
National Aeronautics and Space Administration
Supply Chain Research & Analysis:
Illuminating Risks in Complex Systems
NASA
Goddard
SPACE FLIGHT CENTER
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NASA Goddard Space Flight Center
American Supply Chain Summit
April 26, 2019

Presentation Topics

- Goddard's Mission Portfolio and Supply Chains
- Strategic Challenge: Supply Chain Risks
- Supply Chain Research & Analysis
  - Purpose / Key Attributes
  - Analytical Framework
  - Core Process / Report Types
  - Products of Interest
  - Case Examples
  - Visual Analytics
- Supply Chain Risk Management
- Bringing It All Together
- Summary / Discussion

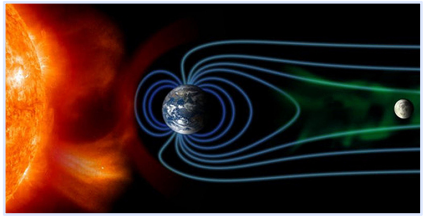
NASA's First Space Center

Lines of Business

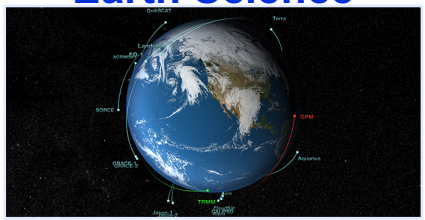
Goddard Space Flight Center

Astrophysics

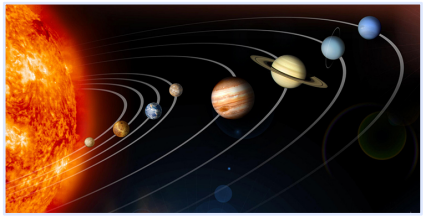
Heliophysics



Earth Science



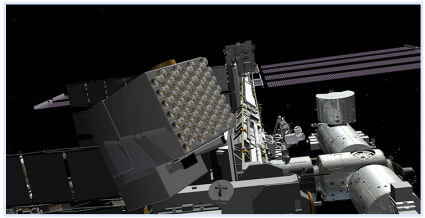
Planetary & Lunar Science



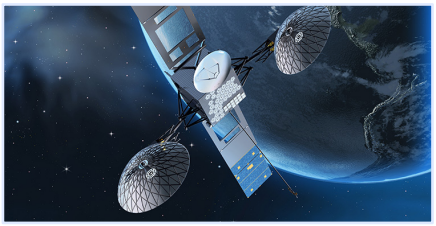
Human Exploration & Operations

Suborbital Platforms

Cross Cutting Technology & Capabilities

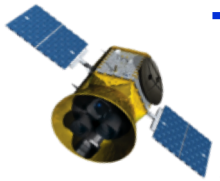


Communications & Navigation



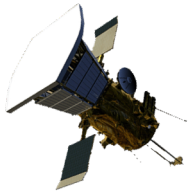
Selected Mission Highlights

Goddard Space Flight Center



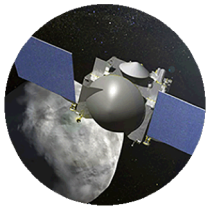
TESS

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



Parker SPP

Repeatedly sample the near-Sun environment



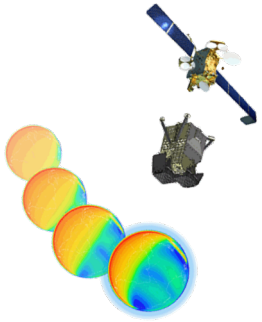
OSIRIS-REx

Rendezvous with the asteroid Bennu 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

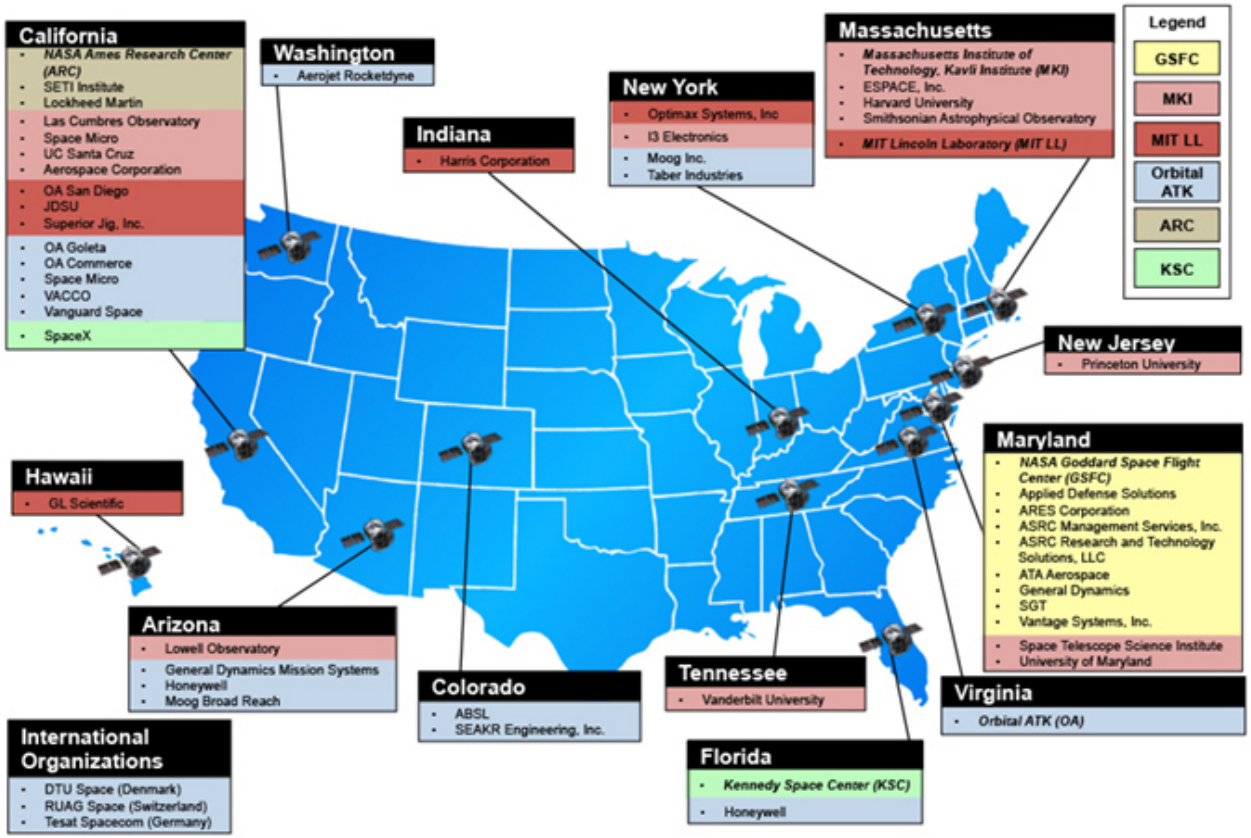
Measure the elevation of Earth's ice sheets, glaciers, sea ice and global vegetation biomass

GSFC Mission Portfolio: ~ 25 Key Projects in Development

Transiting Exoplanet Survey Satellite (TESS)

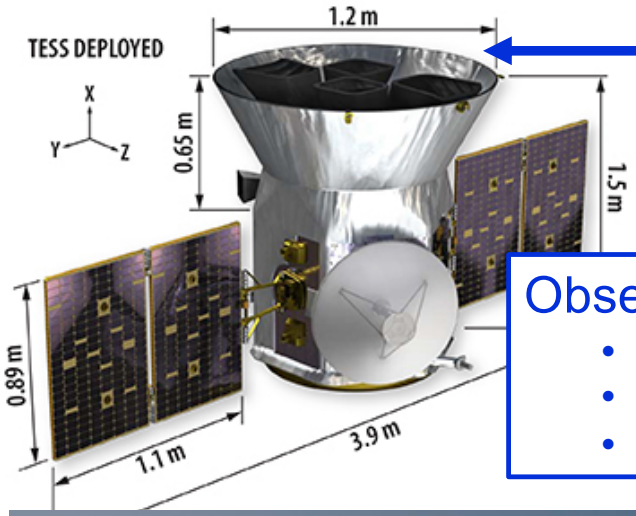
Major Partners and Subcontractors

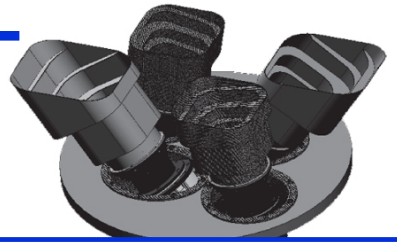
Transiting Exoplanet Survey Satellite (TESS)



System / Supply Chain Complexity

Transiting Exoplanet Survey Satellite (TESS)





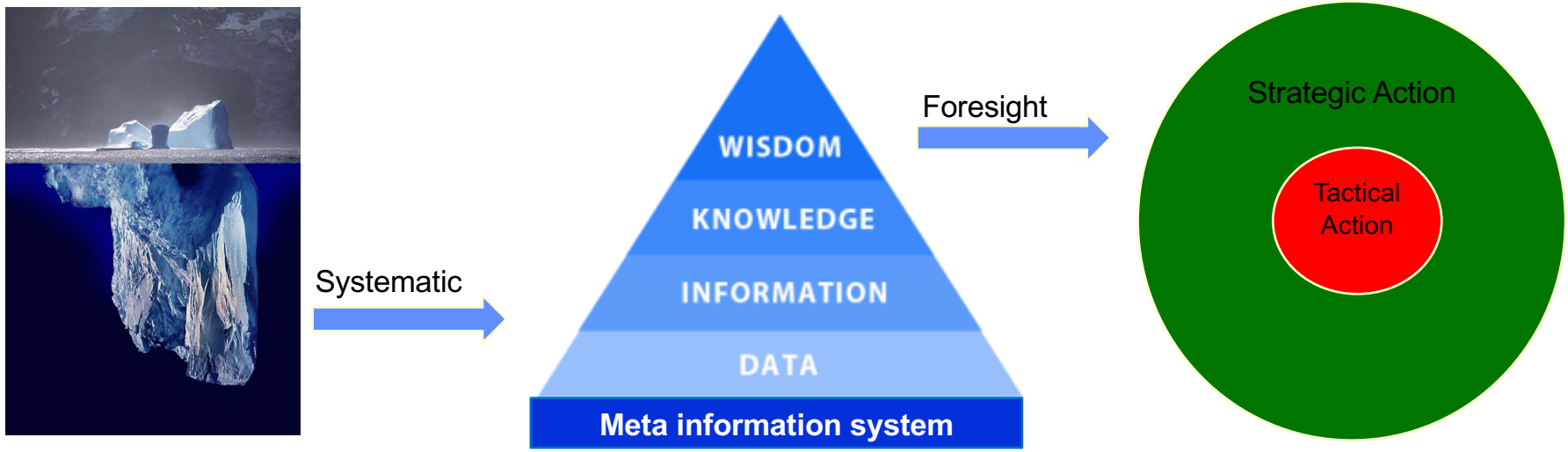
Observatory (system) = spacecraft + instrument

- Subsystems, components, assemblies, parts
- 314+ product line items tracked
- 63+ suppliers identified, located in six countries

Strategic Challenge / Supply Chain Risks

- GSFC mission projects rely upon interconnected, multi-tiered supply chains subject to a broad array of risks that can disrupt the provision of high quality, affordable products and services when needed

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**

Supply Chain Management

Goddard Space Flight Center

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

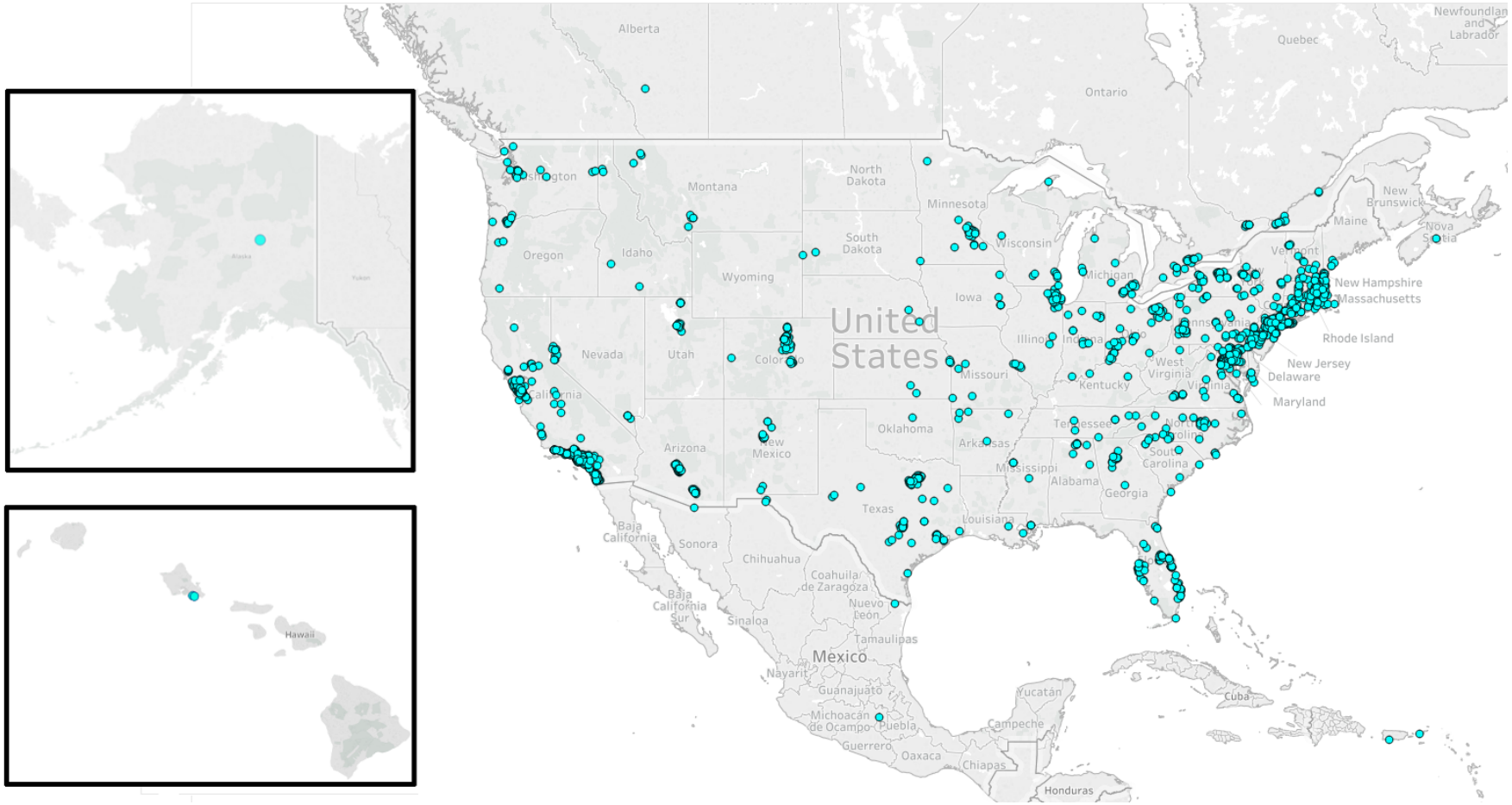
Evaluation & Risk Management

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

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

U.S / North America Locations of Suppliers

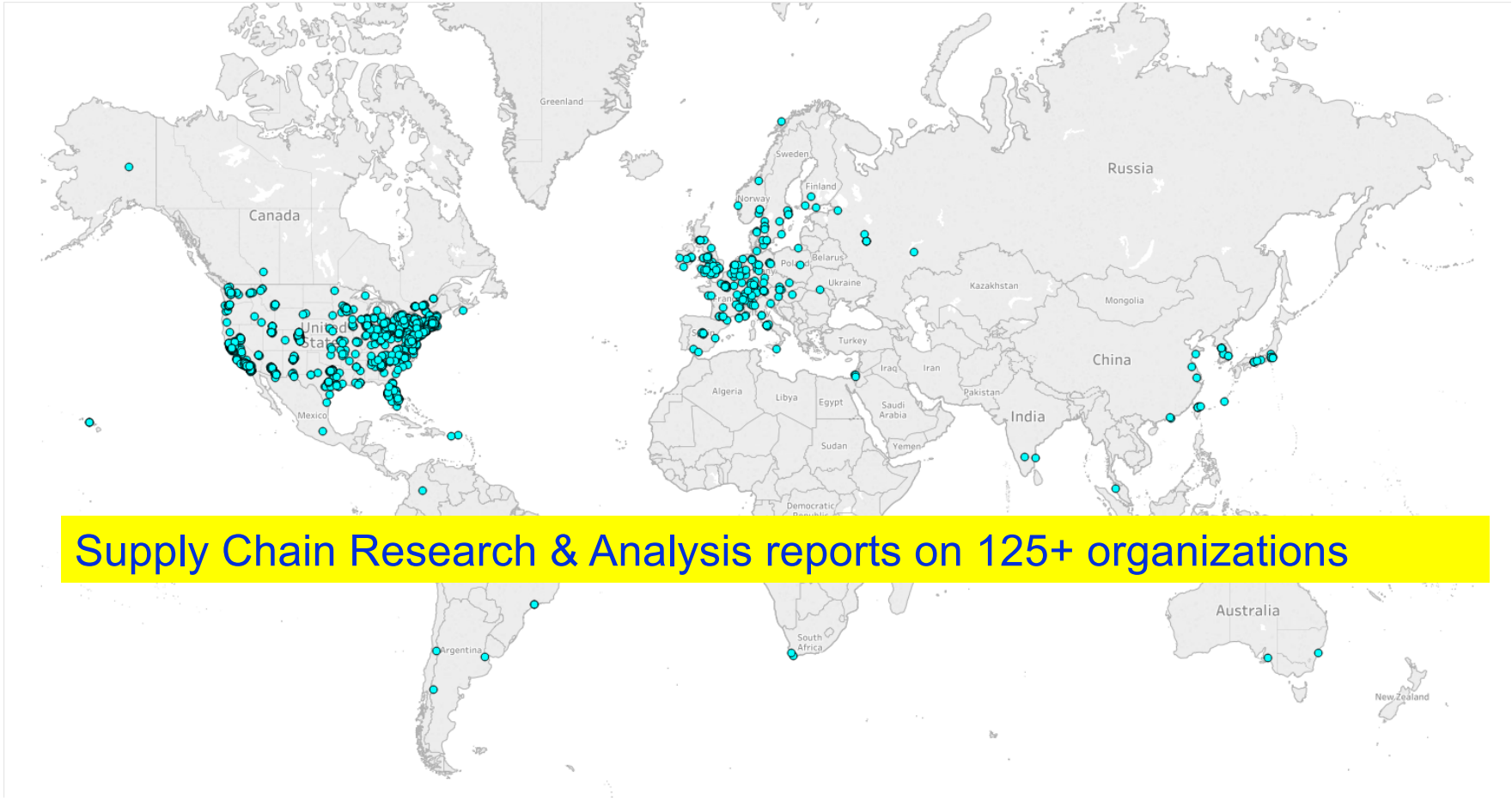
Goddard Space Flight Center



Source: NASA's Meta information system as of 04/04/2019; maps of Hawaii and Alaska not to scale.

Worldwide Locations of Suppliers

Goddard Space Flight Center



Supply Chain Research & Analysis reports on 125+ organizations

Source: NASA's Meta information system as of 04/04/2019

Purpose / Key Attributes

Supply Chain Research & Analysis Reports

Purpose

- Provide insight into the operating environment, capabilities, performance and viability of current and potential suppliers for GSFC mission projects

Key Attributes

- Holistic analytical framework
- Guided by priorities, concerns, needs and products / services of interest
- Open source information + NASA / U.S. Government information
- Internal use only
- Non-intrusive
- Timely, Affordable
- Sound, Credible
- Lean, multidisciplinary team
- Complementary to traditional project management / SMA disciplines and methods

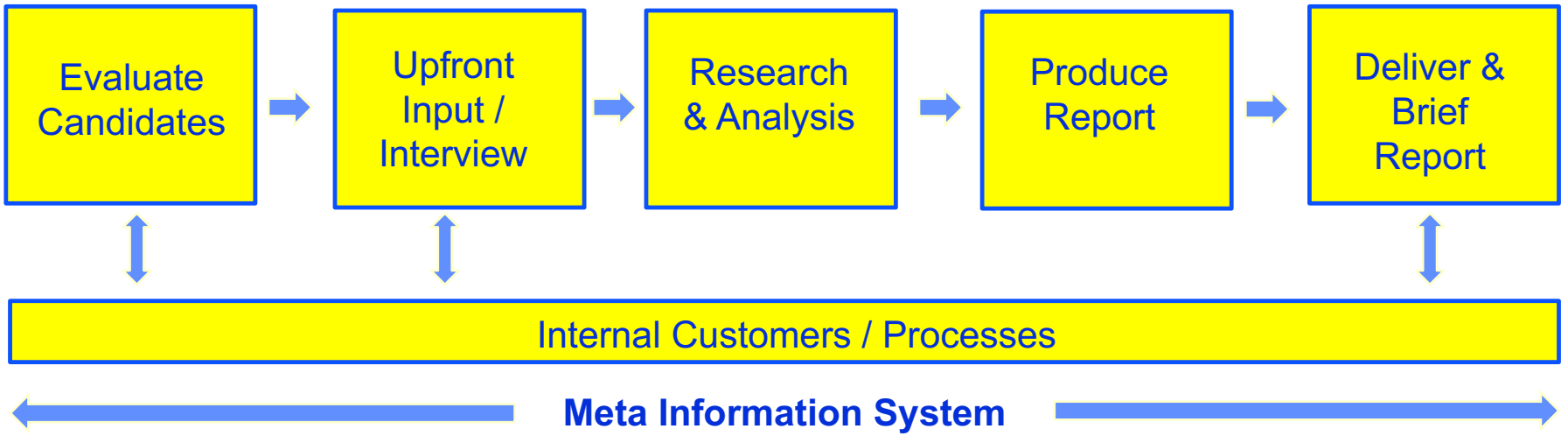
Analytical Framework

Supply Chain Research & Analysis

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

Core Process / Report Types

Supply Chain Research & Analysis



Levels of Research & Analysis / Report Types

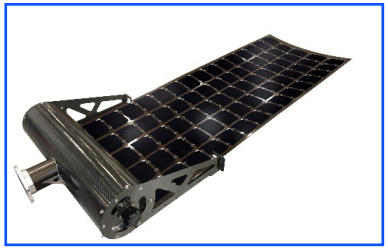
- Rapid Supplier Insight
- Supplier Information Profile
- Supplier Information Profile & SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis

Some Products of Interest

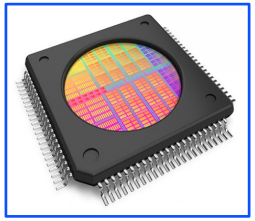
Supply Chain Research & Analysis

Bipropellant Thruster Valve

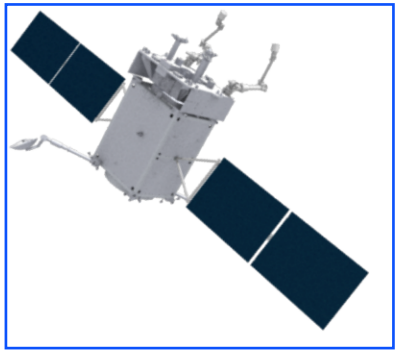
Lithium-Ion Battery



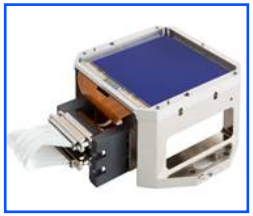
Solar Array



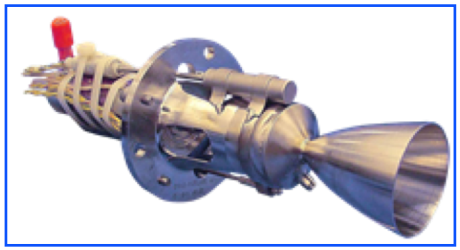
Semiconductor



Spacecraft Bus



Charge-coupled device



Thruster Engine

Inertial Reference Unit

Optical Encoder

Software

Star Tracker

Case Examples

Supply Chain Research & Analysis

- 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; consolidation of sources
- Case 3: Very small, privately-held company (less than 10 employees) that supplies a critical component for spacecraft instruments facing an "existential crisis" as its large corporate competitor and source of a key part is closing down its fulfillment of outside orders

Case Examples

Supply Chain Research & Analysis

- Case 4: Very large U.S. corporation (~$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 and space system operations
- Case 5: 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
- Case 6: Large U.S. corporation (~$2.5 billion / year) with production sites / headquarters in the U.S. which provides a fundamental electronics component used in GSFC mission projects is highly dependent upon production, labor, customers and ownership based in China & Hong Kong

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

Suppliers, On-site Assessments, Research & Analysis

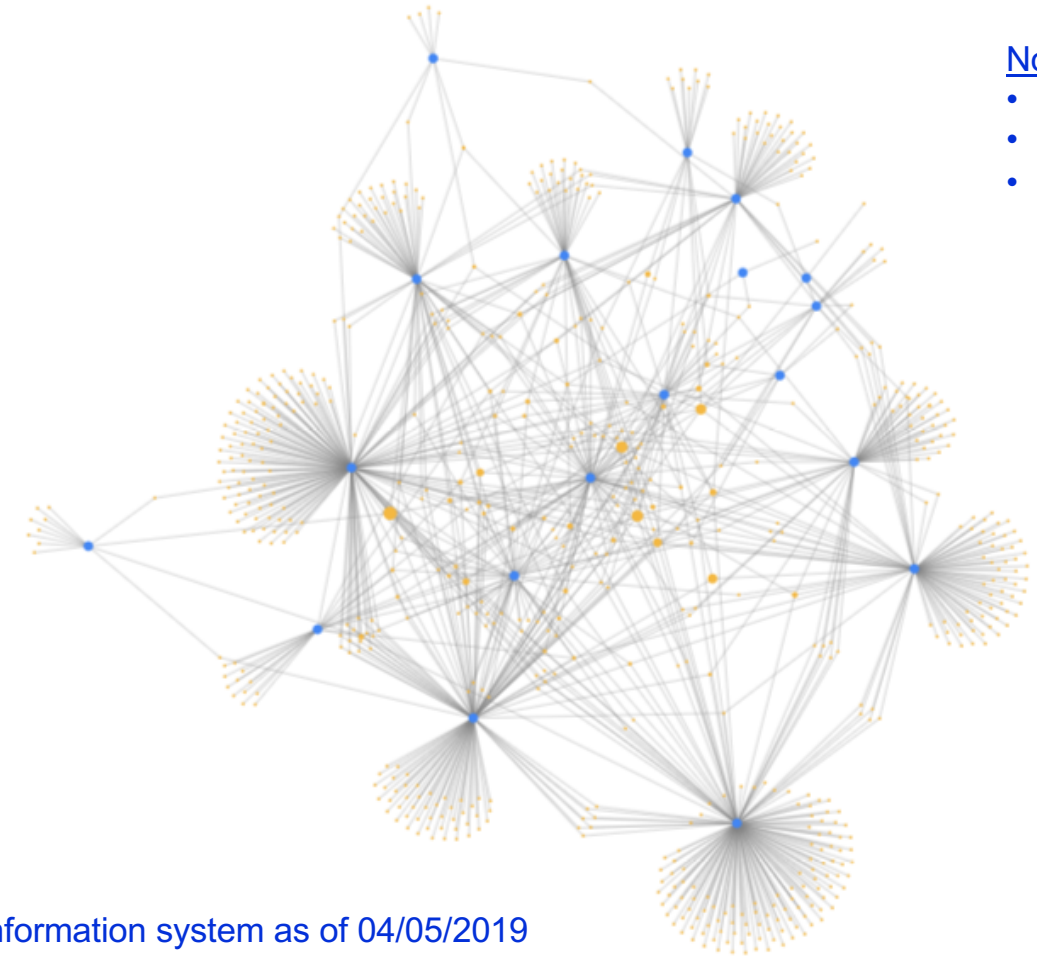
Worldwide

Supplier = On-Site Supplier Assessment = Supplier R&A = Supplier Assessment + R&A =

Source: NASA's Meta information system as of 04/05/2019

Visual Supply Chain Analytics

Meta Information System

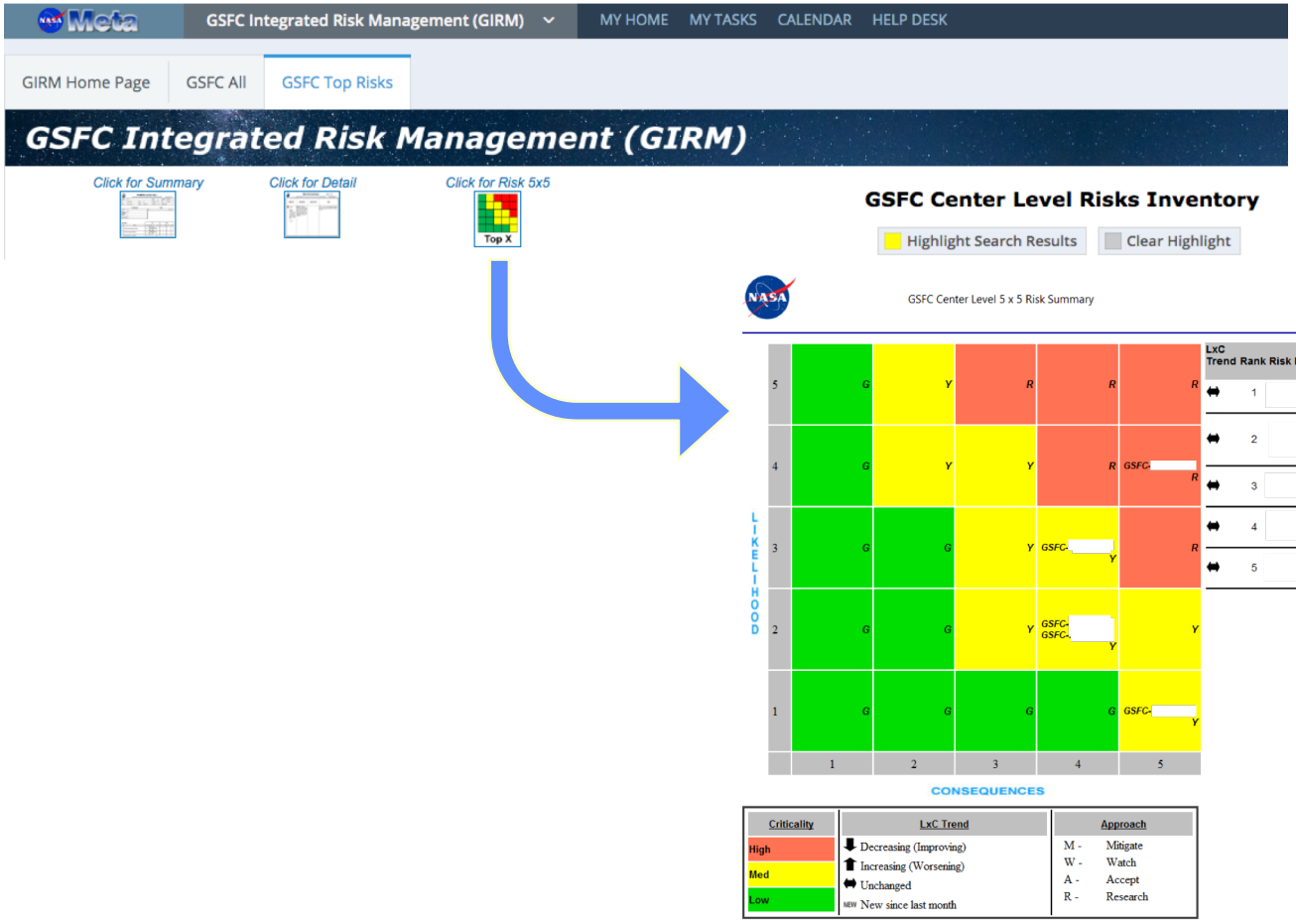


Note:

- blue nodes = projects
- orange nodes = suppliers
- Sizing of supplier nodes dependent upon the number of project relationships

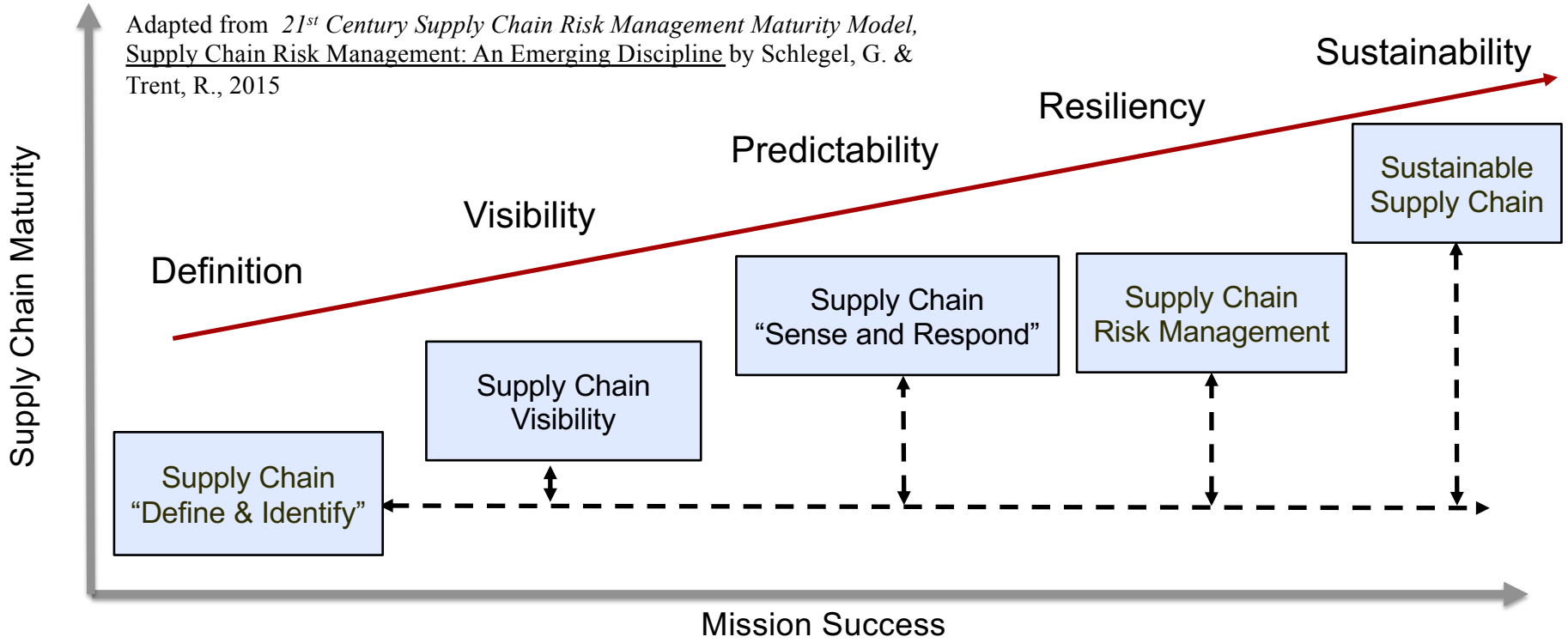
Source: NASA's Meta information system as of 04/05/2019

Supply Chain Research & Analysis to Risk Management



Supply Chain Risk Management

Goddard Space Flight Center



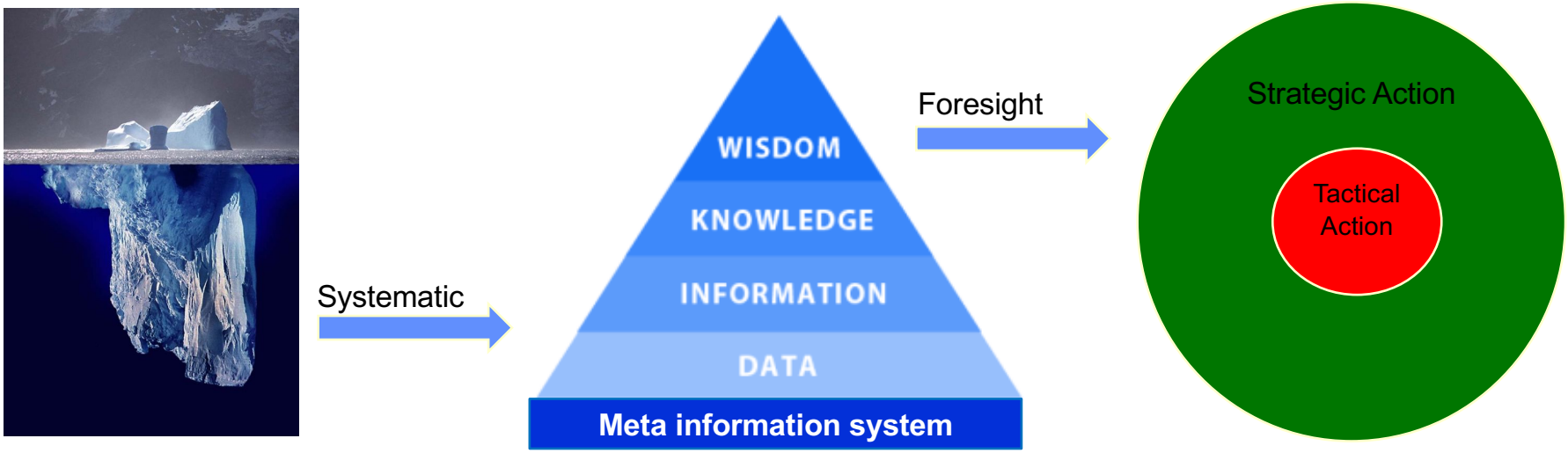
- *Project Management & Procurement*
- *Project Lifecycle Reviews*
- *Internal Management System Assessments*
- *Supply Chain Assessments, Research & Analysis*

- *Supply Chain Mapping & Analytics*
- *Integrated Risk Management*
- *Meta Information System*
- *Digital Transformation*

Bringing It All Together

Meta Information System

- Integrated platform for process performance, data / information management and analytics supporting NASA mission performance, GSFC quality management and GSFC integrated risk management (includes supply chain risks)
- Meta applications bring together data / information / processes to provide insight into suppliers and their products / services for space systems
- Extending Meta capabilities to identify / assess / manage supply chain risks within and across the supply chains of GSFC mission projects



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 proven and innovative ways we are building knowledge for informed planning, oversight and decision-making as we reduce the risks of exploring the Earth and space in achieving mission success

Thank you! Jonathan Root, jonathan.f.root@nasa.gov