Prototyping Science As A Service with **Intelligent Payload Module**

Daniel Mandl - NASA\GSFC

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Team

Daniel Mandl – NASA/GSFC - lead
Robert Sohlberg – Univ. of Maryland/Dept. of Geography – SensorWeb scientist
Pat Cappelaere – Vightel Corporation – SensorWeb architecture
Stuart Frye – NASA/GSFC – SGT Inc. – systems engineer
Vuong Ly – NASA/GSFC – system engineer, software developer
Matthew Handy – NASA/GSFC – software developer
Donald Sullivan – NASA/Ames – flight SW, ground SW for AMES based airborne flights
Geoff Bland – NASA/WFF – Cessna flights
Enric Pastor – Univ. of Cataluña, Barcelona, Spain – UAV Helicopter
Vince Ambrosia - NASA/Ames – AMS instrument, B200/B100 flights, Ikhana
Steve Crago – ISI – Univ. of Southern Cal/ISI – Maestro onboard computer arch
Steve Chien – NASA/JPL – onboard algorithms
Tawanda Jacobs – NASA/GSFC – flight SW
Tim Creech – Univ. of Maryland – NASA Science and Technology Research Fellow
Chris Flatley – NASA/GSFC summer intern
Neil Shaw – NASA/GSFC summer intern
Joshua Bronston – NASA/GSFC co-op

Objectives

- Develop methods to provide low latency users of HyspIRI with quick look data products
- Augment concept of Science As A Service by providing an interface for non-programmer users to define new algorithms and select data sets and data feeds to run the algorithms against
- Virtualize the interface to various environments with adapters that take into account the resources and methods to expose key data and data products
- Experiment with high performance multicore space computing architectures in order to meet the future significantly higher data rates.
- Develop increasingly realistic operational architectures that emulate the target satellite architecture for HyspIRI and other Decadal missions

Funding for IPM Effort

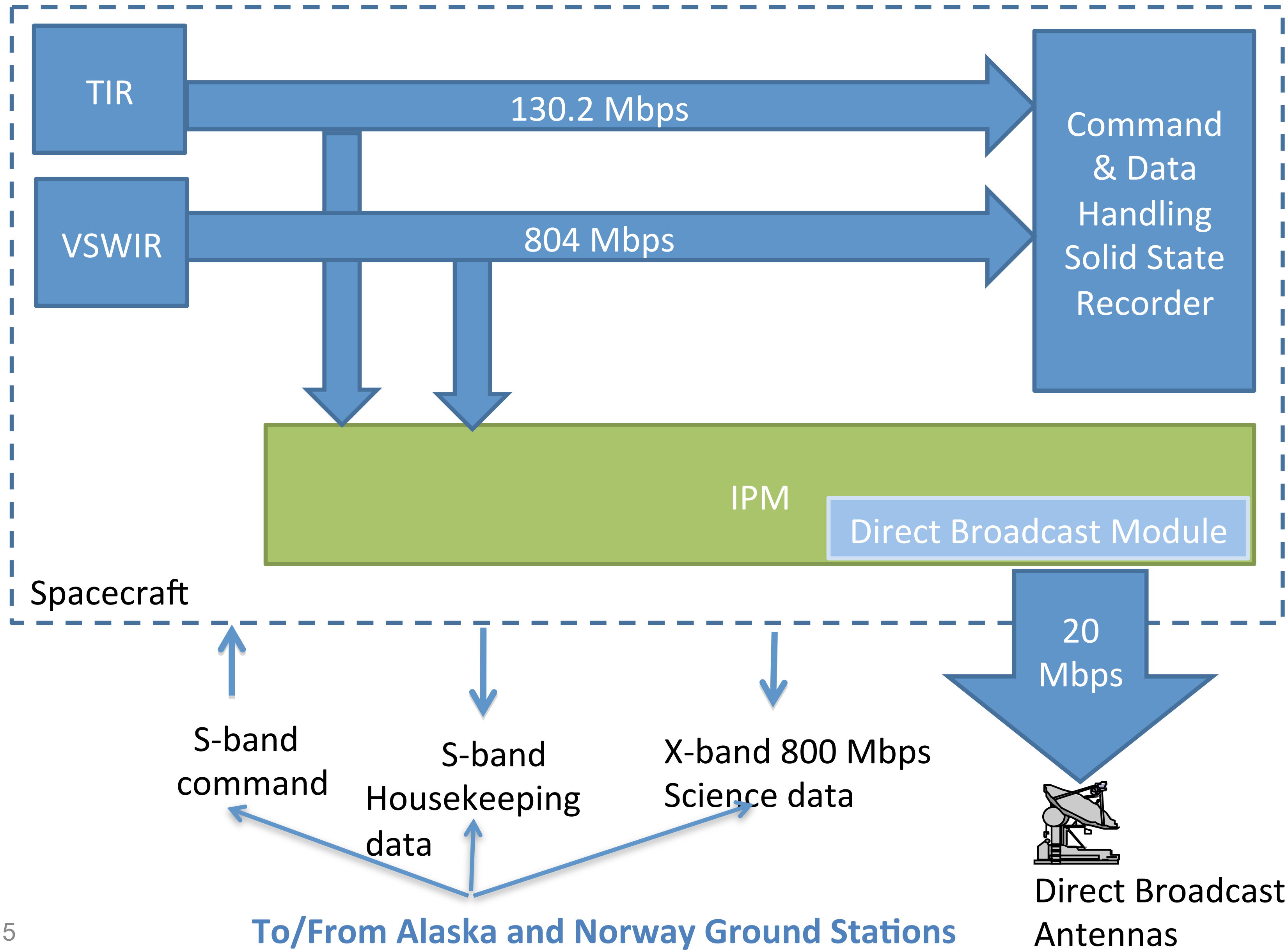
ESTO AIST-11 Award beginning May 2011

"A High Performance Onboard Multicore Intelligent Payload Module for Orbital and Suborbital Remote Sensing Missions"

GSFC IRAD FY 12:

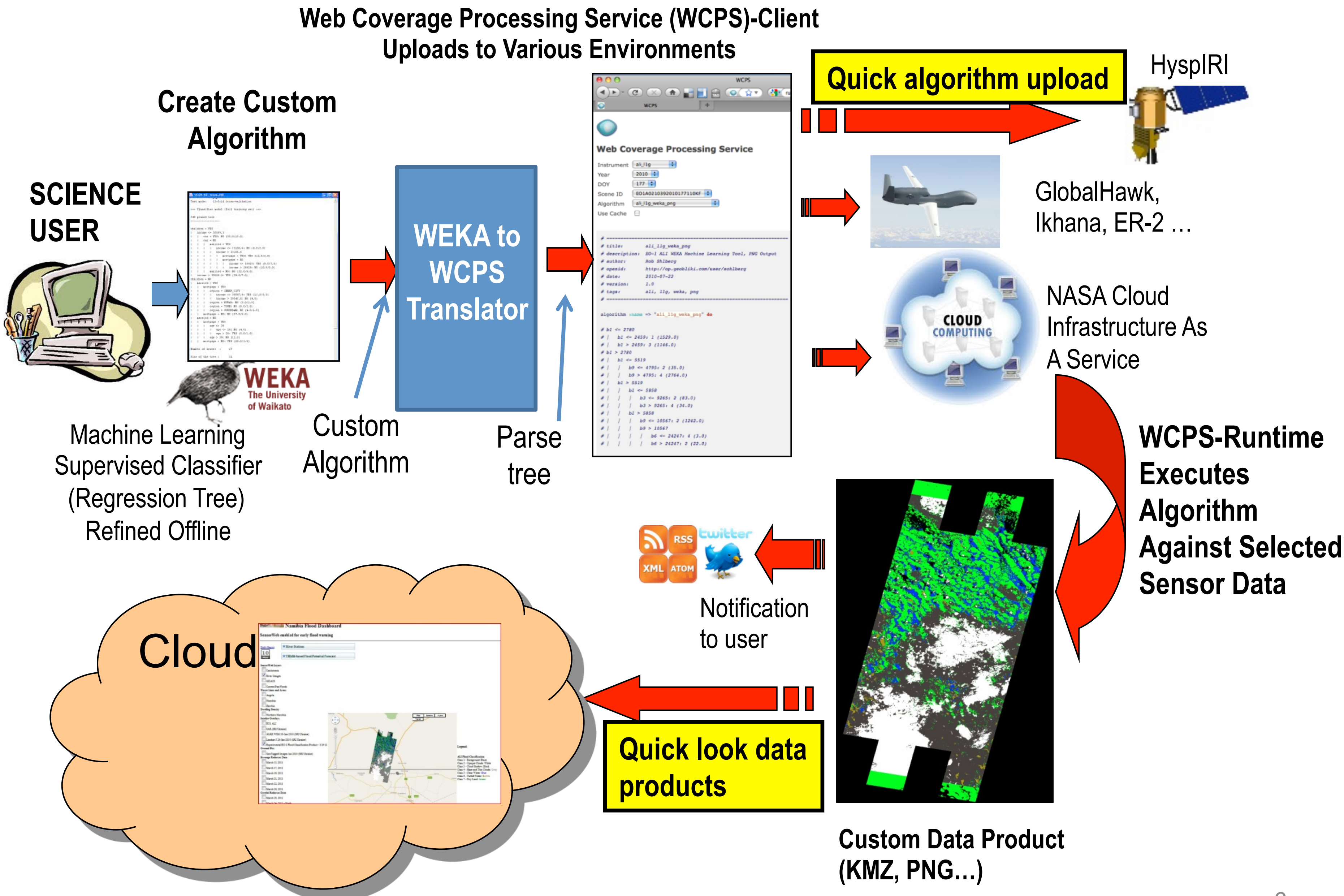
"Optimization of Onboard Processing Using the Maestro Multicore Processor for Decadal Missions" (Stepping stone to AIST award)

Original HyspIRI Low Latency Data Flow Operations Concept

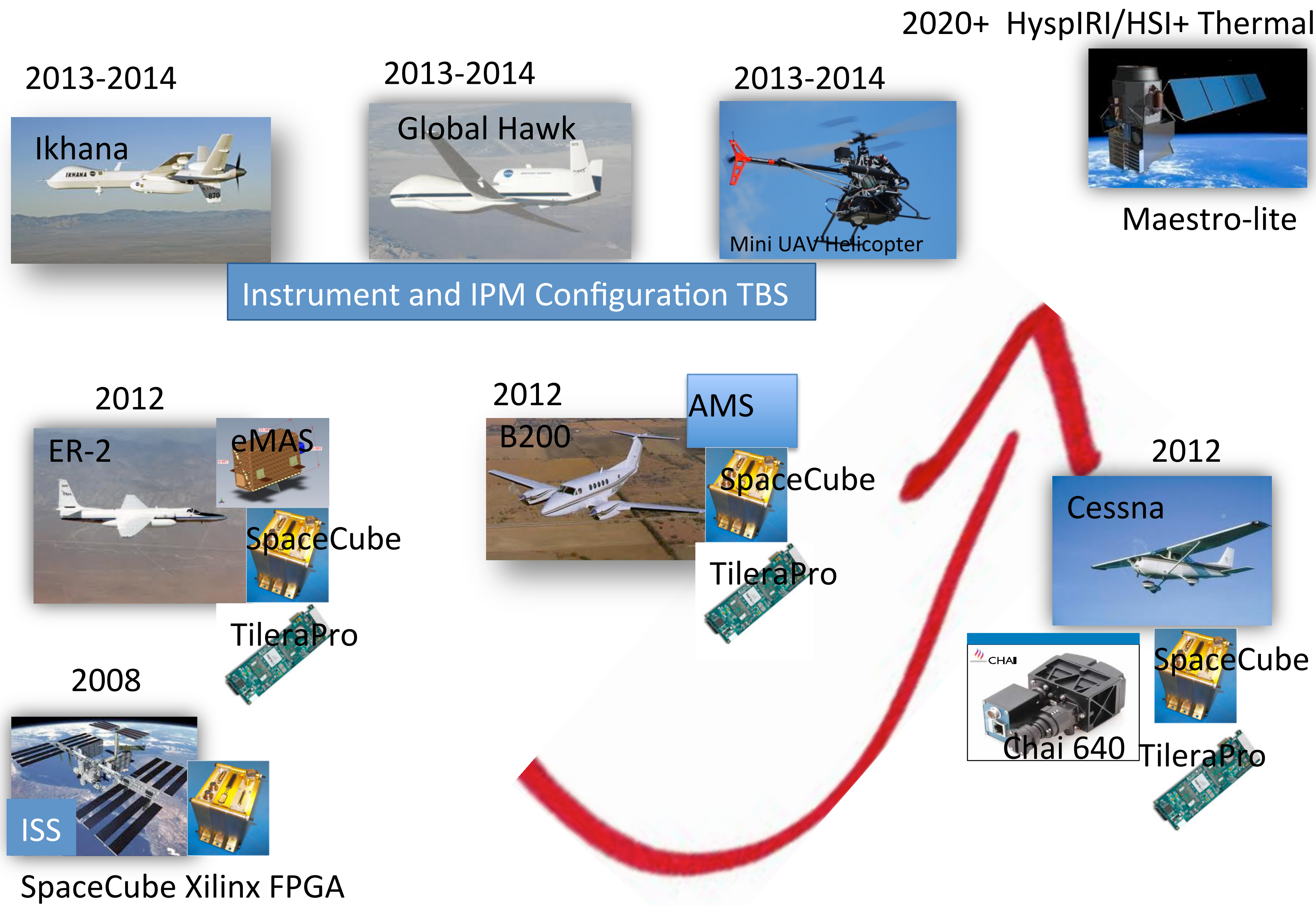


Experimental IPM Quick Load/Quick Look Ops Con

Enhanced Ops Con from Baseline IPM Ops Con

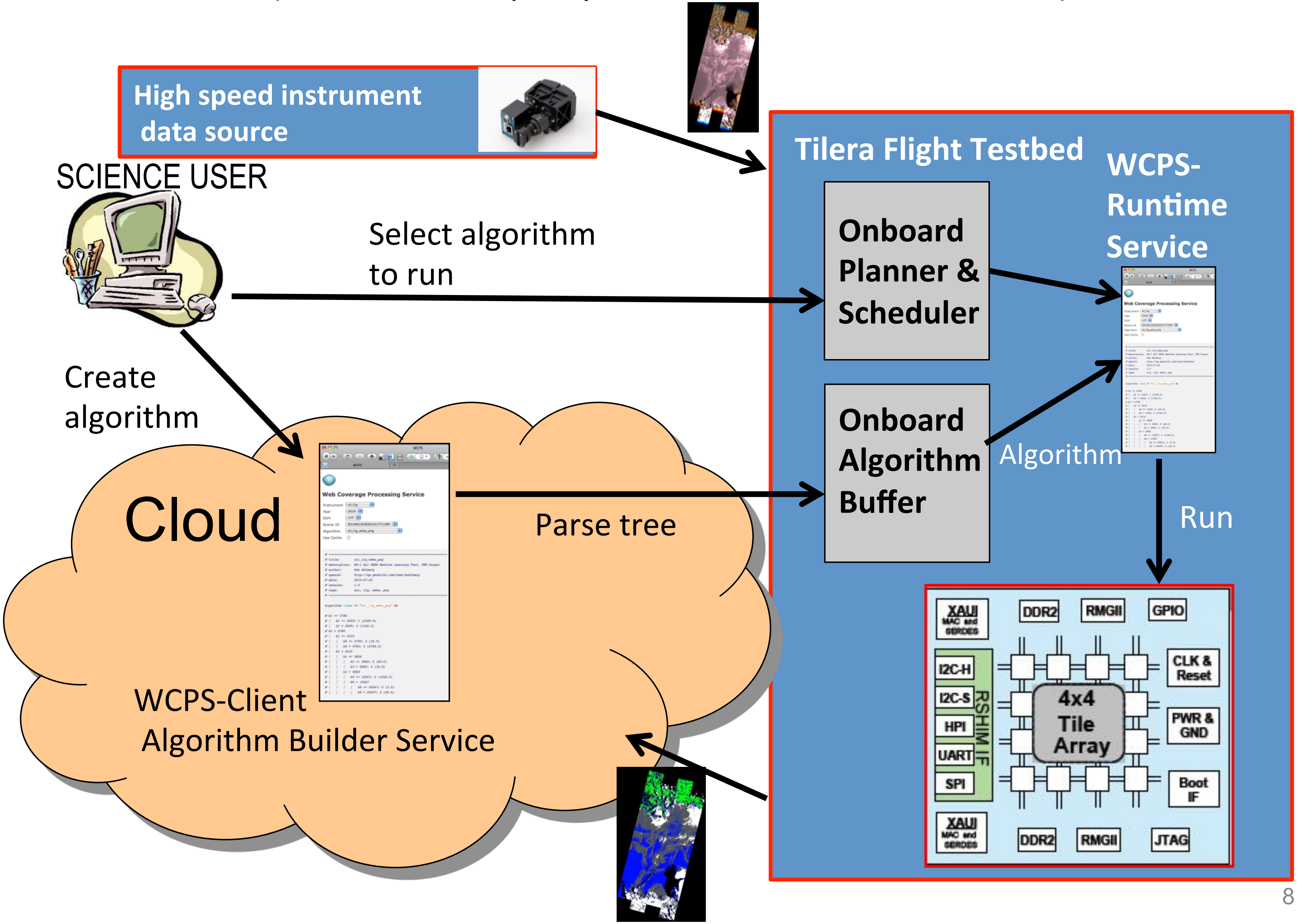


Roadmap for IPM Flight Opportunities



IPM Tilera Flight Testbed Ops Con

(Tilera board is proxy for Maestro and Maestro-lite)



Chai640 Specs

Compact Hyperspectral Advanced Imager UV-VNIR

CHAI V-640

Compact and economical; ideal for UAV and field use.

BRANDYWINE PHOTONICS

CHAI V-640 Instrument* (prototype shown)

The CHAI V-640 is the instrument of choice for applications requiring a compact, low-cost, and high-performance hyperspectral imager. The V-640 integrates the most up-to-date Science CMOS image sensors with a powerful Offner spectrometer to achieve excellent image quality with high sensitivity. The V-640 form factor is suitable for multi-unit arrangements, including side-by-side, fore- and aft- viewing angles, and varying polarizations.

APPLICATIONS

Earth Science, Aerial Survey, Machine Vision, Medical Imaging, Microscopy

ADVANTAGES

High Sensitivity, Lower Cost, Compact, Low Power

MECHANICALS	ESTIMATE
Minimum Size	127 x 101 x 51 mm
Weight	1 kg sensor head 2 kg controller
Power	40 watts
Temperature Range	-20 to +50 C

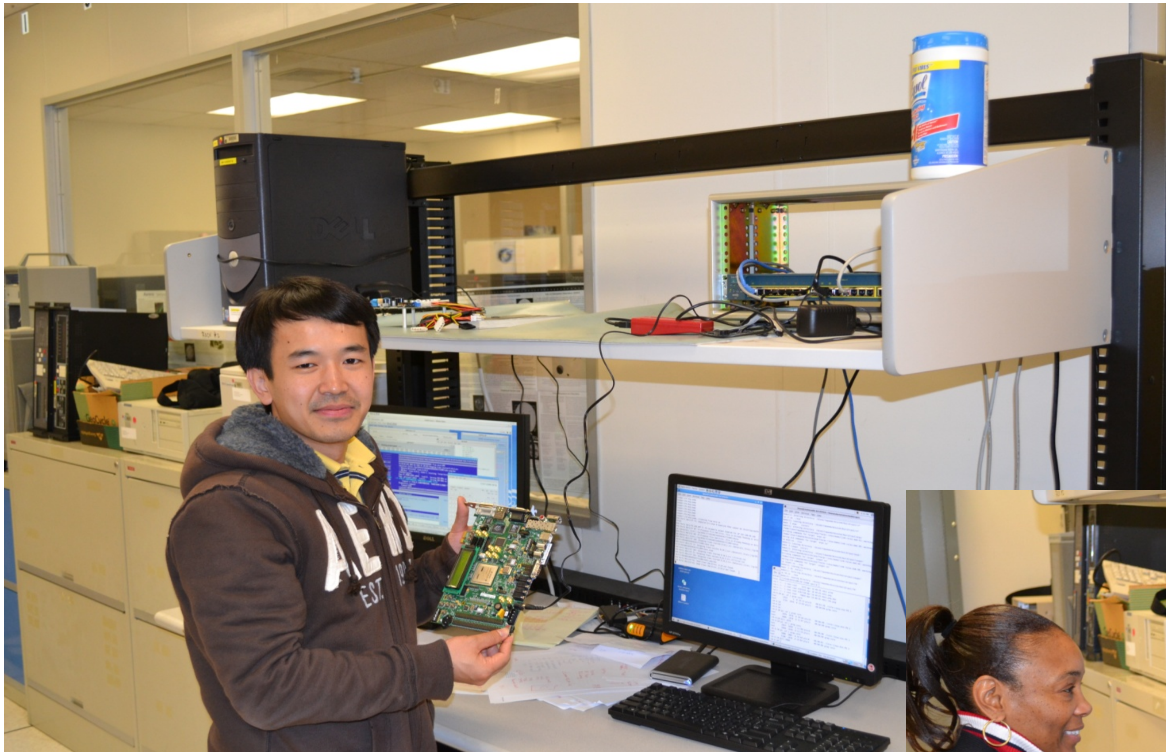
Size does not include laptop, processor or INS.

OPTICS	SPECIFICATION
Spectrometer Type	Offner
Field of View	40 degrees (other upon request)
Cross Track Pixels	640 (with BIN x3)
F-Number	f/2.8
Data Rate	78 Mbps
Spectral Range	380-1000 nm
Smile	<0.1 pixels
Keystone	<0.1 pixels
Stray Light	<1e-4 Point Source Transmission
Spectral Bands	256
Spectral Sampling	2.5, 5, 10 nm
Peak Grating Efficiency	88%
Slit Size	9.6 x .015 mm
IMAGE SENSOR	
Image Sensor	1920 x 1080, 6.5 μm pixels
Well Depth	30,000 electrons
Read Noise	2 electrons
Maximum Frame Rate	60 frames/second
Quantum Efficiency	22% at 400 nm Peak 57% at 600 nm 15% at 900 nm
Camera Interface	CameraLink
Data Acquisition	500 MB Solid State Recorder Serial Interface for GPS/INS
CHAI SOFTWARE	
Trigger Modes	Pilot, GUI, electronic, and Lat/Long triggered acquisition
Visualization	3-band RGB waterfall display of real-time and recorded data
Metadata	Temperature, pressure, and humidity
Data Format	RAW, ENVI BIL, or Processed
Processing	EXPRESSO™

** Final product may differ from image shown.*

Contact John Fisher | jfisher@brandywinephotonics.com | +1 (484) 459-9589 | www.brandywinephotonics.com

IPM Testbed with Tilera Acting as Proxy for Maestro & Maestro-lite Board (building 23)



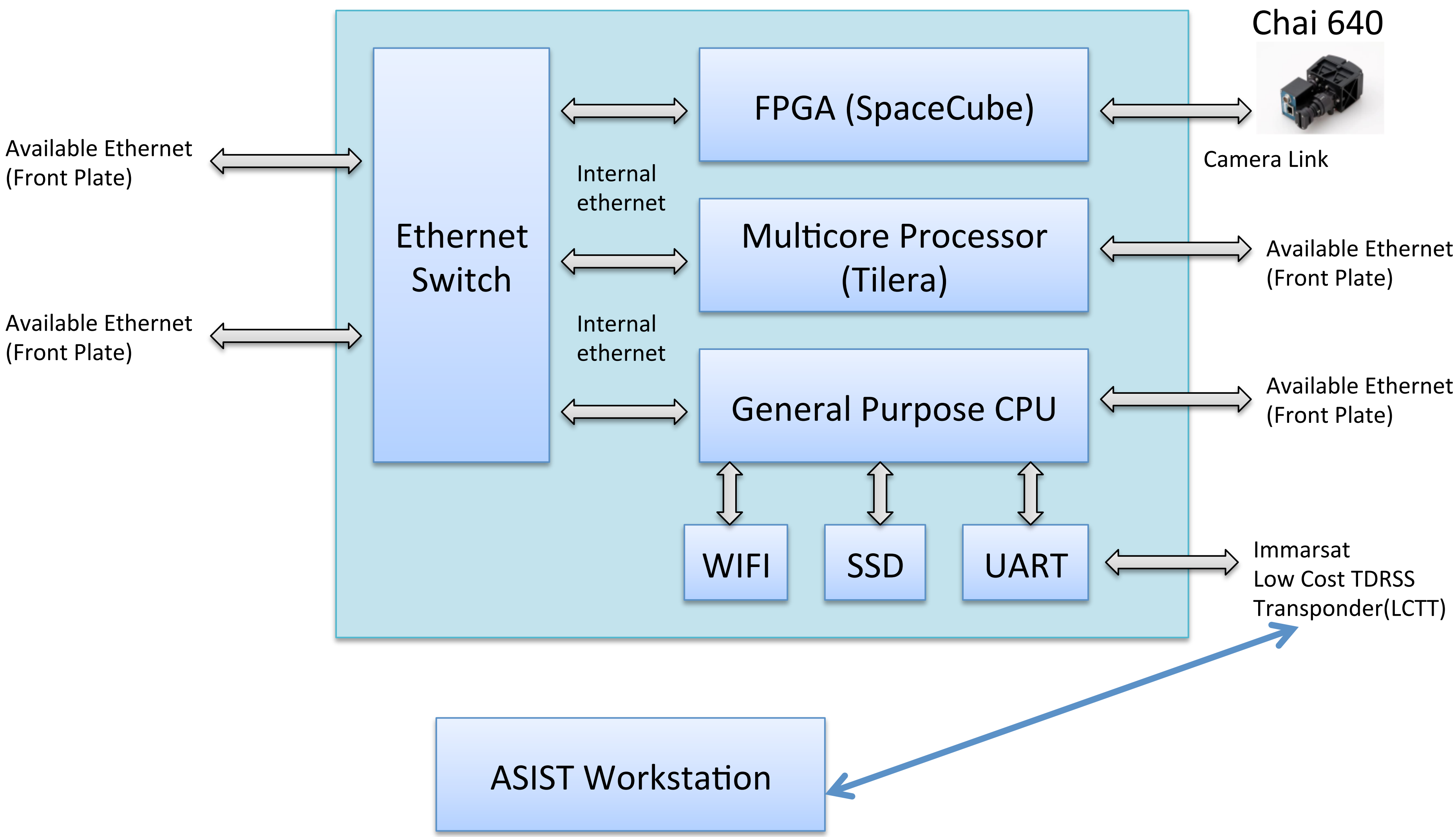
Above: Vuong Ly/583 (Ground System SW Branch) standing in front of IPM testbed holding a SpaceCube board.
Right: Tawanda Jacobs/582 (Flight SW Branch) working on integration of cFE onto IPM testbed.

First Flight Opportunity Summer 2012

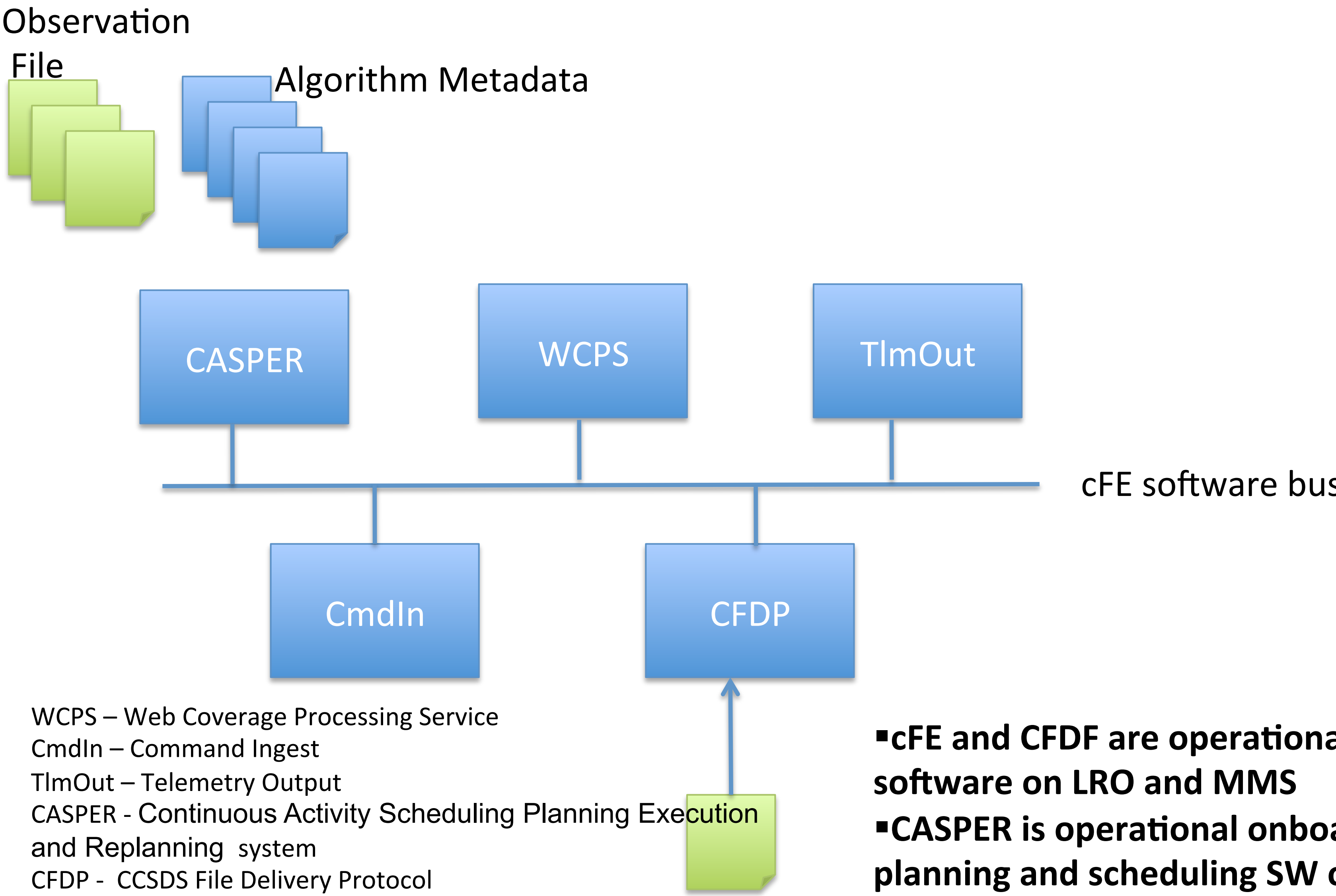
- Use Skycomp helicopter originating out Clarksville Maryland
- Land at GSFC
- Mount IPM
- Test on ground
- Test at various altitudes

Hayesfield Airstrip in Clarksville, Md.

Target Hybrid Architecture



Preliminary Flight Architecture



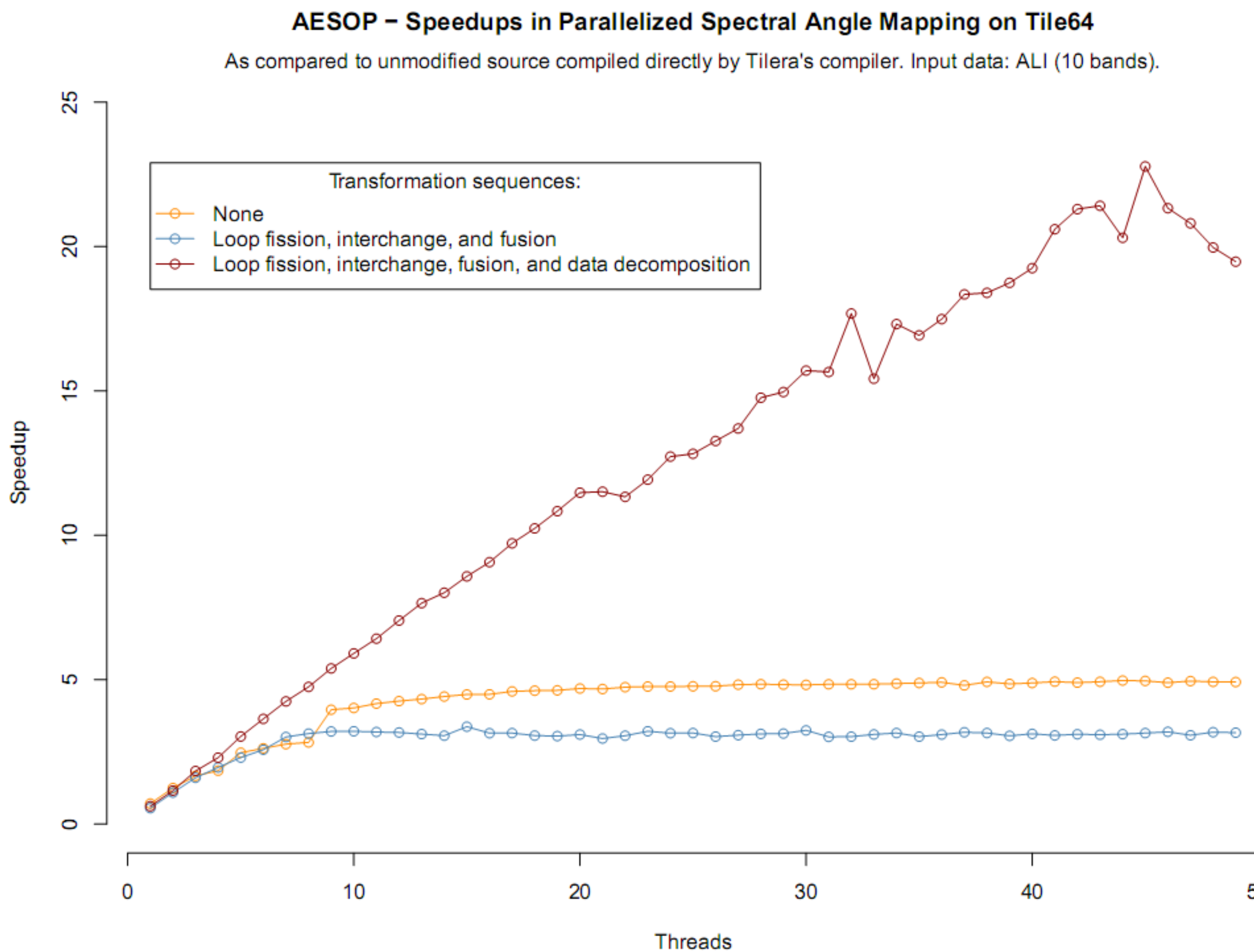
WCPS – Web Coverage Processing Service
CmdIn – Command Ingest
TlmOut – Telemetry Output
CASPER - Continuous Activity Scheduling Planning Execution and Replanning system
CFDP - CCSDS File Delivery Protocol
cFE- Core Flight Executive

- **cFE and CFDF are operational flight software on LRO and MMS**
- **CASPER is operational onboard planning and scheduling SW on EO-1**
- **WCPS is presently TRL 6**

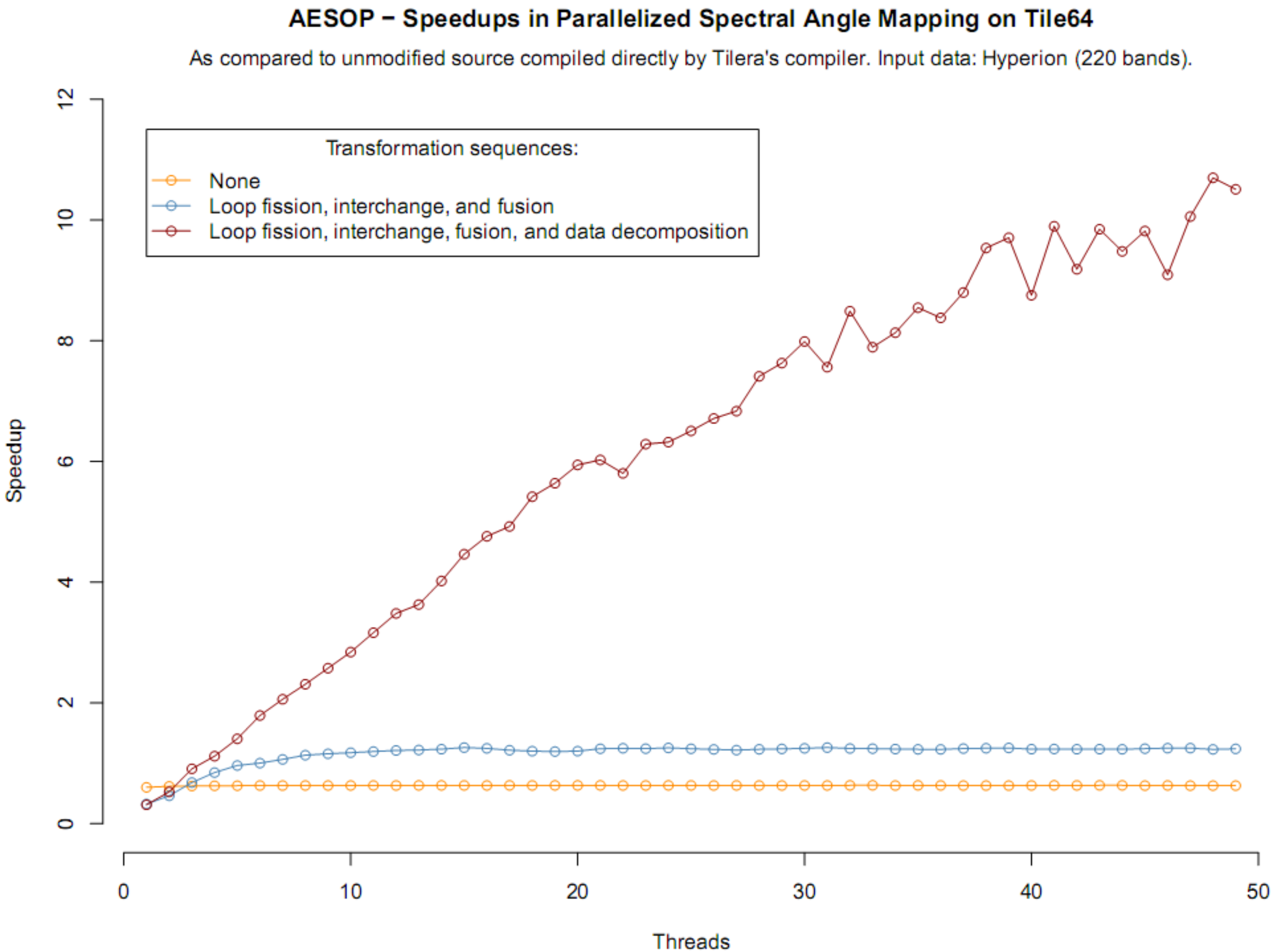
Benchmarks for Use of Parallelization

- Tim Creech, Univ. of Maryland, Phd student
  - NASA Science and Technology Research Fellowship (NSTRF) 3 year grant awardee
- Investigating methods to automatically transform algorithms into parallel processes that can be applied to multicore architectures
  - AESOP is software research area
  - Used algorithms running against EO-1 ALI data on Tilera testbed
- Working towards integrating automatic parallelization into WCPS

AESOP Parallelization Test Results (1 of 2)



AESOP Parallelization Test Results (2 of 2)



Conclusion

- Develop methods to provide low latency users of HyspIRI with quick look data products
  - Showed efforts with Maestro/Tilera, SpaceCube, WCPS
- Augment concept of Science As A Service by providing infrastructure, interfaces and services for non-programmer users to define new algorithms and select data sets and data feeds to run the algorithms against selected data
  - Showed WCPS client to build algorithms in realtime and WCPS runtime to use as adapters in various environments to enable algorithms to run against selected data
- Virtualize the interface to various environments with adapters that take into account the resources and methods to expose key data and data products
  - \- Showed WCPS runtime
- Experiment with high performance multicore space computing architectures in order to meet the future significantly higher data rates.
  - \- Showed a little of benchmarking to see how much performance can be enhanced with a multicore space computing architecture while designing in low power