HyspIRI Low Latency Concept & Benchmarks

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**HyspIRI Low Latency Data Ops Concept**

132 Mbps Multispectral Thermal InfraRed (TIR) Scanner

- **Spectral**
  - Bands (8) 3.98 µm, 7.35 µm, 8.28 µm, 8.63 µm, 9.07 µm, 10.53 µm, 11.33 µm, 12.05 µm
- **Spatial**
  - IFOV 60 m
  - Range 600 km (±25.3° at 626 km)

804 Mbps Hyperspectral Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer

- **Spectral**
  - Range 380 to 2500 nm
  - 10 nm bands
- **Spatial**
  - Range ~146 km
  - (13.2 deg. at 626km)
  - Cross-Track Samples >2560
  - Sampling 60 m

- 20 Mbps Direct Broadcast (10Mbps data throughput)
- Downlink Select Spectral Bands
- Select L-2 Products
- Continuous Earth-view Broadcast
HyspIRI Data Flow

- **TIR**: 130.2 Mbps
- **VSWIR**: 804 Mbps

**Command & Data Handling Solid State Recorder**

**IPM**

- **Direct Broadcast Module**

**Spacecraft**

- **S-band command**
- **S-band housekeeping data**
- **X-band 800 Mbps Science data**

**To/From Alaska and Norway Ground Stations**

**Direct Broadcast Antennas**

**Antennas**

- S-band
- X-band
- 800 Mbps

**To/From** Alaska and Norway Ground Stations
Ongoing Efforts

• Baseline detailed operations concept used to derive cost estimate to be presented by Steve Chien

• Web Coverage Processing Service (WCPS)
  - Allows scientists to define algorithms that can be dynamically loaded onboard satellite or execute as part of the ground processing

• Open Science Data Elastic Cloud
  - Many custom products generated in parallel by many virtual machines
  - Complex products generated in concurrent steps (parallel processing)
  - Elastic response to unanticipated user demand
  - Quick user access (multi-gigabit access)
  - Easy expandability of cloud as needed

• Benchmarking of CPU’s for Intelligent Payload Module
  - SpaceCube (initial results presented at previous workshop)
  - Other CPU’s (future workshops)
  - Onboard processing

• Delay Tolerant Network Communication Connectivity
  - Upload of algorithms and download of data with fault and delay tolerant connection
Experiment with Web Coverage Processing Service (WCPS) Approach to Injecting New Algorithms into SensorWeb

Machine Learning
Data Mining / Classifier
Decision Tree

EO-1, HyspIRI data

WEKA
The University of Waikato

WEKA
The University of Waikato

Custom Algorithm Upload
With Satellite Tasking,
Image Acquisition & Processing
And Data Delivery

Dynamic Upload

Intelligent Agents

NASA Cloud Infrastructure As A Service (IAAS)
Collaboration with Open Cloud Consortium

Reflectance Algorithms
Pattern Matching Algorithms
Geometric Correction Algorithms

Custom Data Product
(KMZ, PNG...)
(e.g. oil classifier)

EO-1, HyspIRI...

GlobalHawk, Ikhana...
Low Fidelity HyspIRI IPM Testbed

**Data Generator Workstation**
- Generates test data and streams it to the board at rates up to 800Mbps.

**NETGEAR Gigabit Switch**
- Allows the board and the data generator workstation to connect at Gigabit speed.

**Compact Flash**
- Ext3 formatted file system with Linux libraries and tools.

**Platform Cable USB**
- Provides an easy method for debugging software running on the board.

**Virtex-5 FPGA**
- GSFC SpaceCube 2 core FPGA
- Configured as dual 400MHz PPC design
- Capable of running with Linux or in a standalone mode

**Xilinx ML510 Development Board**
- Enables the development team to verify the Virtex-5 while GSFC SpaceCube 2 is finalizing the design.
Compute Cloud Testbed

- Open Cloud Consortium (OCC) providing rack with 120 Tbytes usable, 1 – 10 Gbps fiber interface connected to GSFC and Ames and 320 core to support hundreds of virtual machines (part of larger expandable infrastructure consisting of 20 racks)
  - System admin support
  - Funded by multiple sources including National Science Foundation
  - Will stand up 100 Gbps interface wide area cloud (future)
  - Expect to be there at least 5+ years
- Created account on BioNimbus cloud for NASA use
  - Demonstrated performing ALI Level 1R and Level 1G processing in cloud
- Will receive dedicated cloud compute rack in August 2010 donated by Open Cloud Consortium
  - Plan to port automated atmospheric correction using ATREM on Hyperion Level 1R to cloud (presently running on GSFC server)
  - In process of integrating FLAASH atmospheric correction C into an automated process for Hyperion for Level 1R and then porting to cloud
  - Plan to demonstrate Hyperion level 1R and Level 1G processing in cloud
  - Plan to demonstrate multiple simultaneous automated higher level data products maximizing clouds ability to handle parallel processing
  - Make use of software agent-based architecture for intelligent parallel data processing for multiple data products
  - Experiment with security in open cloud (Open ID/OAuth)
Open Cloud Testbed Environment

- Biological data (Bionimbus)
- Astronomical data
- Image processing for disaster relief & HyspIRI Cloud Benchmarking
- Networking data
GLIF is a consortium of institutions, organizations, consortia and country National Research & Education Networks who voluntarily share optical networking resources and expertise to develop the Global LambdaGrid for the advancement of scientific collaboration and discovery.
Delay Tolerant Network (DTN) Protocol Benchmarking

- Prototype being funded by NASA HQ / SCAN
  - Purpose is to provide space network that is delay/disruption tolerant
  - Using EO-1 in FY 11 to demonstrate various scenarios (Hengemihle)
  - Trying to demonstrate how it is applicable to low earth observing missions

- HyspIRI applicability
  - Upload new data processing algorithms for IPM
    - Can send algorithm to DTN node without regard to when contact with satellite occurs
    - DTN node handles uplink when there is contact and send confirmation back to originator
  - Examining scenarios during Direct Broadcast to handle delays during downlink
    - E.g. data product ready but DB station not in view, DB node onboard receives data product and waits for contact to handle downlink and confirmation
EO-1 Configuration for Preliminary Delay Tolerant Network (DTN) Prototype

Lead: Jane Marquart  Implementers: Rick Mason, Jerry Hengemihle/Microtel
Conclusion

- Experimenting with various bottlenecks for end-to-end data flow for low latency users of HyspIRI
- Leveraging other funds and using HyspIRI funds to tailor for the HyspIRI mission
- Results applicable to other high data volume Decadal missions