Supply Chain Resilience in an Era of Strategic Disruption

Logistics Data Infrastructure as a Foundation for Visibility, Decision Advantage, and Security

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Over the last decade, supply chains have moved from the background of global commerce to the foreground of economic and geopolitical risk. What once functioned quietly, with containers moving, inventory turning, and materials flowing, has become a source of strategic exposure. When those flows slow, stall, or fracture, the effects show up quickly: production delays, price volatility, industrial disruption, and pressure on national policymakers.

But disruption itself is not the problem; disruptions happen all the time. The larger issue is how late disruption is recognized. By the time congestion and shortages become obvious to policymakers and the general population, the system has already been under stress for weeks or months.

This paper argues that supply chain resilience depends less on ad hoc interventions and more on having the underlying data infrastructure in place to continuously identify and interpret risk as it is emerging. When logistics data is persistent and accurate, including the timely completion or delay of key operational milestones, it can be analyzed over time to anticipate disruption, allowing for policy and action to be taken proactively instead of reactively.

In today's environment marked by strategic global realignment, shifting trade relationships, and renewed focus on trusted partners, these abilities should be considered foundational. The United States and its allies are rethinking dependencies, strengthening regional ties, and paying closer attention to how logistics infrastructure, data standards, and governance models shape long-term resilience. Logistics data infrastructure, commercially operated and embedded across transportation, storage, and distribution networks, can be a critical enabler of supply chain resilience. It determines whether visibility, coordination, and decision advantage are possible at scale.

In this paper, visibility does not mean logging into a dashboard or pulling a report. It refers to what happens when logistics data is flowing continuously across ocean carriers, marine terminals, rail networks, warehouses, and inland transportation systems as part of normal operations. When the underlying data infrastructure is in place and trusted, the system surfaces problems before congestion, shortages, or missed production targets make them obvious.

Increasingly, the challenge is not only seeing how goods move but understanding total effective supply: what is actually usable over time, based on where material is located, how it is moving, what it is committed to, and when it will become available across jurisdictions.

Where this kind of data infrastructure exists, resilience is built into how the system operates day to day, not something that has to be activated during a crisis.

From Efficiency to Resilience

For decades, global supply chains have been designed and optimized for efficiency. Lean inventories, just-in-time production, and globally distributed manufacturing and sourcing have reduced costs and improved corporate margins. Those systems worked well…until they didn't.

But as supply chains have become more complex and shocks to global shipping have become more frequent, the limits of this efficiency-first design have become painfully obvious. Pandemic demand swings, labor disruptions, extreme weather, cyber incidents, and geopolitical friction have all exposed the same weakness. Complex global supply chains optimized for efficiency offer little short-term tolerance for disruption.

Supply chain resilience is often discussed as redundancy, reindustrializing, reshoring, near-shoring, or even China Plus 1, but the reality is more nuanced. No modern economy can fully decouple from global trade, and stockpiles alone do not solve coordination problems. What matters is whether stress can be detected early, whether it can be understood across organizational boundaries, and whether responses can be coordinated before disruption cascades.

These capabilities do not emerge automatically. They depend on logistics data infrastructure.

Critical Materials and the Defense Industrial Base

The Defense Industrial Base and other critical industries rely on materials and components that move through long, multi-stage supply chains. Policy discussions tend to focus on where these materials are mined, processed, or manufactured, who owns the supplier, and whether production can be reshored.

But access to critical materials can be shaped by something more immediate: where the material is at any given time, how it is moving, the routing, when it will arrive, and when it will actually be available for use in production.

Materials that are contractually secured can still be functionally unavailable. They may be sitting in a congested port, delayed at a transshipment hub, held in a bonded warehouse, or stuck behind regulatory or commercial friction.

Without continuous visibility into these blind spots and conditions, governments and industrial leaders are left to infer risk after the fact. For the Defense Industrial Base, this complicates assessments of surge capacity, production timing, and sustainment readiness. For civilian critical industries, it increases the likelihood that disruptions interrupt production and propagate across sectors before mitigation is possible.

Where Risk Accumulates

Supply chain risk and disruption does not concentrate only at mines, factories, or finished-goods inventories. Much of it accumulates while goods are in motion and at supply chain interfaces, which include the physical, organizational, and data handoffs between carriers, terminals, warehouses, jurisdictions, and systems.

Containers, components, and raw materials spend a significant portion of their lifecycle transiting oceans, through ports, rail networks, warehouses, and storage yards. These nodes are operated by different entities, governed by different laws and contracts, and optimized for throughput rather than systemic awareness.

In practice, awareness across these supply chains is driven by the completion or delay of specific operational milestones. These milestones—such as loading, departure, arrival, discharge, clearance, and handoff to inland transportation—signal whether a shipment is progressing as expected and whether intervention is still possible. When milestone data is delayed, incomplete, or inconsistent across systems, it becomes difficult to distinguish routine variability from emerging disruption, even when physical movement has not yet visibly slowed.

Despite the interconnectedness across global logistics networks, no single actor sees the whole picture. Each party manages its slice of the process, often with its own data, milestones, and incentives. The result is fragmented operational views.

This fragmentation makes it difficult to answer basic questions in the micro and macro when pressure builds:

- How much material is in motion right now?
- Where is it physically located?
- When will it arrive?
- Is it available to be picked up?
- Which delays are temporary and which signal deeper constraint?
- Which chokepoints affect multiple industries at once?

Absent logistics data infrastructure that integrates and processes these signals, risk accumulates quietly until it surfaces as a crisis.

Illustrative Example: Critical Minerals in Motion

Consider a set of critical minerals used across defense platforms, energy systems, and advanced manufacturing. While attention often centers on mining and processing capacity, far less attention is paid to how these materials move between those stages and onward to the manufacturing facilities where they are converted into finished components and products.

In real operations, shipments of these raw or refined critical minerals and precursor materials may spend weeks in transit or storage, moving through secondary ports, sitting in inland warehouses, or waiting for downstream capacity to free up. During that time, they are rarely visible to policymakers or planners.

When congestion or geopolitical disruption occurs, the impact can appear sudden. In reality, the risk has been building across logistics networks that were not designed to surface it. Without the logistics data infrastructure that tracks these materials continuously as they move, the opportunity to intervene early is lost.

Illustrative Example: COVID, Containers, and Congestion

The supply chain disruptions experienced during the COVID-19 pandemic offer another example of how limited logistics data infrastructure amplifies shock.

As demand shifted and labor availability fluctuated, U.S. ports and inland networks experienced historic levels of congestion with more than 100 vessels awaiting discharge at the Ports of Los Angeles and Long Beach. One of the less visible contributors was the lack of standardized, real-time container milestone data across carriers, terminals, and rail networks.

Containers frequently sat idle at container terminals because their status was unclear, charges were being disputed, or downstream capacity was misaligned. Meanwhile, congestion spread from ports into rail yards, warehouses, and distribution centers. Intervention was largely reactive, because no shared operational picture existed across the system.

The disruption was not simply the result of demand volatility. It was exacerbated by incomplete and inaccurate data, and delayed awareness by stakeholders.

Logistics Data Infrastructure and Decision Advantage

Effective resilience depends on decision-making under uncertainty. When observation is fragmented and orientation is slow, decisions tend to be reactive and actions arrive too late.

Commercially operated, nationally scaled logistics data infrastructure spanning transportation, storage, and distribution networks can address this gap by creating continuous observation and shared understanding across the system. When connected and operating across the network, it compresses the time between detection, assessment, and response. This also enables the use of advanced analytics to identify patterns, forecast emerging constraints, and distinguish early warning signals from routine noise. These signals often appear first as delayed, missing, or reordered operational milestones, long before disruption becomes visible at the system level.

In practical terms, this allows governments and industry leaders to:

- See emerging stress before it becomes systemic
- Differentiate temporary delays from structural bottlenecks
- Identify concentration risk across sectors
- Coordinate responses across agencies and partners

Recent initiatives such as the Department of Transportation’s FLOW program reflect growing recognition that fragmented logistics data limits early awareness and coordination. By design, FLOW relies on aggregated and anonymized data to provide macro-level insight into freight flows and system conditions. While valuable for situational awareness, this approach limits visibility into execution-level dynamics, where early warning signals typically emerge through delayed or missed operational milestones. As a result, programs like FLOW underscore both the value of shared data and the need for persistent logistics data infrastructure that operates continuously and at greater granularity across commercial networks.

This is not about controlling supply chains. It is about creating the conditions for informed action for improved national supply chain resilience with direct economic and national security implications.

Illustrative Application: Pax Silica

The Pax Silica initiative reflects a U.S.-led effort to strengthen a secure and resilient silicon supply chain spanning critical minerals, energy, advanced manufacturing, semiconductors, and logistics. By explicitly including logistics, the initiative recognizes that supply chain resilience depends not only on sourcing and processing capacity, but on understanding how material is positioned across the full supply chain.

For initiatives like Pax Silica, a key challenge is understanding total available supply at any given moment. High-purity silica and related inputs may exist simultaneously in several states: moving between stages, staged at ports or storage facilities, allocated to future production runs, or held in reserves. Without integrated insight across stages and statuses, assessments of supply adequacy and risk remain incomplete.

Logistics data infrastructure can help address this gap by connecting movement data with storage, allocation, and production context. When data is normalized across carriers, terminals, storage, and manufacturing facilities, planners can understand not just where material is, but what it is committed to, when it will become usable, how much effective supply is available, and how future availability is likely to evolve under different conditions.

For an initiative that depends on coordination across allied and commercial supply chains, interoperable data standards and shared logistics infrastructure also help support a common view of supply posture without centralized control. Governments and industry partners can align expectations and work to manage disruption using a shared operational picture while retaining authority over their own systems and data.

In this way, logistics data infrastructure functions as an enabling layer for Pax Silica's objectives of helping ensure that secured supply, processing capacity, and reserves translate into usable, timely inputs for semiconductor manufacturing under real-world conditions.

An Operating Example from the Commercial System

Commercial logistics networks already generate large volumes of data across carriers, terminals, railroads, warehouses, and inland transportation providers. The challenge is not access to data, but coherence. Each partner in the network provides data, but in different formats, and often using different language to describe the same thing, or the same language to describe different things. Without alignment, it is difficult to form a reliable operational picture.

Gnosis Freight provides an example of how logistics data infrastructure can operate within this reality. It collects container-level data from disparate commercial logistics systems and translates that information into a single, unified data model. By normalizing milestones, timestamps, and status definitions, the system creates continuity across organizational, modal, and jurisdictional boundaries without requiring participants to change their underlying systems.

This infrastructure operates commercially and within regulated environments. One illustration is the Container Payment Portal, an OSRA-compliant platform in use by major ocean carriers at U.S. ports to support container release and payment workflows. In this role, Gnosis functions as a neutral data layer between carriers, terminals, and cargo owners, aligning milestones and incentives without centralizing control of the underlying data.

The practical effect has been improved transparency, faster container movement, and reduced friction, demonstrating how logistics data infrastructure, when embedded into day-to-day operations, can change system behavior.

Implications for Resilience and Security

The challenges described in this paper are not unique to the United States. Allies and partner nations face similar constraints because they rely on the same global logistics networks and often the same industrial supply chains.

Trusted, U.S.-based, commercially operated logistics data infrastructure can offer a way to improve resilience without centralized control. It can enable shared situational awareness across governments and industry while respecting national sovereignty, commercial autonomy, and existing regulatory authorities. This allows coordination to occur without requiring countries or companies to surrender control of their underlying data or systems.

Over time, shared data standards and interoperable logistics data infrastructure can also reinforce alliance durability, allowing partners to coordinate under stress using a common operational picture rather than fragmented or bilateral information exchanges. In practice, this reduces friction during disruption and makes cooperation more reliable when timing and clarity matter most.

Critically, the value of this infrastructure is greatest when it exists before disruption occurs because once disruption, congestion, shortages, or material constraints are visible to everyone, options narrow quickly and responses become more costly and less effective.

Conclusion

Disruption is an inherent feature of global supply chains. The strategic failure is not that disruption occurs, but that emerging stress is often recognized too late, after congestion, shortages, or production delays have already become visible and options have narrowed.

As supply chains have grown more distributed, resilience has become less about aggregate capacity and more about decision timing. Outcomes are shaped by how early deviations from expected conditions are detected and how much room remains to act once they are identified. By the time disruption reaches senior briefings or headlines, the system has typically been under strain for weeks or months, and responses are necessarily reactive and difficult to coordinate.

Early awareness depends on the ability to observe and interpret change as it occurs, particularly through the completion or delay of operational milestones as goods move across fragmented interfaces. Without persistent logistics data infrastructure to translate and normalize data across disparate networks and systems, routine variability masks emerging disruption and awareness arrives only after consequences propagate. Resilience also depends on understanding total effective supply, what is actually usable, based on where material is located, how it is moving, what it is committed to, and when it will become available.

Taken together, these dynamics point to a simple conclusion: resilience is not about eliminating disruption, but about preserving decision space. Trusted, U.S.-based, commercially operated logistics data infrastructure offers a way to enable this shared, execution-level awareness across the U.S. Government, industry, and partner nations without centralized control, while respecting sovereignty, commercial autonomy, and existing regulatory authority.

Time is the binding constraint. Resilience depends on seeing reality early enough that choice still exists.