

National Aeronautics and Space Administration

From Reactive to Resilient: NASA's Supply Chain Visibility Initiative

*A Proactive Framework Driven to
Strengthen the Space Ecosystem*

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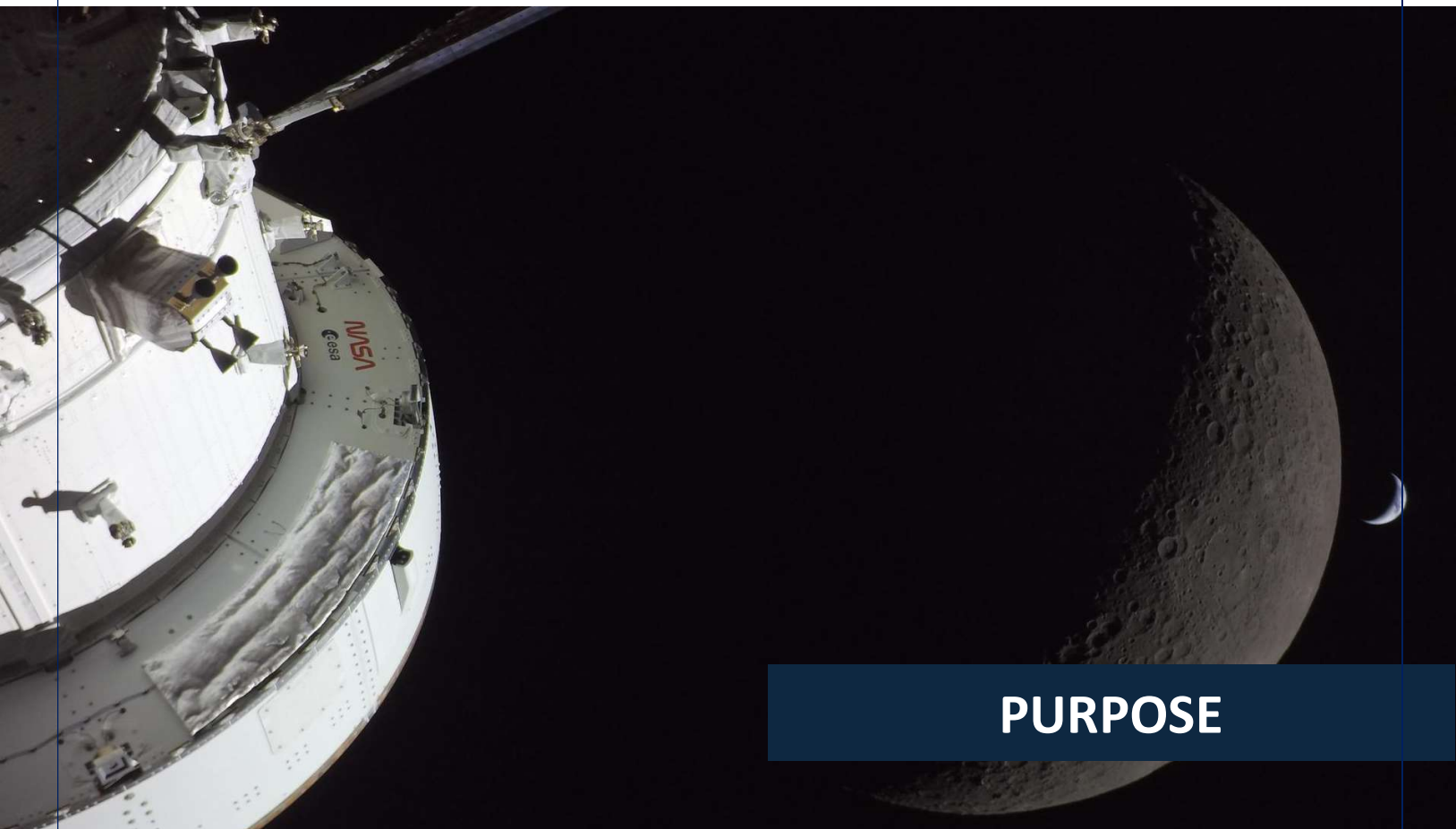


Figure 1: NASA's Orion spacecraft atop the SLS (Space Launch System) rocket launch on the agency's Artemis II test flight, Wednesday, April 1 from Launch Complex 39B at NASA's Kennedy Space Center in Florida. (Credit: NASA/Brandon Hancock)



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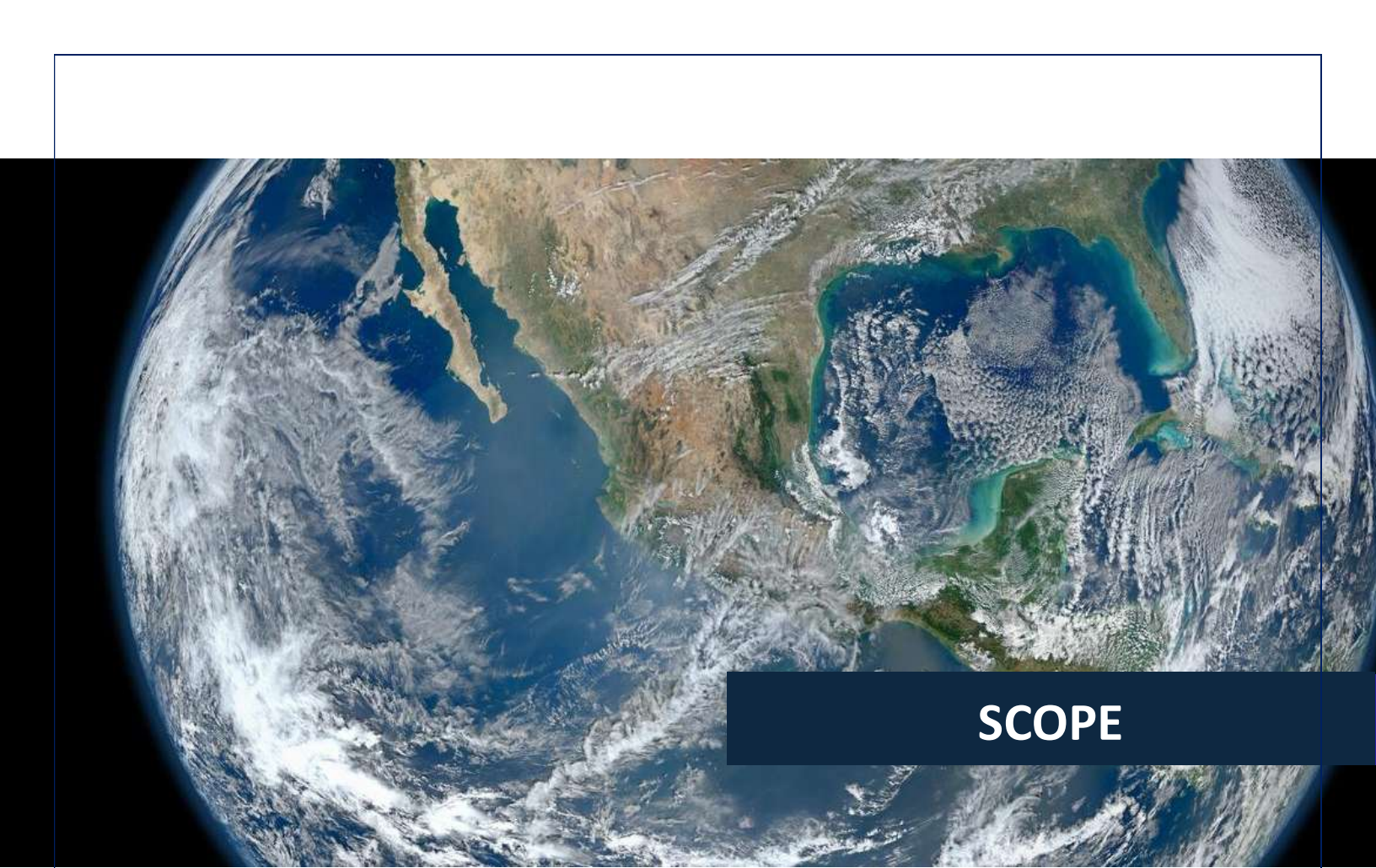


PURPOSE

Figure 2: Orion, the Moon, Earth - NASA's Orion spacecraft captures the Moon and the Earth in one frame during the Artemis II crew's deep space journey. (Credit: NASA)

This paper presents NASA's enterprise approach for Supply Chain Visibility (SCV), a collaborative initiative involving organizational support across many NASA organizations, including the Office of Safety and Mission Assurance (OSMA), Program, Legal Counsel, Engineering, the Mission Directorates, and many others to work towards a unified SCRM strategy. It examines how SCV reporting enables earlier detection of risks contributing to measurable improvements in risk posture – a framework adaptable beyond NASA.

"Develop an integrated lunar architecture and operations plan that identifies the critical path, long lead items, supply chain vulnerabilities, international, interagency, and commercial partnerships and integrate subject matter expertise to drive outcomes within the plan schedule and budget." – Jared Isaacman, NASA Administrator (May 22, 2026)



SCOPE

Figure 3: Composite image created from photographs taken by the Visible/Infrared Imager Radiometer Suite (VIIRS) instrument on board the new Suomi NPP satellite. (Credit: NASA)

As the international space ecosystem expands with new commercial operators, emerging national programs, and increasingly complex mission architectures, supply chain risk evolved from an internal procurement concern into a shared safety and assurance challenge. Supplier weaknesses including quality systems, financial stability, regulatory compliance, and geopolitical exposure now carry consequences that extend well beyond any single agency or program. Recognizing this shift, NASA's OSMA Supply Chain Risk Management (SCRM) Program established SCV as a foundational enterprise capability: a proactive framework for detecting emerging risks and enabling earlier intervention into deeper tiers of the supply chain, where undetected risk often resides.

While NASA actively works to further develop SCV, the complex multi-tier global supply chains spanning commercial industry, non-profits, research institutions, and government partners introduces a need for improved communication and collaboration with industry partners. Over the past several years, NASA has been transitioning from siloed, project-specific SCV practices to a unified Agency-wide approach. This report provides insight into the background and current status of NASA's SCV framework and outlines plans for further developing it.

Executive Summary

EXECUTIVE SUMMARY

Figure 4: Concept for Sustained Lunar Surface Operations at the Moon Base - Artist's rendering depicting astronauts, habitats, rovers, power systems, and cargo operations supporting sustained human activities at the Moon Base near the lunar South Pole. (Credit: NASA)

As the international space ecosystem expands, supply chain risks have evolved from internal procurement concerns into shared challenges for the space and defense industry. Supplier vulnerabilities such as those associated with quality systems, financial stability, regulatory compliance, and geopolitical exposure have direct organizational impact but also impact the broader space community.

Recognizing the need to shift to a more proactive posture, the National Aeronautics and Space Administration (NASA) Office of Safety and Mission Assurance (OSMA) Supply Chain Risk Management (SCRM) Program, established Supply Chain Visibility (SCV) as a foundational enterprise capability. SCV is a proactive, data-driven framework designed to detect emerging risks and enable earlier intervention deep within the supply chain, where hidden vulnerabilities



Figure 5: Gateway space station hosts the Orion spacecraft in a polar orbit around the Moon (Credit: NASA/Alberto Bertolin)

often reside. NASA's approach to SCV is collaborative, involving support across many organizations, including OSMA, Procurement, Programs and Projects, Legal Counsel, Mission Directorates, Engineering, and others, to work towards a unified SCRM strategy.

NASA missions depend on deeply complex, multi-tier global supply chains spanning commercial industry, non-profits, research institutions, and government partners. SCV represents NASA's enterprise-wide shift from reactive supply chain management to a proactive model that tracks every part, material, subsystem, and software element from origin through launch-vehicle integration. This approach strengthens mission assurance, improves supply chain resiliency, and enables NASA to anticipate and mitigate risks before they threaten critical launch windows, safety standards, or national security commitments.

Over recent years, NASA has transitioned from siloed, project-specific SCV practices to a unified, agency-wide approach, driven by U.S. Government policy, increased commercial space activity, and the rising fragility of the national industrial base. Executive Orders and the U.S. Space Priorities Framework emphasize the need for resilient, secure, and transparent supply chains, mandating expanded visibility into prime contractors (suppliers that hold a direct contract with NASA) and their lower-tier suppliers (sub-tiers).

SCV gives NASA a unified, proactive view of both prime contractors and sub-tiers. By requiring contractors to report multi-tier supplier details, SCV enables early identification of risks—such as single-source dependencies, financial instability, and counterfeit vulnerabilities—before they threaten mission success. This unified framework supports compliance with national policy, improves insight into the industrial base, and powers predictive risk analytics across Mission Directorates.

As SCV matures, NASA gains clearer, real-time visibility, stronger resiliency, and the ability to anticipate supply chain disruptions. Robust SCV reduces the cost of failure, protects schedule integrity, and strengthens mission assurance. These outcomes scale across agencies, international partners, and commercial providers in an increasingly interdependent supply chain environment. This paper offers an overview of NASA's SCV and a replicable model for organizations seeking to shift from reactive supply chain response to enterprise-level supply chain resiliency.

SCV Overview

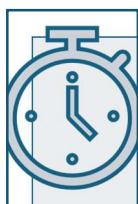
Figure 6: A sliver of the Earth is brightly illuminated against the vast darkness of space. (Credit: NASA)

Within NASA, SCV is the process that allows the collection and sharing of supply chain data, allowing visibility into strengths, risks, and issues. SCV is a shift from reactive to proactive supply chain risk posture, and a path to supply chain resiliency with mission success at the forefront.

- Data collection involves gathering information directly from the supply chain including sub-tier details, places of performance, products and service data (systems, components, parts, raw materials, etc.)
- The data collected is aggregated into other supply chain information systems (internal to NASA and/or 3rd party data) which facilitates advanced levels of insight into NASA's supply chain.

Benefits

When an organization stops reacting to emergencies but instead uses SCV proactively, the entire operational and risk-management models become more efficient and cost-effective. The following are some examples of proactive SCV benefits and how they work in real applications.



Fewer Production Delays - Spotting a late part weeks in advance allows you to change factory schedules before workers sit idle.



Massive Cost Savings - Knowing exactly when parts arrive means you don't have to buy and maintain idle inventory.



Stronger Customer Trust - Providing accurate delivery timelines keeps high-value clients calm and happy.



Rapid Crisis Recovery - If a major storm hits, you can instantly find alternative shipping routes or backup suppliers.

Fewer Production Delays – When a supplier learns that a critical product is delayed at a customs checkpoint, they can promptly adjust their schedule or begin mitigation efforts to minimize the impact. For example, instead of having the assembly team wait for the delayed product, the team can shift to assembling another part of the system. This approach helps keep the overall project timeline on track.

Increased Cost Savings – Historically, suppliers maintained large inventories, commonly known as safety stock, in their facilities to accommodate quick turnaround orders and late shipments. Because warehouse operations are expensive, maintaining larger inventories may not be sustainable for all suppliers. With proactive SCV, organizations can determine which products need to be retained in inventory and which can be trusted to arrive on time. This results in leaner inventory and cost savings, allowing funds to be directed toward efforts that protect the quality of delivered products and services.

Improved Customer Trust – In the space sector, customers may include NASA, other government agencies, academic institutions, or commercial entities. These customers rely on quality deliveries that meet their schedules. Building confidence that suppliers will meet expectations establishes a foundation for unwavering trust, which is essential for mission success. Proactive SCV enables suppliers to provide honest, data-backed arrival predictions, which help protect their reputation and increase their chances of winning future contracts.

Rapid Crisis Recovery – When a major black swan event occurs, such as a global pandemic, a canal blockage, or geopolitical conflict affecting rare-earth raw materials, suppliers with strong SCV capabilities remain composed. Their systems immediately map the disruption, identify which incoming orders are affected, and guide them toward alternative suppliers with available capacity. This demonstrates how supply chain resiliency is strengthened through effective SCV.

Path to Improving SCV within NASA

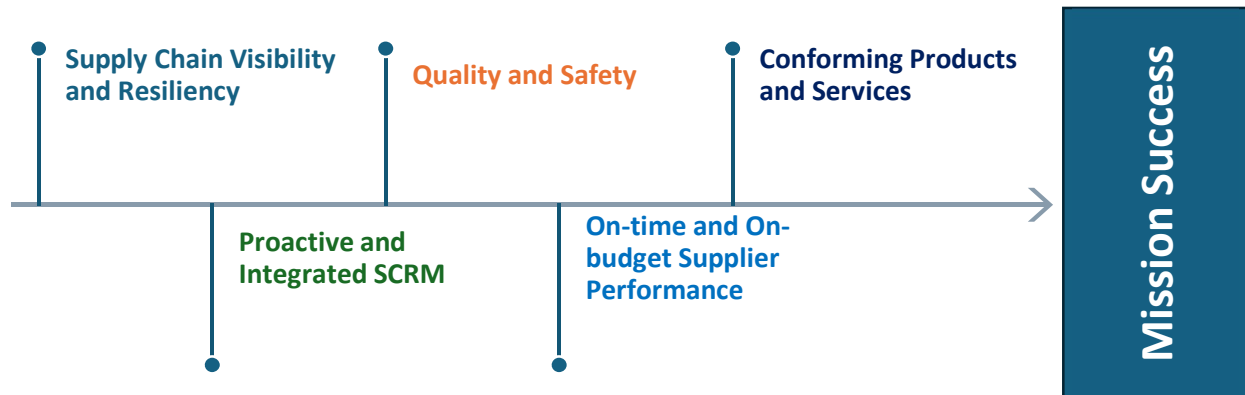
For decades, NASA's supply chain information collection, integration and understanding were highly fragmented. Insight into NASA's supply chain included a myriad of disjointed processes and challenges such as:

- NASA programs and projects managed SCV independently within their respective organizational structures, resulting in supply chain data remaining isolated in silos. When supply chain challenges emerged, individual programs and projects typically resolved issues within their own scope, often without implementing strategies to address the underlying root causes.
- Subject matter experts possessed critical information, but it was not always formally documented; when documentation did exist, it frequently remained isolated.
- Suppliers reported known supply chain risks in accordance with the requirements of each contract, but the data was not shared across the agency.
- While there were some efforts to integrate specific types of data and manage supply chain risks, most organizations maintained their own distinct datasets (for example, in procurement, quality, and engineering.)
- Agency-level risks were typically identified through experience or informal communication, rather than being driven by data.

The inability to access and aggregate the data resulted in supply chain risk evaluations that didn't fully understand and address the risks. In 2019, NASA OSMA established SCRM program which quickly identified the integration challenges and was tasked with identifying and working on a solution. NASA's Supply Chain Insight Central (SCIC) information system was released to help with such efforts. Although initiatives were implemented to integrate supply chain data, the process was slow as the agency lacked collaboration between Centers and organizations to successfully integrate data.

In 2023, after various collaboration efforts, NASA senior leadership established the Supply Chain Resiliency Board (SCRB) to prioritize enterprise-level Supply Chain Resiliency for current and future needs and advance to a more cohesive supply chain culture. The board integrated cross-organizational leaders (Procurement, Legal, SMA, Engineering, Financial, Mission Directorates, Information & Cyber Security, etc.) to deploy strategies and improvements rapidly. All organizations had similar objectives for improving SCV and strengthening the supply chain.

Common Objectives Across SCRM



While all objectives were important, SCV was essential for enabling proactive, cross-functional risk management and informed decision-making. This capability ultimately increased confidence in achieving both product and personnel quality and safety.

A clear distinction existed between supplier-specific risks, often the primary focus of individual programs and projects, and broader supply chain risks, which the agency needed to address in order to maintain a resilient space industrial base. Understanding and managing supply chain risks at the agency-level requires comprehensive SCV. Although both types of risk are significant, effective mitigation of agency-level risks is only possible with robust visibility across the supply chain.

Differences Between Supplier-Specific Risks and Supply Chain Risks

	Supplier-specific Risk	Supply Chain Risk
Scope	One Supplier	Multi-tier Supplier Network
Risk Visibility	Tier 1	All associated tiers
Risk Factors	Risks are specific to that supplier (<i>e.g., supplier performance, financial health, key workforce competency, nonconforming product, quality system, etc.</i>)	Risks are associated with the entire supply chain ecosystem (<i>geopolitical tensions, sector dependencies, wide-ranging regional/market disruptions, access to critical materials, etc.</i>)
Consequence	Isolated Impact: One NASA Project	Wide-ranging Impact: Multiple NASA Projects; cross-Mission disruption

One of the agency's top objectives was to obtain comprehensive SCV information. Initial assessments revealed that visibility into prime contractor data was generally sufficient; however, significant gaps existed at the sub-tier levels of the supply chain. The SCRB concluded that an enterprise-wide solution was necessary and a decision was made to implement internal improvements and establish partnerships with prime contractors to jointly enhance SCV. This collaborative approach will also allow prime contractors to align with NASA's Small Business Innovation Research (SBIR) and address industrial base needs.

SCV Deployment

Rapidly evolving federal supply chain policies and priorities, along with persistent supplier disruptions have demanded a strategic shift in how NASA manages its critical supply chain. To secure long-term program stability and align with United States Government (USG) directives, NASA had to aggressively strengthen its supply chain resilience and visibility frameworks.

The Urgency

Identified gaps in supply chain data integration, increased reliance on commercial products and services, ongoing supplier challenges, and evolving governmental executive orders and administrative policies prompted NASA to accelerate the implementation of a comprehensive SCV approach across the agency. When the SCRB was established, United States Government (USG) administration policies on supply chain management clearly emphasized the importance and necessity of strengthening supply chain resilience.

[Executive Order \(EO\) 14005](#), Ensuring the Future is Made in All of America by All of America's Workers (1/25/2021): "the United States Government should [...] maximize the use of goods, products and materials produced in, and services offered in, the United States."

[EO 14017](#), America's Supply Chains (2/24/2021): "the United States needs resilient, diverse and secure supply chains to ensure our economic prosperity and national security."

[United States Space Priorities Framework](#) (12/2021): "the United States will [...] strengthen the resilience of supply chains across the nation's space industrial base."

[EO 14123](#), White House Council on Supply Chain Resilience (6/21/2024): "the Council shall coordinate and promote Federal Government efforts to strengthen long-term supply chain resilience and American industrial competitiveness"

More recently, NASA is assessing SCRM program and SCV improvements to comply to the latest USG White House EO 14415, titled "**Securing America's Defense Supply Chains and Ensuring Domestic Acquisition of Critical Materials**" and dated July 20, 2026.

This policy mandates that the United States secure critical technology supply chains against foreign subversion by prioritizing domestic or allied sourcing for manufacturing, heavily impacting NASA's aerospace procurement and collaboration with defense contractors. By January 1, 2027, the policy restricts supply chain waivers under 10 U.S.C. 4872, which may require NASA to proactively audit dual-use technologies and ensure compliance within its contractor base.

To ensure long-term program stability, NASA may act to map material origins and transition to compliant sources, mitigating risks to space exploration hardware. The elimination of routine waivers may necessitate immediate, strict oversight of both prime contractors and sub-tier suppliers to avoid disruptions in technology acquisition.

Establishing the SCV Process

To address SCV gaps, NASA's OSMA SCRM program began working towards integrating internal supply chain data into the SCIC information system. However, a more consistent and reliable process was needed to gather information about NASA's supply chain not just at the prime contractor level but for sub-tiers.

Effective June 28, 2024 and in accordance with the decision of the NASA SCRB, NASA implemented the SCV Reporting Data Requirement Description (DRD), which established prime contractors as a key part of agency efforts to pro-actively address U.S. industrial base and supply chain risks. NASA Headquarters' OSMA SCRM program, on behalf of the SCRB and in collaboration with the Office of Procurement, Mission Directorates and other SCRB members, lead and coordinated the implementation of the SCV Reporting DRD contractual requirement. The requirement for implementation was issued on July 16, 2024, Procurement Information Circular for the implementation of SCV Reporting (NFS Case 2024-N014) providing instructions to NASA's Contracting Officers (COs) for the implementation of the SCV Reporting.

The SCV Reporting DRD is flowed to primes via solicitations and new contractual awards, including task orders, of Programs and Projects governed by NPR 7120.5, NASA Space Flight Program and Project Management Requirement when:

- Contract or task order is \$20 million or more (including options),
- Products to be delivered are in the Program or Project's critical path, or
- Program/Project determines that supply chain management is necessary.

The SCV Reporting requirement is also added to solicitations and contracts, including task orders, where a prime contractor is or may procure on behalf of NASA, or serves as a procurement agent for products and services for Programs and Projects governed by NPR 7120.5, NASA Space Flight Program and Project Management Requirements.

Compliance with the SCV Reporting requirement is established by holding prime contractors accountable to provide information pertaining to the product and/or service deliverables required by the NASA contract for the following contractual tier-suppliers:

- i. Tier One (1) – NASA's prime contractor
- ii. Tier Two (2) – The prime contractor's direct subcontractors
- iii. Tier Three (3) – The suppliers to the Tier 2 subcontractors

For each Tier 1, Tier 2 and Tier 3 supplier, the prime contractor is responsible for providing:

Name of Operating Entity (doing business as);

Direct contracting customer entity, for Tier 2 and Tier 3 issued procurement contracts, and period of performance (start and end dates for awards and amendments);

Location(s) of contract performance, including complete addresses (street number, city, state, country, ZIP code or international equivalent);

Unique identification codes or contract numbers for the contract(s) as issued by NASA, the prime contractor, and the subcontractor(s);

Commercial and Government Entity (CAGE) code, Unique Entity Identifier (UEI) or North Atlantic Treaty Organization Commercial and Government Entity (NCAGE) code, or N/A if not applicable;

Summary description of the contractually required product or service deliverables, including the product/service name, part or model number, or other identifying information as applicable;

Identification of the NASA Technology Taxonomy, and subordinate technology subarea(s) as applicable, that correspond to the contractual products or services and their utilization, application, or integration.

Via the SCV Reporting requirement, prime contractors are also responsible for flowing down the SCV Reporting requirements to their Tier 2 suppliers as necessary to support the prime contractor's fulfillment of the Tier 3 SCV Reporting requirement.



Figure 6: Roman Space Telescope Arrival – The Pegasus barge delivered NASA's Nancy Grace Roman Space Telescope for the Artemis III SLS rocket core stage to Kennedy. (Credit: NASA/John Kraus)

Fundamentals of an Effective SCV

Addressing a Culture Shift from Reactive to Proactive

Effective SCV involves understanding the critical supply chain at all levels (from raw materials to the operational system) and requires real-time data sharing on component lead times, sub-tier supplier risks, and strict counterfeit-parts tracking and rapid management of nonconforming products. SCV helps identify bottlenecks, prevent counterfeit parts from being used, and protect critical launch milestones before they impact the flight line.

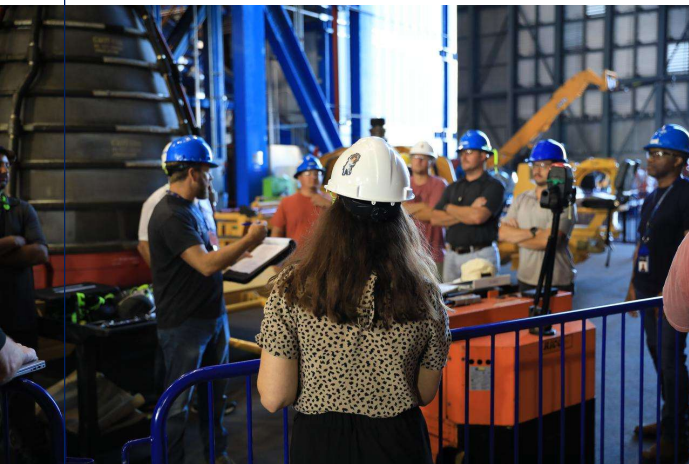


Figure 7: Artemis III RS-25 Engine Processing – NASA employees discuss rocket engine installation at inside the Vehicle Assembly Building at NASA's Kennedy Space Center. (Credit: NASA/Clayton Rougelot)

Proactive SCV transforms NASA's procurement and logistics from a reactive day-to-day task into a robust risk-management shield for mission assurance. In an environment where a single flawed microchip or a suspected counterfeit part can ground a multi-billion-dollar rocket, waiting for failure to happen is a luxury the space sector cannot afford. By establishing a traceable and reliable mapping of the supplier network, NASA gains the predictive intelligence required to intercept threats throughout the lifecycle of the mission. Instead of discovering a part or material is obsolete, or a small mom-and-pop supplier has gone bankrupt when an order goes unfulfilled, a robust SCV system helps flag vulnerabilities months in advance. The early warning enables program and project managers to qualify

alternative suppliers, re-engineer components, or buffer inventories, effectively neutralizing risks before they can threaten a planetary launch window.

Furthermore, SCV elevates risk-mitigation efforts from reactive practices to predictive and strategic frameworks across the entire project lifecycle. One of a kind and highly-delicate spaceflight hardware, such as satellite optical instruments or cryogenic valves, is highly vulnerable to environmental stressors during transit. A robust SCV framework is embedded into

all phases of the mission, including pre-phase A and the solicitation and supplier-qualification stage.

To achieve full SCV, NASA relies on four core inter-dependent tasks:

1. Flow-down of SCV Reporting – Contractually requiring prime contractors to report lower tier suppliers to provide products and services in support of the prime contract.
2. Comprehensive Supply Chain Information System – Transitioning from manual and siloed supplier tracking to a more automated and integrated online system enables efficient and reliable risk assessment methods.
 - a. This approach provides a centralized platform for integrating both internal and external data, offering a dependable resource for stakeholders (e.g., program and project managers, engineers, and safety and mission assurance personnel) to instantly query the supply chain history of any active, mission-critical component throughout the lifecycle of a program or project.
3. Multi-Tier Supplier Mapping – Tracing critical supply chain ecosystem beyond the prime, down to sub-tiers. This helps identify hidden single-source bottlenecks, financial insolvencies, or foreign-influence risks deep within the supply chain. Benefiting the Program/Project by preventing a mission-critical halt due to unexpected supplier-related product failure or delays.
4. Industrial Base Partnership – Collaborating closely and partnering with prime contractors to achieve SCV objectives enhances NASA’s mission success. This approach provides programs and projects with a deeper understanding of their supply chain ecosystems, both within their own operations and across other programs and projects throughout the agency.

The SCV Framework

Building an effective and highly visible SCV framework requires a combination of clear communication standards across NASA, modernized software capabilities, and rigorous data collection and reporting practices. Within industry, organizations that operate mature SCV programs rely on several proven methods to keep supply chain systems efficient and resilient. These same principles are what NASA aims to strengthen as SCV continues to evolve and grow across the agency.



Figure 8: Artemis II Crew Arrives at KSC Ahead of Launch.
(Credit: NASA/Brandon Hancock)

Secure Web-based Prime Contractor Reporting – Instead of forcing every prime contractor to download expensive, clunky software, modern organizations build a central secure web-based solution. Prime contractors of all sizes (from tiny mom-and-pop machine shops to multi-billion-dollar spacecraft manufacturers) can securely log in through a web browser to update their production schedules and shipping statuses.

Standardized Technology Nomenclature – To prevent data confusion, every supplier in the supply chain must speak the same language. Organizations typically enforce universal technology nomenclature for purposes of tracing hardware and running analytics. For example, NASA uses its Technology Taxonomy, which is a comprehensive classification system that organizes, identifies, and categorizes the vast array of technologies relevant to critical space missions, and provides an indexed, multi-level structure that maps out the agency's technological capabilities and needs.

Supply Chain Metrics and Key Performance Indicators – Performance metrics enable organizations to monitor supply networks through integrated data, allowing agency-level indicators to trigger early risk notifications. Concurrently, program leadership retains flexibility to generate tailored analytics to proactively shift work away from unreliable vendors and increase oversight before performance issues escalate. By focusing on analytics that are critical to operations, organizations can act proactively by shifting work away from unreliable suppliers or increasing surveillance where is most needed before performance issues escalate.

Competency – Effective SCV depends on people. Requirements must be clearly communicated, contractors need to provide accurate data, and teams must be prepared to perform the necessary analytics. Training and disciplined execution are essential when deploying any new initiative. At NASA, this included routine check-ins and close coordination across organizations involved in the supply chain.

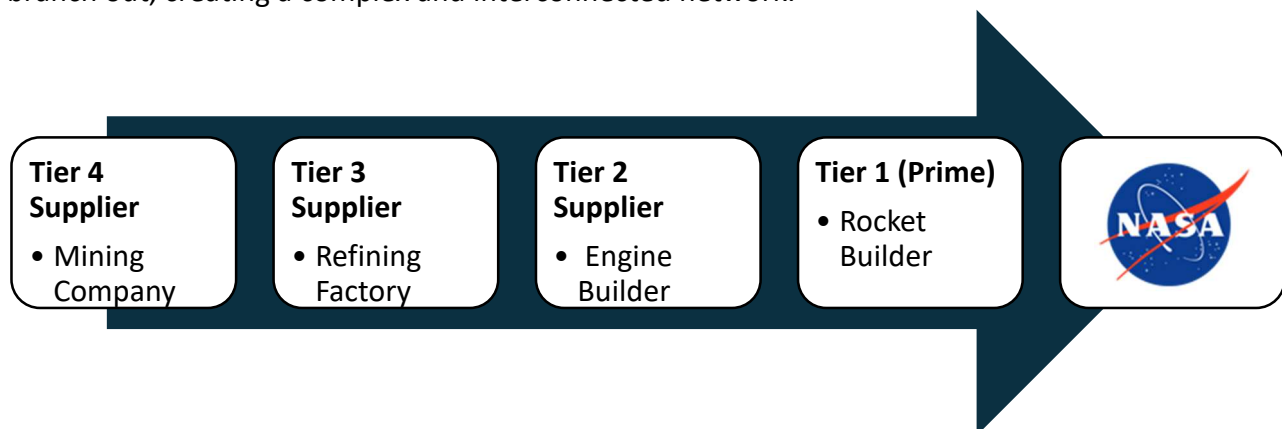
Flexibility – Any new process must be practical, adaptable, and user-friendly for the team using it or they will eventually fail. It is crucial for an organization to listen to those performing the work and to allow reasonable flexibility, helping avoid delays and ensuring smoother adoption during early implementation.

SCV Across the Industrial Base

Foundations of SCV in the Industrial Base

The "industrial base" is the collective network of original equipment manufacturers, raw material providers, test laboratories, distributors, and engineering support companies that sustain a nation's infrastructure and defense capabilities. In this complex, interconnected ecosystem, SCV operates on an enormous scale.

The graphic below illustrates the various levels within a supply chain network. In practice, the supply chain can extend to more than four sub-tiers, starting from NASA and reaching all the way to the raw material suppliers. At each level after the prime contractor, multiple suppliers may branch out, creating a complex and interconnected network.



As SCV deepens and the industry adapts to evolving risks, several advanced strategies are shaping how organizations manage supply chain complexity and resiliency. The following concepts highlight essential approaches (from tracking deep tier suppliers to aligning government and commercial priorities) that are transforming SCRM within the aerospace industry.

- **Deep Tiering** – When a company builds a rocket, they buy the engines from a "Tier 1" supplier (the prime contractor). That engine builder buys an engine from a "Tier 2" supplier, who buys raw titanium from a "Tier 3" mining company. True industrial base

visibility means tracking all the way down to Tier 3 and beyond. If a tiny Tier 3 supplier faces a shortage, the entire industrial base feels the shockwave.

- **Shared Government and Private Standards** – To protect national security, governments work closely with private space firms to establish data-sharing protection laws. These rules mandate that suppliers report where they buy and sell their products/services to help mitigate the risk of adversarial nations secretly sabotage or spying on critical infrastructure components, or weaponizing critical raw materials and components of national security importance.
- **Industry Capacity Assessments** – SCV provides government and industry leaders a holistic view of the supply chain. If multiple aerospace companies are all trying to buy specialized carbon fiber from the same handful of factories, the visibility network can help flag that the industrial base is hitting its maximum capacity, signaling to NASA that it is time to invest in deploying mitigations such as finding and qualifying new supplier sources or finding alternative solutions.
- **Alignment and Prioritization of Defense and Civilian Missions** – Many space companies launch satellites for both private internet companies and operations related to USG national security and interests. SCV can help orchestrate this dual-use supply chain network by helping ensure that urgent missions get priority access (to shipping lanes and launch pads, for example) without derailing commercial space commerce.



Figure 9: NASA mission programs and projects rely upon the U.S. industrial base and transnational supply chains of commercial, non-profit, and government organizations to develop and operate complex, high-value, and innovative systems for the nation. (Credit: NASA)

SCV Impacts on the Space Sector

SCV is widely utilized across various industries, though its application and depth can vary significantly. Industries that require thousands of piece parts often have a more comprehensive understanding of the origins and flow of those components. In contrast, the space industry is unique: product requirements frequently push technological boundaries, relying on research to produce only a handful of specialized products.

While NASA is increasingly integrating commercial products and advancing the commercialization of space systems, similar risks persist across the broader industrial base. These risks include material issues, obsolescence, supplier unavailability, logistics challenges, and socio-political impacts affecting key space suppliers. Establishing a consistent approach to managing these risks is critical, as it directly influences national investments in areas where the industrial base needs support most.

In most everyday businesses, a supply chain delay might result in an empty store shelf for a few days, customers turning to alternative providers, or late deliveries. However, in the space industry, a single supply chain error can lead to missed flight windows, significant delays, costly rework or retesting, and ultimately even critical mission failure. The stakes are uniquely high-risk for several reasons, including:

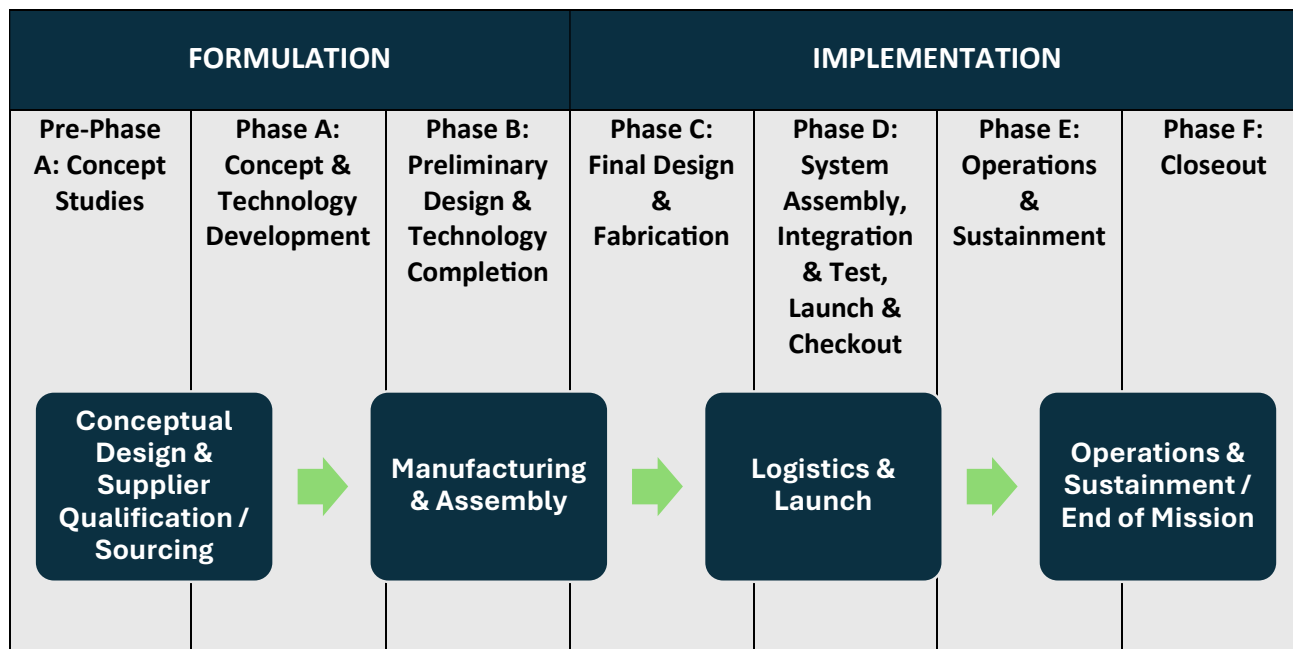
Industrial Risk	Risk Description	Successful SCV Impact
Extreme Environments	- Parts must survive intense heat, cold, and radiation. - Space hardware operates in a vacuum, faces intense solar radiation, and swings between hundreds of degrees of boiling heat and freezing cold. - The ability to withstand extreme environment depends on product reliability and testing.	- Help identify if the right products were used, prompting early detection of risks. - The Industrial Space Base is phased with distinct risks, and integrating those risks with the related supply chain risks provides a clearer understanding of their potential impact.
Zero-Defect Tolerance	- Critical path product defects can lead to mission failures. - One microscopic flaw can destroy a whole satellite. - If a valve fails on a satellite orbiting thousands of miles above Earth, the mission is lost.	Provides a trail showing traceability of the product and the associated inspections and test results.

Counterfeit Electronic Components	• Fake, low-grade chips can fail silently in orbit and are a massive threat to Space safety. • Dishonest suppliers sometimes take cheap electronics, polish off the labels, print fake military logos on them, and sell them for a premium.	• Supports counterfeit prevention by creating a traceable chain of custody. • In the event that a suspect counterfeit is identified, SCV can quickly help assess where the part is deployed.
Strict Export Laws	• Government agencies heavily guard advanced designs and protect space technology. • In the United States, laws like ITAR and Export controls dictate exactly who has access to restricted components.	• Help ensure that sensitive parts are not accidentally routed to the hands of unauthorized foreign-based or foreign-controlled supplier.

SCV in NASA's Product Life-cycle Stages

SCV's Role in Every Phase of the Product Life Cycle

One of the fundamental concepts used within NASA for the management of major systems is the program/project life-cycle, which defines a process with milestone at distinct phases to develop a Project. A product's life-cycle is the journey it takes from conceptual design to end of mission. SCV is not just an instrument for looking back and learning which suppliers were part of the Program/Project's supply chain ecosystem, SCV changes how engineers work at every step of the mission and leverage supply chain information for proactive and real-time risk mitigation efforts.



- ❖ **Conceptual Design & Supplier Qualification/Sourcing** – In conceptual design, NASA can use available information to determine feasibility, options, and make decision fueled make/buy decisions. Risk-based surveillance is applied at contracts starting early to the end. .
- ❖ **Manufacturing & Assembly** – SCV enables the capture of sub-tier data, facilitating coordination of identified risks with prime contractors and empowering Primes to communicate those risks to NASA. For Program Management, agency-level risk notifications will be automated as information is collected, ensuring leaders have timely access to critical data for informed decision-making.
- ❖ **Logistics & Launch** – Because spaceflight leaves zero margin for error, reliable visibility into the tier-subcontractor network prevents delays, controls quality, and secures complex launch schedules. This helps ensure that mission-critical logistics and launch windows are strictly maintained.
- ❖ **Operations/Sustainment & End of Mission** – The lifecycle of a spacecraft does not end at launch. Many satellites and spacecraft are designed to operate for years, or sometimes even decades. An advanced SCV system can give NASA comprehensive visibility into the full supply chain ecosystem of missions currently in operation as well as those from previous programs and projects, strengthening planning and decision-making efforts for future missions.

Leveraging SCV for Risk Management

SCRM aims to protect NASA from unexpected disruptions by rapidly assessing, understanding, and mitigating associated risks at all product life-cycle stages. An integrated SCV information system serves as a high-tech, data-driven shield that helps Program/Project leadership access the information needed to identify and address risks effectively. The goal is for NASA to have a robust SCV information system that allows early detection or rapid deployment of mitigations when impacted.

Examples of Supply Chain Disruptions

Geopolitical Mapping

- Modern SCV software can overlay a map of a Program/Project's supplier network with near real-time notifications of geopolitical instabilities such as disputes or trade wars.
- Risk managers can quickly see suppliers located within that region, allowing them to move operations to safer regions before sanctions or borders lock down.

Weather Disruption Alerts

- SCV software can integrate directly with meteorological tracking systems to provide notifications of potential impacts to supply chain operations.
- If a destructive hurricane forms in the Atlantic Ocean, the system provides insight into potentially impacted suppliers and logistical impacts (e.g., enroute cargo on a ship).

Weather Disruption Alerts

- SCV software can integrate directly with meteorological tracking systems to provide notifications of potential impacts to supply chain operations. If a destructive hurricane forms in the Atlantic Ocean, the system provides insight into potentially impacted suppliers and logistical impacts (e.g., enroute cargo on a ship).

Supply Chain Dependencies

- A robust SCV reveals when the organization relies too heavily on a single point of failure.
- If the data shows that 100% of a critical system comes from one specific source, risk managers will use that insight to implement a dual-sourcing strategy, splitting their orders between two independent factories located in different parts of the world.

Risks of Not Having an Effective SCV System

In the space industry, SCV is a mission-critical requirement. The sector's reliance on highly specialized components, extreme quality standards, and strict government regulations intensifies the consequences of supply chain blindness or disjointed visibility. Examples of such mission-critical consequences include:

1. Program Schedule Slips and Launch Window Misses

Supply chain delays in space programs create a domino effect—missing a single critical part can push launches past fixed windows, halt multimillion-dollar integration, leave specialized teams idle, and freeze contract payments. These risks compound, threatening both schedule and financial stability across the entire supply chain.

2. Compromised Quality Assurance and Potential Mission Failure

Lack of SCV exposes space programs to counterfeit and untested components, undermining reliability and mission safety. Without traceability and assurance of proper testing, organizations face increased risk of substandard parts entering critical systems, threatening both operational integrity and compliance.

3. Critical Single-Source and Sub-Tier Vulnerabilities

Hidden dependencies, obsolete parts, long lead-times, and supplier insolvency all stem from limited SCV. These risks can disrupt production, delay missions, and expose organizations to sudden shocks, making proactive monitoring and diversified sourcing essential for resilience.

4. Severe ITAR, Export Control, and Sovereign Compliance Violations

These type of risks are interconnected and stem from gaps in SCV, especially at lower tiers and logistics nodes. Addressing them requires robust tracking, vetting, and audit mechanisms across all supply chain layers. Risks in this category include export violations, foreign influences, regulatory audit failures due to data gaps, breach of security clearance.

5. Extreme Cost Overruns and Premium Expediting Fees

Last-minute disruptions in space supply chains sharply increase logistics and engineering costs, and expose organizations to severe financial penalties. Risks include premium freight charges, redundant engineering re-work, and liquidated damages for late payload deliveries. Proactive visibility and contingency planning are essential to mitigate these impacts.

Common Pitfalls of SCV

Implementing a robust SCV system may sound ideal, but it can quickly fail if critical elements are not properly implemented, integrated, or maintained. SCV is not something done by one organization within NASA, SCV relies on commitment and active engagement from various stakeholders across the agency.

Inadequate Leadership Alignment and Commitment

Stronger direction and alignment with SCV priorities is required to translate strategy into meaningful progress. Lack of needed investment and commitment to drive accountability and ensure leadership at all levels integrates SCV objectives into operational practices can stall the maturity of SCV within the organization.

Data Overload and Lack of a Defined Cohesive SCV system

If organizations lack robust processes and tools for integrating supply chain data, information overload can quickly make analysis unmanageable. Excessive alerts lead to “alarm fatigue,” causing staff to overlook real risks. Without standardized practices and systems, it becomes difficult to trace suppliers and effectively manage risks throughout critical supply chains.

Human Input Errors and Inconsistency

An SCV tracking system is only as reliable as the data entered into it. If data integrity and consistency is not prioritized, the entire system becomes compromised, and users lose trust in its accuracy. This is often summarized as “Garbage In, Garbage Out.” This can also be a root cause of the organization's lack of committed to internal integration and the talent required to provide necessary support.

Siloed Software and Decentralized Data Systems

Large organizations (e.g., Programs/Projects, Directorates) often struggle with fragmented digital supply chain ecosystems. Office of Procurement (OP) team may use one system, Program/Project engineering another, and Logistics a third. When these systems cannot communicate without manual intervention, SCV breaks down and critical updates disappear into gaps between departments or don’t happen at all.

Cybersecurity Vulnerabilities

In the space and defense sectors, a highly visible supply chain can unintentionally become a roadmap for hackers or hostile actors. When a company opens a shared portal for hundreds of small vendors to upload data, a single weak password at one supplier can compromise the entire network. This can allow unauthorized access, theft of sensitive rocket designs, or monitoring of military shipment schedules.

The Future of SCV

Leveraging Artificial Intelligence (AI) to Strengthen SCV

AI has changed supply chain tracking from a reactive history lesson into a predictive instrument. When implemented effectively, AI handles the heavy lifting of sorting through massive amounts of supply chain network data to find hidden patterns.

NASA will be able to use AI to predict problems, plan ahead, and keep an eye on suppliers of greater risk that are part of the supply chain ecosystem.

Advantages of Investing In and Leveraging AI

Dynamic Mission Demand Forecasting	AI can help analyze changing schedules, past launches, and key engineering trends to predict exactly what materials NASA will need for future missions. This way, NASA can order the right parts and supplies before they're needed to avoid delays during the formulation life cycle.
Autonomous Supply Chain Risk Monitoring	AI can monitor all the companies that supply NASA with critical products and services for things such as geopolitical or regional vulnerabilities, financial risks, patterns of quality or nonconforming products, or late deliveries. If a supplier looks risky, AI can warn appropriate NASA leadership so they can quickly work on needed risk mitigation efforts.
Automating Tasks	In most cases, AI can handle boring, entry-level and repetitive jobs better than humans. Using AI to do such monotonous tasks can save time and money when workforce and budgets are strained.
Spotting Problems Early	AI can analyze tons of information from different places, super-fast. It can notice patterns or weird things that might mean there's a delay or something's stuck. This helps organizations fix problems before they get too big or out of control.
Making Everything Faster	Provided AI is effectively implemented, it can automatically create and manage procurement orders, keep track of shipments, and warn key staff if something's wrong. It can even adjust how much inventory is in stock so there's always enough, but not too much.

Next Steps

Improvements to SCV going forward aim to grow SCV reporting and provide proactive data-driven risk analysis in support of NASA's critical-path missions.

Enhance visibility into Prime Contractor's supply chain providing products/services to NASA critical missions

- Provide insight into NASA's sub-tier suppliers and their role supplying products/services across the agency, Mission Directorates, and Programs/Projects
- Facilitate data needed to visualize NASA's supply chain across all Mission Directorates (MD) and Programs/Projects
- Improve SCV Training and Communication

Improve SCRM analytics and trends to aid decision-making and risk mitigation efforts

- Implement performance metrics
 - Focus SCV metrics on critical risk areas
 - Outcome-oriented metrics that align SCV efforts and enterprise goals
 - Facilitate supply chain data to allow for the real-time monitoring of critical risk areas as related to the supply chain
- Provide ability to map suppliers and flag potential risks related to
 - Heavy Supplier Dependencies (over-reliance)
 - Limited and Sole Source Suppliers
 - Domestic unavailability of critical raw materials
 - Geopolitical vulnerabilities
 - Other supplier-related disruptions

Identify supply chain risks related to NASA critical products

- Identify suppliers providing critical at-risk items industrial technology or other raw materials critical to NASA missions

Near-term Priorities (12 – 18 months)

1. **Expand reporting coverage** – Complete prime contractor onboarding to the SCV DRD across all eligible NPR 7120.5 efforts; drive Tier-2 and Tier-3 coverage with measurable thresholds (e.g., % of critical-path contracts with verified multi-tier data).
2. **Integrate and strengthen the SCV information system backbone** – Continue integrating internal/third-party supply chain information into NASA's SCV information system; standardize technology nomenclature via the NASA Technology Taxonomy to enable reliable analytics.
3. **Operationalize metrics** – Institutionalize enterprise Key Performance Indicators (e.g., supplier dependency index, financial health, counterfeit incidents, supply chain assessment nonconformances, export-control violations) and automate agency-level alerts for emerging risks.
4. **Strengthen competencies and governance** – Scale training for SCV processes and analysis; maintain disciplined execution to avoid “alarm fatigue” and data-quality drift; reinforce cross-functional governance to reduce silos.
5. **AI-enabled risk monitoring** – Deploy AI use-cases that accelerate detection of supply chain disruptions such as geopolitical tensions and weather threats, supplier financial-health monitoring, and dependency analytics while maintaining human-in-the-loop oversight.



Figure 10: An artist rendition of an astronaut in NASA's Artemis exploration suit against a lunar backdrop, with a reflection of Mars across the helmet visor, symbolizing humanity's next giant leap from the Moon to the Red Planet. (Credit: NASA)

Conclusion

Ultimate SCV Benefits to NASA

NASA's adoption of SCV moves the agency from a reactive posture to a proactive enterprise capability that guards mission assurance, schedule integrity, product quality and safety, and national interests. By formalizing SCV as a foundational element of NASA's OSMA SCRM Program and integrating contributions across Procurement, Programs/Projects, Legal, Engineering, Mission Directorates and others, NASA now has a shared, data-driven framework to identify emerging risks early and where vulnerabilities most often hide in multi-tier supplier networks.

As NASA continues to gain visibility into prime contractors and sub-tier suppliers, it enables cross-agency insight, improved SCRM analytics, and clear mapping of supplier roles, dependencies, and risk-critical attributes across Mission Directorates and Programs. With proactive SCV initiatives, NASA can quickly identify common, limited-source, and system-level suppliers, map them to its taxonomy, and pinpoint suppliers providing critical or at-risk industrial technologies essential to mission success.

Because NASA missions rely on deep, global, multi-tier supply chains spanning industry, academia, and government partners, visibility beyond the prime contractors to sub-tiers is essential to uncover bottlenecks, prevent counterfeit or non-conforming parts, and guard critical launch windows against avoidable delays. Embedding SCV across the full program/project lifecycle (from pre-Phase A qualification through Phase F closeout) turns supplier information into mission-risk intelligence, enabling proactive surveillance, smarter make/buy decisions, and early routing to alternative sources when needed.

Projected Measurable SCV Outcomes

To ensure SCV efficacy, NASA's Programs and Projects can establish clear methodologies to track and quantify the initiative's value and impact.

- ✓ **Mission assurance & schedule protection:** fewer surprises; earlier re-planning; minimized idle labor and retest cycles.
- ✓ **Counterfeit & quality risk reduction:** traceable chain-of-custody, faster impact assessment when suspect parts are identified, and stronger prevention at intake.
- ✓ **Compliance monitoring:** improved readiness for export controls, ITAR/EAR obligations, and forthcoming EO 14415 constraints on waiver use.
- ✓ **Industrial-base insight:** visibility to capacity constraints, geographic concentrations, and cross-program dependencies to inform agency-level interventions.
- ✓ **Cost efficiency:** targeted safety-stock, lower premium expediting, and fewer late-stage engineering workarounds.

Guardrails to Sustain SCV Progress

Though a cohesive SCV is more developed today than it was years ago, the effort is ongoing. Similar to Mission Assurance and Quality, SCV is a continuous effort that keeps getting more robust as it matures. The path to NASA's supply chain resiliency relies on SCV to continue to grow. Ultimately, NASA will benefit from SCV by facilitating the sustained development of a cohesive approach towards SCRM across the agency and leveraging AI to help automate and improve access to real-time supply chain information for faster and more effective decision-making. This, however, includes multiple elements to secure sustained progress and continuity.

- ❖ **Leadership alignment & funding:** keep SCV objectives visible in program baselines and center plans; resource integration efforts to avoid partial adoption.
- ❖ **Data discipline:** enforce standards, validation, and versioning; measure data completeness at each tier; treat "garbage-in, garbage-out" as an explicit risk.
- ❖ **Cybersecurity & access controls:** secure supplier portals and SCV data flows; protect sensitive industrial-base maps against misuse or adversarial targeting.
- ❖ **Anti-silo architecture:** integrate Procurement, Quality/Engineering, Logistics, and Mission operations systems to ensure alerts and mitigations traverse organizational boundaries.

NASA stands at a pivotal moment. By fully embracing SCV as a core pillar of mission assurance, the agency can transform risk management from reactive to proactive. Now is the time for every stakeholder to champion SCV integration, drive measurable outcomes, and operationalize data-driven insights. Leadership commitment to expanding SCV reporting, strengthening governance, and deploying AI-enabled risk monitoring, helps ensure NASA's supply chain remains resilient, transparent, and ready for the challenges ahead.



Figure 11: Türkiye Artemis Accords Signing – Monday, August 31, 2026, at the Mary W. Jackson NASA Headquarters building in Washington. Türkiye is the 71st country to sign the Artemis Accords, which establish a practical set of principles to guide space exploration cooperation among nations participating in NASA's Artemis program. (Credit: NASA/Bill Ingalls)

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Imagery List

Figure 1

NASA's Orion spacecraft atop the SLS (Space Launch System) rocket launch on the agency's Artemis II test flight, Wednesday, April 1 from Launch Complex 39B at NASA's Kennedy Space Center in Florida. (Credit: NASA/Brandon Hancock)

Figure 2

Orion, the Moon, Earth - NASA's Orion spacecraft captures the Moon and the Earth in one frame during the Artemis II crew's deep space journey. (Credit: NASA)

Figure 3

Composite image created from photographs taken by the Visible/Infrared Imager Radiometer Suite (VIIRS) instrument on board the new Suomi NPP satellite. (Credit: NASA)

Figure 4

Concept for Sustained Lunar Surface Operations at the Moon Base - Artist's rendering depicting astronauts, habitats, rovers, power systems, and cargo operations supporting sustained human activities at the Moon Base near the lunar South Pole. (Credit: NASA)

Figure 5

Gateway space station hosts the Orion spacecraft in a polar orbit around the Moon (Credit: NASA/Alberto Bertolin)

Figure 6

Roman Space Telescope Arrival – The Pegasus barge delivered NASA’s Nancy Grace Roman Space Telescope for the Artemis III SLS rocket core stage to Kennedy. (Credit: NASA/John Kraus)

Figure 7

Artemis III RS-25 Engine Processing – NASA employees discuss rocket engine installation at inside the Vehicle Assembly Building at NASA’s Kennedy Space Center. (Credit: NASA/Clayton Rougelot)

Figure 8

Artemis II Crew Arrives at KSC Ahead of Launch. (Credit: NASA/Brandon Hancock)

Figure 9

NASA mission programs and projects rely upon the U.S. industrial base and transnational supply chains of commercial, non-profit, and government organizations to develop and operate complex, high-value, and innovative systems for the nation. (Credit: NASA)

Figure 10

An artist rendition of an astronaut in NASA's Artemis exploration suit against a lunar backdrop, with a reflection of Mars across the helmet visor, symbolizing humanity's next giant leap from the Moon to the Red Planet. (Credit: NASA)

Figure 11

Türkiye Artemis Accords Signing – Monday, August 31, 2026, at the Mary W. Jackson NASA Headquarters building in Washington. Türkiye is the 71st country to sign the Artemis Accords, which establish a practical set of principles to guide space exploration cooperation among nations participating in NASA’s Artemis program. Photo Credit: (NASA/Bill Ingalls)

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