HyspIRI Mission Concept

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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 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		✓

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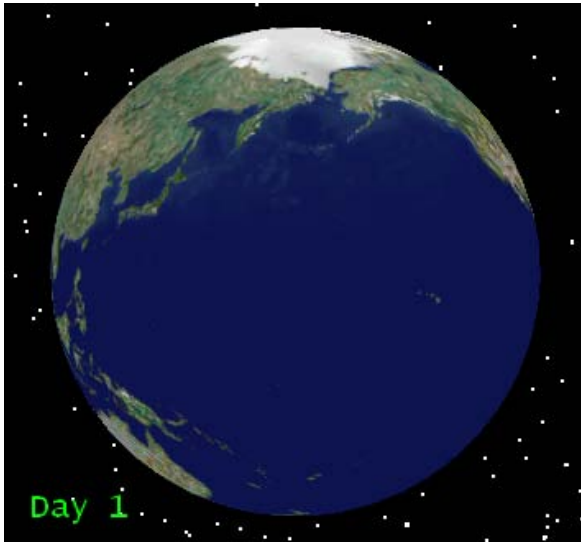
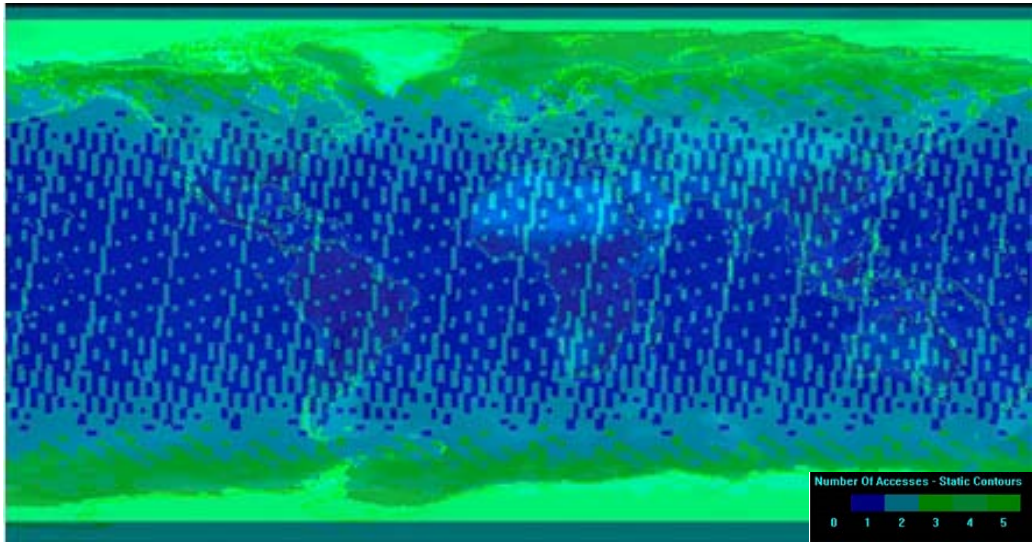
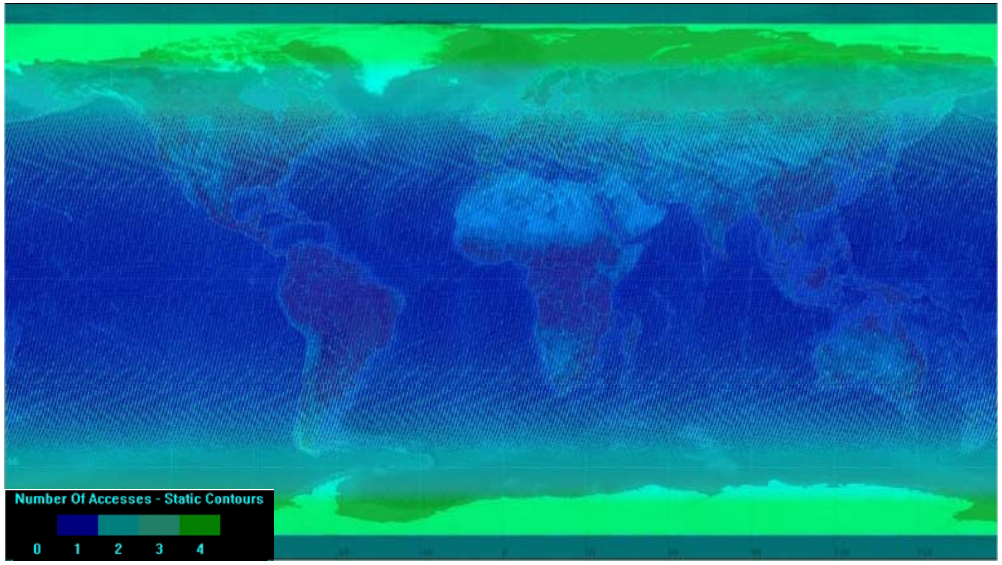
HyspIRI Global Coverage



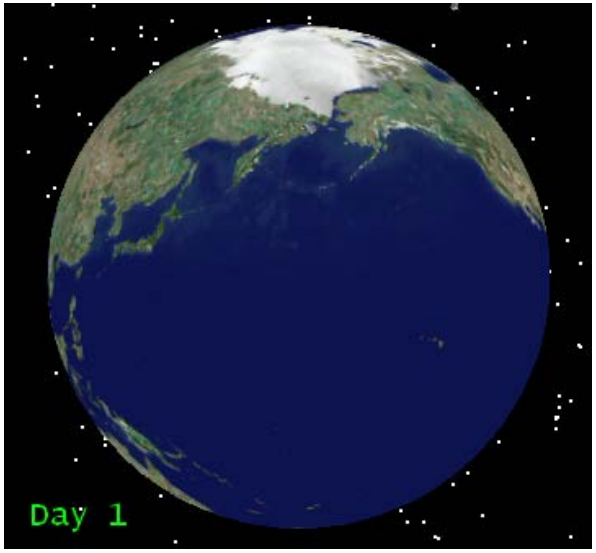
TIR Coverage after 5 days





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



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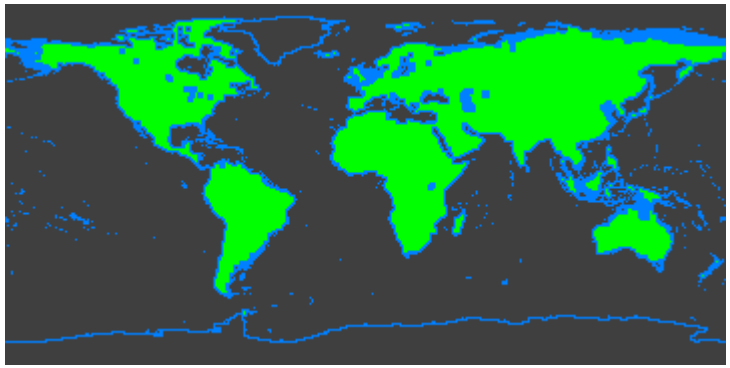
Data Acquisition Scenario

- 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 not acquiring data at 100% duty cycle
- Low-latency products available via Direct Broadcast system
  - Applications (not science) driven

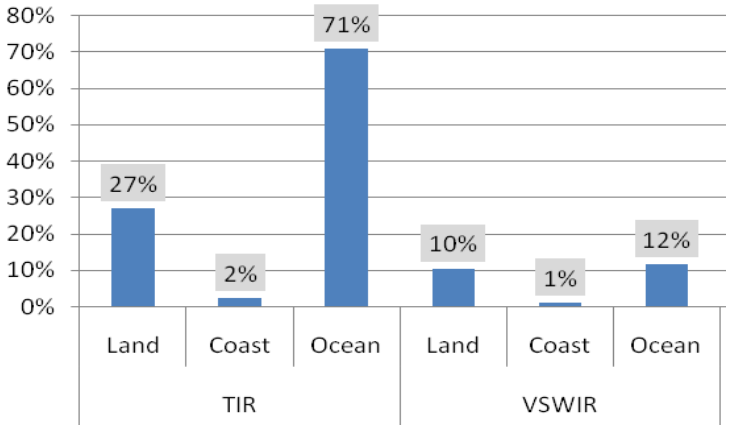
Imaging Mode

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



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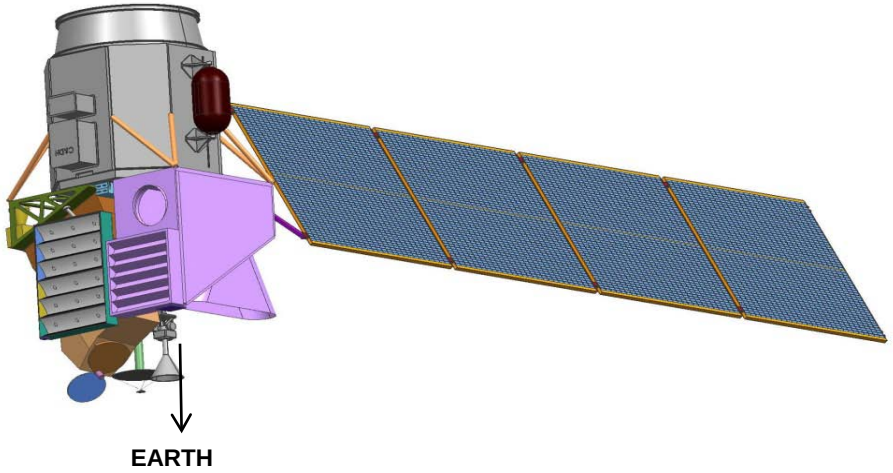
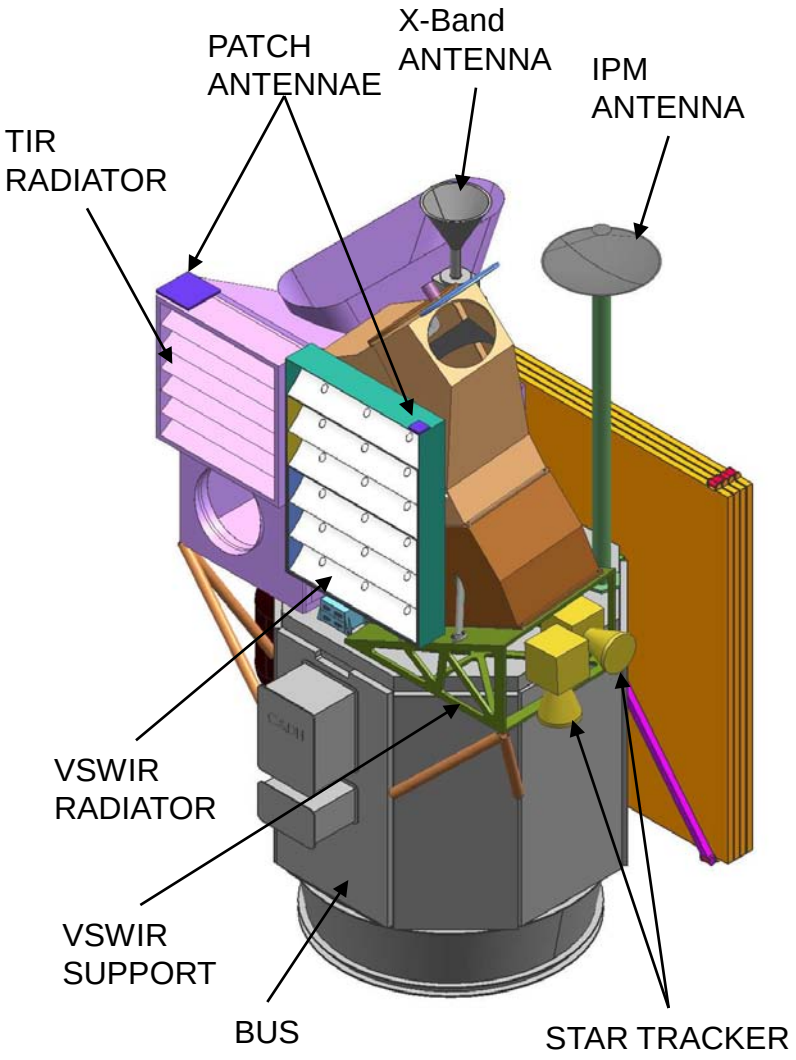
Flight System Concept

- 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): 520 kg
  - Launch Mass: 681 kg
  - JPL DP Margin: 31%
  - Required Power (CBE): 620W
  - Available Power: 965W, 7.2 m^2 array





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Key Bus Performance Range Summary

	Requirements	RSDO SA-200HP	HyspIRI SA-200HP	Modifications
Orbit	626 km 10:30 LTDN	✓	✓	-
Mission duration	3 years, selective redundancy	4 years, selective redundancy	3 years, single string	Remove redundancy to reduce cost
Thermal	Passive architecture	✓	✓	-
Downlink	800 Mbps	80Mbps	800 Mbps	Dual-pol X-band
Propellant	75 m/s 37 kg	131 m/s 67 kg tank	131 m/s 67 kg tank	-
Onboard recorder	1 Tbit	134 Gbits	1Tbit	SEAKR SSP-R
Payload mass	126kg	666 kg	666 kg	Support structure for Instuments
Payload Power	885 W	650 W	965 W	Single wing configuration, add one panel
Pointing Knowledge	See table below	0.5 arcsec (3σ)	<=0.5 arcsec (3σ)	Replaced one of two coarse Ball CT-602 star tracker with one fine Lockheed Martin AST-301 star tracker.
Pointing Accuracy		16 arcsec (3σ)	<=16 arcsec (3σ)	
Pointing Stability		0.1 arcsec/sec (3σ)	<=0.1 arcsec/sec (3σ)	

Pointing	VSWIR Requirement	TIR Requirement	Rationale	Driver
Knowledge	< 48 µrad (3σ/axis)	< 48 µrad (3σ/axis)	<30m (3σ) post-reconstruction orthorectification knowledge at 626km altitude	TIR
Accuracy	<4.5 mrad (3σ/axis)	<4.5 mrad (3σ/axis)	VSWIR: Limits cross-track error to < 3 km on the surface	VSWIR
Stability	±0.1 mrad/sec (3σ)	±24.7 mrad/sec (3σ)	VSWIR: Limit smear to < 0.6 meters as one pixel crosses a spot on the surface in 8.8 msec TIR: Time for 6 pixels in TDI string to cross a point on the surface at nadir is 0.39 msec.	VSWIR

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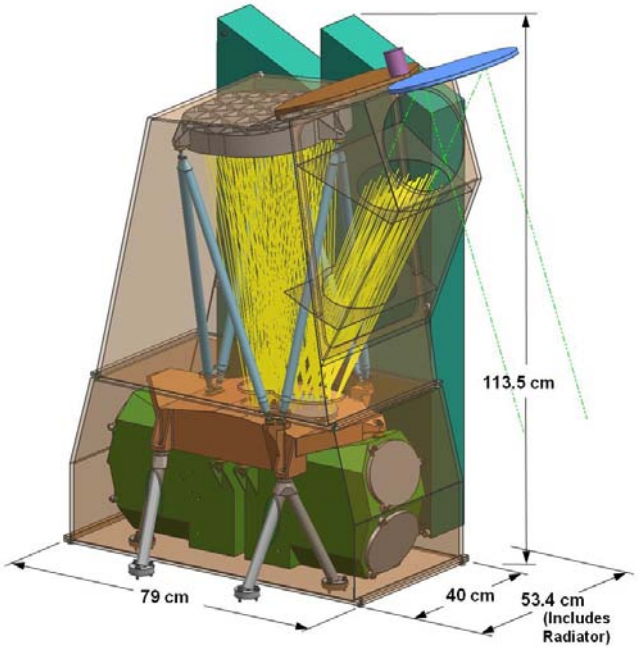
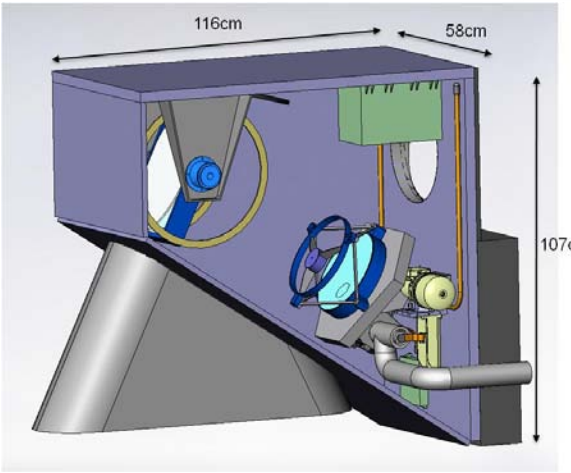
Science Payload Accommodation and System Margins

Accommodations	VSWIR	TIR
Mass (CBE)	55 kg	60 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

	Required	Design	Margin (D-R)/D
Swath width VSWIR	141km	151 km	6%
Swath width TIR	536km	600 km	11%
Recorder capacity	0.8 Tb	1.0 Tb	20%
Power	620 W (CBE)	965 W	36%
LV mass capability	520 (CBE, dry)	790 kg	34%





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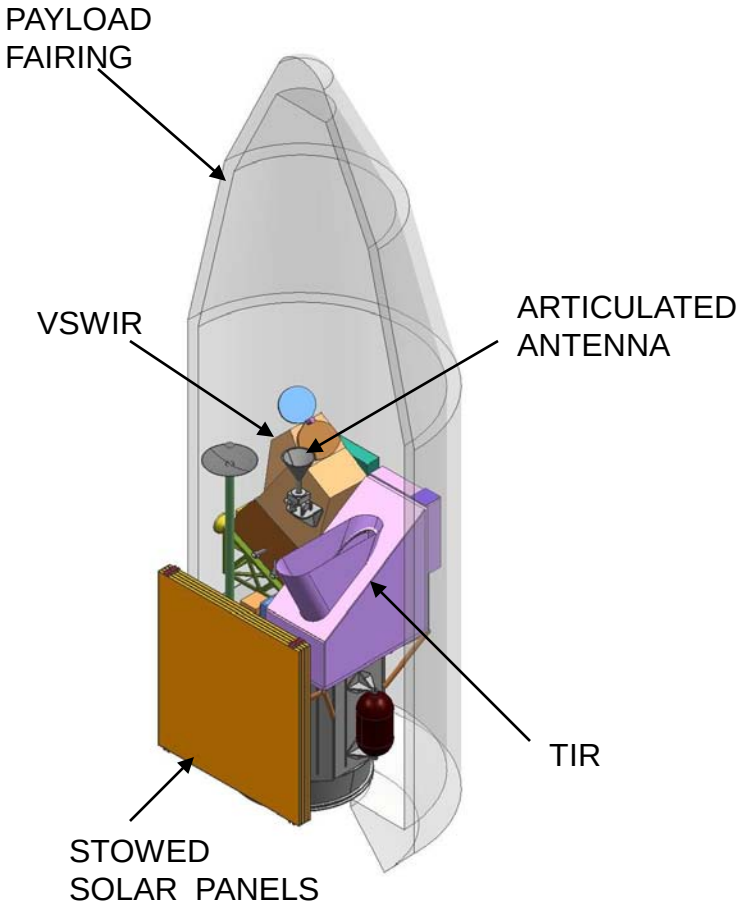
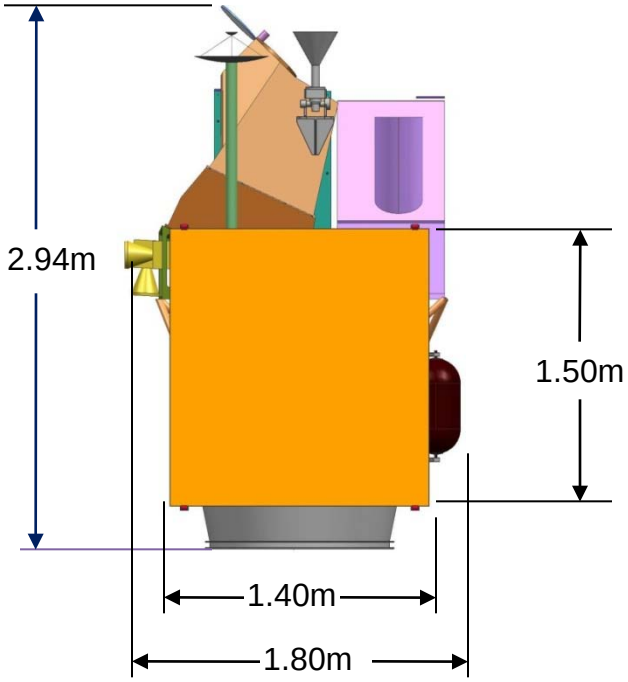
Launch Vehicle Concept



- Taurus 3210 can meet the mission needs
  - Closest fit among currently NASA approved launchers
  - 31% margin (per JPL Design Principles) 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



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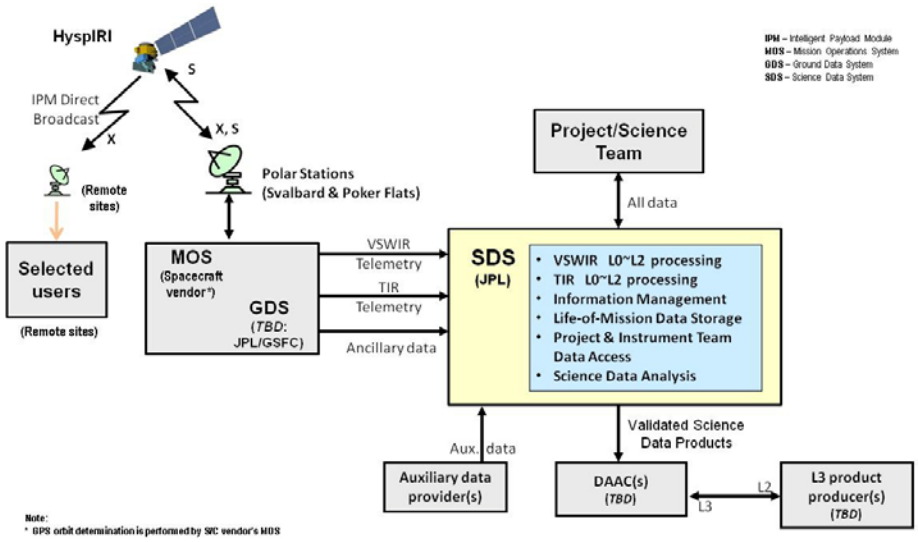
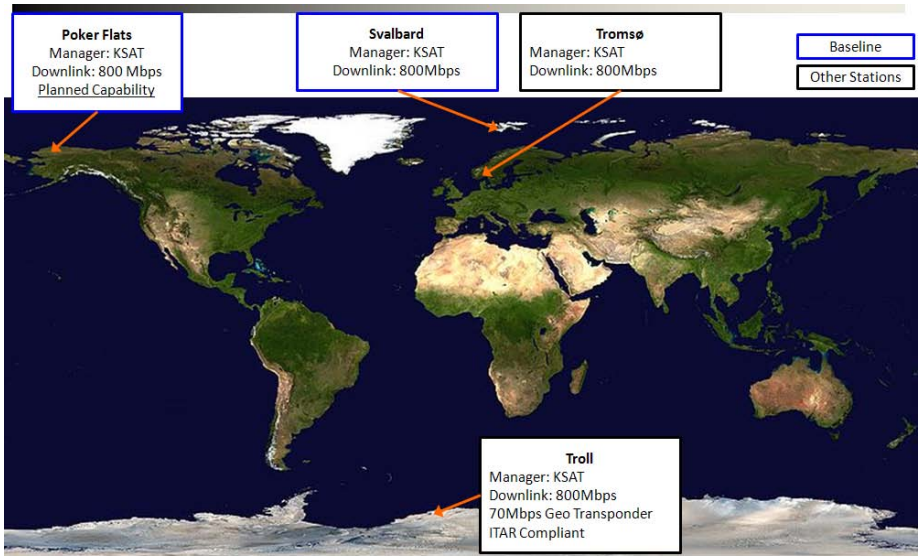
Ground System Concept

- Data Downlink
  - KSAT Ground network
    - Svalbard @ 800 Mbps Dual-pole X-Band (existing)
    - Poker Flats @ 800 Mbps Dual-pole X-Band (in development)
    - Other stations available
  - Almost 100% data return with 1 Tbit SSR on spacecraft
- Data Processing
  - SDS sized to process L0 through L2 data for both instruments
  - Deliver L2 data products to DAAC
  - L3 data products produced by users

HyspIRI will utilize existing infrastructure with proven capability to downlink and process all science data





BACKUP

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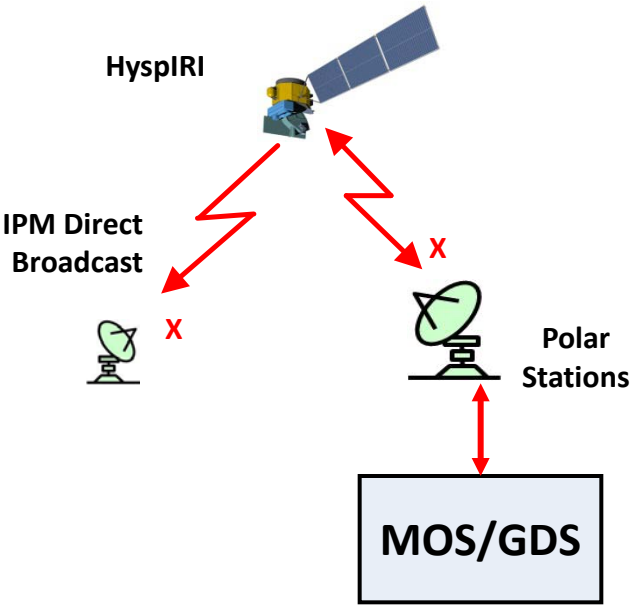
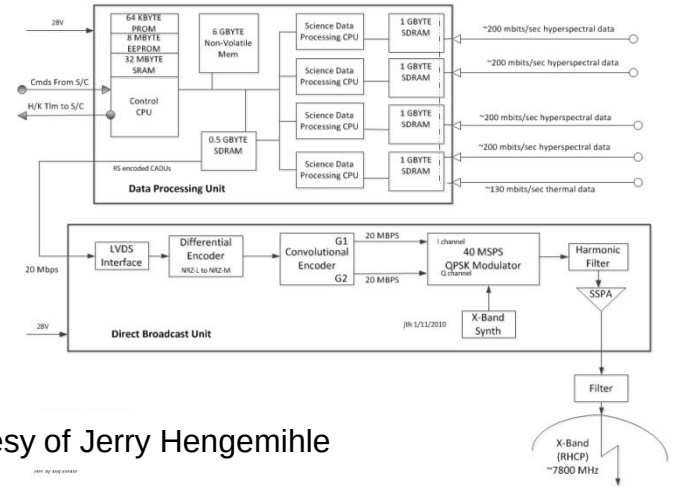
Low Latency Data – Direct Broadcast

- 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





Courtesy of Jerry Hengemihle

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

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Key Driving SDS Design Requirements

- Data Downlink Volumes: 5.3 Tb/day Max. (4.6 Tb/day Mean)
- Data Product Types: 2 Level 0's, 2 Level 1's, 2 Level 2's, *tbd* L3
- Data Product Availability:

Product Application	Nominal Latency From Receipt of Required L0a Data at Processing Node	Comments
Routine Science	1 week – 2 weeks	Products meet science/calibration specifications
Priority Target Events	1 day	Data acquisitions are not routinely planned but event-driven Products are L1 and L2/3 in limited quantity Products may not meet science/calibration specifications
Intelligent Payload Module Direct Broadcast	No latency requirement for SDS	Data broadcast via the IPM will not end up at the SDS

- **Total Mission Data Volume***: 47.2 Tbits (6.2 Tb L0B's, 18.6 Tb L1B's, 22.5 Tb L2's) per day
  58.2 Pb over mission life
- **Processing Loading:** Sized to meet respective product latency requirements (no backlog and with margin to include *one* reprocessing campaign
- **SDS sized for 5.2 Tb/day**
  - 98.1% of the time, less than 5.2 Tb is downlinked per day

Notes: * Mission data volume based on maximum L0A downlink volume; exclusive of data from Direct Broadcast;
Assumes all L0 processed to L1 & L2; all in 16-bit per sample;
Assumes data compression ratios of 3:1 for all VSWIR and 2:1 for all TIR image bands; assumes no compression for ancillary bands;
Tb – Terabits (10^12 bits); Pb – Petabits (10^15 bits)