b>0.25</b>
<b>EROS A1</b>	Israel	Com.	12/5/2000	<b>1.8</b>
<b>EROS B1</b>	Israel	Com.	6/1/2003	<b>0.5</b>
<b>EROS B2</b>	Israel	Com.	6/1/2004	<b>0.5</b>
<b>EROS B3</b>	Israel	Com.	6/1/2005	<b>0.5</b>
<b>EROS B4</b>	Israel	Com.	6/1/2006	<b>0.5</b>
<b>IRS TESS</b>	India	Gov.	10/22/2001	<b>1.0</b>
<b>IRS Cartosat 2</b>	India	Gov.	6/1/2004	<b>1.0</b>
<b>Helios-1A</b>	France	Mil	7/1/1995	<b>1.0</b>
<b>Helios-1B</b>	France	Mil	7/1/1995	<b>1.0</b>
<b>Pleiades-1</b>	France	Gov	6/1/2005	<b>0.7</b>
<b>Pleiades-2</b>	France	Gov	6/1/2006	<b>0.7</b>
<b>Helios-2A</b>	France	Mil	6/1/2004	<b>&lt;1</b>
<b>Helios-2B</b>	France	Mil	TBD	<b>&lt;1</b>
<b>IGS-01</b>	Japan	Mil	11/1/2003	<b>1.0</b>
<b>IGS-02</b>	Japan	Mil	6/1/2004	<b>1.0</b>
<b>Resurs DK-1</b>	Russia	Gov.	9/1/2003	<b>0.4</b>
<b>Resurs DK-2</b>	Russia	Gov.	9/1/2004	<b>0.4</b>
<b>Resurs DK-3</b>	Russia	Gov.	9/1/2005	<b>0.4</b>
<b>KOMPSAT-2</b>	Korea	Gov.	1/1/2004	<b>1.0</b>
<b>RADAR</b>				
<b>TerraSAR X</b>	Germany	Gov	6/15/2005	<b>1.0</b>
<b>TerraSAR L</b>	Germany	Gov	3/15/2006	<b>1.0</b>
<b>SAR-LiPe-1</b>	Germany	Mil	6/1/2005	<b>1.0</b>
<b>SAR-LiPe-2</b>	Germany	Mil	TBD	<b>1.0</b>
<b>COSMO-Skymed-1</b>	Italy	Gov.	1/1/2007	<b>1.0</b>
<b>COSMO-Skymed-2</b>	Italy	Gov.	6/1/2007	<b>1.0</b>
<b>COSMO-Skymed-3</b>	Italy	Gov.	11/1/2007	<b>1.0</b>
<b>IGS-R1</b>	Japan	Mil	11/1/2003	<b>1 to 3</b>
<b>IGS-R2</b>	Japan	Mil	6/1/2004	<b>1 to 3</b>
<b>Resurs DK-2</b>	Russia	Gov.	9/1/2004	<b>1.0</b>
<b>Resurs DK-3</b>	Russia	Gov.	9/1/2005	<b>1.0</b>

# Mid-Res Land Imaging Satellites



# MID-RES LAND IMAGING SATELLITES

SATELLITE	COUNTRY	OWNER	BEST RES M	LAUNCH
<b>OPTICAL</b>				
Landsat 7	US	Gov.	15.0	1999.29
EO-1	US	Gov.	10.0	2000.95
<b>LCDM-A</b>	<b>US</b>	<b>Com.</b>	<b>7.5</b>	<b>2006.90</b>
<b>LCDM-B</b>	<b>US</b>	<b>Com.</b>	<b>7.5</b>	<b>2006.90</b>
<b>RapidEye-A</b>	<b>Germany</b>	<b>Com.</b>	<b>6.5</b>	<b>2005.76</b>
<b>RapidEye-B</b>	<b>Germany</b>	<b>Com.</b>	<b>6.5</b>	<b>2005.76</b>
<b>RapidEye-C</b>	<b>Germany</b>	<b>Com.</b>	<b>6.5</b>	<b>2005.76</b>
<b>RapidEye-D</b>	<b>Germany</b>	<b>Com.</b>	<b>6.5</b>	<b>2005.76</b>
<b>SPOT-2</b>	<b>France</b>	<b>Gov.</b>	<b>10.0</b>	<b>1990.10</b>
<b>SPOT-4</b>	<b>France</b>	<b>Gov.</b>	<b>10.0</b>	<b>1998.23</b>
<b>SPOT-5</b>	<b>France</b>	<b>Gov.</b>	<b>2.5</b>	<b>2002.32</b>
<b>IRS 1C</b>	<b>India</b>	<b>Gov.</b>	<b>6.0</b>	<b>1995.90</b>
<b>IRS 1D</b>	<b>India</b>	<b>Gov.</b>	<b>6.0</b>	<b>1997.79</b>
<b>IRS ResourceSat-1</b>	<b>India</b>	<b>Gov.</b>	<b>6.0</b>	<b>2003.50</b>
<b>IRS ResourceSat-2</b>	<b>India</b>	<b>Gov.</b>	<b>6.0</b>	<b>2006.05</b>
<b>CBERS-1</b>	<b>China/Brazil</b>	<b>Gov.</b>	<b>20.0</b>	<b>1999.79</b>
<b>Ziyuan-ZY-2A</b>	<b>China</b>	<b>Gov.</b>	<b>9.0</b>	<b>2000.68</b>
<b>Ziyuan-ZY-2B</b>	<b>China</b>	<b>Gov.</b>	<b>3.0</b>	<b>2002.84</b>
<b>CBERS-2</b>	<b>China/Brazil</b>	<b>Gov.</b>	<b>20.0</b>	<b>2003.70</b>
<b>DMC China DMC</b>	<b>China</b>	<b>Gov.</b>	<b>4.0</b>	<b>2004.33</b>
<b>CBERS-3</b>	<b>China/Brazil</b>	<b>Gov.</b>	<b>5.0</b>	<b>2005.34</b>
<b>CBERS-4</b>	<b>China/Brazil</b>	<b>Gov.</b>	<b>5.0</b>	<b>2008.50</b>
<b>KOMPSAT-1</b>	<b>Korea</b>	<b>Gov.</b>	<b>6.6</b>	<b>1999.99</b>
<b>Proba (Hyperspectral)</b>	<b>ESA</b>	<b>Gov.</b>	<b>8.0</b>	<b>2001.82</b>
<b>RocSat2</b>	<b>Taiwan</b>	<b>Gov.</b>	<b>2.0</b>	<b>2003.93</b>
<b>ALOS</b>	<b>Japan</b>	<b>Gov.</b>	<b>2.5</b>	<b>2004.25</b>
<b>UoSat 12</b>	<b>Singapore</b>	<b>Gov.</b>	<b>10.0</b>	<b>1999.36</b>
<b>DMC AlSat-1</b>	<b>Algeria</b>	<b>Gov.</b>	<b>32.0</b>	<b>2002.92</b>
<b>DMC NigeriaSat-1</b>	<b>Nigeria</b>	<b>Gov.</b>	<b>32.0</b>	<b>2003.60</b>
<b>DMC ThaiPhat</b>	<b>Thailand</b>	<b>Gov.</b>	<b>36.0</b>	<b>2003.92</b>
<b>DMC BilSat</b>	<b>Turkey</b>	<b>Gov.</b>	<b>12.0</b>	<b>2003.92</b>
<b>DMC UK</b>	<b>UK</b>	<b>Gov.</b>	<b>32.0</b>	<b>2003.92</b>
<b>TopSat</b>	<b>UK</b>	<b>Gov.</b>	<b>2.5</b>	<b>2003.98</b>
<b>DMC VinSat-1</b>	<b>Vietnam</b>	<b>Gov.</b>	<b>4.0</b>	<b>2004.33</b>
<b>RADAR</b>				
<b>ERS-2</b>	<b>ESA</b>	<b>Gov.</b>	<b>30.0</b>	<b>1995.30</b>
<b>ENVISAT</b>	<b>ESA</b>	<b>Gov.</b>	<b>30.0</b>	<b>2002.16</b>
<b>RadarSat 1</b>	<b>Canada</b>	<b>Gov.</b>	<b>8.5</b>	<b>1995.75</b>
<b>RadarSat 2</b>	<b>Canada</b>	<b>Gov.</b>	<b>3.0</b>	<b>2004.33</b>
<b>ALOS</b>	<b>Japan</b>	<b>Gov.</b>	<b>7.0</b>	<b>2004.25</b>

# FRANCE

- Current
  - SPOT-4, 10 meter Pan, 20 meter MS
  - SPOT-5, 2.5/5 meter Pan, 10/20 meter MS
  - Helios 1a and 1b, about 1 meter Pan, (Military)
- Planned
  - 2 Pleiades (0.7 meter Pan) to be launched in 6/05 & 6/06
    - Part of bilateral program with Italy's Cosmos-Skymed 1 meter radar program
    - Program is being sold as dual purpose, serving both military and civil needs (SPOT-5 has also been so advertised)
  - 2 Helios 2, with higher Pan and MS. (Military)
    - First could be launched as soon as '04
    - Discussed as part of a European defense system that includes Germany's SAR-Lupe radarsats

# ITALY & GERMANY

- Italy
  - Cosmos-Skymed, 1 meter radar
    - 3 satellites to be launched in 2007
    - Part of a bilateral agreement with France
- Germany
  - TerraSar X & L, Two 1 meter radars, 6/05 and 3/06 launch
    - Funded primarily by the government for commercial operations
  - SAR-Lupe, 1 meter X band radar (Military)
    - 2 under contract, a 5 satellite European system proposed
    - First launch by 2005
  - Rapid Eye, 6 band, 6.5 meter, 158 Km swath optical system (Commercial)
    - Long search for private funds, Current launch 2005
    - Would potentially compete with LDCM winner



# INDIA

## Current

- IRS-1C & 1D
  - 6 M Pan, 23 M MS, 188 M WF
- TESS, 1 M Pan
  - Lunched as a “test” 10/22/01

## Planned

- ResourceSat-1 & -2
  - 6 M Pan, 6 & 23 M MS, 188 M WF
  - Launch of first TBD, missed 12/03 plan
  - Second scheduled for 1/1/2006
- Cartosat-2
  - 1 M Pan
  - Launch mid 2004

# JAPAN

- ALOS
  - 2.5 M PAN, 10 M MS, 7 M SAR
  - After many delays, scheduled for mid 2004 launch
- “Information Gathering” (Military)
  - 4 satellite system in 2 pairs
  - Each pair includes
    - 1 meter Pan
    - 1 to 3 meter SAR
  - Initial pair to launch in late ‘03
  - 2nd pair in 6/04

# CHINA

## Current

- CBERS-1, With Brazil 10/14/99
  - All the Landsat bands
  - 20 M Pan, 20/40/80 M MS
- Ziyuan ZY-2A, 9 M Pan, 9/1/00
- Ziyuan ZY-2A, 3 M Pan, 10/27/02

## Planned

- CBERS-2, Same, Scheduled 8/10/03
- China DMC, 4 M Pan, 32 M MS, 5/1/04
- CBERS-3, 5 M Pan, MS like 1, 5/1/05
- CBERS-4, Same as 3 6/1/08

# RUSSIA

- Russia has plans for a three satellite system for civil and commercial use.
  - **First launch in September of 2003**
  - Resurs-DK-1 with a Pan 0.4 meter, 3 band MS 2 to 3 meter optical sensor
  - Resurs-DK-2 and -3, with same optical system plus a 1 meter Radar
  - Sovinform Sputnik represented by Central Trading Systems in the US is in the process of raising financing for commercial ground stations.
- Other Russian sources have been discussing 3 satellites
  - SOKOL-1 with a 1 meter Pan
  - SOKOL-3 with a 0.5 meter Pan
  - Condor-E with a 1 meter radar
- Central Trading Systems and Land Info International currently offer archived Russian satellite data including
  - DK-1 0.95 meter data
  - DK-2 1.56 meter data
  - KRV-1000 2 meter data

# SURREY

## SSTL MINI-SATS

### Current

- UoSat-12 Singapore 10 M Pan, 5/12/99
- DMC AISat-1 Algeria 32 M MS, 11/28/02
  - First of the Disaster Management Constellation

### Planned

- DMC second launch 8/15/03
  - NigeriaSat, Nigeria 32 M MS
  - ThaiPhat, Thailand, 36 M MS
  - BilSat, Turkey, 12 M Pan, 26 M
  - UK, England, 32 M MS
- TopSat, England, 2.5 M Pan 11/15/03
- DMC upgrade, 4 M Pan, 32 M MS 5/1/04
  - VinSat, Vietnam
  - ChinaSat China
- DMC satellites will be operated as a group
  - Daily overpass anywhere

# WHAT DOES THIS PLAN PLETHERIA MEAN?

- Nationalistic concerns seem to demand national control of land imaging.
  - The “dual use” mantra invoked in Europe to justify Pleiades- COSMO-Skymed and TerraSAR are cases in point
  - Japan’s deployment of “Information System” military satellites that have only equal or less optical capability than currently available US satellites is another example.
  - Singapore, Algeria, Nigeria, Thailand, Turkey, Vietnam, Taiwan, Korea are 8 more.
    - And these are mid-resolution systems
- Our technological/cost lead in optical systems is small and would seem to be getting smaller.
  - SSTL’s 2.5 M TopSat quoted cost is \$12 M
- Everyone else is planning civil radarsats

# WHAT SHOULD BOARD DO ABOUT THESE PROMISED OBSERVATIONAL RICHES?

The board should consider recommending that NOAA and/or other agencies:

- Keep current a data base of all land imaging satellites better than Landsat. NOAA has contracted Mitretek to begin this.
- Implement a program to purchase and evaluate the type and quality of all image products as they become available.
  - The NIMA/Stennis Jason evaluation program is an excellent example of the value of doing this.
  - Neither our science or our application communities will take advantage of data they have no way of evaluating.
- NOAA should propose to its international partners that all archive all their images, make an open meta database of their holdings and offer such data, after a suitable time period, to the international science community for COFUR, i.e. internationalize the current US Landsat policy