HyspIRI Mission Concept

Bogdan Oaida, with contributions from many

[bogdan.oaida@jpl.nasa.gov]

Jet Propulsion Laboratory
California Institute of Technology

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

HyspIRI Mission Concept

Orbit Selection

- Key Orbit Design Considerations
  - Local time of observations
    - Sun-synchronous
    - 10:30 AM LTDN
  - Altitude
    - Low Earth Orbit
    - Repeating Ground track
  - Global coverage in a minimum number of days given the swath-width of each instrument.
    - VSWIR: 19 days revisit at the equator
    - TIR: 5 day revisit at the equator (1 day + 1 night)
- 626 km altitude at equator suits the needs of both instruments

Orbit selection and operations concept meet science requirements with very infrequent ground commanding or maintenance.
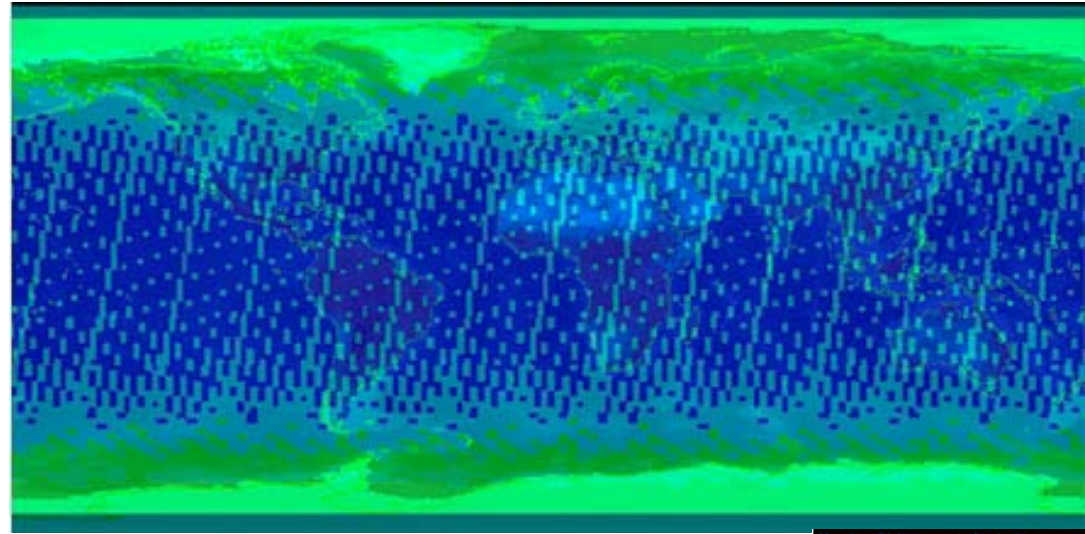
Operations Concept

- Systematic mapping vs. pointing capability
- Target map driven - No need for uploading acquisition sequences
- High resolution mode and Low resolution mode
- Direct Broadcast capability
 - Uses Intelligent Payload Module
  - Applications-driven

Operational Requirement	VSWIR	TIR
10:30 am sun-sync orbit	✓	✓
626 km altitude at equator	✓	✓
19 days revisit at the equator	✓	
5 day revisit at the equator		✓
Day Observation	✓	✓
Night Observation		✓
Pointing strategy to reduce sun glint	✓	
Surface reflectance in the solar reflected spectrum for elevation angles >20	✓	
Avoid terrestrial hot spot	✓	
Monthly Lunar View calibration	✓	✓
Weekly Solar View Calibration	✓	
Blackbody View Calibration		✓
Deep Space View Calibration		✓

HyspIRI Global Coverage

- Due to the min 20 deg Sun elevation angle constraint on the VSWIR acquisition, the latitudes covered change with the seasons

VSWIR Coverage after 19 days
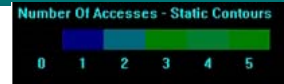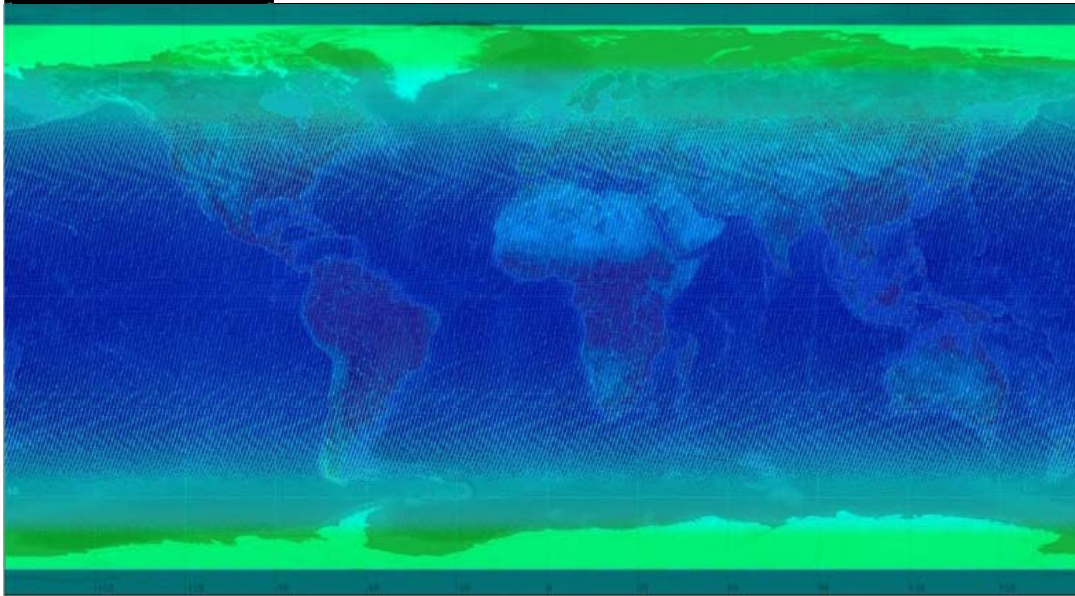
TIR Coverage after 5 days

Data Acquisition Scenario

- Systematic mapping vs. pointing capability

- Target map driven - No need for uploading acquisition sequences

- Data acquisition driven by land and coastal aquatic (<50m depth) coverage
  - Impact by low resolution modes on data volume is relatively small

- Both instruments on 24/7, but VSWIR <u>not</u> acquiring data at 100% duty cycle

- Low-latency products available via Direct Broadcast system
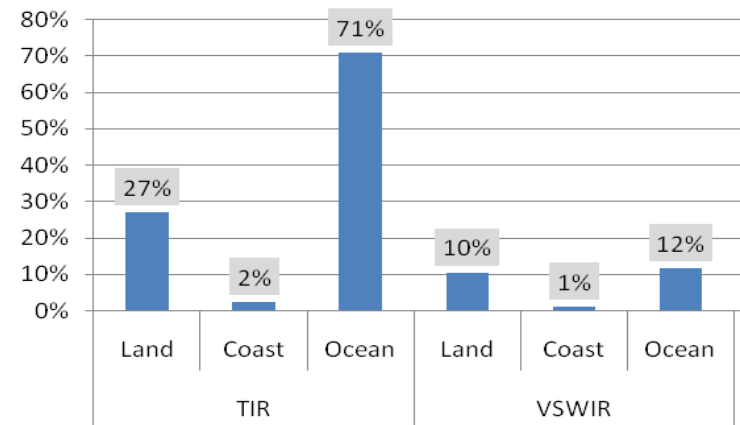 - Applications (not science) driven

Imaging Mode

Instrument	Land	Coastal	Deep Ocean	Greenland	Antarctica
VSWIR	60 m	60 m	1 km	1 km	1 km
TIR	60 m	60 m	1 km	1 km	1 km

Target Map
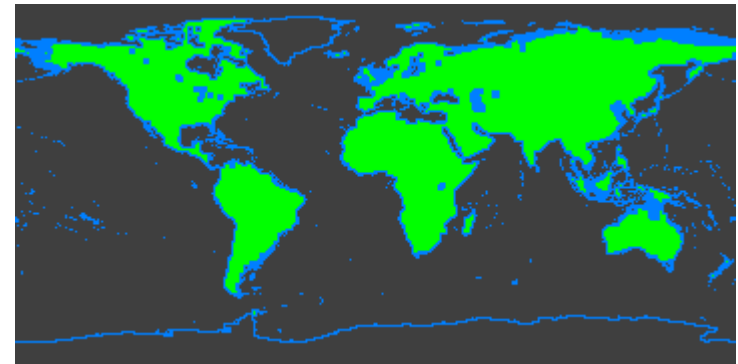
Duty Cycle

HyspIRI Data Volume

Histogram
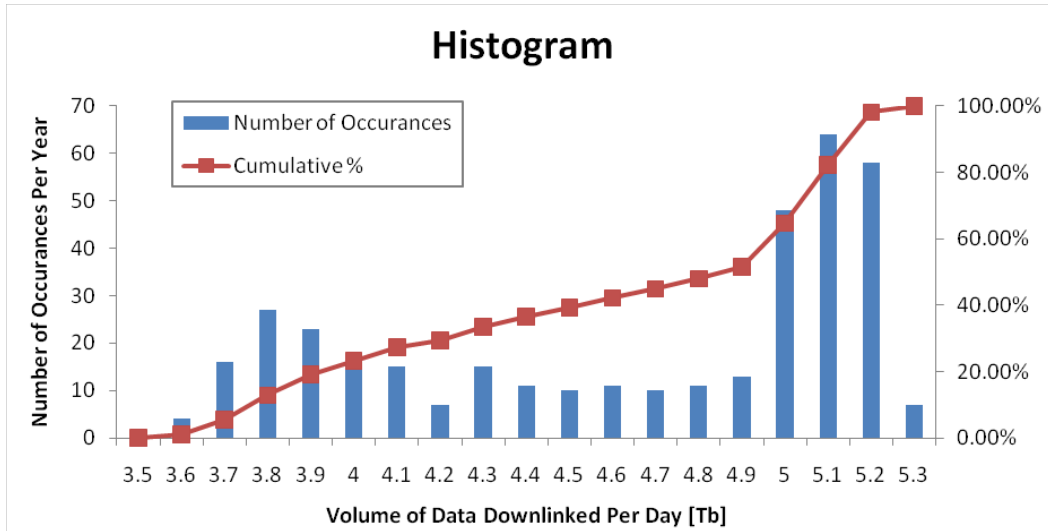
	Rate (Mbps)	On-board Compression
VSWIR: land	804.1	3:1
VSWIR: shallow	865.9	3:1
VSWIR: ocean	3.9	3:1
TIR: land	130.2	2:1
TIR: shallow	130.2	2:1
TIR: ocean	0.6	2:1
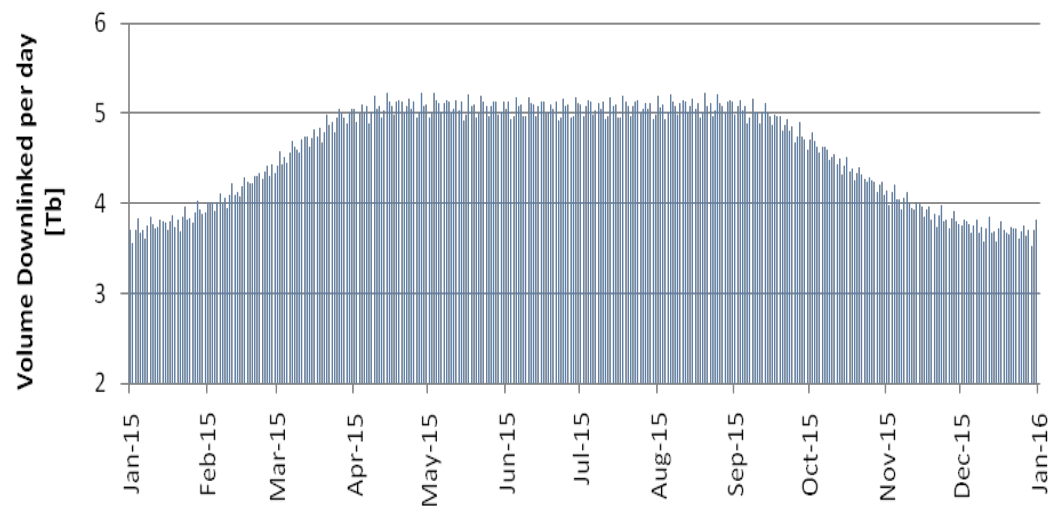
	Avg (Tb)	Min (Tb)	Max (Tb)
Per Day	4.59	3.53	5.22
Per Orbit	0.30	0.00	0.73

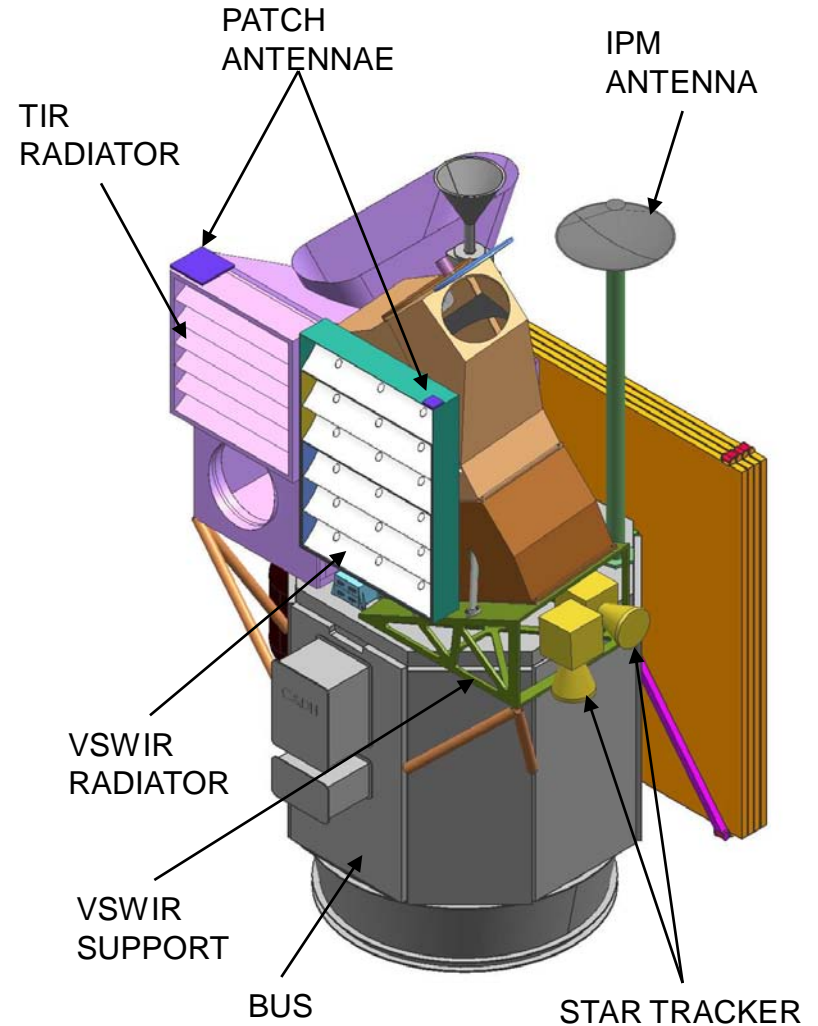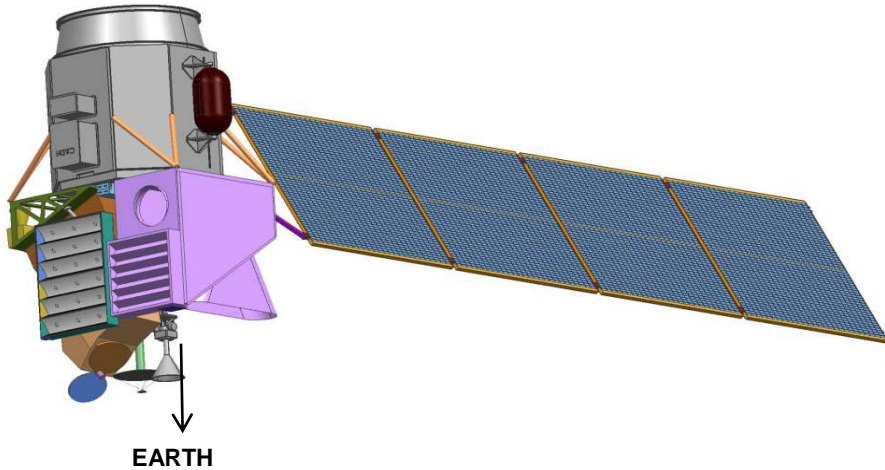Total data volume for the 3 year mission: 5024 Tbits

Managing Data Volume

- ## On-board storage (current baseline)
  - 3.1 Tb capacity (~65% used nominally)
  - WorldView-1 and -2 have 2.2 Tb SSR
    - WorldView1: 0.33 Tb/orbit
    - WorldView2: 0.52 Tb/orbit
- ## Downlink method
  - X-band (current baseline)
    - 800 Mbps, dual-pole, to Svalbard and Trollsat (KSAT); Poker Flats used as backup
    - WorldView-1 and GeoEye-1 use similar downlink architecture
- ## Ground communications / latency
  - Back end infrastructure may need upgrading to ensure timely delivery of data

HyspIRI will require more capabilities than currently used by NASA.
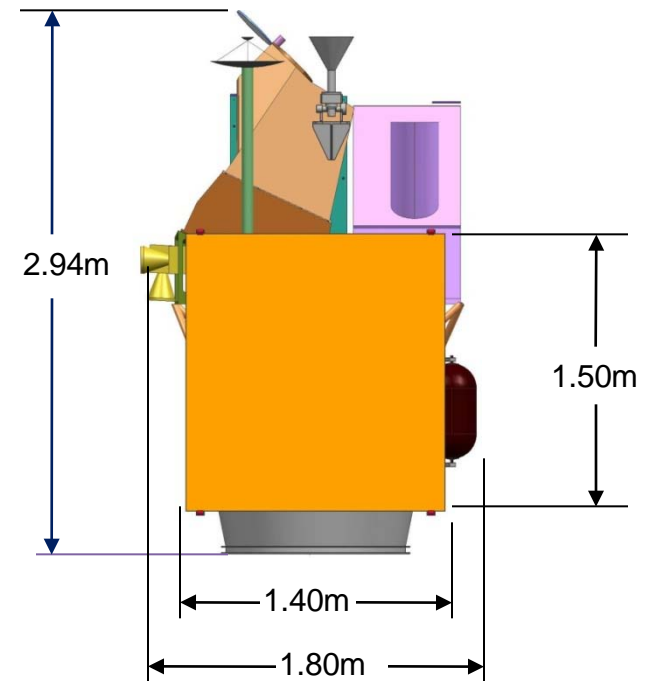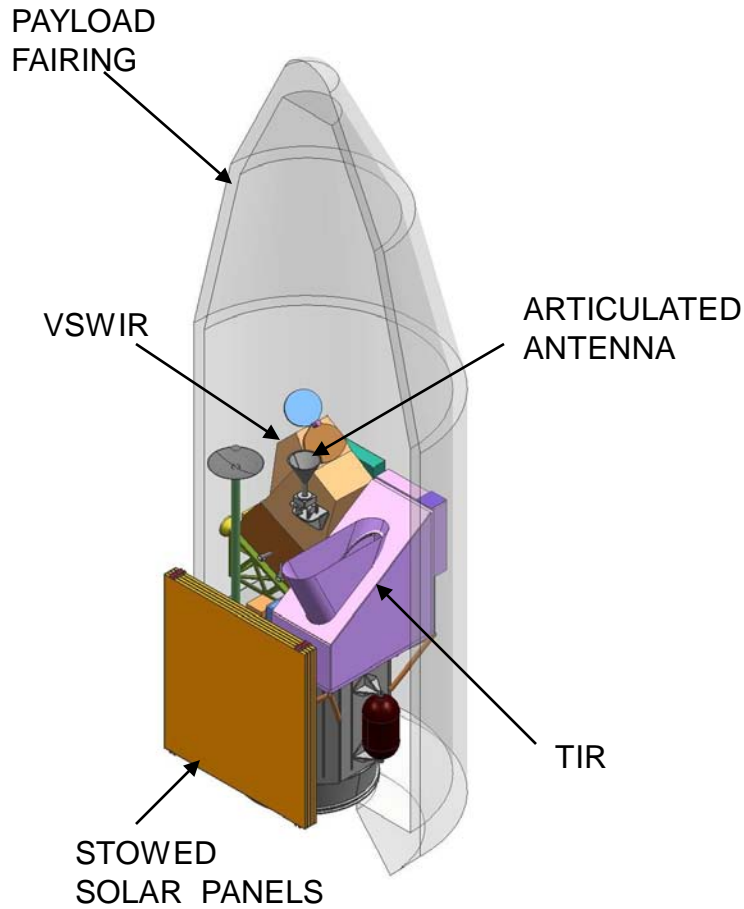*Suitable solutions are being used by existing commercial missions.*

Flight System Concept

- Industry procured spacecraft bus
  - SA-200HP used as an example for the study to identify and cost needed modifications
- HyspIRI specific
  - Payload integrated on the top plate (TIR, VSWIR) and inside the S/C
  - Configuration chosen to minimize/eliminate thermal impacts on the payload radiators
  - Spacecraft Dry Mass (CBE): 530 kg
  - Launch Mass: 693 kg
  - JPL DP Margin: 30%
  - Required Power (CBE): 620W
  - Available Power: 965W, 7.2 m^2 array

EARTH

PATCH ANTENNAE

IPM ANTENNA

TIR RADIATOR

VSWIR RADIATOR

VSWIR SUPPORT

BUS

STAR TRACKER

Launch Vehicle Concept

- Taurus 3210 can meet the mission needs
  - Closest fit among currently NASA approved launchers
  - 30% margin (dry-mass CBE) with a Taurus-class launch vehicle
  - Fits dynamic volume envelope
  - 790 Kg launch capacity for HyspIRI Orbit
- Launch window
  - Mapping orbit reachable once per day

PAYLOAD FAIRING

VSWIR

ARTICULATED ANTENNA

TIR

STOWED SOLAR PANELS

2.94m

1.50m

1.40m

1.80m

Payload Accommodation and System Margins

Accommodations	VSWIR	TIR
Mass (CBE)	60 kg	64 kg
Volume	1.1 x 0.5 x 0.8 m	1.2 x 1.1 x 0.6 m
Power	41 W	103 W
FOV (crosstrack)	13.62 deg	50.7 deg
FOV (alongtrack)	95.9 microrad	95.9 microrad
Orientation	4 deg to starboard	nadir

Pointing	
Accuracy	165 arcsec (3σ/axis)
Knowledge	2 arcsec (Pitch/Yaw axis 3σ); 8 arcsec (Roll axis 3σ)
Stability	5 arcsec/sec (3σ)

|	Required	Design	Margin (D-R)/D
Swath width VSWIR	141km	151 km	6%
Swath width TIR	536km	600 km	11%
Recorder capacity	2.0 Tb	3.1 Tb	37%
Power	620 W (CBE)	965 W	36%
LV mass capability	530 (CBE, dry)	790 kg	32%

BACKUP
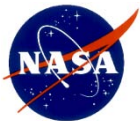
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

2010 HyspIRI Science Symposium - GSFC

Low Latency Data – Direct Broadcast

- Direct Broadcast Capability
- Low latency data (<6hrs)
- Applications Driven, Targeted Science
  - Non-stop data acquisition
  - Decision making capability
- Not tech development
- Design taken from NPP's high rate data (HRD) broadcast system
- Baseline design
  - 20 Mbps X-band
  - An Earth-coverage dish estimated at 0.5 m diameter
    - Reflector is shaped to provide peak gain at ~60 degrees off boresight
- Any user should be able to receive data when S/C is above 5 degrees

The DB capability will make use of high heritage technology and existing algorithms to enable the development of low latency data products and applications.

HyspIRI

IPM Direct Broadcast

X

X

Polar Stations

MOS/GDS
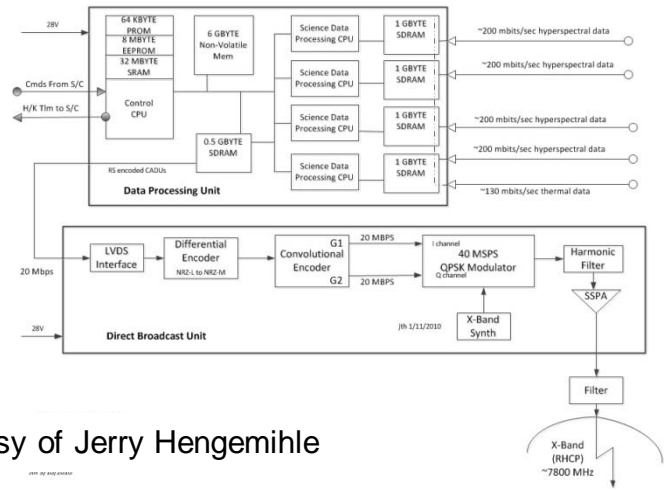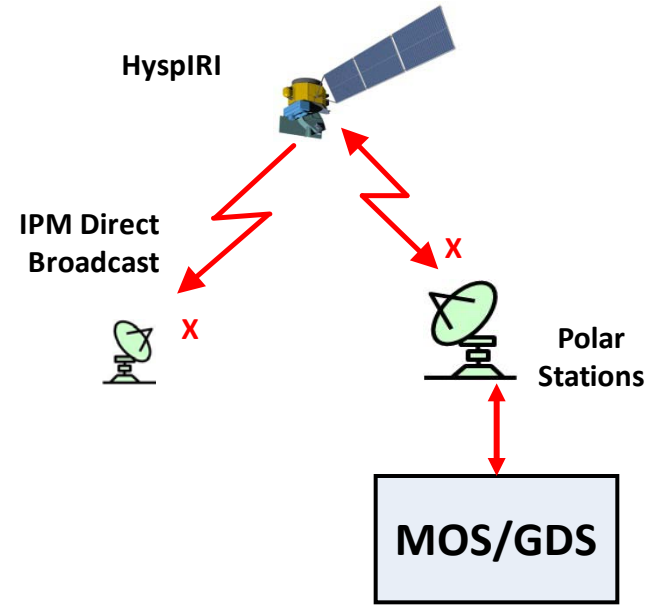
Courtesy of Jerry Hengemihle

Ground Station Capability

NASA

Non-NASA

Not Used

Poker Flats
Manager: USN
Downlink: 150Mbps

Svalbard
Manager: KSAT
Downlink: 800Mbps

Tromsø
Manager: KSAT
Downlink: 800Mbps

McMurdo
Manager: NASA
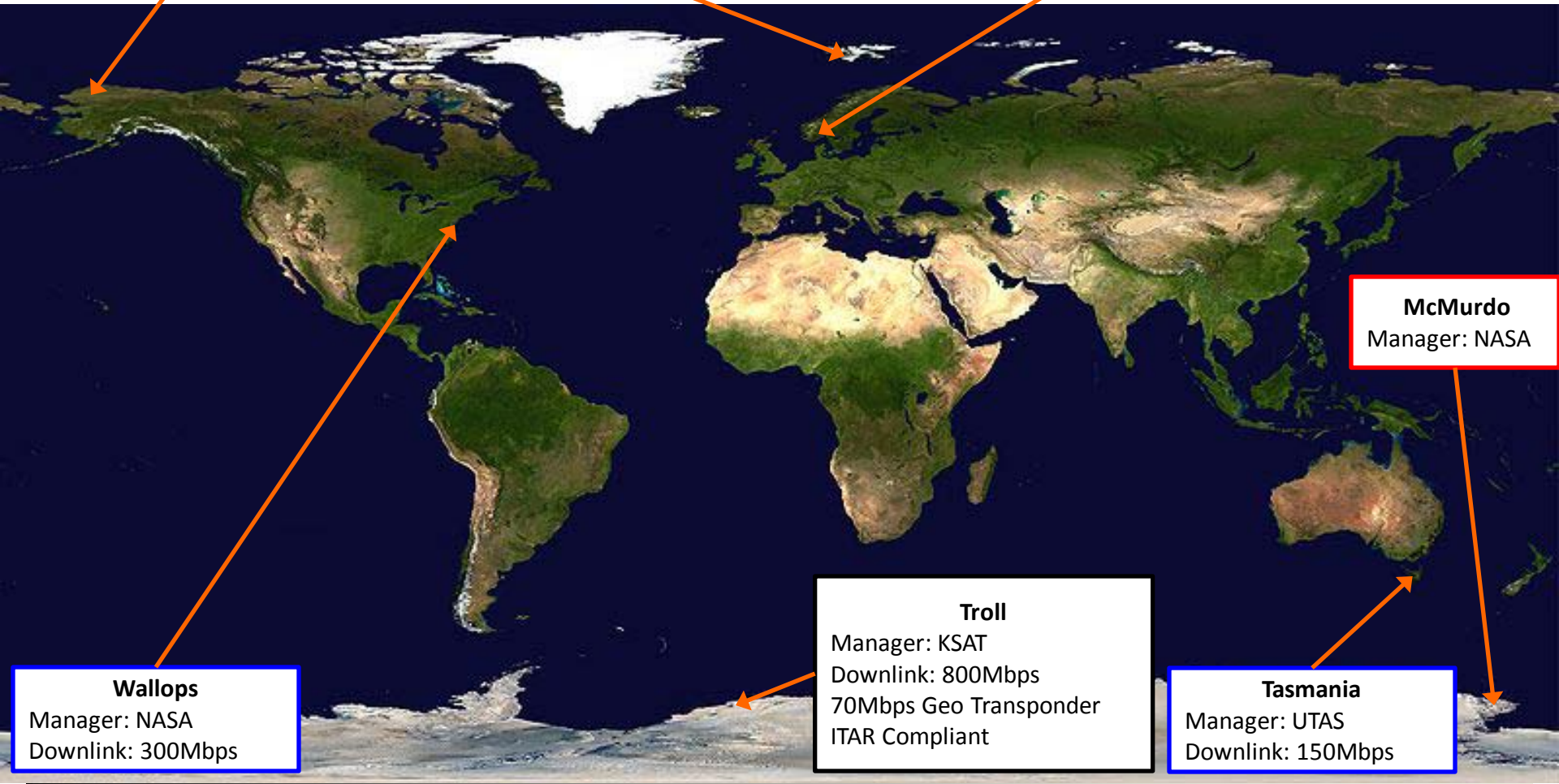
Wallops
Manager: NASA
Downlink: 300Mbps

Troll
Manager: KSAT
Downlink: 800Mbps
70Mbps Geo Transponder
ITAR Compliant

Tasmania
Manager: UTAS
Downlink: 150Mbps