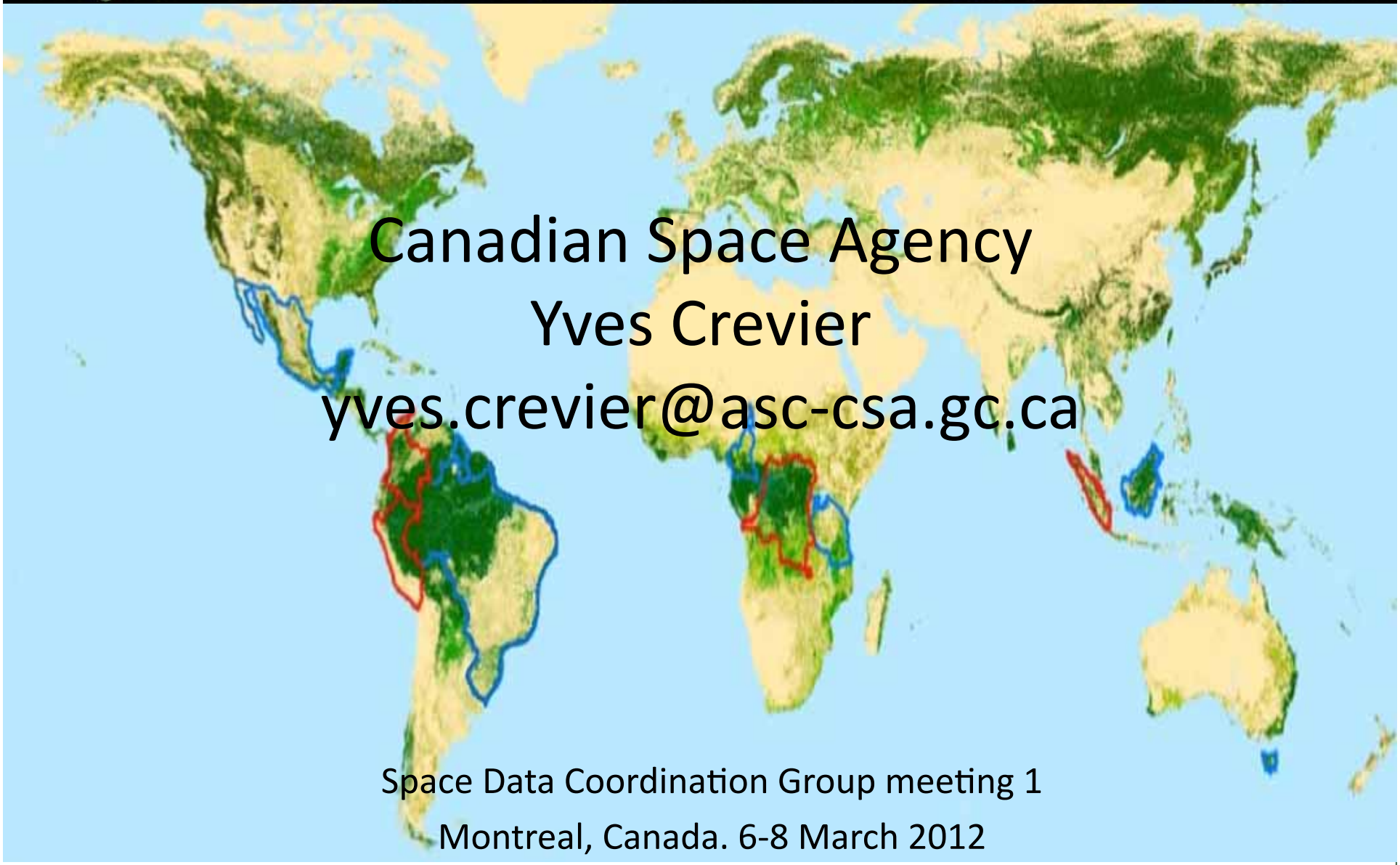
CEOS Committee on Earth Observation Satellites



Canadian Space Agency

Yves Crevier

yves.crevier@asc-csa.gc.ca

Space Data Coordination Group meeting 1

Montreal, Canada. 6-8 March 2012

Forest Carbon Tracking

Global Forest Observations Initiative

GEO GROUP ON EARTH OBSERVATIONS

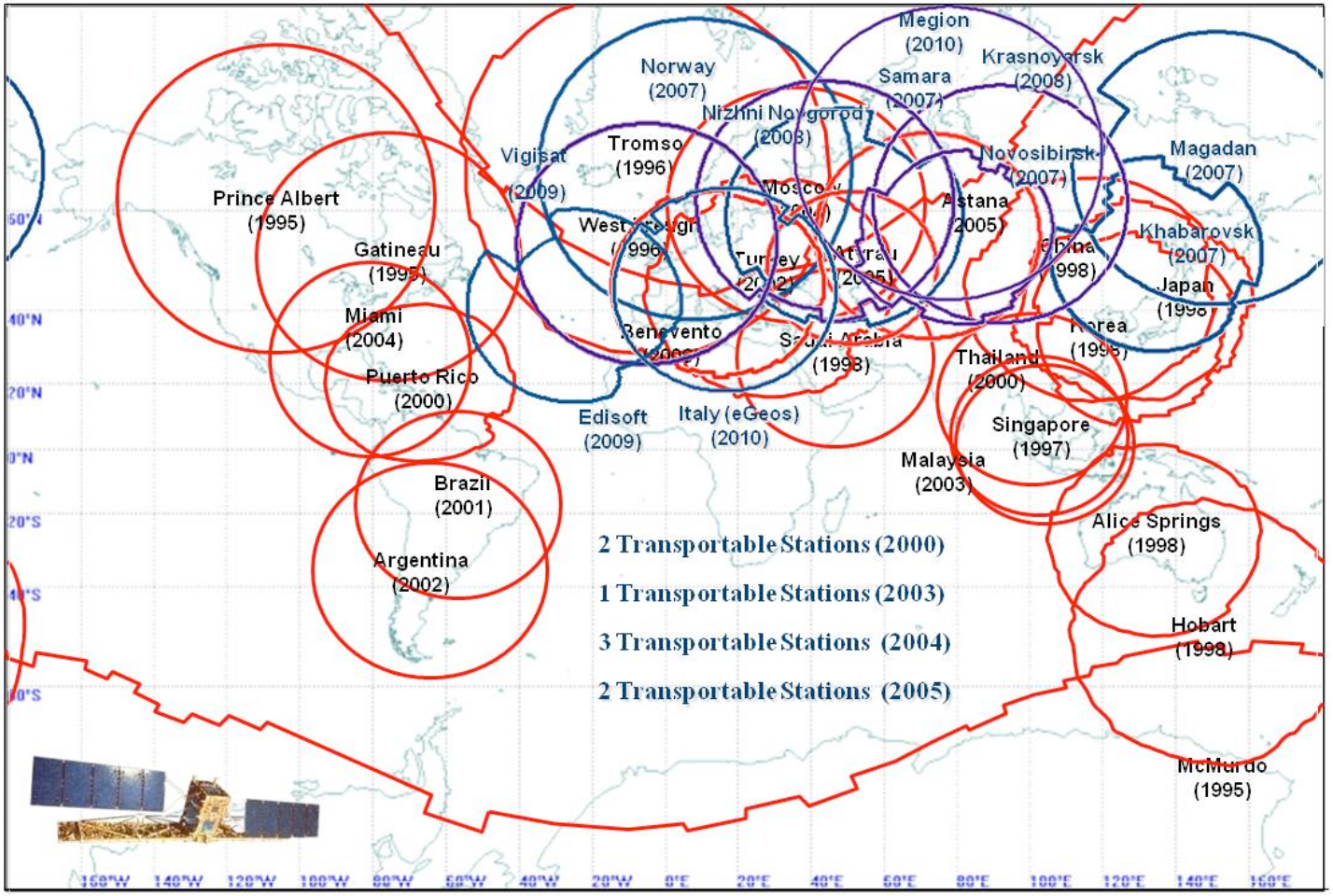
RADARSAT 1

http://www.asc-csa.gc.ca/eng/satellites/radarsat1/default.asp

- C-Band SAR sensor (single pol. capability – H transmit and H receive)
- In operation since 1996
- Public/Private partnership
- Demonstrated potential for routine observation (support science and operational activities)
- 17+ years of archive collected over the globe – still imaging
- Hot backup to RADARSAT-2
- Alleviate conflicts on RADARSAT-2 for which equivalent beam modes exist on RADARSAT-1
- No signs of imminent system failure to jeopardize continued Mission Operations
- No on-board recorder available – only direct downlink

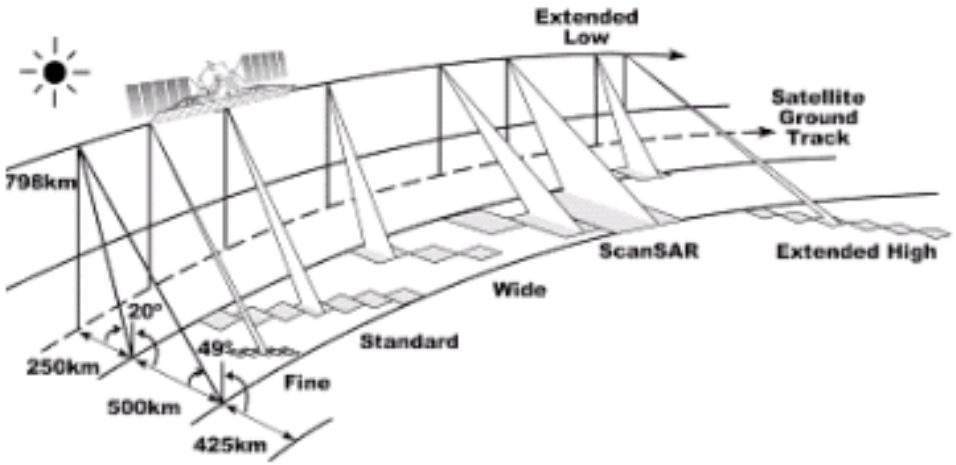
RADARSAT 1

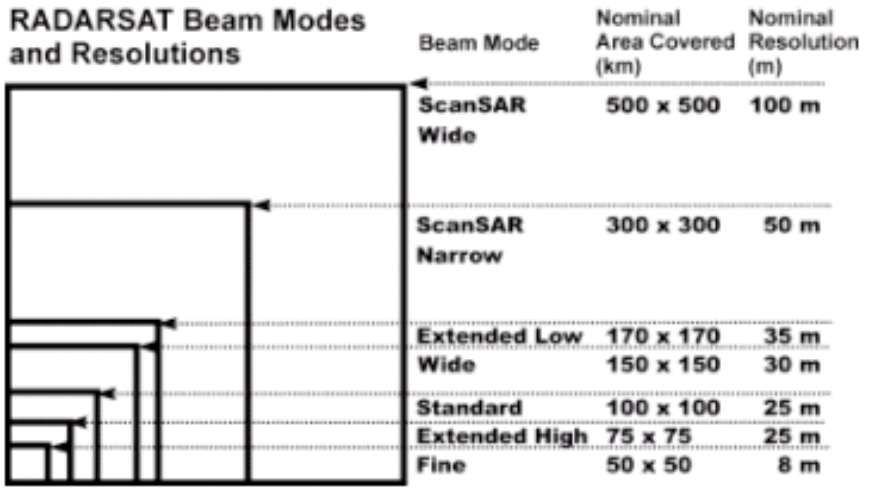
http://www.asc-csa.gc.ca/eng/satellites/radarsat1/default.asp



RADARSAT 1

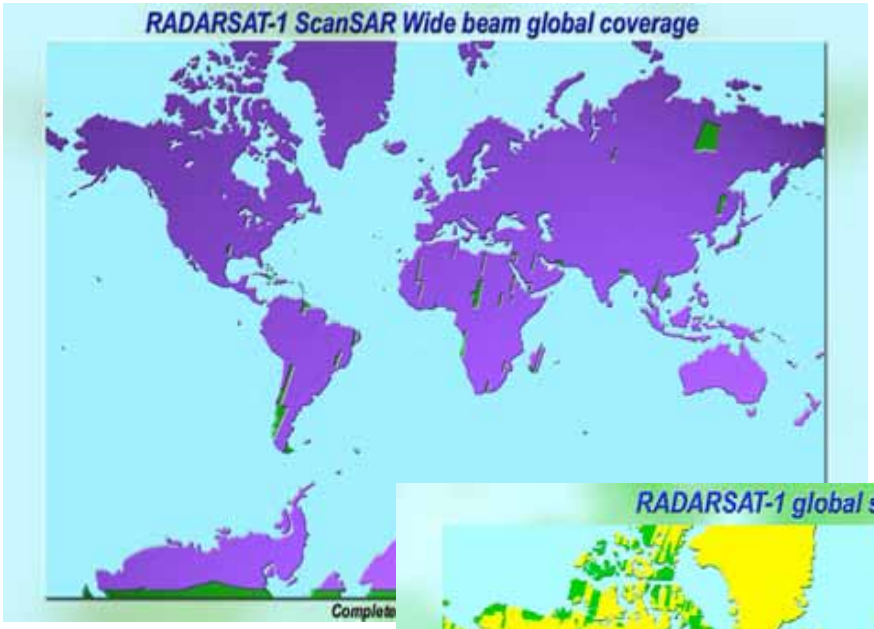
http://www.asc-csa.gc.ca/eng/satellites/radarsat1/default.asp



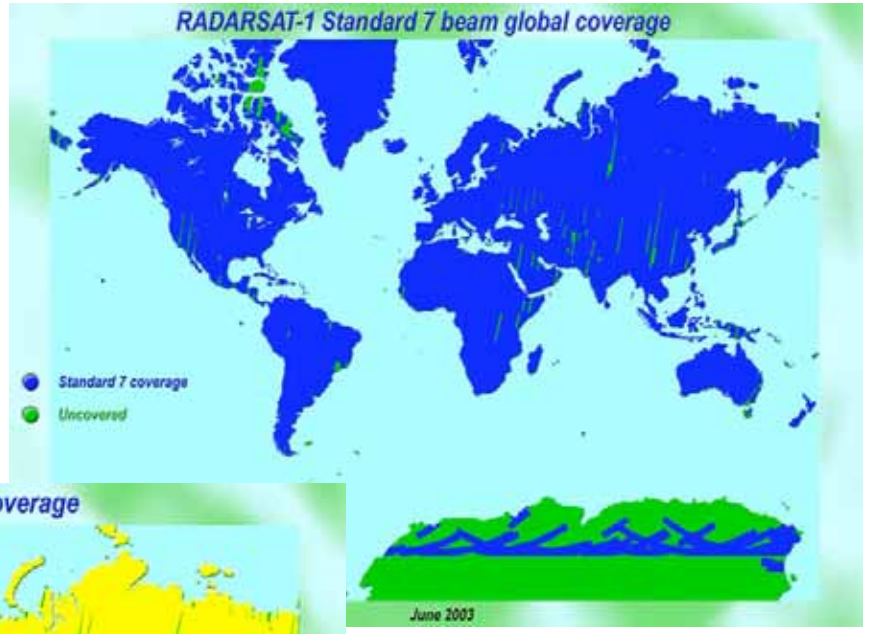


Orbit Characteristics	
Altitude	793-821 kilometres
Inclination	98.6 degrees
Duration of one orbit	100.7 minutes
Descending node	06:00
Ascending node	16:00
Sun-synchonous	14 orbits per day

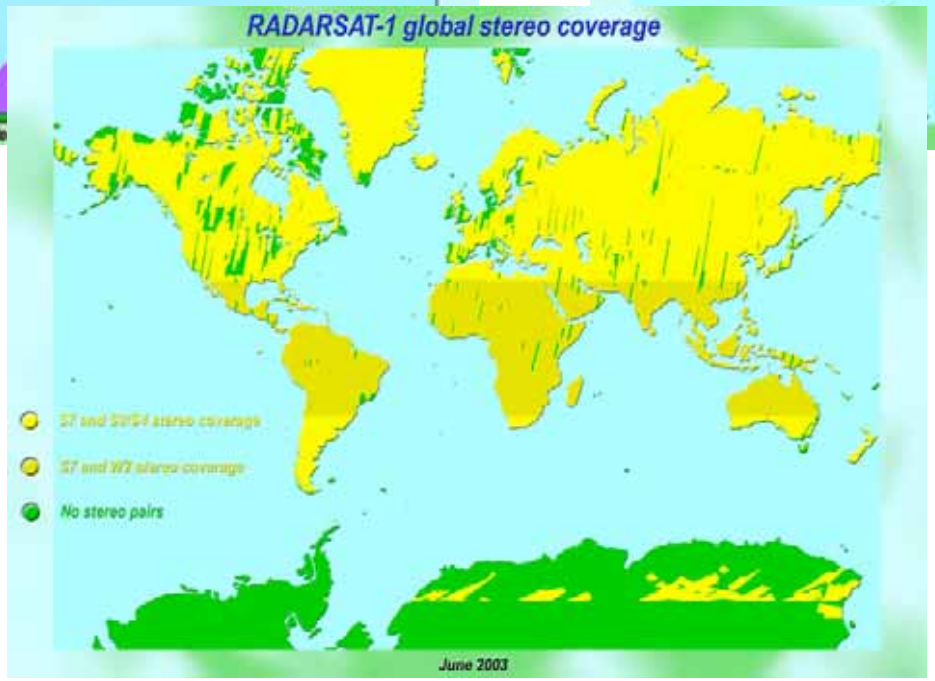
Background Mission



SCW

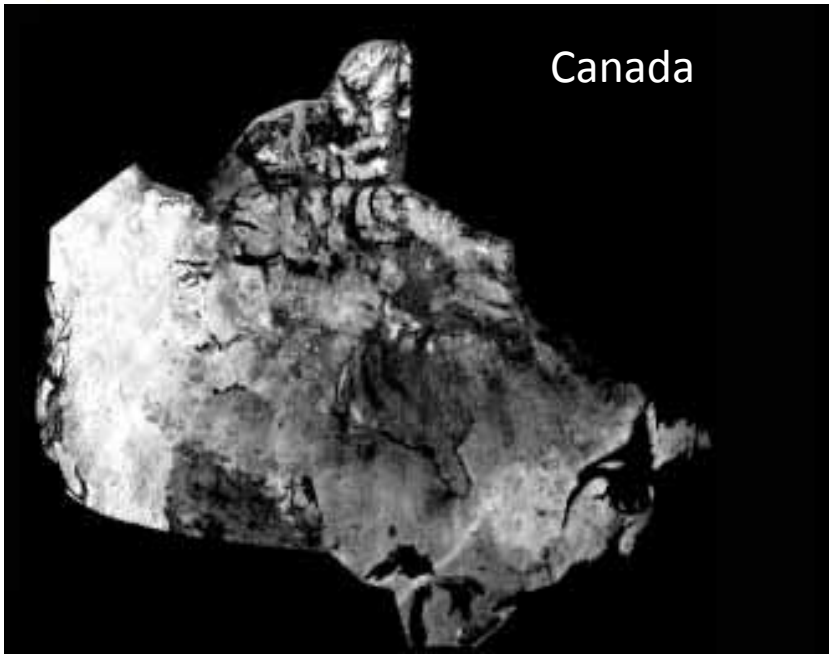


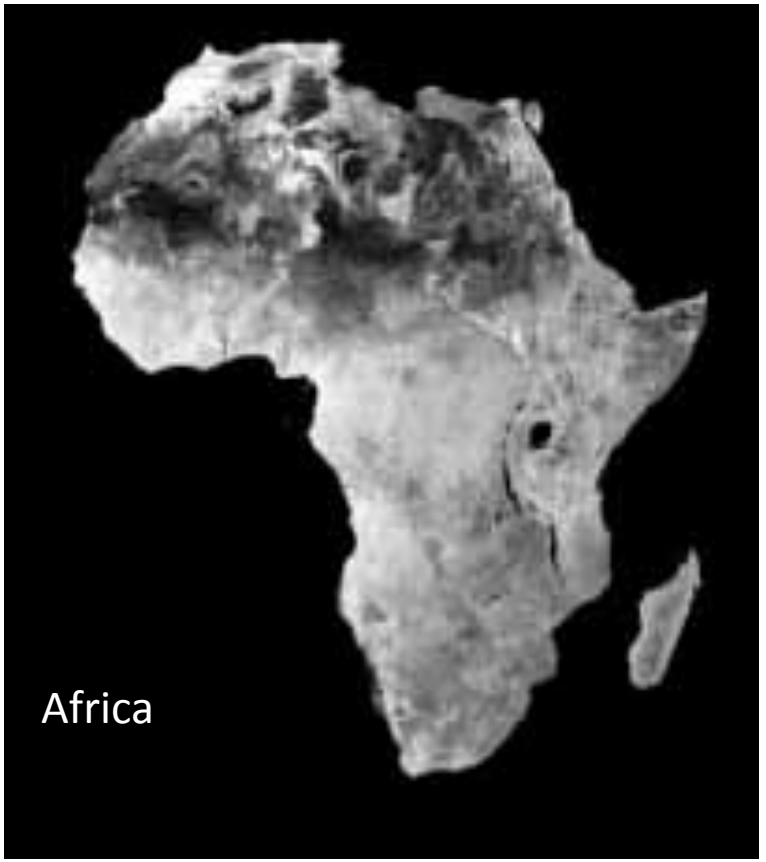
S7

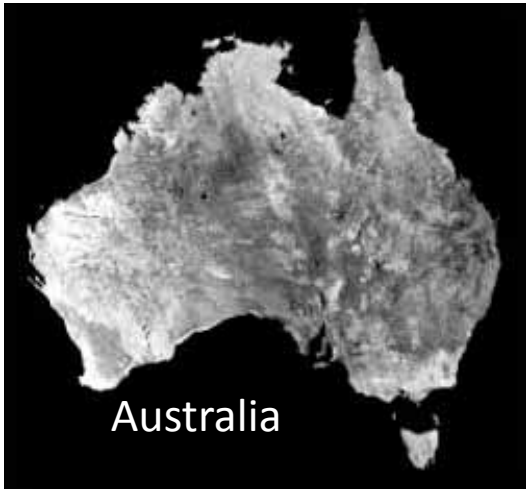


S7 and S2/S4
S7 and W2

Continental Mosaics



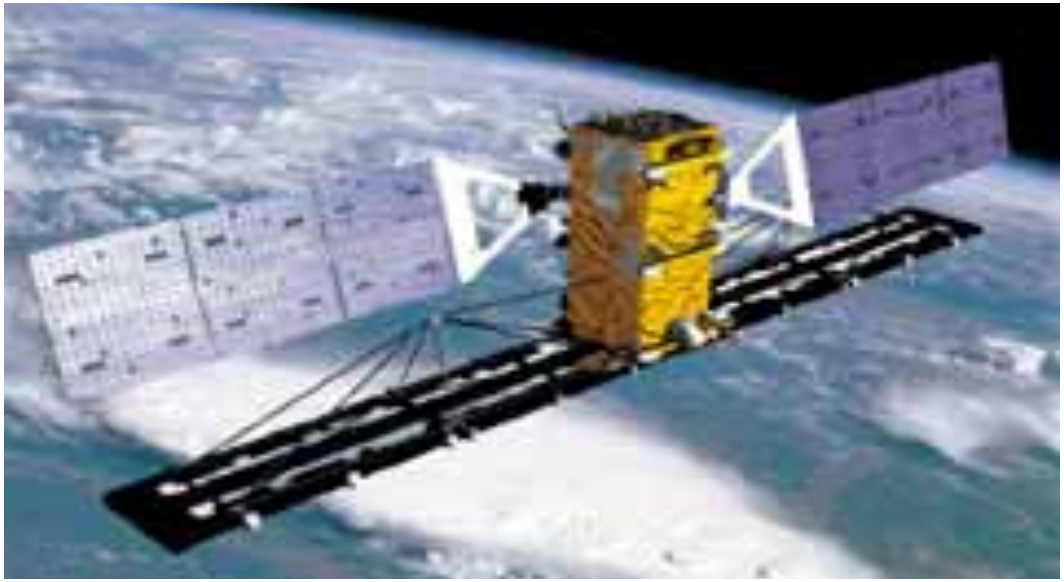




RADARSAT 2

http://gs.mdacorporation.com/SatelliteData/Radarsat2/Products.aspx

- Advanced SAR instrument – Heritage modes, + multi-polarization and polarimetric modes, high-resolution capabilities, combined wide swath + high res, routine right and left looking capabilities
- Owned and operated by Mac Donald Dettwiler and Associates (MDA) – Government of Canada data allocation available for science activities



RADARSAT 2

http://gs.mdacorporation.com/includes/documents/RS-2_Product_Details%20V1-9_2011_AUG_23.pdf

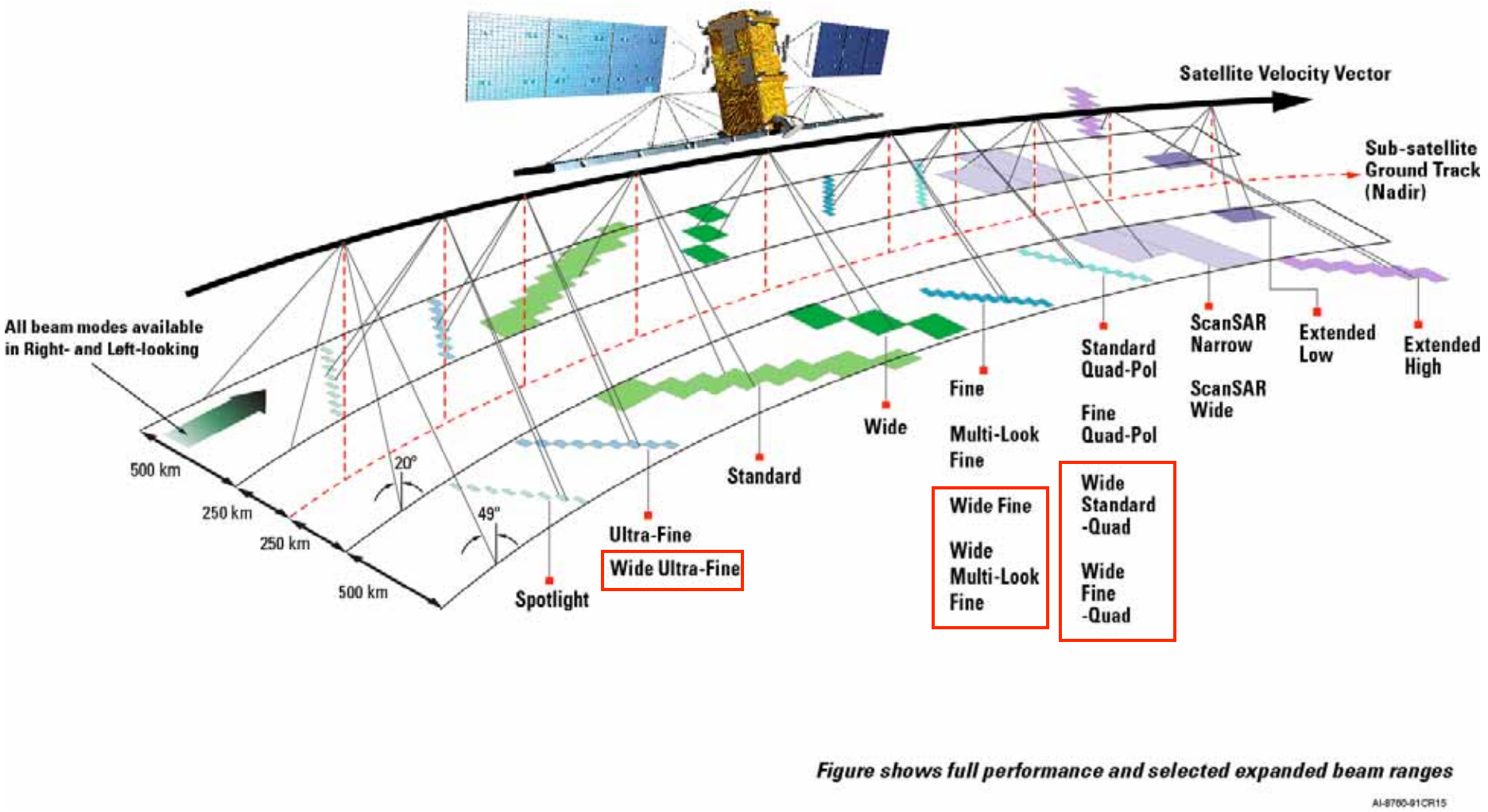


Figure shows full performance and selected expanded beam ranges

AI-8760-91CR15

RADARSAT-2, new wide image modes

Summary of New image modes introduced in 2011

	Resolution	**New Swath Width**
Wide Ultra-Fine	3 m	38-54 km (from 20 km)
Wide Multi-Look Fine	5 or 10 m (1 or 4 looks)	90 km (from 50)
Wide Fine	10 m	120-180 km (from 50 km)
Wide Fine Quad-Pol	8m	50 km (from 25 km)
Wide Standard Quad-Pol	25m	50 km (from 25 km)

New XF (Extra Fine) image mode: **24 day repeat** coverage of **very large areas** to be released in June 2012

	Resolution	**New Swath Width**
XF-1, 2, 3, 4 **Inc. angles 20^{o}- 50^{o}**	**5 m** (1 look)	**110-180 km**

RADARSAT 2 Attributes for GFOI

- RADARSAT-2 provides excellent wide area high/medium resolution coverage and capacity.
- RADARSAT-2 has remaining capacity that is sufficient for creating and maintaining a high/medium resolution archive of SAR data
- Analysis of exact-repeat stacks of SAR imagery allows for effective and efficient quantitative assessment of land cover and changes in forest environments:
  - Precise amplitude change detection
  - Texture mapping
- RADARSAT-2 can be used as an important data source for forest monitoring

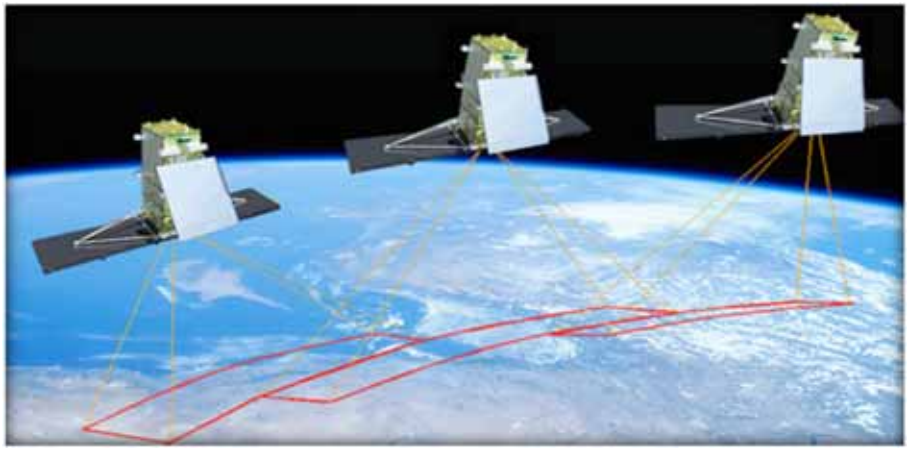
Ongoing Acquisitions for FCT

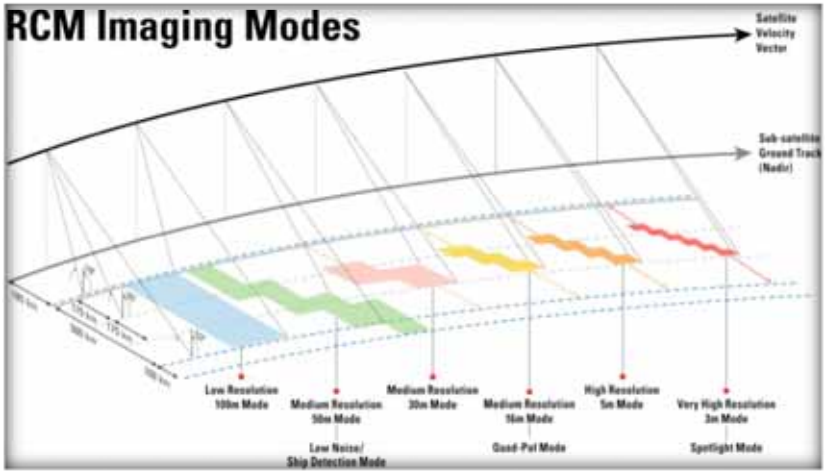
- Current Acquisitions
  - Preferred beam mode (according to experts):
    - Wide 3 for national coverages
    - Fine Quad (greater than 34 degrees) for verification sites – Ultra Fine only available in selective single pol.
  - National coverages – 2 times/year (1 wet and 1 dry coverage)
  - Verification sites – images acquired in ascending and descending modes every cycles (every 24 days)
- Access to data needs to be negotiated with MDA

RADARSAT Constellation Mission

http://www.asc-csa.gc.ca/eng/satellites/radarsat/default.asp

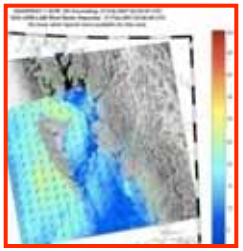
- Evolution of the RADARSAT Program (i.e. 3 satellites – 32 minutes separation);
- Continuity of C-Band SAR for Operational Users
- Improved revisit over wide areas
- Improved reliability (i.e. redundancy and scalability)
- Evolution to wider Operational use
- Government-owned and operated
- Average daily global access of land and oceans (daily revisit – 50m res.) & int. areas;

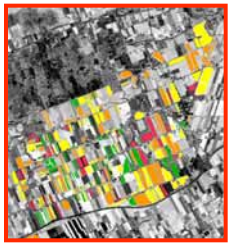


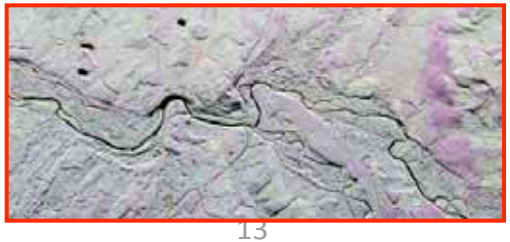
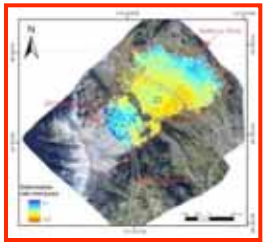


Core Use Areas

Maritime Surveillance	Environmental Monitoring	Disaster Management
• Ice & Iceberg Monitoring • Pollution Monitoring • Vessel Detection • Including AIS • Marine Winds	• Forestry • Protected Areas & Wildlife Habitat • Agriculture • Wetlands • Coastal Change	• Flood Monitoring • Wind Storms • Earthquakes • Landslides • Volcanic Activity • Permafrost

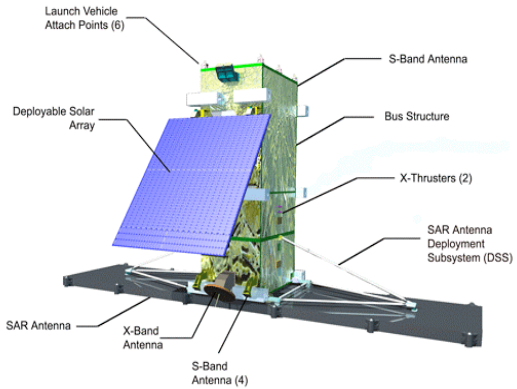


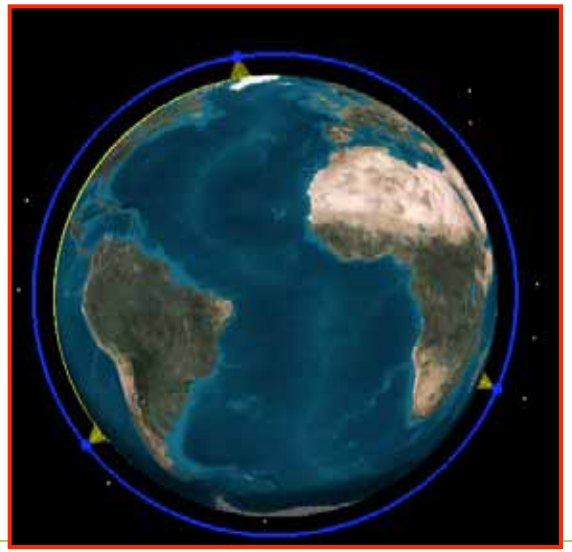



System Specifications

Bus	Canadian Smallsat Bus
Launcher	DNEPR specifications (for design) can use PSLV, Falcon V
Total Mass	< 1300 kg with margin
Antenna	9.45m^2
Frequency	5.405 GHz (C-band)
Orbit	600 km, 100m radius orbital tube
Polarisation	Single Pol, Dual Co-/Cross-Pol selectable & Compact Polarimetry on all modes; Dual Co-Pol on most modes; One fully polarimetric mode
Imaging Time	12 minutes/orbit (peak 20 minutes every three orbits) 10 minutes continuous imaging
Lifetime	7 years (each satellite)





Imaging Modes

Mode	Nom. Res. m	Num Looks rng x az	Nominal Swath Width (accessible) km	Min Along Track Length km	Nom-inal NESZ dB	Polarization Options								
						Single Pol				Dual Pol				Quad Pol
						HH	VV	HV	VH	HH+HV	VV+VH	HH+VV[2]	Compact	HH+VV+ HV+VH
Low Resolution 100m	100	8x1	500 (500)	10	-22	✓	✓	✓	✓	✓	✓	✓	✓	
Medium Resolution 50m	50	4x1	350 (500)	10	-22	✓	✓	✓	✓	✓	✓	✓	✓	
Medium Resolution 16m	16	1x4	30 (350)	10	-25	✓	✓	✓	✓	✓	✓	✓	✓	
Medium Resolution 30m	30	2x2	125 (350)	10	-24	✓	✓	✓	✓	✓	✓	✓	✓	
High Resolution 5m	5	1	30 (500)	10	-19	✓	✓	✓	✓	✓	✓	✓	✓	
Very High Resolution 3m	3 @35°	1	20 (500)	10	-17	✓	✓	✓	✓	✓	✓	✓	✓	
Low Noise	100	4x2	350 (500)	10	-25	✓	✓	✓	✓	✓	✓	✓	✓	
Ship Detection	var.	var.	350 (600)	10	var.	✓	✓	✓	✓	✓	✓		✓	
Quad-Polarization	NR[1]	NR[1]	> 20 (NR[1])	10	NR[1]									✓
Spotlight	1 (az) x 3 (grd) @35°	1	5 (350) *Goal*: 8 (350)	5	-17	✓	✓	✓	✓	✓	✓		✓	

Mission Operation Concept

- **Largely pre-programmed acquisitions to meet clearly defined user needs** → *Standard Coverages*
  - *Collections of data acquired routinely in harmonized and de-conflicted imaging modes intended to optimize and maximize the utility of the data across all User requirements*
- **Routine generation of data/products** placed **"immediately**" in archive/ catalogue **accessible on-line and free of charge**
- Additional "ad-hoc" requests to be treated on a priority scale basis; top priority is for Canadians over Canada.

CSA currently conducting capacity assessment for Domestic use and Excess capacity

Data Policy - General Concepts

Free and open access for non-commercial / non-sensitive data

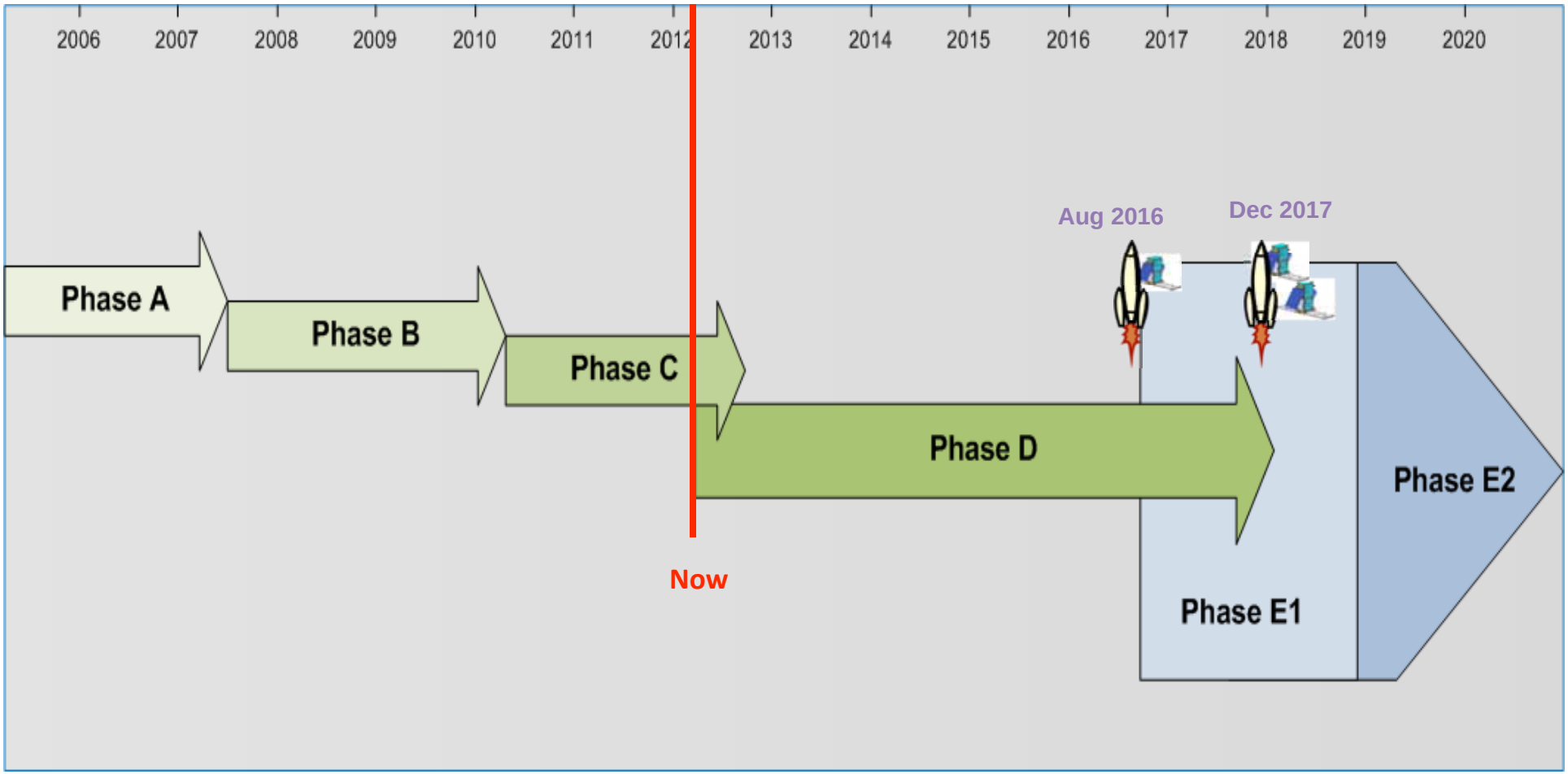
- Data to remain property of the Crown (Gov't of Canada) with all the necessary copyright protection
- Data Policy must comply to Cdn Remote Sensing Space Systems Act (RSSSA) re: licensing and security issues
- RCM is to continue the commercial legacy of previous RADARSAT missions

RCM – Sentinel-1 Interoperability

- Ground Segment interoperability is a design goal of the RCM as articulated in the Mission Requirements
- Basic description of cooperation envisaged between Sentinel-1 and the RCM is noted for further elaboration in ESA Draft Sentinel High Level Operations Plan
- Interest in collaboration expressed by CSA and ESA Senior Management

RADARSAT Constellation Mission

Project Schedule



N

Summary of CSA Capacity

- Limited use of RADARSAT 1 data
  - Lack of on-board recorders
  - Valuable archive
- No use of RCM before circa 2017
  - Still defining the details of the data policy
  - Working in assessing excess capacity potentially available for International Initiatives (GFOI, GEOGLAM, and others)
- Available mission is RADARSAT 2
  - Proven capabilities and enhanced info content, C-Band work horse with excess capacity
  - Commercial mission!
    - Need to demonstrate and document C-Band and confirm the usefulness in the context of the near term GFOI implementation phase
    - Explore ALL potential funding solutions to guarantee provision of data for GFOI operations – IFI or donor agency, bi- or multi-lateral agreement between Forest Authorities with Canada, Canada only, CSA only, etc...