HyspIRI Low Latency Concept & Benchmarks

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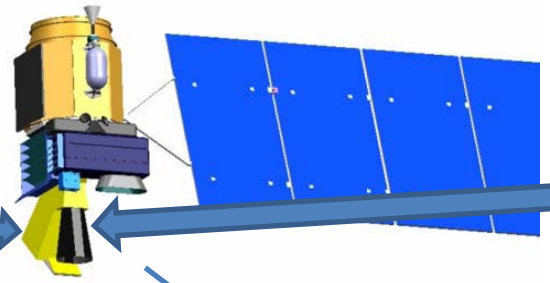
HyspIRI Science Workshop
August 24-26, 2010
Pasadena, CA

HyspIRI Low Latency Data Ops Concept

132 Mbps
Multispectral
Thermal InfraRed
(TIR) Scanner



804 Mbps
Hyperspectral Visible
ShortWave InfraRed
(VSWIR) Imaging
Spectrometer

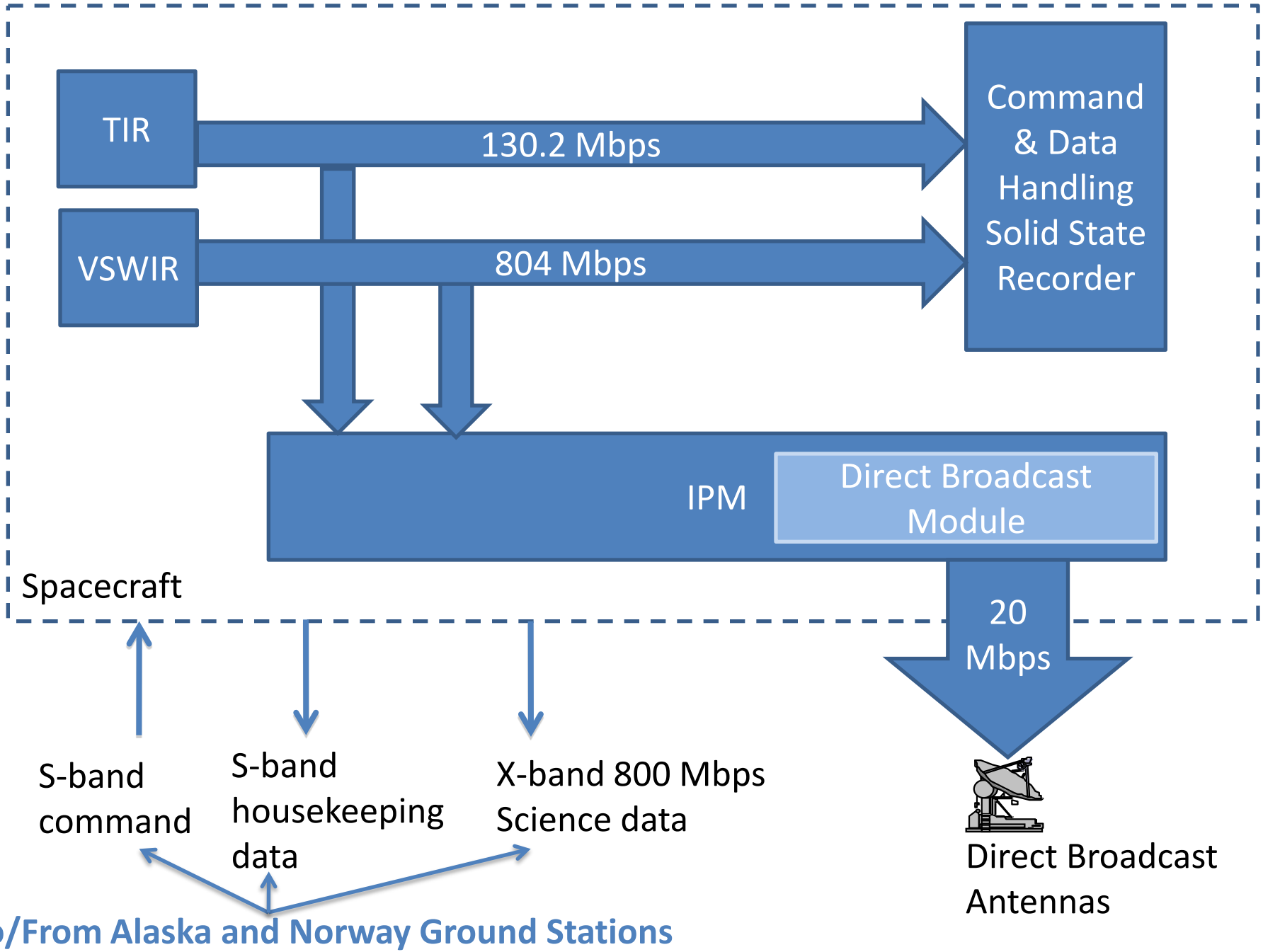
Spectral
Bands (8) 3.98 µm, 7.35 µm, 8.28 µm, 8.63 µm, 9.07 µm, 10.53 µm, 11.33 µm, 12.05
Spatial
IFOV 60 m
Range 600 km (±25.3° at 626 km)

Direct
Broadcast

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



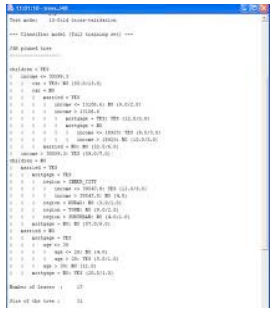
Ongoing Efforts

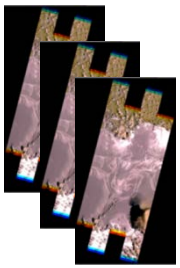
- Baseline detailed operations concept used to derive cost estimate to be presented by Steve Chien
- Web Coverage Processing Service (WCPS)
  - Allows scientists to define algorithms that can be dynamically loaded onboard satellite or execute as part of the ground processing
- Open Science Data Elastic 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

Science User

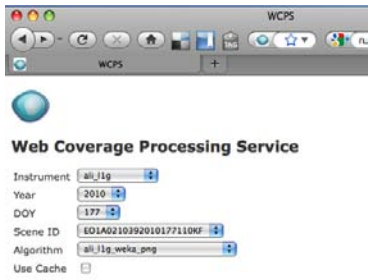
Machine Learning
Data Mining / Classifier
Decision Tree

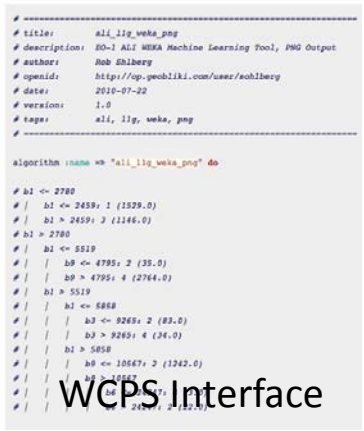




EO-1, HyspIRI data

Agent Converts WEKA Tree
Object to WCPS Algorithm





WCPS Interface

Dynamic
Upload

EO-1, HyspIRI…

GlobalHawk,
Ikhana…

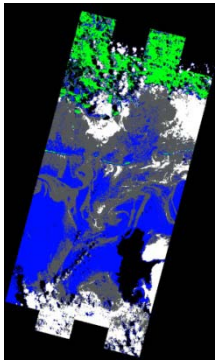
Intelligent Agents

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

Reflectance
Algorithms

Pattern
Matching
Algorithms

Geometric
Correction
Algorithms

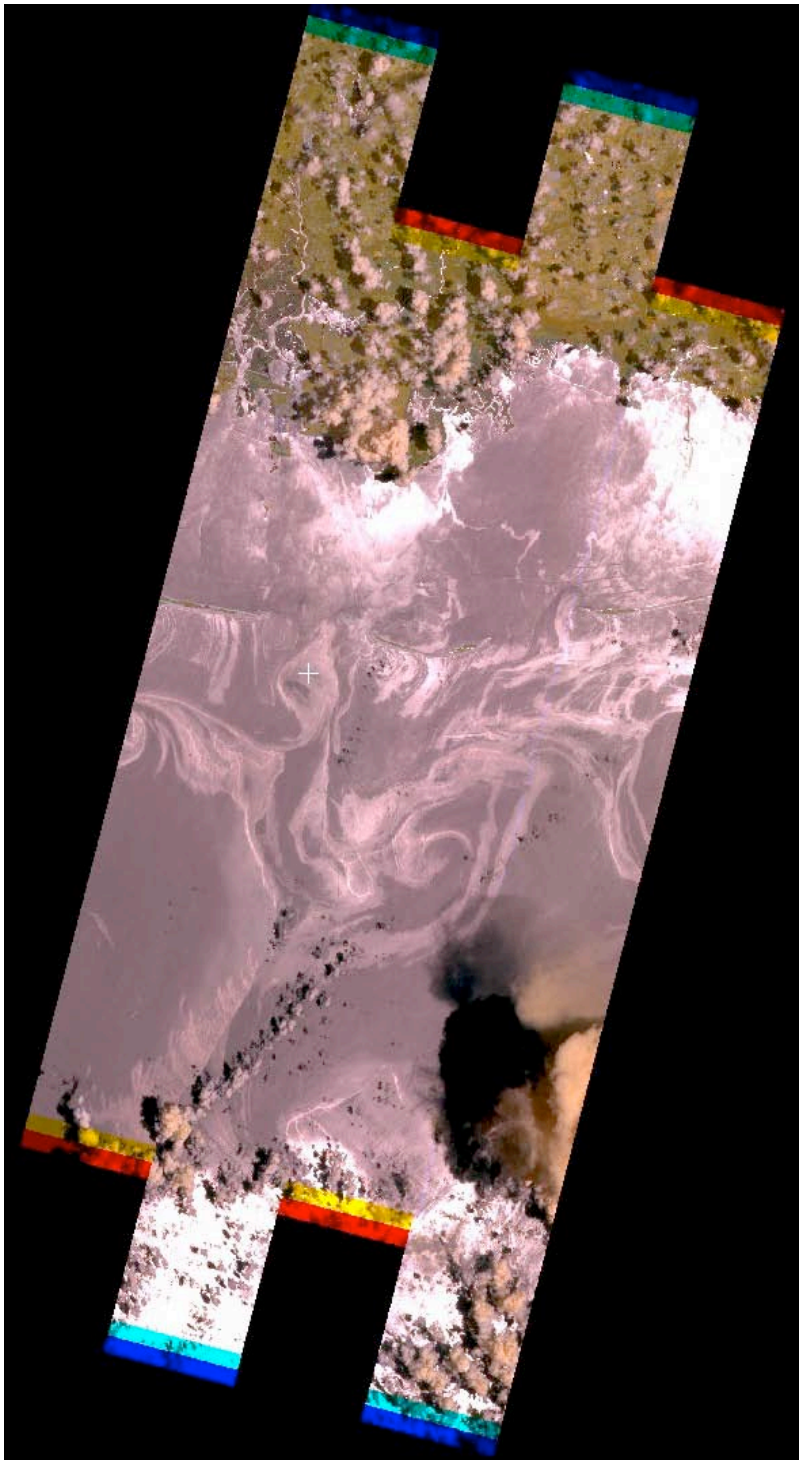


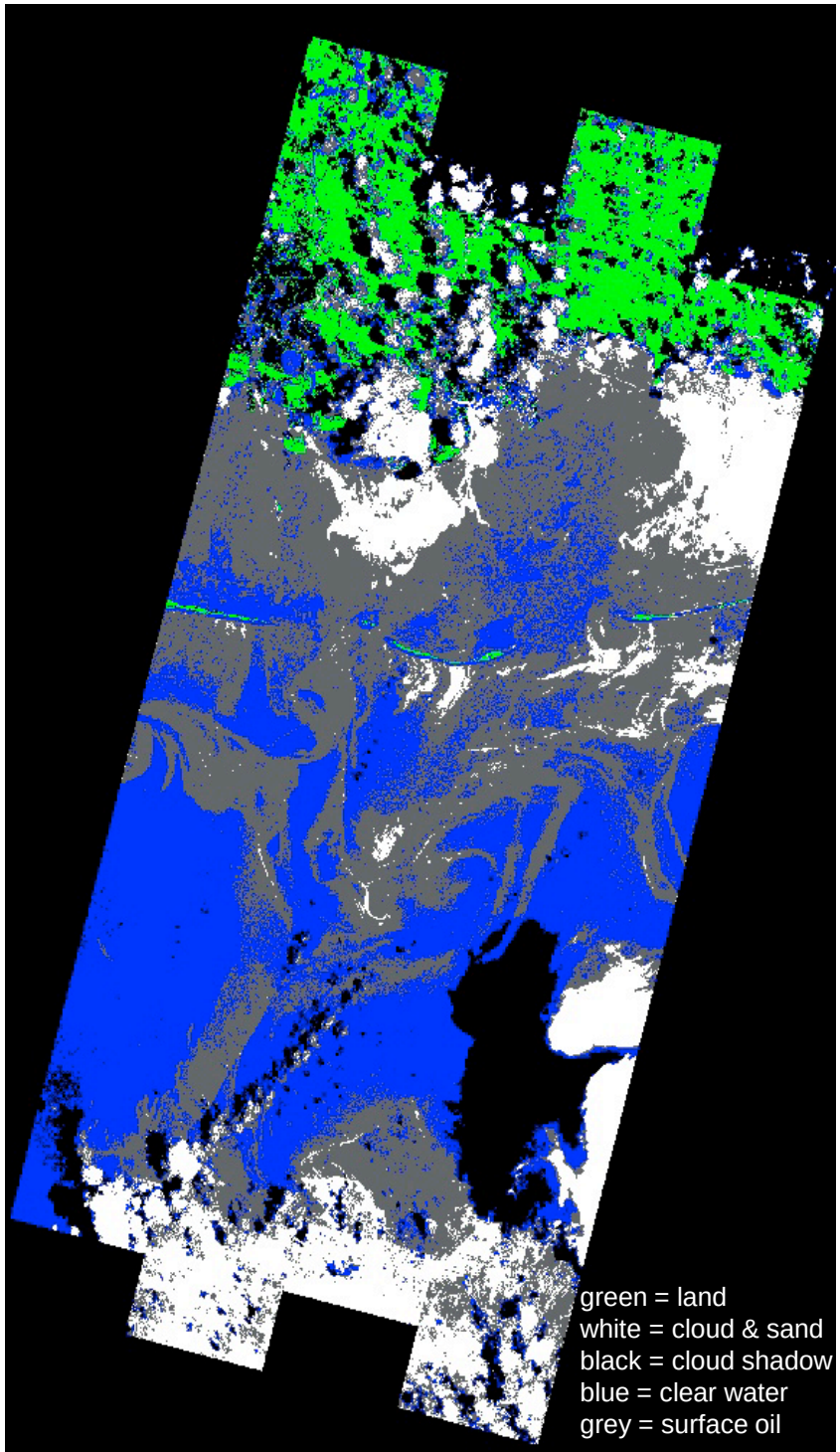
Custom Data Product
(KMZ, PNG…) (e.g. oil classifier)

Data Distribution
And Notification

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

Mobile Bay Oil Spill Detection Using EO-1 Advance Land Imager Data





Low Fidelity HyspIRI IPM Testbed

Data Generator Workstation

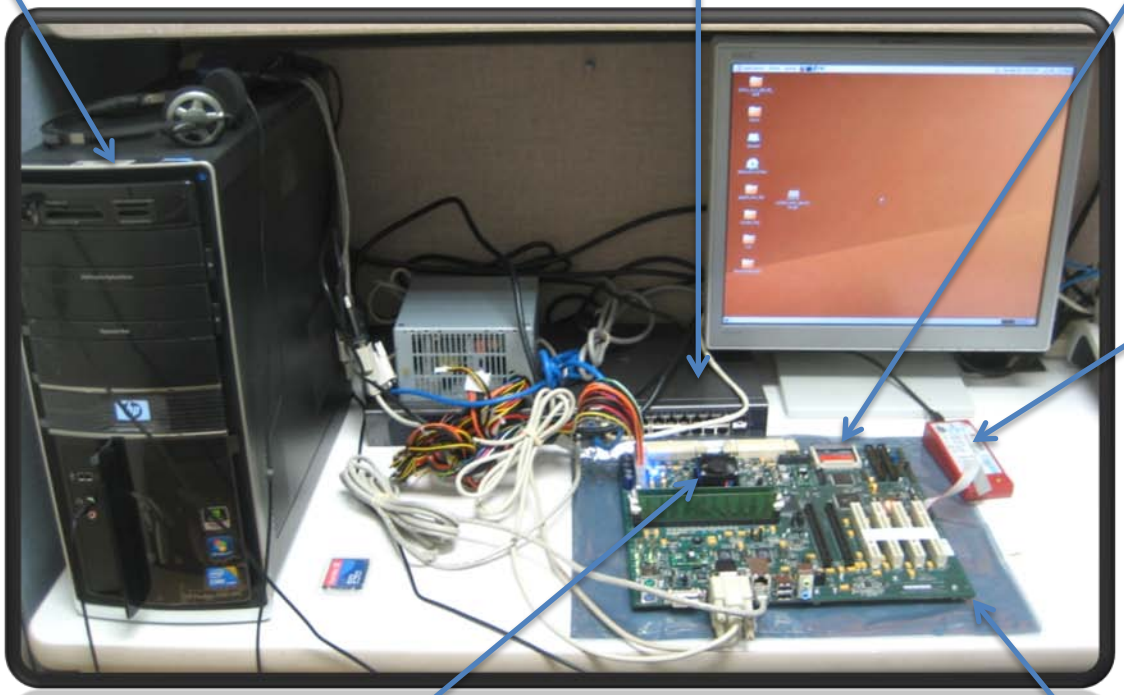
- Generates test data and streams it to the board at rate up to 800Mbps.

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

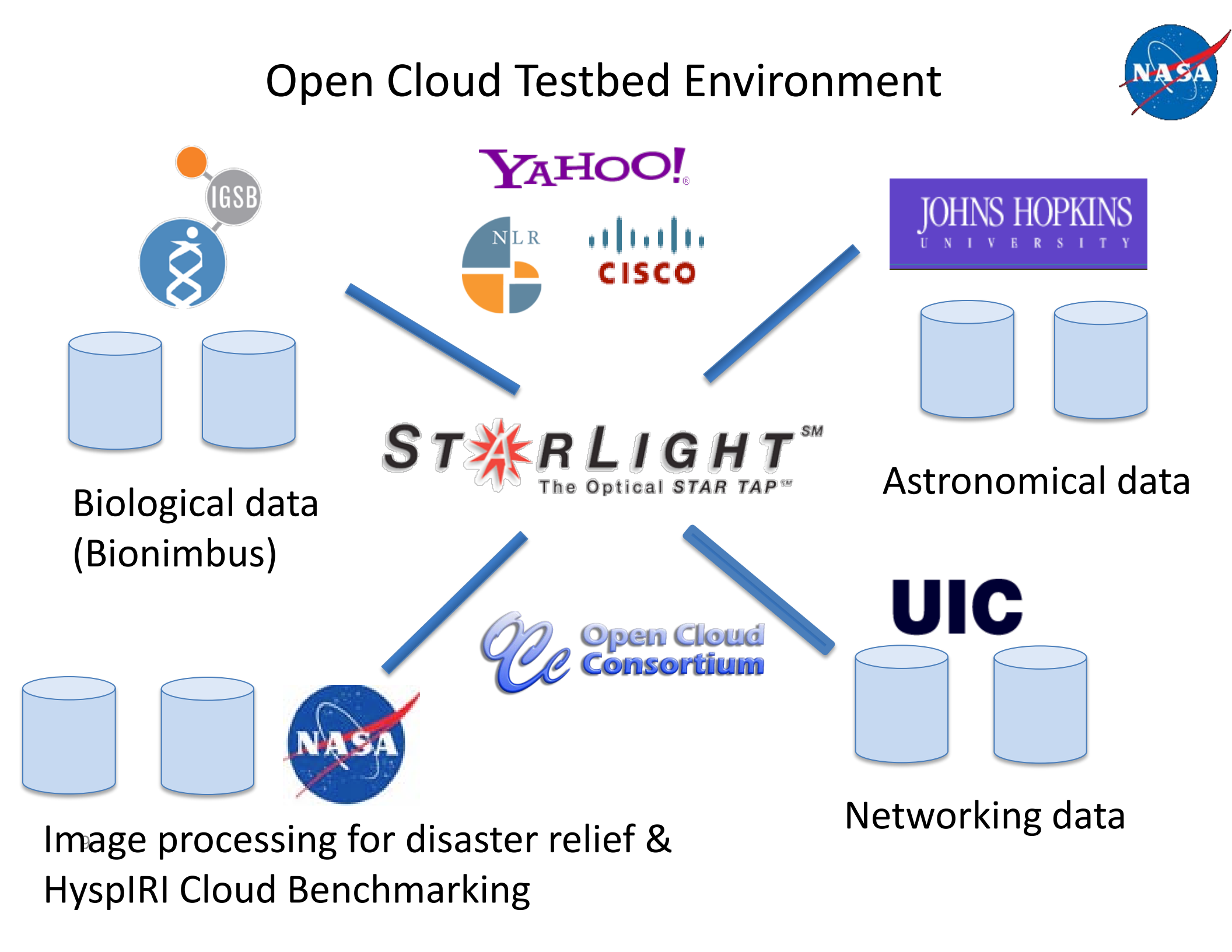
Xilinx ML510 Development Board

- Enables the development team to verify the Virtex-5 while the GSFC SpaceCube 2 is finalizing the design

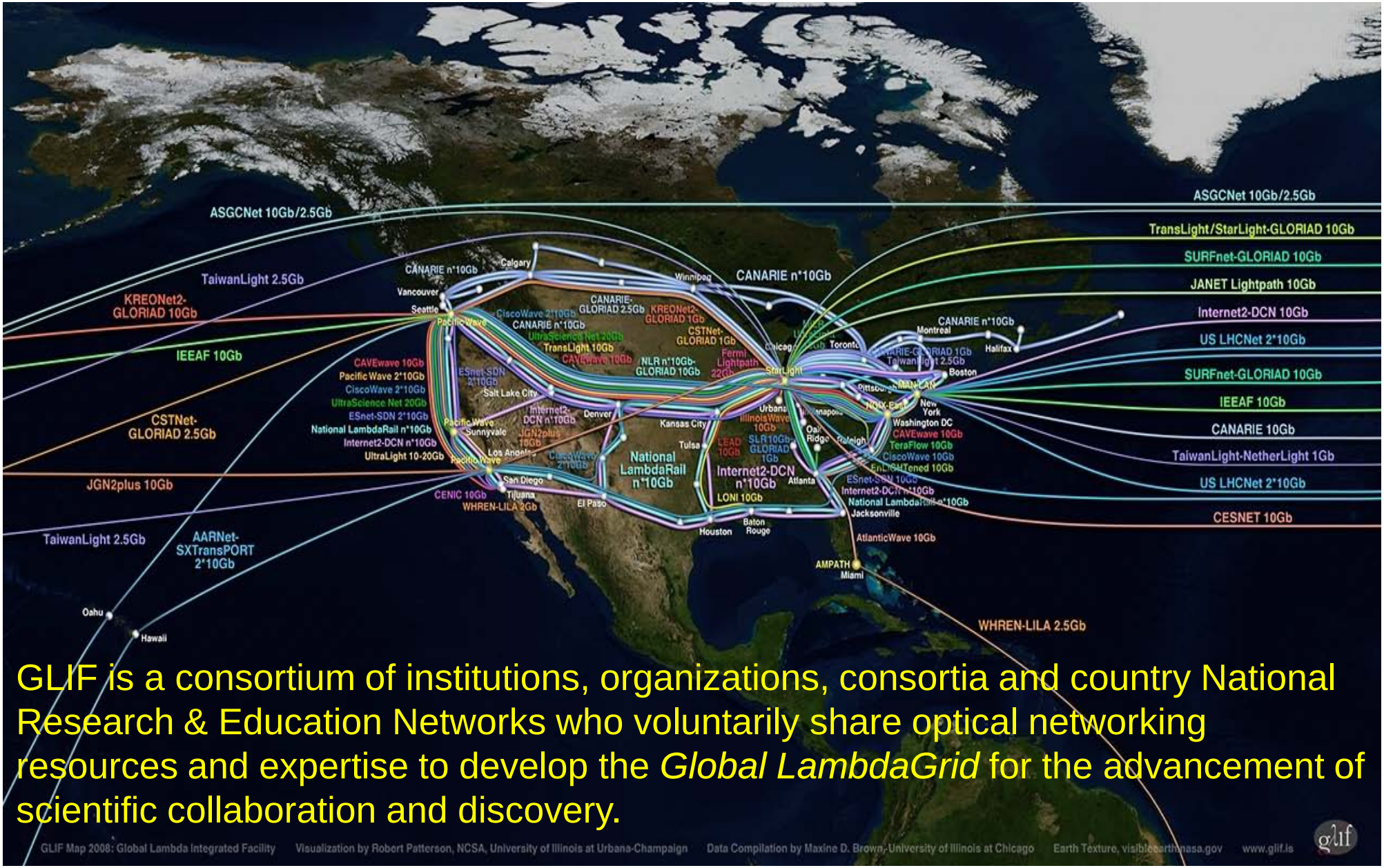
Compute Cloud Testbed

- 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 EO-1 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 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



Global Lambda Integrated Facility (GLIF)
OCC Collaboration with Starlight (part of GLIF)

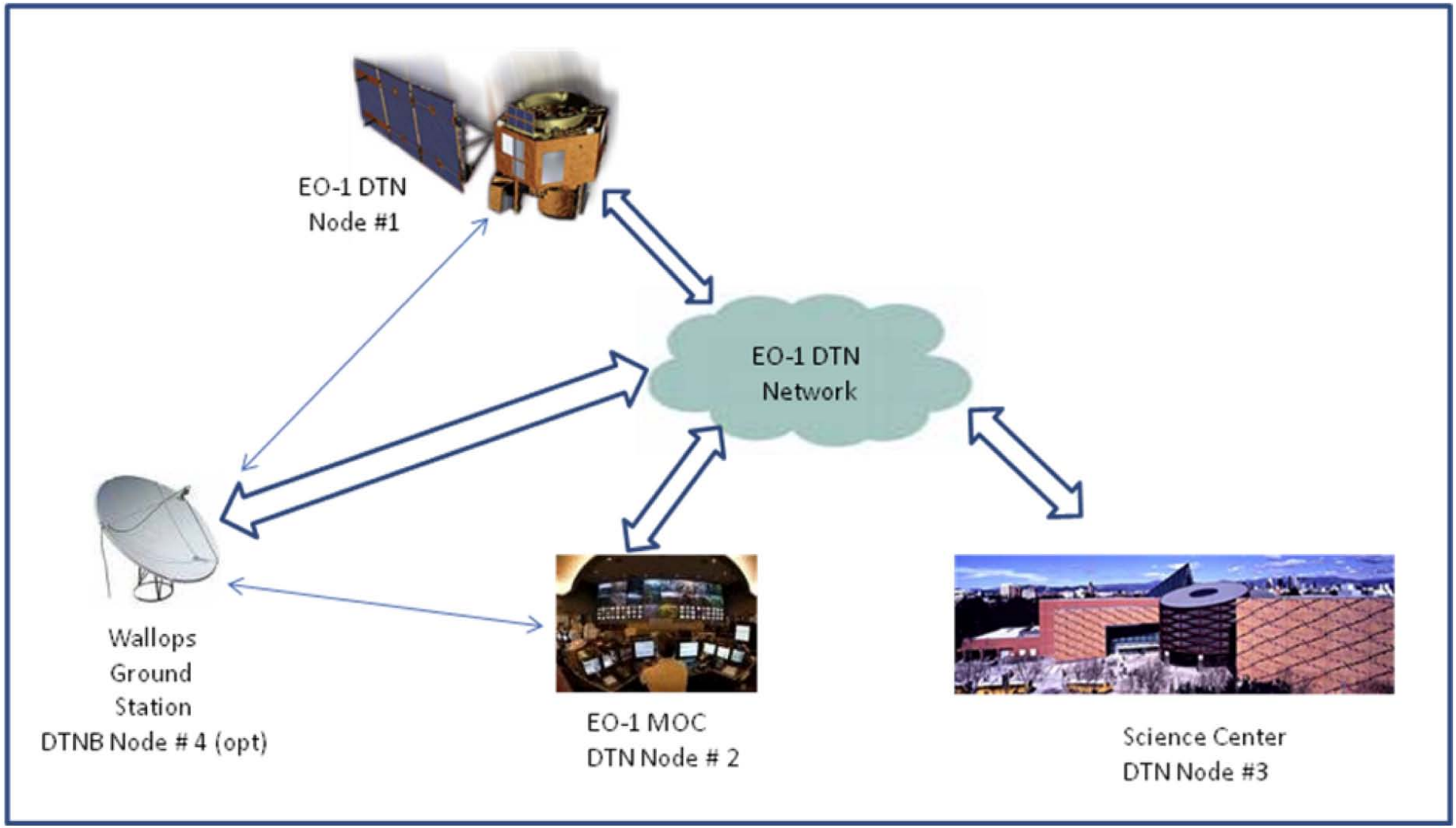


GLIF is a consortium of institutions, organizations, consortia and country National Research & Education Networks who voluntarily share optical networking resources and expertise to develop the *Global LambdaGrid* for the advancement of scientific collaboration and discovery.

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