Overview of
HyspIRI Mission Characteristics

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Goal of the Mission Concept Study

• To assess the feasibility of a mission that meets the science objectives by:
  – Including a high level description of a particular implementation,
  – Identifying major risks,
  – Estimating the cost to develop and execute the mission.

• To provide a baseline:
  – For comparison of alternate implementations,
  – For evaluating the impact of different science requirements.

Second iteration for HyspIRI, but will be further refined in preparation for a Mission Concept Review
Inputs

• Science Traceability Matrix
  – Mission requirements

• Instrument accommodation requirements

• Programmatic approach to Decadal Survey Missions

• Context
  – Existing or completed missions with similar characteristics
  – Previous studies

Overall approach: use demonstrated solutions wherever possible to decrease technical and schedule risk.
Orbit Design

• Local time of observations
  – Sun-synchronous, 11:00 +/- 30 minutes.

• Altitude
  – Low Earth Orbit, frozen.

• 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)
  – Combined solution: 626 km altitude at equator

There is a suitable orbit that matches the characteristics of both instruments.
Geometrical Access in 19 days

Number of daytime VSWIR access (no nighttime)

Number of daytime TIR access (nighttime is identical)

The above plots show the average gap between access to each location. Effects of Sun illumination and clouds are not included.

The 626 km orbit is one of the few that also minimize the maximum temporal gaps between acquisitions.
Sun Illumination (VSWIR)

- Impact of the latitude variations of the sub-solar point
  - Latitude extent of VSWIR coverage varies seasonally
- Variations of the Local Time of Ascending Node.
- Optimization of the VSWIR pointing.
- Small variation of the local time of observations with latitude.
December solstice: worst case Sun illumination in the Northern hemisphere.

Equinox: sun elevation greater than 20 degrees between +/- 70 deg latitude.

Sun illumination constraints reduces VSWIR coverage during local winter.
• LTDN varies yearly +/- 15 minutes from selected value (11:00).
• LTDN closer to noon narrows the problem-free region between sun-glint and hot-spot. (right image)
• Small red box is VSWIR swath
• Boresight is 4deg off-nadir in the cross-track direction away from the sun.
Data Acquisition Scenario & Mission Operations

- **Target maps driven**
  - No need for uploading acquisition sequences
- **Low resolution mode**
  - Ocean & Ice coverage, little impact
- **Direct broadcast option**
  - To demonstrate real-time use of data
- **Systematic mapping vs. pointing capability**
- **Downlink scheduling**

Systematic mapping maximizes science return and minimizes complexity of Mission Operations
Data Volume

• Duty-cycle and data rates:
  – Duty cycle based on target masks
    • Full swath width acquisition baselined
    • Partial swath acquisition could reduce data volume
  – Includes illumination constraints (VSWIR)
  – Includes compression (TIR: 2x, VSWIR: 3x)
  – Includes overhead
  – Continuous averaged data-rate: 65 Mbps

• Data volume:
  – 372 Gb / orbit
  – 5.5 Tb / day

<table>
<thead>
<tr>
<th></th>
<th>VSWIR</th>
<th>TIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>rate (Mbps)</td>
<td>288.5</td>
<td>59.2</td>
</tr>
<tr>
<td>duty_cycle ratio</td>
<td>0.148</td>
<td>0.400</td>
</tr>
<tr>
<td>effective rate</td>
<td>42.700</td>
<td>23.672</td>
</tr>
<tr>
<td>overhead</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>avg rate w/ ovrhd</td>
<td>46.970</td>
<td>26.039</td>
</tr>
<tr>
<td>Obstruction ratio</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>After screening</td>
<td>37.576</td>
<td>26.039</td>
</tr>
</tbody>
</table>

WorldView-1: 331 Gb/orbit
DESDynI: 352 Gb/orbit

HyspIRI data-set is comparable to existing commercial and other future NASA missions.
Managing the Data Volume

• On board storage
  – 3 Tb (WorldView-1 has 2.2 Tb)

• Downlink options
  – X-band
    • Upgrade 3 existing stations to 600 Mbps
    • WorldView-1 (launched 2007/09) 800 Mbps
  – Ka-band
  – Optical communications
  – TDRSS

• Ground communications / latency

HyspIRI will require more capabilities than currently used by NASA. Suitable solutions are being used by existing commercial missions.
Spacecraft and Launch Vehicle

• **Spacecraft**
  – Most accommodation requirements can be met by typical COTS spacecrafts.
  – Unique needs for HyspIRI were met by adding the cost of upgrades using commercially available parts.
  – We plan to work with industry to refine our understanding of suitable spacecrafts.

• **Launch vehicle**
  – The combined mass of the payload and a candidate spacecraft can be launched with 9% margin (over CBE +contingencies) by a Taurus-class launch vehicle.
  – Available volume in the launch vehicle fairing has also been verified.

Suitable spacecrafts and launch vehicles exist. A conservative cost estimate was used by TeamX.
Science and Science Data System

• Science:
  – Includes science management, project scientist, science teams and their involvement in algorithm development, science sequence development, instrument pre-launch calibration

• Science Data System:
  – Produces and archive L0 and L2 products during phase E and F.

• Archiving and data analysis costed separately.

NASA is defining the scope of SDS for Decadal Survey missions, between ESSP and EOS models.
Project Cost

• Methodology, margins
• Bottom line
• Comparison to DS
• Opportunities for cost reductions
  – Evaluate alternate mission implementations
    • Assess potential of newer technologies: lower cost, higher margins.
  – Evaluate alternate science (less, or more with partner)
  – Evaluate international cooperation
  – NASA investments

In-line with the DS.
There are opportunities to reduce the cost.
Project Development Schedule

• Studied schedule
  – Based on mature science (TBC)

• Launch readiness date
  – Based on existing technologies

• Impact/opportunities with a delayed start
  – Increased cost for early phases
  – Potential cost decrease due to new technology
  – Later availability of science products

HysPIRI maturity is consistent with a 2014 LRD. Working toward a possible transition to phase-A by October 2009.
Next Steps

• Assess impact of workshop.
• Support work on level 1 requirements (a NASA HQ document)
• Work on cost reduction opportunities
• Involve industry
• Prepare Mission Concept Review