APICS2018

Supply Chain Research and Analysis for Space Systems

Jonathan Root
Safety and Mission Assurance Directorate
NASA Goddard Space Flight Center

Presentation Topics

- Goddard Space Flight Center's Mission Portfolio
- Strategic Challenge / Supply Chain Risks
- Purpose / Key Attributes
- Analytical Framework
- Core Process / Report Types
- Products of Interest
- Case Examples
- Bringing It All Together
- Summary / Discussion

Goddard Space Flight Center

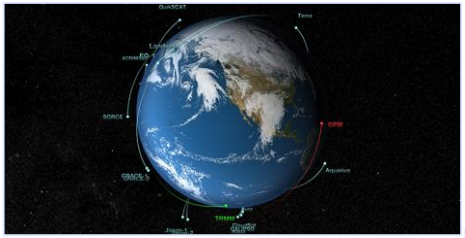
NASA's first space center

Goddard Space Flight Center

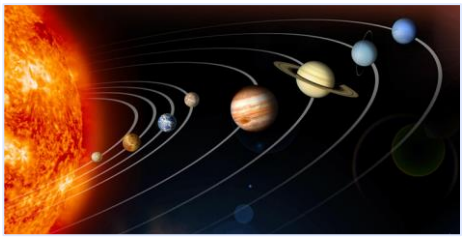
Lines of Business

Astrophysics

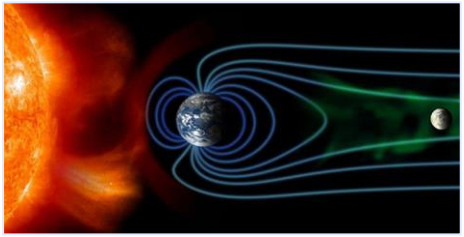
Earth Science



Planetary & Lunar Science

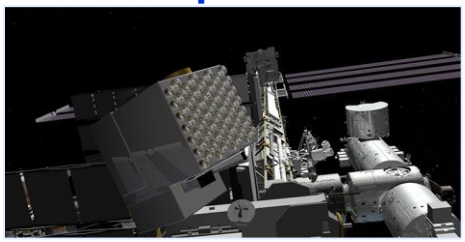


Heliophysics



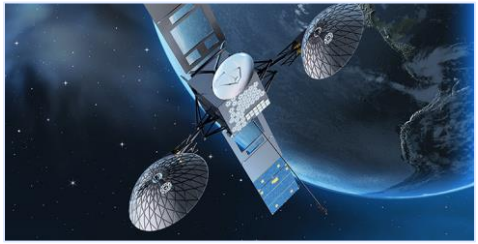
Human Exploration & Operations

Cross Cutting Technology And Capabilities



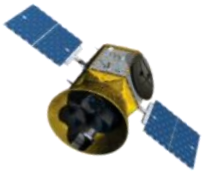
Suborbital Platforms

Communications & Navigation



Goddard Space Flight Center

Selected 2018 Highlights



TESS

Search for planets outside of our solar system while monitoring the brightness of more than 200,000 stars

Parker Solar Probe

Repeatedly sample the near-Sun environment

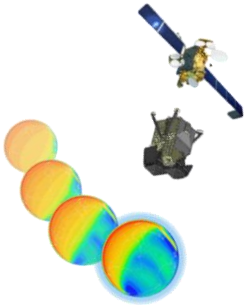
OSIRIS-REx

Rendezvous with the asteroid Bennu in 2018 and return a sample to Earth in 2023

2018

GOES-S

Significantly improve the detection and observation of Earth's environmental phenomena



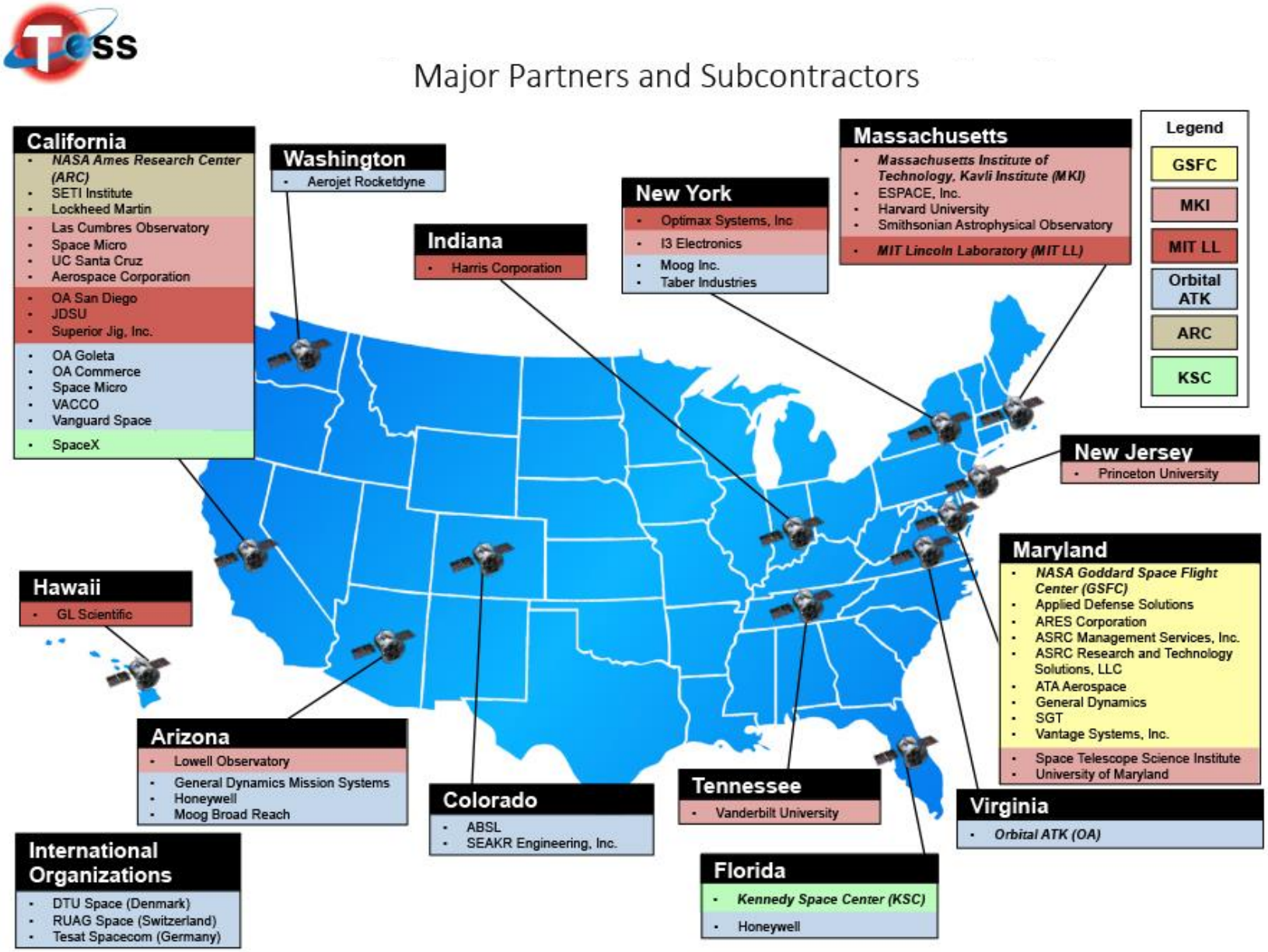
GOLD

Investigate the dynamic intermingling of space and Earth's uppermost atmosphere

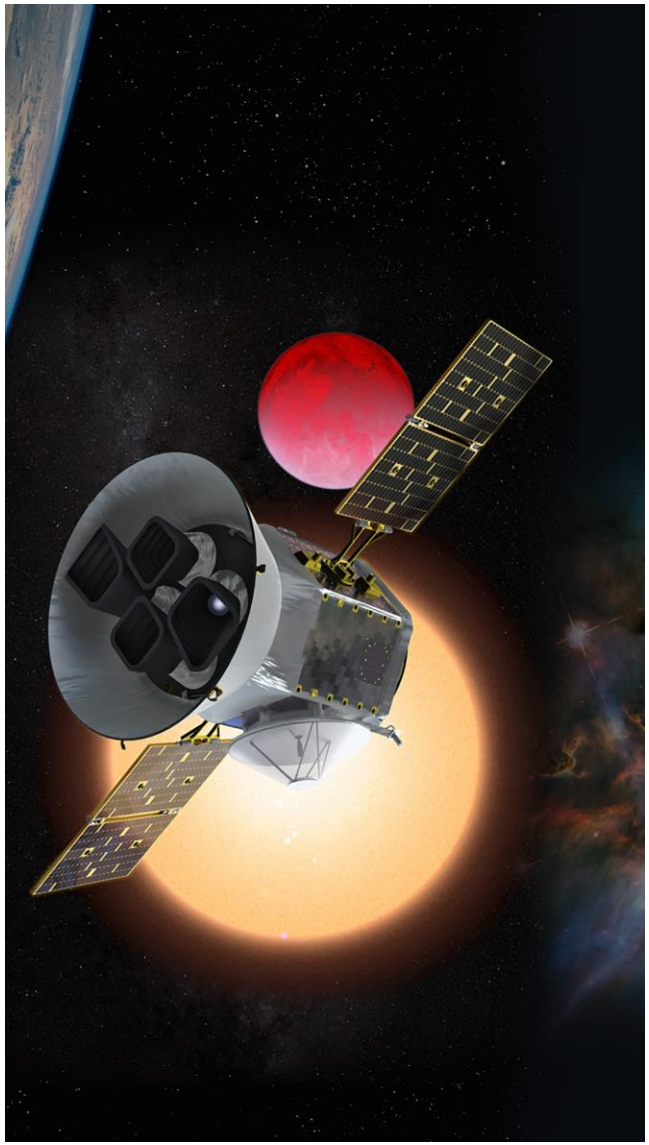
ICESat-2

Measure the elevation of Earth's ice sheets, glaciers, sea ice and global vegetation biomass

Transiting Exoplanet Survey Satellite (*TESS*)



Transiting Exoplanet Survey Satellite (*TESS*)



- Launched April 18, 2018
- Medium-Class Explorer … not to exceed $180 - $200 million total cost to NASA (not including launch and related costs of ~$87 million)
- 286 configuration items (products / services) tracked within the project's work breakdown structure
- 61 suppliers located in six countries identified
- GSFC performed project management, including systems engineering and safety & mission assurance

Project Configuration

Notional / Simplified

Project Management Function

- Level 1 / Science Observatory
- Level 2
  - ***Spacecraft Bus***
  - Science Payload / Instruments
- Level 3
  - ***Spacecraft Bus subsystems***
    - ***Propulsion***
    - Attitude Control
    - Structure
    - Thermal Management
    - Electrical Power
    - Electrical
    - Command & Data Handling
    - Communication
- Level 4
  - ***Propulsion components*** (e.g., propellant tanks, valves, thrusters)
- Levels 5 to 7 …. Assemblies, Parts and Materials

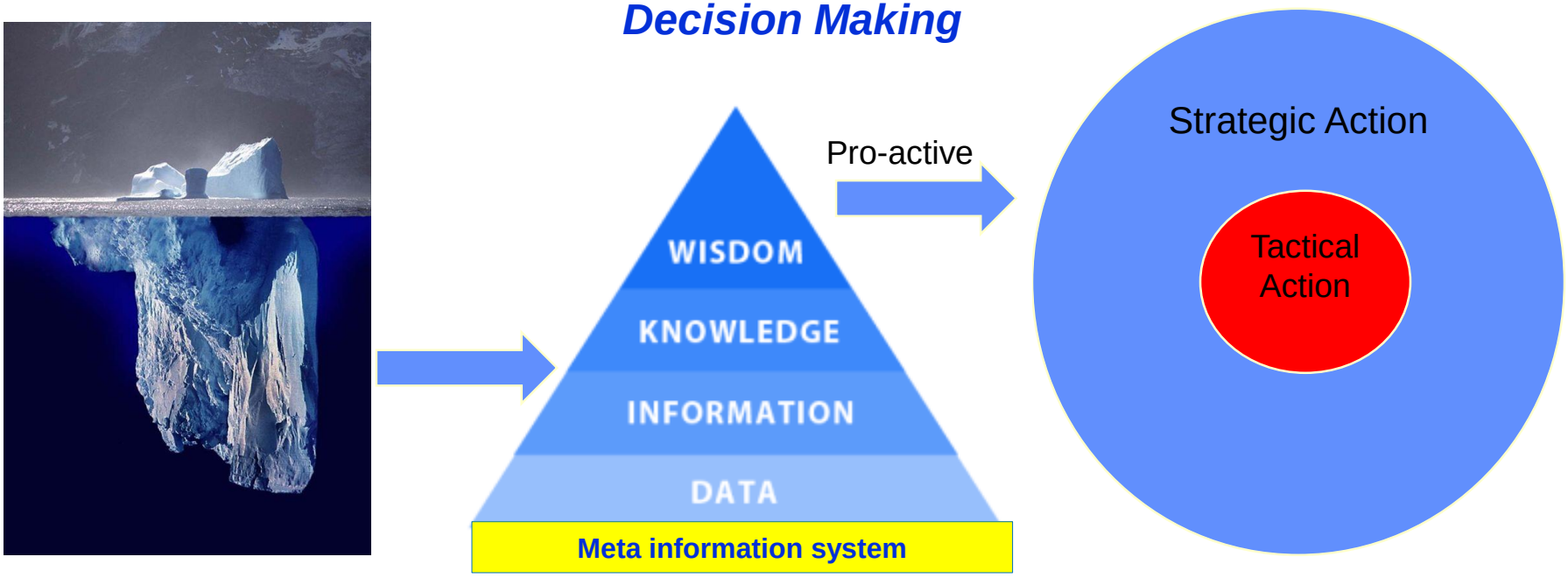
Goddard Space Flight Center

A Diverse Mission Portfolio

Strategic Challenge / Supply Chain Risks

- GSFC mission projects rely upon interconnected, multi-tiered supply chains of organizations operating under direct and indirect contracts and other agreements around the world that are subject to an interrelated and broad array of risks that can disrupt the provision of products and services when needed and in conformance with requirements

Building Knowledge and Processes for Informed Planning, Oversight and Decision Making



As we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know. Donald Rumsfeld, Secretary of Defense, 2002

GSFC Supply Chain Management

Mission Performance

Spacecraft, Science Instruments, Ground Systems

= Safety & Mission Assurance
= Flight Projects Management
= Engineering & Technology
= Procurement

Outcomes

- Quality Products and Services
- On-Time Delivery at Acceptable Cost
- Innovative Problem-Solving / Continual Improvements
- Risk Reduction

Core Functions

Supplier Development

- Technology Investments
- Procurement Policy
- Small Business Program
- Outreach

Acquisition

- Acquisition Strategy
- Proposal Team Building
- Procurement (direct and indirect)

Performance Management

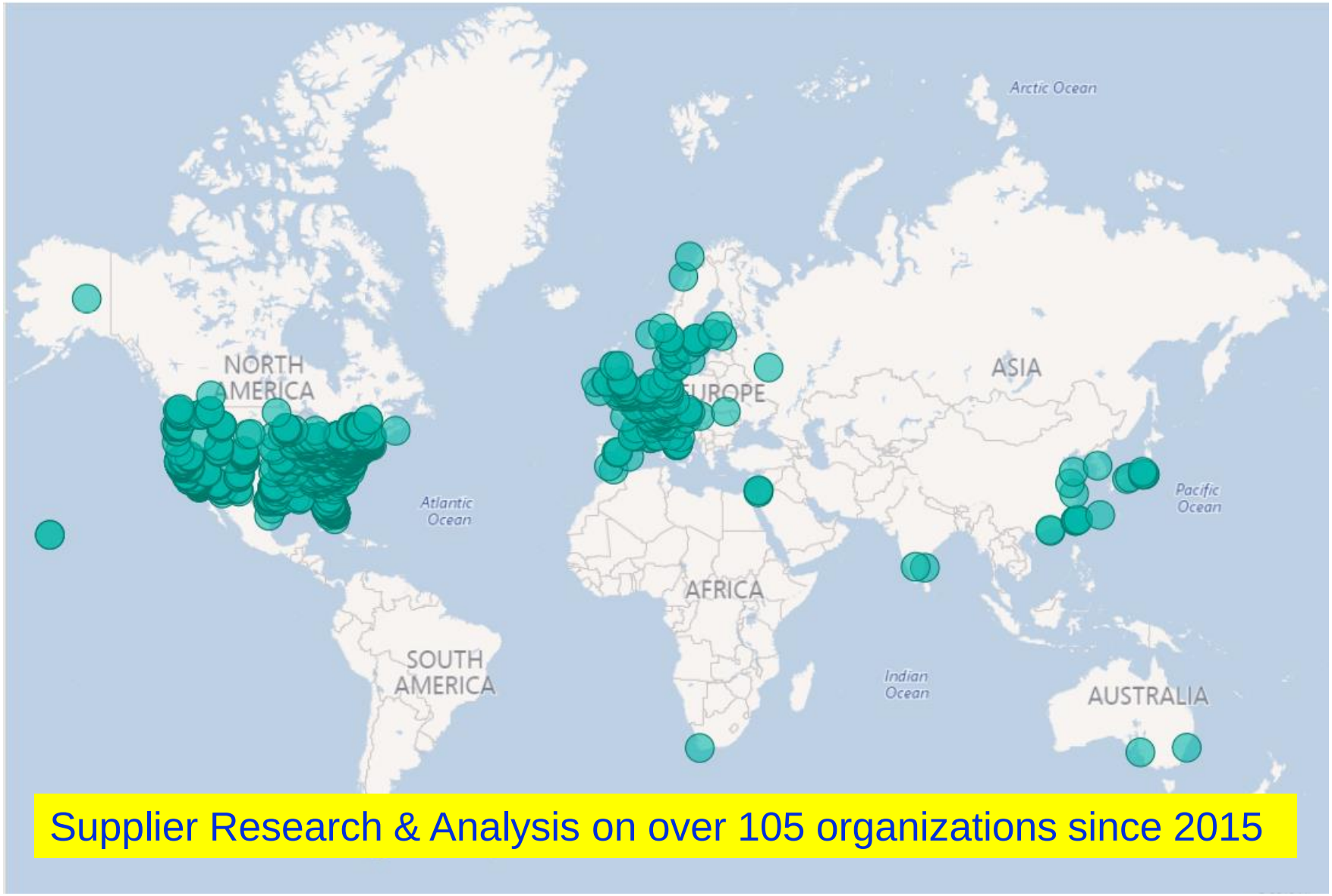
- Project Management / Contract Oversight
- Mission Assurance Requirements
- Surveillance, Inspections and Alerts
- Parts to System-level Testing

Evaluation & Risk Management

- Project Lifecycle Reviews
- Supply Chain Assessments, Research & Analyses
- Project and Enterprise Level Risk Management

Information Systems for Process / Data Management and Informed Decision-Making

Worldwide Locations of Identified Suppliers



Supplier Research & Analysis on over 105 organizations since 2015

Source: NASA's Meta information system as of 08/23/2018

Purpose / Key Attributes

Purpose

- Supplier Research & Analysis (SRA) is designed to provide insight into the operating environment, capabilities, performance and viability of current and potential suppliers for GSFC mission projects in support of SMA and project management needs

Key Attributes

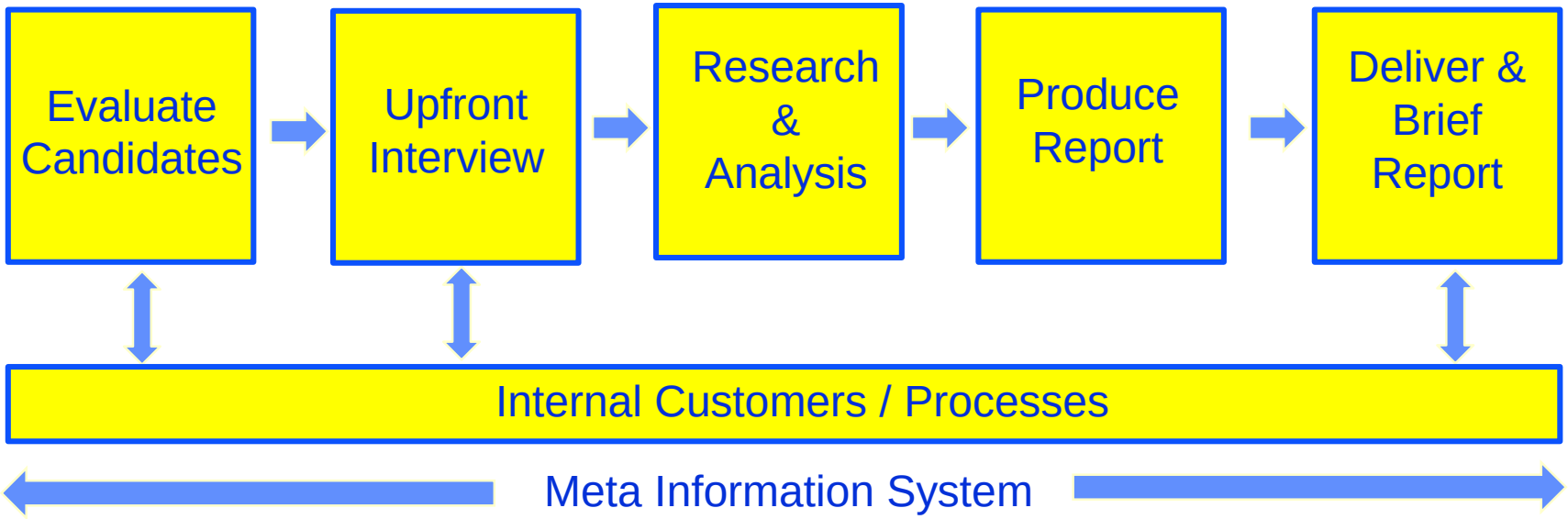
- Holistic analytical framework based on selected technical, business enterprise, market and security factors
- Guided by priorities, concerns, needs and products/services of interest
- Primarily open source information sources (cited with confidence ratings) blended with NASA / U.S. Government information
- Internal use only
- Non-intrusive
- Timely
- Affordable
- Sound, Credible
- Lean, multidisciplinary team
- Complementary to traditional SMA disciplines / project management methods

Analytical Framework

Categories	Key Factors
Technical	Quality Management, Manufacturing, R&D/Innovation
Business Enterprise	Leadership & Organization, Workforce, Supplier/Supply Chain Management, Financial Status, Business Alliances
Market	Industry Position, Market Trends, Regulatory & Legal
Security	Socioeconomic Environment, Cybersecurity, Physical Security

Core Process / Report Types

Core Process for Supplier Research & Analysis (SRA)



Levels of Research & Analysis / Report Types

- Rapid Supplier Insight
- Supplier Information Profile
- Supplier Information Profile & SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis

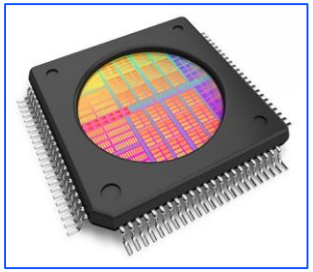
Products of Interest

(examples)

Bipropellant Thruster Valve

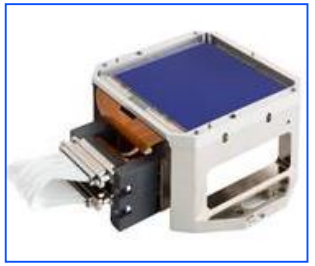
Lithium-Ion Battery

Solar Array



Semiconductor

Spacecraft Bus



Charge-coupled device

Thruster Engine

Inertial Reference Unit

Optical Encoder

Software

Star Tracker

Case Examples

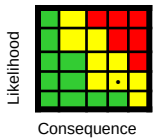
- Case 1: Very small, privately-held company (less than 10 employees) located 3500+ miles from GSFC under contract to produce components on the critical path of several GSFC mission projects
  - Leadership / business continuity: "one-man show"
  - Inadequate quality management, history of delivery delays and security concerns
- Case 2: Well-established, recurring commercial source ($300 million / year) of a critical component for GSFC mission projects under acquisition by a large corporation (~$3.0 billion / year)
  - Possible operational disruptions due to acquisition
- Case 3: Very large enterprise (~$10 billion / year) with multiple subsidiaries that supply key components / subsystems for GSFC mission projects experienced prior cyberattack and illicit technology transfer events
  - Future security incidents could impair design / production
- Case 4: Entrepreneurial business established in 2001 with experience in design / technology development for space systems identified as a potential subcontractor to develop and integrate micro-satellites for a possible mission
  - Home-based company led by an entrepreneur lacks capabilities at present…no discoverable facility for production/integration/test nor quality management

Supplier Research & Analysis reports illuminate strengths, weaknesses, opportunities and threats in providing insight and situational awareness

Case Example

Supplier Research & Analysis to Risk Management

Sourcing of XXXXX for GSFC Flight Projects

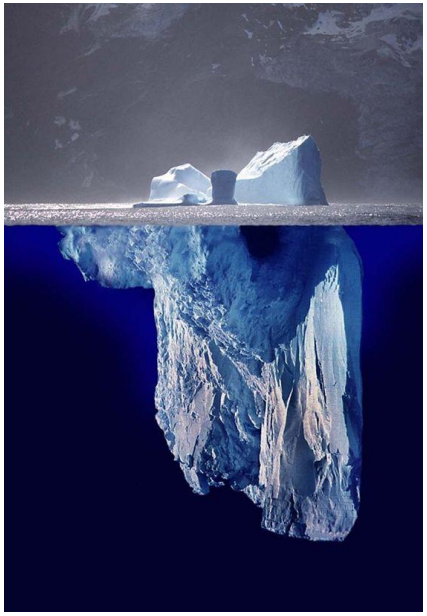
		Risk Statement (Condition; Consequence)	Approach: Research	Notes/Actions:
		Given that multiple GSFC projects are reliant upon two suppliers of XXXXX of which one (XXXXX) is vulnerable to business and market issues that could disrupt or terminate production; **there is a possibility** that GSFC projects could be effectively limited to a de facto sole source (XXXXX) **resulting in:** 1.insufficient production capacity to meet requirements on schedule at planned cost, and/or; 2.the need to urgently and reactively establish alternative sources with associated technical uncertainty, schedule delay and additional cost. **Context:** Supplier Research & Analysis reports provided insight into two suppliers of XXXXX upon which GSFC projects are reliant: XXXXX and XXXXX. GSFC experience with suppliers of XXXXX and XXXXX is limited primarily to XXXXX (as a key supplier to XXXXX) and XXXXX. XXXXX is a small privately-owned, family-run manufacturing company located in XXXXX with a workforce of ~ 35 to 50 employees and annual revenue of ~ $10 million. As such, it is relatively vulnerable to business and market risks that could disrupt its operations. Supplier of XXXXX products for: GOES 16(R), S, T, U; IceSat-2, JPSS 1, 2, 3, 4; JWST; Landsat-9; Lucy; Restore-L; RRM3; TESS, Europa Clipper Propulsion, and a potential supplier for WFIRST. XXXX (manufacturing facility in XXXXX) is a privately-held subsidiary of XXXXX public corporation (revenue of $1..2 billion in 2017). The organization's products are used in GSFC projects, including DSCOVER, JWST, LandSat-8 (LDCM), MAVEN, NICER, TDRS-12/L and Europa Clipper Propulsion.	**Actions per XX/XX/2018 meeting:** 1.Investigate and determine if suppliers of XXXXX have established or pending relationships with alternative, qualified suppliers of XXXXX. 2.Continue supplier research to identify and gain insight into current / potential suppliers of XXXXX and XXXXX.	**Risk Coordinator:** Code 382/J. Root **Risk Originator:** Code 382/J. Root **Update as of X-XX-2018:** Action 1: XXXXX Action 2: XXXXX **Recommendation**: monitor periodically to maintain awareness.
	Risk Rating Rationale Likelihood: Likelihood of XXXXX experiencing disruption or termination of its production of XXXXX is low but credible given the relative vulnerabilities of the organization. Consequence: Disruption or termination of XXXXX production could increase technical uncertainty, cause schedule delays and add to planned costs for multiple GSFC projects. Use of XXXXX that are defective could result in mission failure.			
LxC = 2x4 **Risk Area: Supply Chain**  				

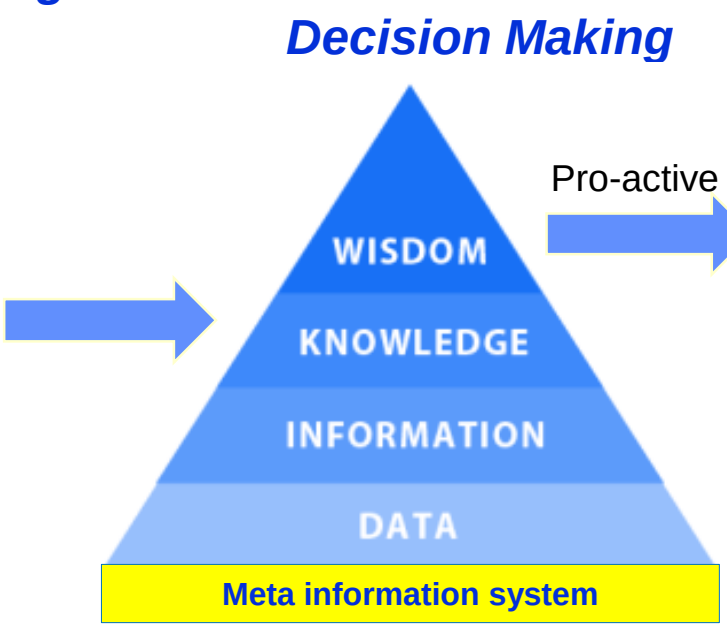
Bringing It All Together

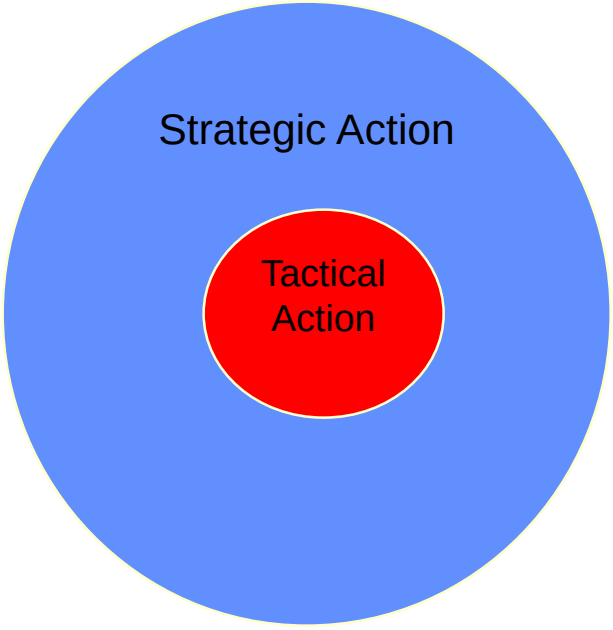
Meta Information System

- State-of-the-market information system for process performance, data / information management and analytics supporting NASA mission performance, GSFC quality management and GSFC supply chain risk management.
- Meta-supported processes and capabilities integrate data and information from ongoing research, reporting, reviews, assessments and analyses on suppliers and their products / services for space system projects
- Extending Meta to improve understanding / insight and to identify / assess / manage supply chain risks within and across the supply chains of GSFC-managed projects

Building Knowledge and Processes for Informed Planning, Oversight and Decision Making



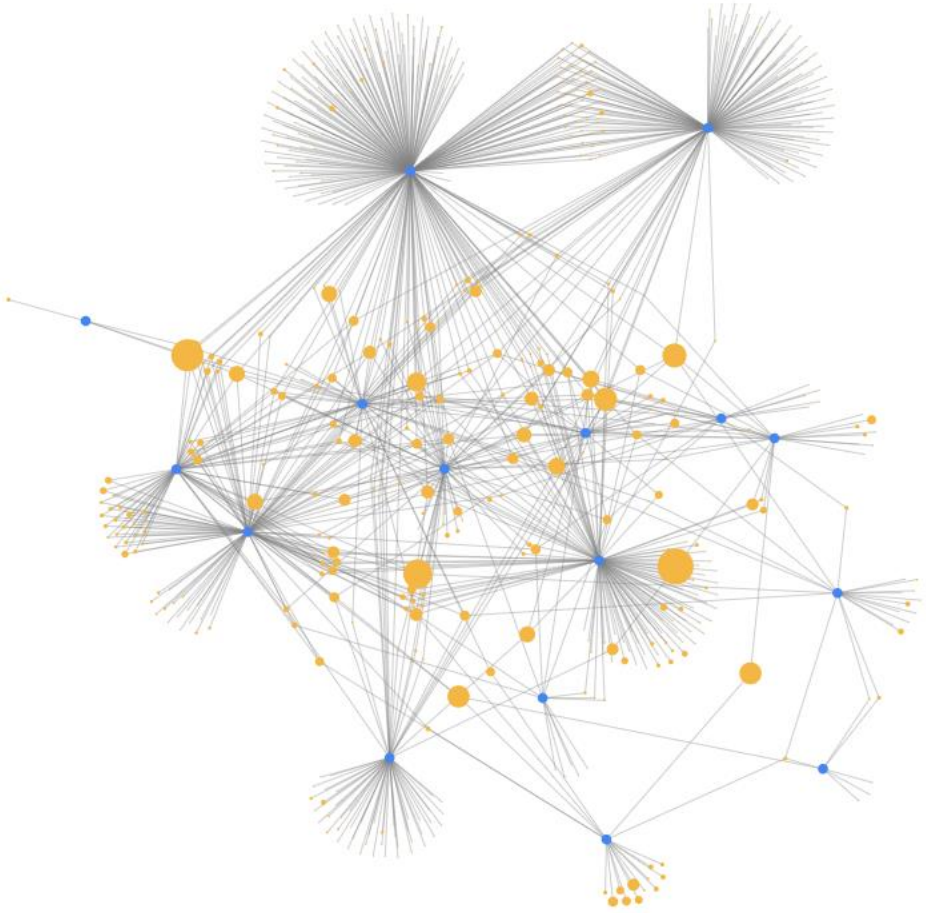




Visual Supply Chain Analytics

Meta Information System

Project Supplier Relationships

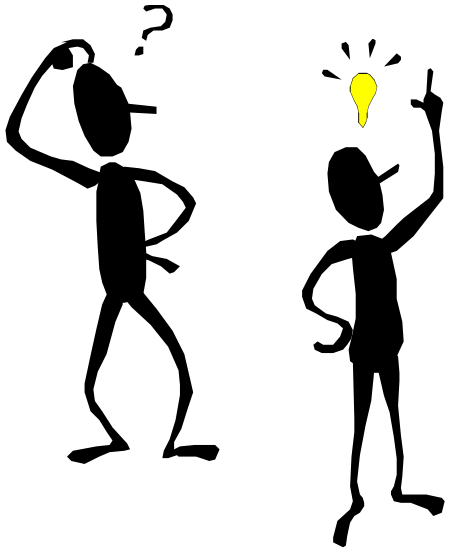


How to Read: The blue nodes represent projects, and the orange nodes represent suppliers. The weight or size of the nodes of the suppliers, depends on the number of projects related to each, respectively.

Project

- ATLAS
- CASSINI
- Fermi (GLAST)
- GEDI
- GOES-16 (R)
- GOES-17
- ICESat-2
- ICON
- IXPE
- JPSS-1
- JPSS-2
- JWST
- JWST Sunshield Elements
- LandSat-9
- LCRD
- Lucy
- MAVEN
- MMS
- MOMA
- NICER
- O2O
- OSIRIS-REx
- PACE
- POES
- PSP
- Restore-L
- SDO
- TESS
- TIRS-2
- WFIRST
- XARM

Summary / Discussion



An Old Proverb

For want of a nail the shoe was lost;
For want of a shoe the horse was lost;
For want of a horse the rider was lost;
For want of a rider the battle was lost;
For want of a battle the kingdom was lost;
And all for the want of a horseshoe nail.

In summary … in proven and innovative ways we are building knowledge for informed planning, oversight and decision-making in order to reduce the risks of exploring the Earth and space in achieving mission success.

A final note …. registration is underway for the Supply Chain 2018 conference at the NASA Goddard Space Flight Center in Greenbelt, MD. October 23 -25, 2018. Go to https://supplychain.gsfc.nasa.gov to view the agenda and register. Space is limited!

Thank you! Jonathan Root, NASA Goddard Space Flight Center, jonathan.f.root@nasa.gov