Earth Observation
Remote Sensing Trends

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Key Themes:

- Overview: Earth observation investment
- EO program focus
- The commercial data market
- Challenges and conclusions
Overview:
EO Investment
Government Space Program Investment ... The Past...

1990 Civil Budgets for Space* Throughout the World (USD in millions)

- United States 12,460
- Canada 222
- France 1,263
- Germany 789
- Italy 747
- Japan 1,124
- NASA 11,985 (excluding aerospace R & D)
- ESA 2,429
- ISRO 211
- SOE 800
- UK 271
- West Germany 789
- Soviet Union 5,232 **

* budget authorization
** 1 ruble = 1.66 $ (official exchange rate as of June 1991)
Non government users' contributions excluded for CNES and NASA
Source: Euroconsult's ECOSPACE data base

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World Government Expenditures for Civil Space Programs in 2007
Total: US$ 29.42 billion

USA 17,297

NASA 16,263
(excluding aeronautical R&D)

NOAA 1,034
Others 650

Budget Authority for the United States and Payment Appropriations for ESA; Non-government user contributions (CNES, JAXA) excluded; (1) Excludes funding from Third Parties; (e) estimate. 2006 figures for Austria, Belgium, Denmark, Finland,Netherlands, Norway, Sweden


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Government EO Programs (1)

Earth Observation is the largest satellite-based investment

- Human spaceflight is very specific to the US representing 90% of overall investment
- EO is a primary area of investment for the majority of government space programs
- In 2006 $6.3 billion was invested into EO and meteo programs reaching $7 billion in 2007
- Representing 24% of all space sector investment (38% excl. human spaceflight) in 2007

Earth observation to remain a priority area.

Over 2007-2012 42% of all civil-government satellites launched will be for Earth observation purposes.

In terms of satellite capacity the key however will be emerging programs.

EO program focus
Increasing number of satellites from emergent national programs, with countries looking for autonomous satellite capacity.

By 2017:
- About 29 national agencies to launch EO satellites
- Will represent 1/3rd of EO satellites worldwide

1A. Established government program

Rapidly developing capacity for self-sufficiency and commercial gain  
(ISRO, KARI …)

- ISRO develop a series of thematic EO satellites; aimed at self-sustainability
- KARI quickly building on early missions

Established government programs have climate change at the top of the agenda, however programs prone to cuts

Science missions tend to be one-offs; need for greater continuity

Single-instrument specific missions are preferred over multi-instrument arrays.

Net result in the medium-term is a loss in instrumentation.

2. Emerging government program

**Looking to develop satellite technology**

- Most emerging nations launch generic (medium resolution optical sensors) to meet local/regional requirement.
- Nations look to gain technology know-how and build on experiences: Algeria, Turkey, Thailand...
- 2nd Generation launched have been/will be more capable than the first: DMC, Alsat...
- Programs will look to commercialize data – initially data low cost / free

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**Main Medium Resolution Satellites** Launched to 2007, Planned/Anticipated: 2007-2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Satellite</th>
<th>Launch Date</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>Landsat 5</td>
<td>1984</td>
<td>15m</td>
</tr>
<tr>
<td>1999</td>
<td>Landsat 7</td>
<td>1988</td>
<td>15m</td>
</tr>
<tr>
<td>2002</td>
<td>SPOT 4</td>
<td>1998</td>
<td>10m</td>
</tr>
<tr>
<td>2008</td>
<td>SPOT 5</td>
<td>2002</td>
<td>10m</td>
</tr>
<tr>
<td>2011</td>
<td>LDCM</td>
<td>2007</td>
<td>15m</td>
</tr>
<tr>
<td>2012</td>
<td>LDCM 2</td>
<td>2011</td>
<td>15m</td>
</tr>
</tbody>
</table>

**Sources:**
3. Dual-use coming to fruition

Cross-over between military and commercial high-res

Roadmap for European defense Earth observation satellites

- Security the first consumer of commercial data
- Dual-use capacity realized through COSMO-Skymed and Pleiades; commercialized through data providers
- Further programs remaining military only: Helios, SAR-Lupe
- Calls for greater coordination European military EO; future to lie in MUSIS?

The commercial data market
4. The commercial actor

Targets geometric accuracy, high-res. and data delivery

- Commercial data focuses on optical high-res. timely data delivery and high geometric accuracy
- Increasing commercial radar
- 8 commercially operated satellites + 1 constellation in operation
- In 2007 Public-Private-Partnerships realized with the launch of TerraSAR-X, Radarsat-2 and RapidEye in 2008

Strong growth in the commercial data market

07’ commercial data market $735M; to reach $2.5 - $3.4 billion in 2017

- More capable systems have boosted the commercial data market: +15% CAGR (02-07)
- Government the primary user for commercial data: over 80%, security first application
- Increasing data supply: commercial actor + dual-use + government...
- More commercial data to come through government-sponsored programs: India, Korea, Taiwan

Earth Observation Commercial Data Sales 2000-2007
v. Number of Operational Commercial High Resolution Satellites

EO commercial sector diversifying (1)

- 29+ commercially operated satellites will be launched 2007-2016

- Commercial operators will look to develop constellations

- Emergence of new entrants
  - Gazprom - 4 satellite constellation
  - Iridium NEXT - 66 satellites for environment monitoring
  - 4C Control - 2 high-res SAR satellites
  - E-Corce - high-res optical 13 satellite constellation
  - ...

- Increasing number of government satellites to look towards commercialization

- maximize return on investment

- Develop downstream services through free data
  - Landsat
  - CBERS
EO commercial sector diversifying (2)

- Increase in operational radar capacity:

1995
- Radarsat - CSA
- ASAR – ESA (Envisat)
- ERS-2 - ESA

2002
- Radarsat 2 - MDA
- ERS-2 - ESA
- RADARSAT-2 - MDA
- ASAR – ESA (Envisat)

2007
- Radarsat 3 x 3 - MDA
- COSMO-Skymed 1 - ASI
- RADARSAT-2 - MDA
- ASAR – ESA (Envisat)

2012
- Radarsat 4 - MDA
- COSMO-Skymed 2 - ASI
- RADARSAT-2 - MDA
- ASAR – ESA (Envisat)

2017
- Radarsat 5 - MDA
- COSMO-Skymed 3 - ASI
- RADARSAT-2 - MDA
- ASAR – ESA (Envisat)

Challenges and Conclusions
Services showing slower uptake

Real take-up of commercial data relies on services

- The same growth witnessed in the data market is not experienced in EO services
- Value-added services valued at $1.5 billion in 2007; 5% CAGR
- Services will be aided by more dedicated systems and timely delivery of data
- Service industry given a boost with the advent of web-based virtual-globes
- Low-cost data reduces barriers of entry increases usage
Services showing slower uptake (2)

Low-cost data increases user uptake of services

CBERS data usage by application, 2007

CBERS data usage by end-user, 2007

<table>
<thead>
<tr>
<th>Category</th>
<th>CBERS Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cart. / Land use</td>
<td>33%</td>
</tr>
<tr>
<td>Environment</td>
<td>26%</td>
</tr>
<tr>
<td>Energy</td>
<td>23%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>9%</td>
</tr>
<tr>
<td>Forestry</td>
<td>8%</td>
</tr>
<tr>
<td>Disaster Monitoring</td>
<td>7%</td>
</tr>
<tr>
<td>Oceanography</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sector</th>
<th>CBERS Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>51%</td>
</tr>
<tr>
<td>Government</td>
<td>26%</td>
</tr>
<tr>
<td>Education</td>
<td>23%</td>
</tr>
</tbody>
</table>
Global environment issues require constant supply of geo-information

- CEOS calls for a coordinated response to global collection of geo-information
- Emerging space nations first look to regional needs rather than global concerns
- Increased cost and access to 3rd party data remains an issue

Increasing high-resolution systems from numerous sources make tools for data restriction unworkable

- Buy-to-Deny and Shutter control difficult to implement with multitude of satellites
- To be addressed to counter friction in the market place and allay national security concerns
Commercial operators look to diversify data usage away from security

Commercial data competition will increase but will help develop downstream services: success of various methods of commercialization will encourage further systems
- Which method of commercialization will be preferred?

Commercialization creates vertically integrated actors
- Thales / Telespazio
- EADS Astrium / Infoterra
- MDA / MDA Geospatial

Further consolidation and integration within the value-chain as companies look to tap into the large but fragmented service sector
- MDA Geospatial acquire Vexcel Canada
- EADS Astrium Services acquires SPOT Image
- Fugro GEOS acquire NPA Group
THANK YOU

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*Consulting*: Euroconsult has conducted over 450 consulting missions in the satellite sector over the last 20 years for clients located in more than 40 countries. Missions include independent assessment & due diligence for public & private sector projects; Assist private and public organizations in their decision-making process; Market analysis for satellite products and services

*World Summits & customized training*: the World Satellite Business Week has become the annual meeting place for senior executives from the international satellite industry and financial community to benchmark, do business and network with their partners, existing and prospective clients. The event gathers each year in Paris 450 senior executives from over 175 companies Over 70% CEOs, CFOs, GMs, SVPs, VPs...