



Promises and Problems

The Worldwide Growth in Remote Sensing Capabilities



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May 7, 2015*

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U.S. Geological Survey

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Remote Sensing History

- **Earth Resources Technology Satellite – ERTS**
 - **Launched 1972, later renamed Landsat-1**



- **SPOT-1 follows in 1986 – 14 years later**

- **Ikonos-1 launches 1999 – 13 years**
 - **Commercial remote sensing begins**



Fast-forward to Today

- **All nations are to submit launch records to the UN Register of Objects Launched into Outer Space**
 - **Maintained by the United Nations Office for Outer Space Affairs (UNOOSA)**
- **In 2013 4,500 applications to launch satellites were submitted from 72 countries**
- **...Things are Changing**

Countries w/ Land Remote Sensing Satellites

- Algeria
- Argentina
- Azerbaijan
- Belarus
- Brazil
- Canada
- Chile
- China
- Egypt
- ESA
- France
- Germany
- India
- Indonesia
- Iran
- Israel
- Italy
- Japan
- Kazakhstan
- Korea
- Malaysia
- Nigeria
- Pakistan
- Peru
- Russia
- Singapore
- Saudi Arabia
- South Africa
- Spain
- Taiwan
- Thailand
- Turkey
- Venezuela
- Vietnam
- UK
- Ukraine
- United Arab Emirates
- USA
- ...and more

Int'l Government Activities

Gov't efforts

- **Landsat achieves operational budgeting in FY16 budget request**
- **Brazil launched CBERS-4 in Dec, 2014**
 - **Signs contract with China for launch of CBERS-4A in 2018**
- **SPOT-7 is now Azersky**
- **Sentinel-1 launched**
 - **Part of very ambitious Copernicus program!**

ESA Sentinel-2A

- 13 spectral bands, 10m, 20m, 60m
- 290km swath
- Moved to French Guiana 21 April
- Preparing for launch 11 June



India Space Research Organization

- ResourceSat-2 currently operating
 - ResourecSat-2A to launch 2016?
- ResourceSat-3 planned
 - Increasing resolution to 23.5m
 - 700km swath



 USGS



Germany (DLR) - EnMAP



- **Hyperspectral Sensor to Launch in 2017**
- **30m resolution**
- **30km swath**
- **~244 spectral bands**
- **To be launched aboard India PSLV**

EIAST



- **2009: DubaiSat-1 2.5m Pan, 5m MS**
 - 30% of manufacturing done by Emirati engineers
- **2013: DubaiSat-2 1m pan, 4m MS**
 - 70% by Emirati engineers in UAE and Korea
- **2017: Khalifa Sat 0.7m pan, 4m MS**
 - 100% work done by Emirati engineers

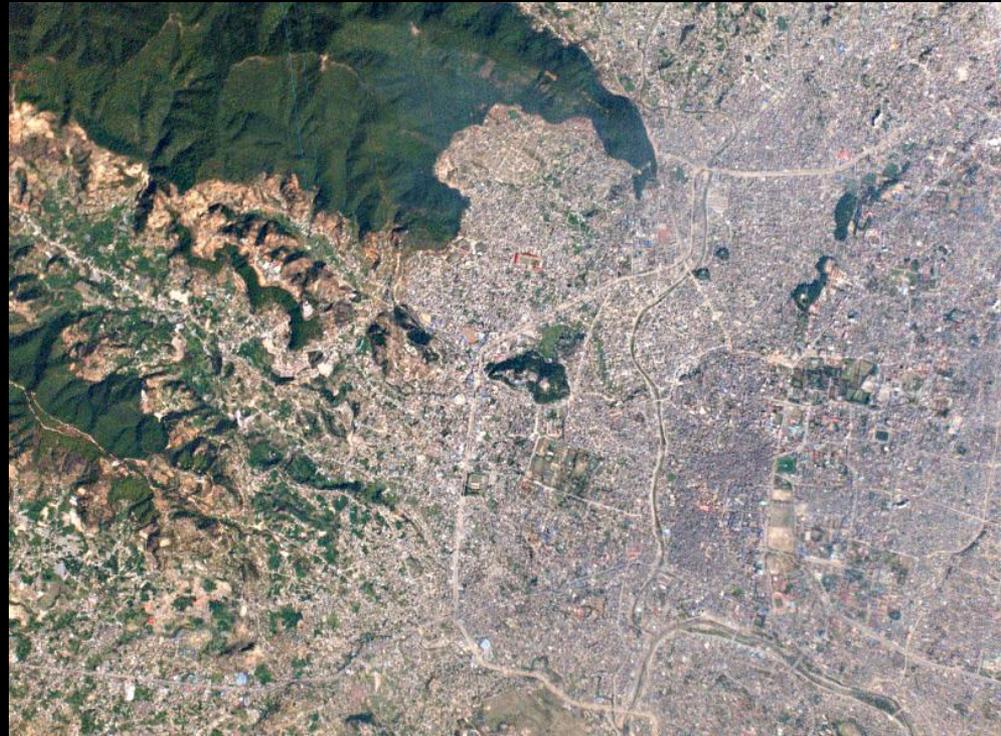




Commercial Activities

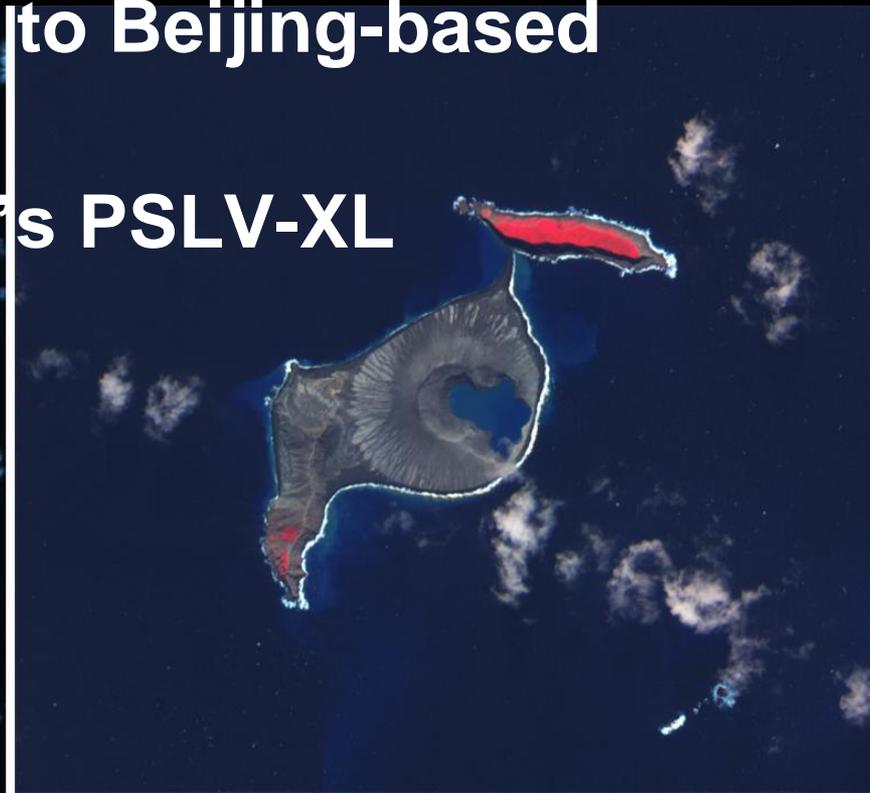
Planet Labs

- Launched 67 satellites in 2014
- 16 already launched in 2015, with more planned
- Last week placed ~3,000 images of Nepal on the USGS Hazards Data Distribution System



DMC-3

- Newest of Disaster Monitoring Constellation
- UK-built three satellite constellation
- 75cm pan, 3m MS
- 100% of capacity leased to Beijing-based 21AT
- To be launched on India's PSLV-XL



Elecnor Deimos



- 2009: Bought Deimos-1
- 2011: Built Satellite Factory
- 2014: Launched Deimos-2



PanGeo Alliance



- A global Alliance of satellite operators

- Elecnor Deimos (Spain)



- EIAST (UAE)



- SpaceEYE (China)



- AquilaSpace (US)



- An Evolving Partnership



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Aquila Space Inc.

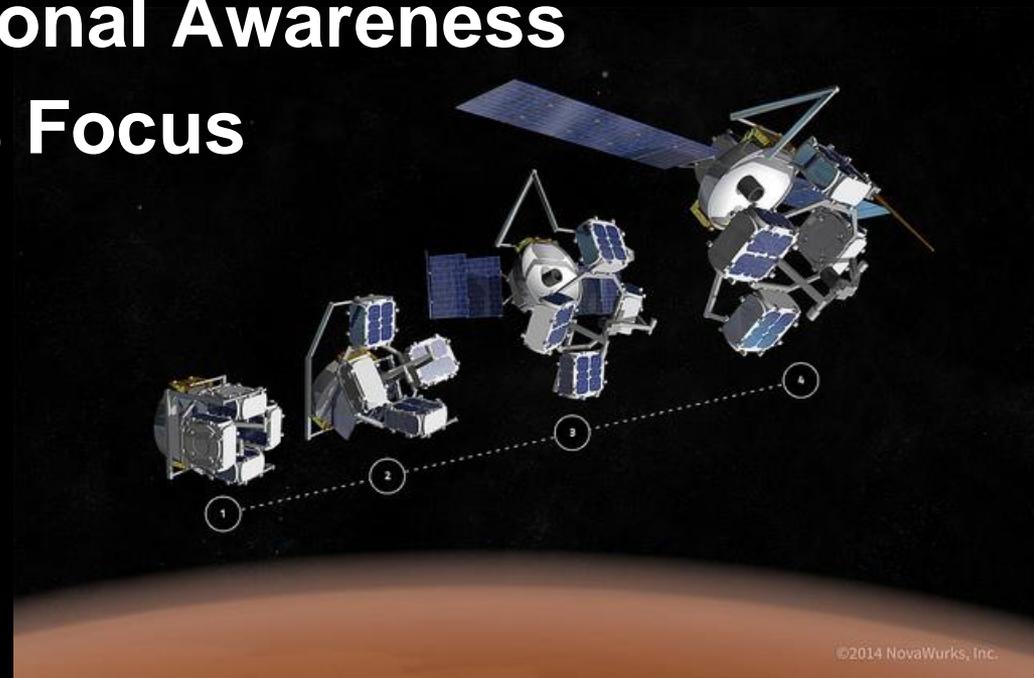


- Building the Landmapper constellations
- Landmapper BC and Landmapper HD
- First 4 sats to launch in 2016



NorStar Space Data Inc. (NSDI)

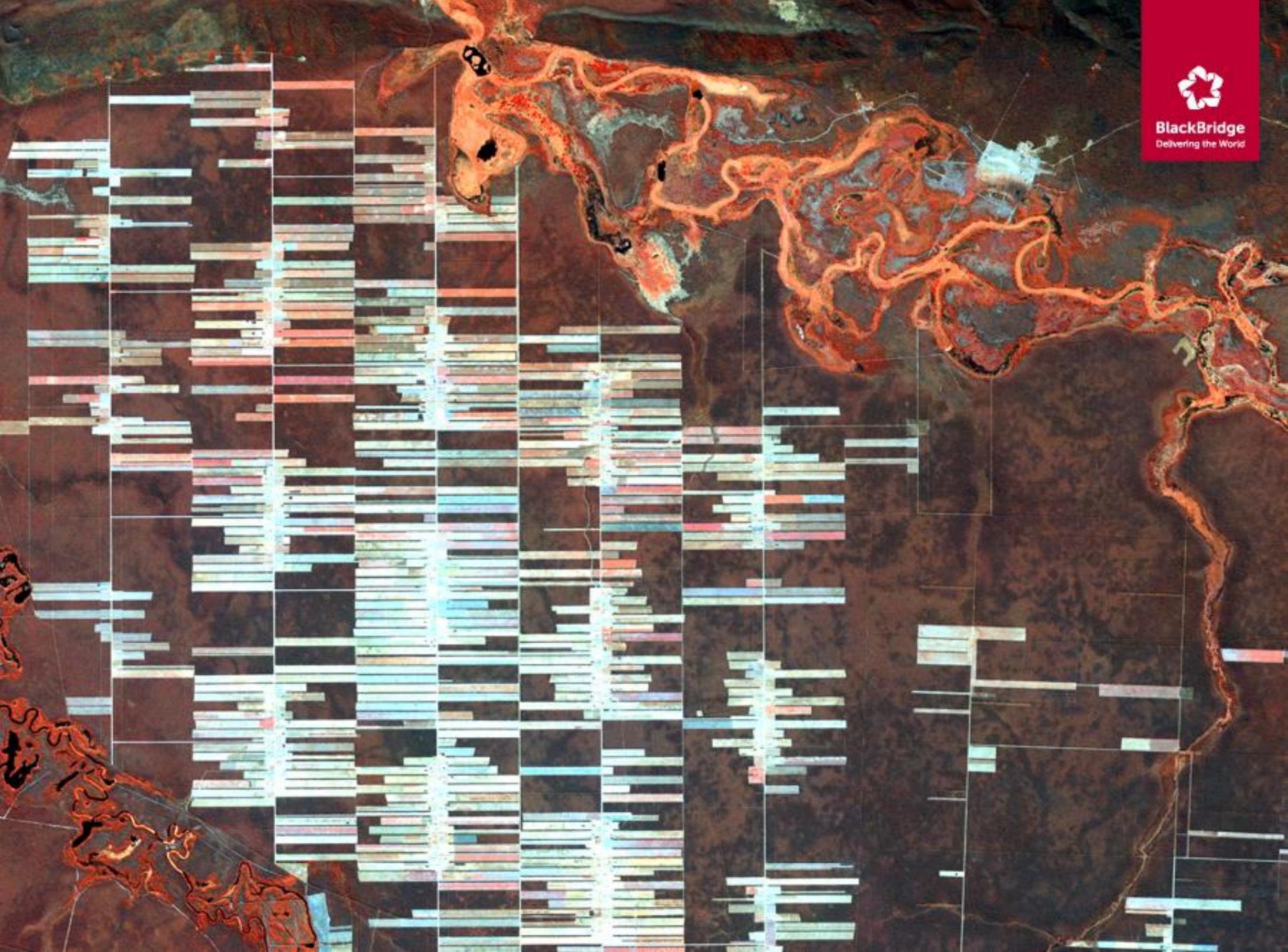
- **Plans to build a baseline of 40 satellites to cover the globe daily**
 - Annual rolling replenishment of satellites
- **Hyperspectral and infrared to MWIR**
- **Also Space Situational Awareness**
- **Natural Resources Focus**
 - Sustainable
 - Responsible



- **Plans for a 15+ satellite constellation**
 - Five spectral bands
 - 2-m pan, 5m MS, 180km swath
 - Daily Revisit
 - To launch by 2019
- **Generate up to 60 Petabytes annually**
 - “Scientific quality Earth Observation data”
- **“We’re not a satellite company, we’re an information company.” – Lars Dyrud, CEO**

SkyBox Imaging

- **SkySat-3 launching June (?) 2015**
 - SkySat “Gen II”
 - First US-based satellite to be launched by ISRO
- **SkySats-4 thru 13 to launch in 2016**
 - Part of an even-larger fleet of SkySats envisioned for precision mapping
 - 15 more to be ordered in 2015
 - Some planned to be launched on the Virgin Galactic LauncherOne rocket



BlackBridge
Delivering the World

RapidEye+



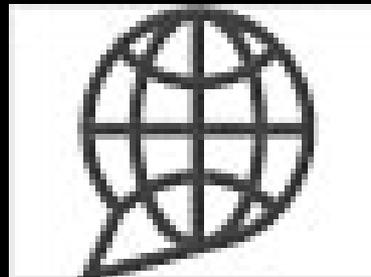
BlackBridge

Delivering the World

- **2014: BlackBridge unveils new constellation**
- **14 spectral bands**
- **Improved coverage**
- **To launch in ~2019**
- **Engineering work underway now**

Are We in a Bubble?

- pets.com
- webvan.com
- garden.com
- theGlobe.com



Some Succeeded...

- ..and They Changed Our World



SPACEX

amazon.com®



Google™



Google Earth

USGS



Challenges

Big Data Analytics

- Amazing data volumes will be coming
- *Information vs. Data*
- Will require new technologies, new software

- This will be the path to Success

Pictures vs Measurements

- **Multiple markets/needs**
- **What is the value of Calibration, spectral content, data quality?**
- **Who provides reference/control?**
- **What standards are needed? Who develops them?**
- **What research is needed to help our industry grow and be successful?**

Data Preservation

- **Massive Data = Costs & Headaches**
- **Value of “new” data vs “old” data**
 - **Two different markets**
- **Long-term Archiving:**
 - **What is worth keeping?**
 - **Who preserves the data?**
 - **Who should be able to access it, and How?**

Evolving Roles

- **What is the role of Gov't?**
 - **Provider or Customer... or Both?**
 - **Regulations? Standards?**
- **Role of International Bodies**
 - **Cooperation, worldwide standards, practices**
- **Role of Industry**
 - **Developing markets**
 - **Communicating needs with gov't, others**
- **Role of ASPRS**

Parting Thought:

- **“By 2030, up to 10 percent of the world’s gross domestic product could be linked to space in some way.” - Dylan Taylor, global chief operating officer of Seattle-based Colliers International**
- **Our industry, our community, is part of it!**