NASA SLI-Technology Studies

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Background

• 2014: NASA/USGS Architecture Study Team (AST) examined options for long-term mission architectures
  • Based on LST feedback, emphasized opportunities for smaller observatories
    • Smaller platform => lower cost => higher launch cadence & constellation formation => more frequent imaging
    • Enables SLI launch as secondary payload (cost reduction)
  • Other options included
    • Migration of SLI to hyperspectral capability
    • Reliance on international systems (e.g. Sentinel-2) for reflective multispectral continuity

• 2014-15: Reduced Instrument Envelope Size (RIES) Studies
  • Funded six companies to pursue small instrument concepts that could meet Landsat-8 requirements (+ 60m TIR)

• 2016: NASA Earth Science Technology Office (ESTO) ROSES Solicitation
SLI Reduced Envelope Study

- SLI funded six contracts to study options for reducing VSWIR/TIR instrument size
  - Goal of 50x50x50cm volume, 50W, 50kg, with L8 specs (and 60m TIR)
  - Contractors asked to explore design concepts, identify driving requirements, consider technologies that are likely to be available in the Landsat 10 era
  - Disaggregation of TIR and VSWIR could be considered

- Awards made to:
  - Ball Aerospace & Technologies Corporation of Boulder, CO
  - Exelis Inc., Geospatial Systems of Fort Wayne, IN
  - Lockheed Martin Space Systems Company of Greenbelt, MD
  - Northrop Grumman Systems Corporation, Aerospace Systems of Redondo Beach, CA
  - Raytheon Company of El Segundo, CA
  - Surrey Satellite Technology US LLC of Englewood, CO

- 6-month studies complete March 2015 (with subsequent follow-on studies)
General REIS Findings

• The 50/50/50 target was not realistic, but many designs approached the volumetric goal (<1m$^3$ designs are feasible).
  – Both single- and multiple-instrument approaches
  – Small, fast optics
  – Smaller pitch detectors
  – Variety of scanning modes possible (pushbroom, push-whisk, step-stare...)
    • 15° Field of view requirement limits telescope choices for a pushbroom; Whiskbroom scanners could use smaller FOV telescope designs
  – Compact fast telescope designs may be susceptible to stray light, and increased AOI variation on focal plane

• Edge Slope Response (~Point Spread Function) at longest wavelength (2.2 or 12 μm) drives aperture requirements and overall instrument size
  – Techniques exist to reduce the diffraction dictated apertures at the expense of data rate, SNR, and edge response ring.
    • FPA Oversampling
    • Detector geometries
    • MTF compensation in re-sampling algorithms (aka sharpening filters)

• Onboard calibration does not generally drive instrument size
ESTO ROSES 2015 Solicitation

• Proposals to advance SLI goals through technology development

• Two types of proposals solicited
  – Advanced Technology Demonstrations
    • Instrument prototypes and demonstrations
    • 3-4 awards with up to $4.8M program budget (year 1)
    • 1-5 year awards
  – Technology Investments
    • Component or breadboard demonstrations of new technologies that could be infused in future land imaging instruments
    • 3-4 awards with up to $1.2M program budget (year 1)

• Reference Mission Architecture (based on Landsat-8) provided in solicitation

• Selections pending (likely August 2016)
General Technology Concepts

• Compact multispectral instruments
  – Pushbroom, Push-whisk, Step-stare
  – Wide FOV for better than 16-day coverage (e.g. ACMS)

• Hyperspectral systems
  – Grating (Ofner, Dyson)
  – Prism

• Near-term Components
  – Tactical cryocoolers
  – New detectors & arrays
  – Alternative calibration sources

• Advanced imaging technology
  – Optical interferometry
  – Waveguide optical systems
SLI-T Strategy FY16/17/21

FY15 Studies

ROSES 1 (FY16)
- System (Vis/SWIR/TIR)
  - 20% Subsystem
  - 80% Subsystem
  - ($10-$15M) 2-4 Engineering Models
  - EVI, EVM, EVS
  - L9 (2020)

ROSES 2 (FY17)
- Subsystem

ROSES 3 (FY21)
- System (Vis/SWIR/TIR)
  - 20% Subsystem
  - 80% Subsystem
  - ($15-$20M)
  - L10 (2027)

Other:
- L9 (2020)
- L10 (2027)
- L11 (2034)

for Landsat (next +1)
for Landsat (next +2)
Architecture Considerations

• Curtis: Have the technology studies to date eliminated any potential architecture or measurement concept for L10?
  – Not really. Very small cubesats (<=6U) probably not feasible, but other smallsat concepts are possible
  – Compact VSWIR and TIR imagers can be built that satisfy L8/L9 requirements
  – Compact hyperspectral imagers appear feasible with a few caveats
    • Stray light from grating systems difficult to predict
    • 10nm wavelengths may not “phase” with L8 30nm bandpasses
    • Required hyperspectral SNR may require aggregation to ~60m for compact system

• Key issues for future SLI mission architecture
  – What VSWIR enhancements are desired or required? What are their benefits relative to the existing capability? Can these be prioritized so that trades can be performed?
  – What is the appropriate role for Sentinel-2 in improving temporal frequency?
  – What frequency and resolution is required/desired for TIR observations?
  – Is there a community need/desire for hyperspectral data?