

National Aeronautics and Space Administration



Supply Chain Research & Analysis: Illuminating Risks in Complex Systems

Goddard
SPACE FLIGHT CENTER

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American Aerospace & Defense Summit
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Presentation Topics

- Goddard's Mission Portfolio and Supply Chains
- Strategic Challenge: Supply Chain Risks
- Supply Chain Research & Analysis
 - Objectives / 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





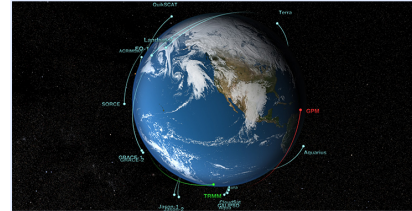
Lines of Business

Goddard Space Flight Center

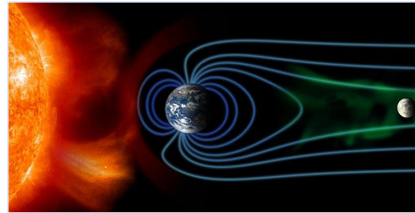
Astrophysics



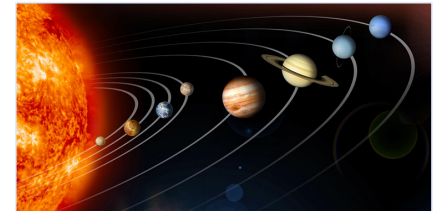
Earth Science



Heliophysics



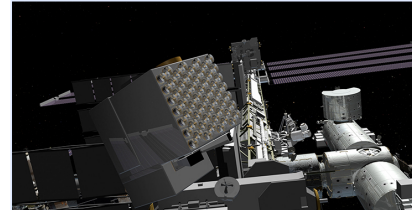
Planetary & Lunar Science



Human Exploration & Operations



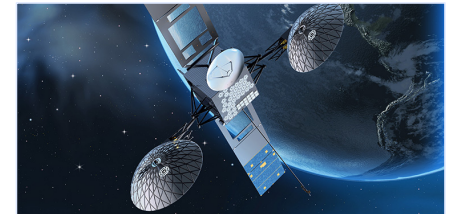
Cross Cutting Technology & Capabilities



Suborbital Platforms



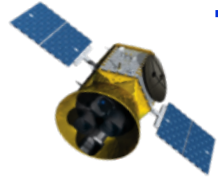
Communications & Navigation





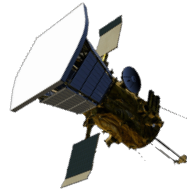
Selected Mission Highlights

Goddard Space Flight Center



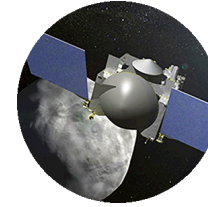
TESS

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



Parker SPP

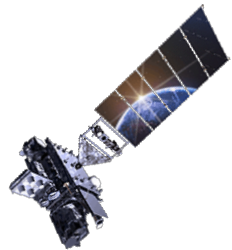
Repeatedly sample the near-Sun environment



OSIRIS-REx

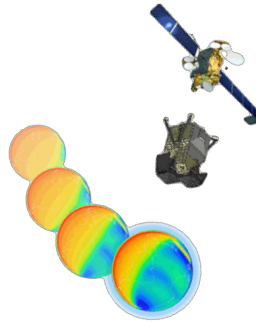
Rendezvous with the asteroid Bennu and return a sample to Earth in 2023

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)

Medium Class Explorer

NASA GSFC performed project management

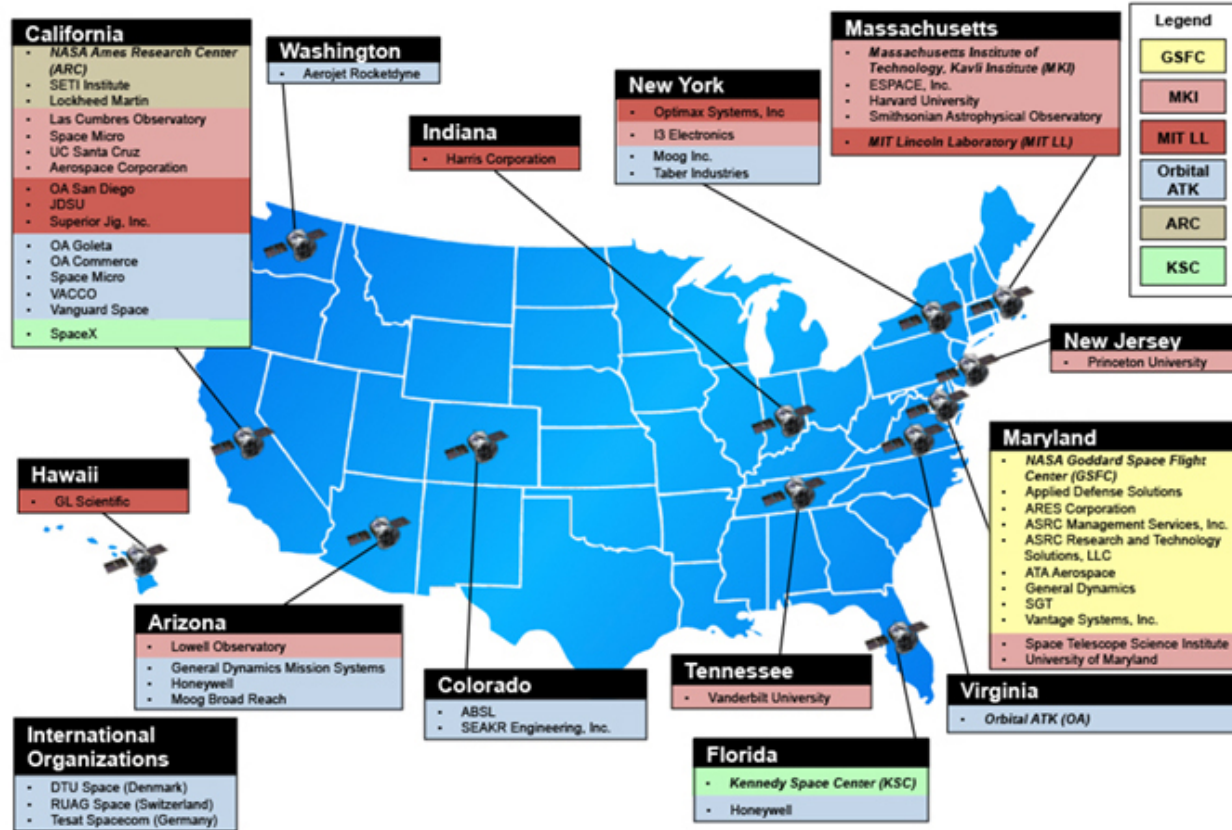
Launched April 18, 2018





Major Partners and Subcontractors

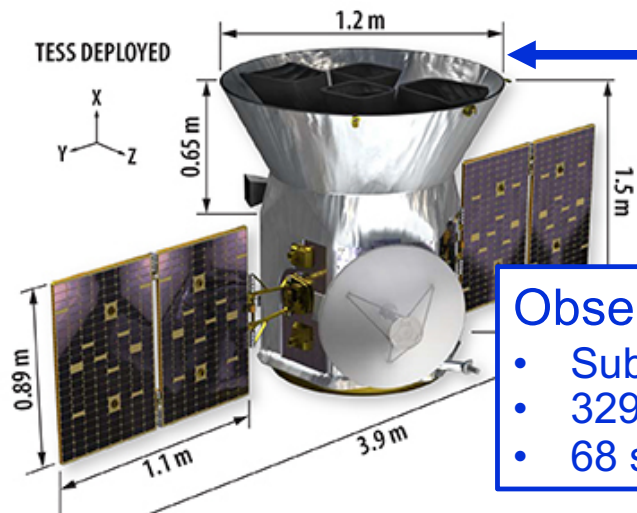
Transiting Exoplanet Survey Satellite (TESS)





System / Supply Chain Complexity

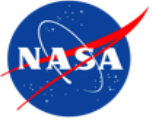
Transiting Exoplanet Survey Satellite (TESS)



Observatory (system) = spacecraft + instrument

- Subsystems, components, assemblies, parts
- 329 products tracked throughout configuration levels 1 to 11
- 68 suppliers, located in six countries





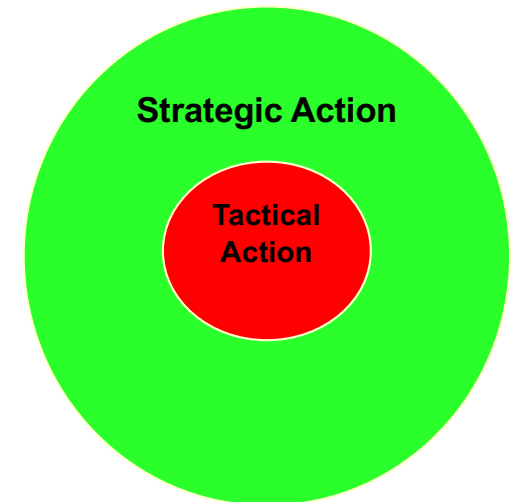
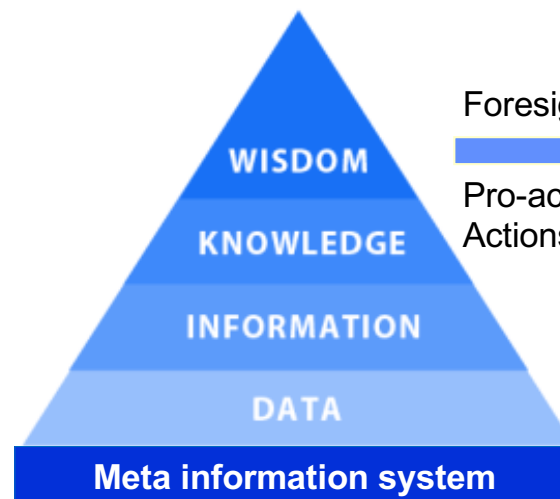
Strategic Challenge / Supply Chain Risks

GSFC mission projects rely upon multitiered, interconnected and global supply chains subject to a broad, dynamic array of risks that threaten – and when realized – disrupt or deny the timely, affordable provision of products and services as required for mission success

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



Build Visibility
→



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



A World of Risks Threaten Supply Chains

Trends / conditions driving risks, including:

- Globalization of markets, technology and industry with supply chains operating across geographical, political, social, cultural and economic environments
 - Supply chains yield advantages and exposure to risks
- Competition and conflicts
- Climate change

Dynamic interplay of a wide array of risk types, such as:

Natural Disasters / Hazards

Man-Made Disasters / Hazards

Geopolitical Events

Regulatory Shifts

Litigation

Fragile Markets / Industries

Enterprise Management

Workforce / Talent Losses

Diminishing / Single / Sole Sources

Foreign Influence / Dependency

Product / Service Security

Cyberattacks

Fragile Supplier

Transport Network / Logistics

Building Supply Chain Visibility is Key to Managing Risk Exposure



Supply Chain Management

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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 Avoidance / 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

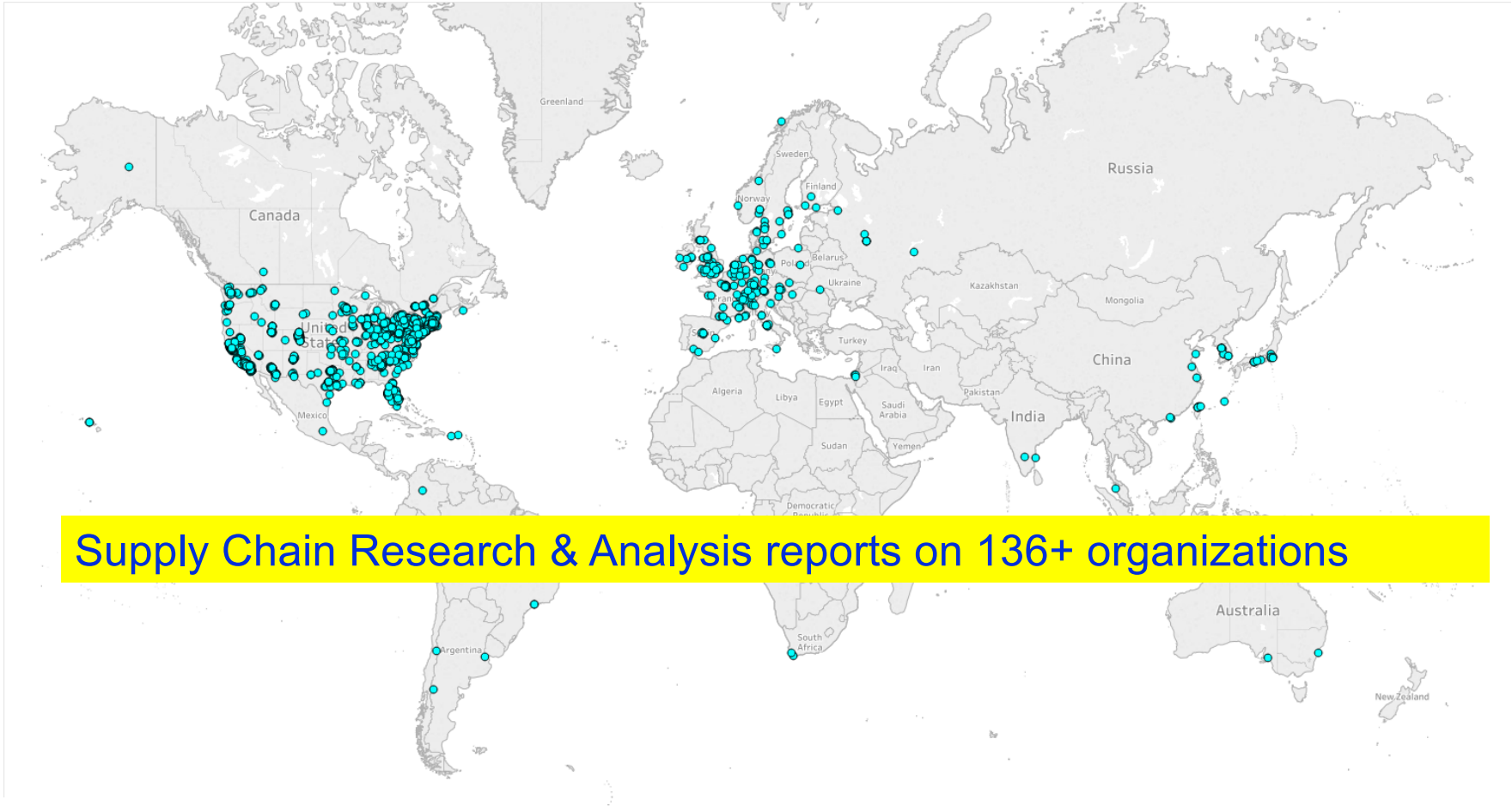
- Project Lifecycle Reviews
- Internal Management System Assessments
- Supply Chain Assessments, **Research & Analyses**
- Project and Enterprise Level **Risk Management**

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



Worldwide Locations of Suppliers

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Source: NASA's Meta information system



Objectives / Key Attributes

Supply Chain Research & Analysis

Objectives

- Provide situational awareness of and insight into the operating environment, management and operations of current and potential suppliers
- Illuminate concerns, risks and issues
- Build visibility into current and evolving supply chains
- Enable and support informed decision-making, oversight and risk management

Key Attributes

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



Analytical Framework

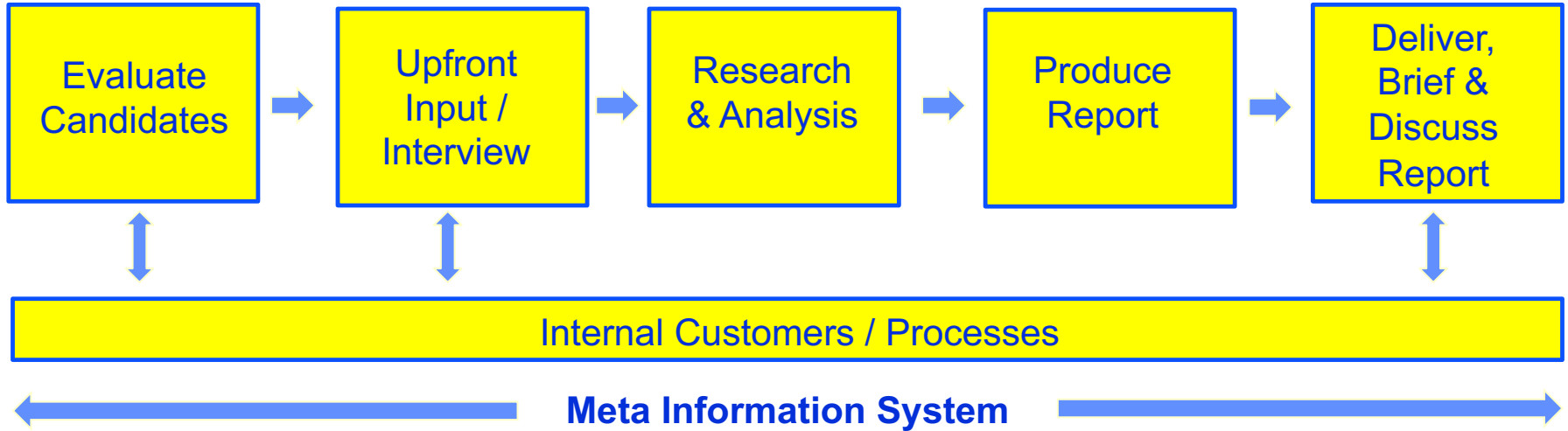
Supply Chain Research & Analysis

Categories	Key Factors
Technical / Production	Quality Management, Manufacturing, R&D/Innovation
Business Enterprise	Leadership, Strategy, Organization, Workforce, Supply Chain Management, Financial Health, Business Alliances
Market	Industry Position, Trends and Conditions, Regulatory/Legal
Security	Geopolitical Situation, 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
 - SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis
 - Risk Statements



Some Products of Interest

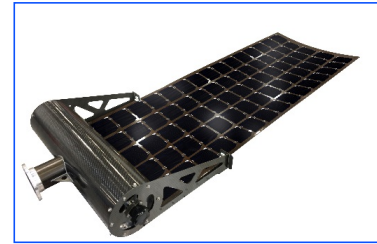
Supply Chain Research & Analysis



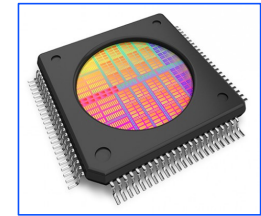
Bipropellant Thruster Valve



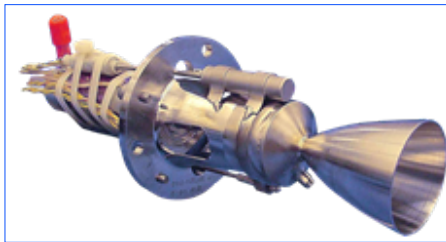
Lithium-Ion Battery



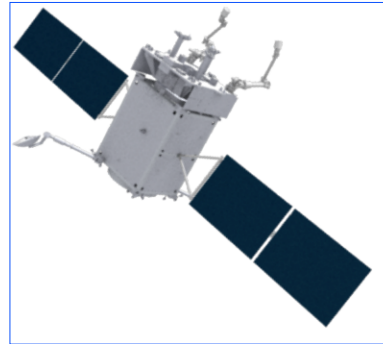
Solar Array



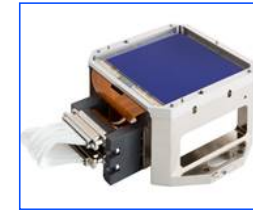
Semiconductor



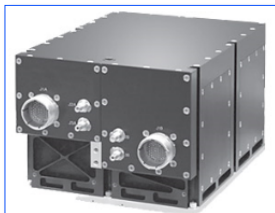
Thruster Engine



Spacecraft Bus



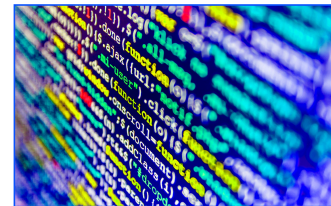
Charge-coupled device



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 acquired 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 assembles a critical component for spacecraft instruments facing an “existential crisis” as its large corporate competitor and source of a key part closes 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 ...no 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 key electronics part 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 = ●

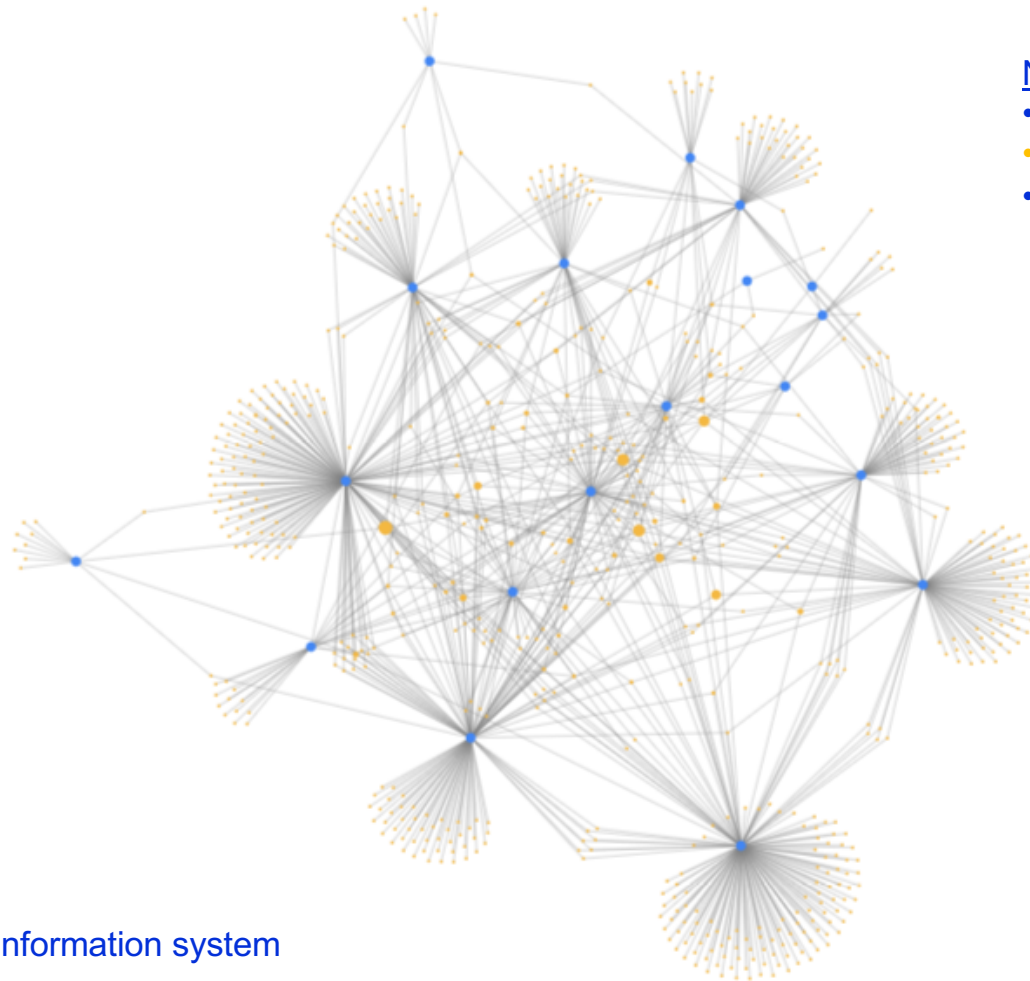


Source: NASA's Meta information system



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



Supply Chain Research & Analysis to Risk Management

GSFC Integrated Risk Management (GIRM) ▼
 MY HOME MY TASKS CALENDAR HELP DESK

GIRM Home Page | GSFC All | GSFC Top Risks

GSFC Integrated Risk Management (GIRM)

[Click for Summary](#) | [Click for Detail](#) | [Click for Risk 5x5](#)

GSFC Center Level Risks Inventory

Highlight Search Results
 Clear Highlight

GSFC Center Level 5 x 5 Risk Summary
 Report generated by Meta on 04/06/2019

Likelihood	Consequences					LxC Trend	Rank	Risk ID	Approach	Risk Title
	1	2	3	4	5					
5	G	Y	R	R	R	↔	1		R	
4	G	Y	Y	R	R	↔	2		R	
3	G	G	Y	Y	R	↔	4		R	
2	G	G	Y	Y	Y	↔	5		R	
1	G	G	G	G	Y	↔				

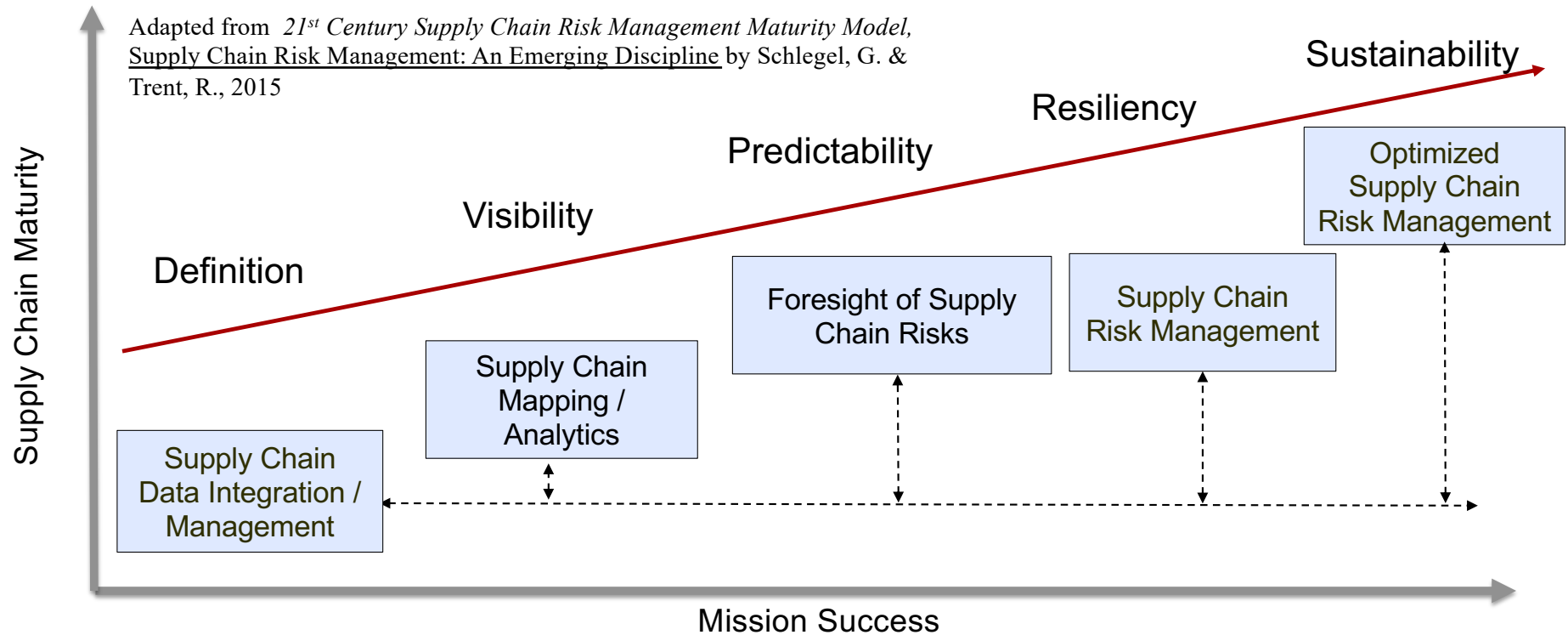
Criticality	LxC Trend	Approach
High	↘ Decreasing (Improving)	M - Mitigate
Med	↗ Increasing (Worsening)	W - Watch
Low	↔ Unchanged	A - Accept
	🆕 New since last month	R - Research



Supply Chain Risk Management

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Adapted from *21st Century Supply Chain Risk Management Maturity Model*,
Supply Chain Risk Management: An Emerging Discipline by Schlegel, G. &
Trent, R., 2015



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

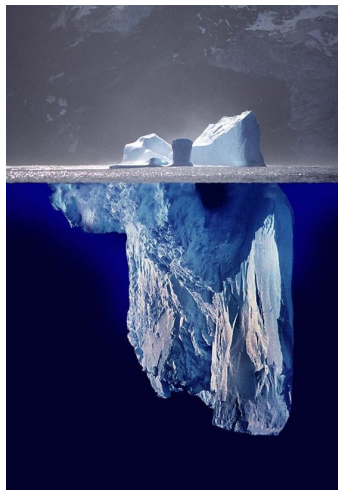
- *Supply Chain Mapping & Analytics*
- *Integrated Risk Management*
- *Meta Information System*
- *Digital Transformation*



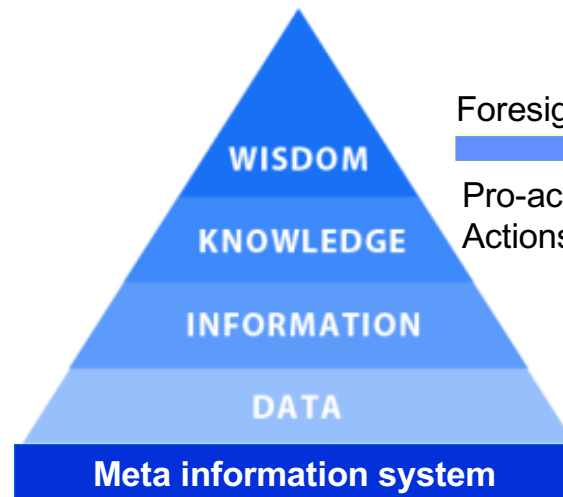
Bringing It All Together

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 build supply chain visibility and provide greater insight into suppliers and their products / services for space systems
- Extending Meta capabilities to identify / assess / manage risks within and across the supply chains of GSFC mission projects



Build Visibility



Foresight



Pro-active
Actions





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