STRENGTHENING AMERICA'S TRANSPORTATION RESILIENCE

Innovating to Enhance Unified Response and Recovery

Tony Colavito
Dr. Patti Liguori
Dr. Gene Lin

MITRE | SOLVING PROBLEMS FOR A SAFER WORLD®

A WHOLE-OF-NATION APPROACH TO IMPROVE TRANSPORTATION RESILIENCE

The U.S. economy, security, and defense are vulnerable to transportation disruptions. The May 2021 Colonial Pipeline ransomware shutdown, the June 2023 I-95 bridge fire and collapse, and the July 2024 CrowdStrike Windows outage are recent examples that demonstrate how disruptions halted fuel movement along the East Coast, degraded the movement of commodities, and significantly delayed air travel. Impacts from these types of events can rapidly spread both geographically and economically.

A whole-of-nation approach that unifies actions by federal agencies; state, local, tribal, and territorial (SLTT) governments; infrastructure owner-operators; and private-sector service providers is needed to quickly and effectively respond to disruptions and manage the cascading effects. A whole-of-nation approach offers a means to collectively assess disruptions—whether occurring individually or simultaneously—informing more efficient responses to safeguard our country, people, and national interests.

MITRE convened more than 40 experts from 18 agencies across eight federal departments to discuss methods and opportunities to improve transportation system resilience.[1] In a parallel effort, an analysis of 14 transportation disruptions between 2018 and 2024 was conducted by MITRE and confirmed the vulnerabilities identified in the convenings.[2]

The result is the identification of the following capability gaps that impede a unified response and put national interests (i.e., food, medical, critical infrastructure, and military deployment) at risk:

- The federal government does not consistently apply policies to guide rapid activation of its resources and capabilities and effective engagement to stabilize national interests following transportation disruptions.
- Transportation infrastructure and operational use data are not accessible to inform effective actions that stabilize national interests following transportation disruptions.
- Government and industry have limited decision support aids available to assess and choose between courses of action in response to transportation disruptions.

CALL TO ACTION

A whole-of-nation collaboration and response will require innovative policies and capabilities. The key is to specify problems and identify solutions in a way that works for all stakeholders within a Community of Interest (COI) representing key transportation modalities, emergency management functions, and national interests. This COI will focus on enhancing responses to transportation disruptions through collaborative innovation, gap identification, and agile development of mission-based solutions. It will aim to

[1] MITRE, "Unified Response to National Transportation Disruptions: Building Blocks to Success Identified by Federal Agencies," November 2024.

[2] MITRE, "Unified Response to National Transportation Disruptions: Successes and Gaps Observed in Recent Transportation Disruptions," November 2024.

integrate existing capabilities, both to save costs and to empower those closest to these capabilities to be creative in response to new situations.

Leveraging diverse expertise, this COI will prioritize scenarios that pose significant risks to any transportation disruption response, such as technology outages and infrastructure failures. Through workshops, the COI will elicit needs and innovate solutions, building off data, systems, and platforms readily available to establish a system-of-systems solution to improve responses to disruptions.

INNOVATION AREAS

Integrating and innovating potential improvements to incident response in the transportation sector will require the cooperation of federal and SLTT governments, as well as private entities. There is great diversity across all transportation modalities, both in the ownership of transportation infrastructure and in the market share of various operators. All stakeholders need to work together to ensure that the response and eventual recovery are efficiently executed with the least disruption to individual companies and the public at large.

Nevertheless, the federal government plays an outsized role. First, both the operational and economic impacts of transportation disruptions impede interstate commerce—the sole jurisdiction of federal government. Sustainable solutions must, therefore, be supported by federal law and policy.

Second, transportation infrastructure is supported by federal grants and financing, so existing funding mechanisms should facilitate a resilient system response. Third, transportation and supply chain disruptions can affect multiple national interests, including several sectors of critical infrastructure, national critical functions,[3] homeland security, and national defense.

The federal government needs to support the mechanisms and processes[4] for prioritizing the problems to be addressed, and for coordinating national resources across the public and private sectors.

Guiding Federal Involvement

A whole-of-nation approach to responding to transportation disruptions requires clear guidance to activate the federal government's resources more quickly and effectively. Shared expectations about the federal government's involvement will enable the transportation community to act more decisively when addressing transportation disruptions.

Figure 1. FHWA I-95 Bridge Collapse Inspection (U.S. Federal Highway Administration, 2023).

[3] https://www.cisa.gov/topics/risk-management/national-critical-functions

[4] FEMA's Whole Community Approach to Emergency Management is a model that might be adapted for transportation disruptions: https://www.fema.gov/sites/default/files/2020-07/whole_community_dec2011__2.pdf

Federal Activation: The federal government actively mitigated fuel shortages following the 2021 Colonial Pipeline ransomware shutdown and managed critical supply chains related to the 2022 rail labor strike. However, a federal leadership role in incident response is not always guaranteed. Infrastructure owners and operators were responsible for managing the 2023 I-95 Philadelphia bridge collapse, the 2023 Norfolk Southern software outage, and the 2024 CrowdStrike Windows outage with little federal response to mitigate downstream effects.

Federal Agencies: In preparing for the 2022 rail labor strike, the U.S. Department of Transportation (USDOT) led the federal response—in coordination with the Department of Labor, the White House, and many other agencies—because transportation was the cause of the disruption. Convened federal experts highlighted that the federal response first required USDOT to assess its capabilities, stand up a team—including staff augmentation from the Federal Emergency Management Agency (FEMA)—and establish processes to manage information flow, leading to inefficiency and delays. In hindsight, another agency may have been better suited to lead considering that a rail labor strike would have adverse consequences on health, safety, and economic viability, and the USDOT was not immediately equipped to lead.

One immediate solution is to refine the federal government's response strategy to transportation disruptions. Potential updates include developing guidance describing the

Guide activation of federal resources to execute a rapid and effective whole-of-nation response to transportation disruptions.

decision criteria for federal government engagement, identifying appropriate agencies to orchestrate a response, and outlining how agency roles evolve over the course of the response lifecycle. These efforts should build on the National Response Framework[5] and National Security Memorandum 22.[6] Such federal guidance can help resource, train, and equip agencies to rapidly contribute to response and recovery efforts. Defined roles further set the table for memorandums of understanding, tabletop exercises, and response playbooks to align how agencies interact with one another and with communities following a disruption.

Delivering the Operational Picture

A common operating picture (COP) in the context of transportation system disruption is a set of multimodal data about nearby flows of vehicles—whether on highways, through maritime ports, through pipelines, by rail, or through airports—and the infrastructure status (e.g., normal, reduced, closed) along their routes. This envisioned COP provides emergency managers with important situational awareness about whole-of-nation priorities. While rerouting normal traffic flows and restoring damaged infrastructure occur at the local level, their importance to transportation systems and supply chains elevates these tasks to national significance. Effective decision making

[5] FEMA, "National Response Framework," 2019.

[6] White House, "National Security Memorandum on Critical Infrastructure Security and Resilience," April 2024.

following a disruption, requires knowledge of alternative transportation modes and the surrounding geographic region. Recent history suggests that managers responsible for coordinating national response often lack ready access to such knowledge.

Maintaining Flows Despite Constrained Resources: The 2023 Norfolk Southern software bug disrupted the rail operator's scheduling and operations for several days. Due to reliance on shared rail infrastructure, the disruption resulted in delays in Amtrak and Virginia Rail passenger train services, as well as delayed delivery of goods between suppliers and distribution centers. Had the outage remained unresolved beyond several days, the impacts of the increasing highway traffic congestion—affecting both commuters and freight—and the disruption to supply chains, particularly those with early links involving Norfolk Southern, would have had far-reaching consequences.

Bringing National Resources to Bear: Immediately after the 2021 Colonial Pipeline ransomware attack, the pipeline was out of service for six days, contributing to energy supply constraints along the eastern seaboard. While supply networks for fuel shifted to accommodate alternatives to the pipeline, public perception of an insufficient supply ensued. People waited in long lines at gas stations across the southeastern United States, with many creating personal stockpiles of gasoline. This incident illustrates the continued need for public messaging that is carefully coordinated between the pipeline operator and the government.

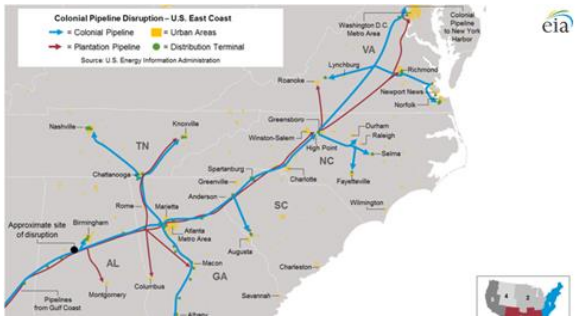

Figure 2. Impact of the Colonial Pipeline Disruption on the U.S. East Coast (as reported by the U.S. Energy Information Administration, September 21, 2021).

The intelligence community has hypothesized that cyber-initiated disruptions of critical infrastructure—such as the 2023 Norfolk Southern and the 2021 Colonial pipeline events—are part of a nefarious foreign strategy "designed to deter U.S. military action by impeding U.S. decision-making, inducing societal panic, and interfering with the deployment of U.S. forces."[7]

Much of the data required to provide national emergency managers with situational awareness already exists, albeit in siloed resources. The envisioned transportation COP would involve establishing a translational layer to connect existing data sets and systems across federal, SLTT, and private stakeholders. Convened federal experts cited examples such as the Homeland Security Information Network and the Web-based Emergency Operations Center as working models for a COP.

Integrate regional infrastructure and transportation data to inform more effective responses to transportation disruptions.

[7] Office of the Director of National Intelligence, *Annual Threat Assessment of the US Intelligence Community*, February 6, 2023.

A COP could augment existing work by the Bureau of Transportation Statistics in building a national repository of multimodal transportation data, providing the foundation for collaborative analysis and collective decision making related to prioritization of resources. Convened participants described how such a repository could serve two functions: (1) provide data of known provenance and update frequency, and (2) be an organizational home for how public agencies contact private agencies to share data and analyses.

Informing Response Actions

The U.S. response to transportation disruptions must consider whole-of-nation objectives, including safety, security, and the economy. Convened participants reported that they lacked the capabilities to generate a range of options for courses of action and to assess and choose between courses of action in response to transportation disruptions. This deficiency hinders the ability to improve solutions, maintain resiliency, and manage the cascading effects of transportation disruptions on safety, security, and the economy.

Optimization of Response Actions: The elevated gasoline purchases after the 2021 Colonial Pipeline ransomware incident is an example of the continuing importance of quantifying the disruption impacts. Colonial Pipeline and the Department of Energy closely coordinated their analyses of energy supplies and provided unified communications with the public.

Expand decision aids to account for whole-of-nation objectives when selecting responses to transportation disruptions.

Predicting Cascading Impact: The 2023–2024 AT&T outages, 2024 CrowdStrike Windows outage, and 2022 Denver and Dallas GPS outages exposed significant vulnerabilities within the transportation sector. These incidents revealed the absence of decision aids for government and private-sector emergency managers to rapidly quantify the outages' national impacts and assess the effectiveness of their collective action to address them. Although the private sector and multiple federal agencies—such as the Cybersecurity and Infrastructure Security Agency, Federal Communications Commission, Department of Defense, Department of Commerce, and Federal Aviation Administration—were involved in resolving these disruptions, their responses noticeably lacked models and tools to understand possible courses of action.

Figure 3. Empty Shelves at a Grocery Store (Davis, T., Imperfectly Happy, March 7, 2021).

Predictive tools and models are needed to enhance risk and impact analysis across industries. Understanding the current challenges both in their complexity and in their scope is crucial for developing effective strategies.

A collaborative platform will immediately enhance communication among stakeholders and, by helping integrate and organize their siloed information as a system-of-systems, enable the collective definition of response priorities, actions, and resource allocations.

Supported by a whole-of-nation partnership, this platform will combine ideas, capabilities, infrastructure, data, and frameworks into a solid foundation for innovation in unified response actions. The platform will support responders in quickly generating alternative courses of action and making well-informed decisions by providing insights into potential impacts, trade-offs, and cascading effects. Use of this platform will ultimately lead to better alignment between response actions and strategies and all national objectives: safety, security, and the economy.

SHAPING AND IMPLEMENTING SOLUTIONS

Engage with a national COI focused on strengthening transportation system resilience. Innovative collaboration, scenario identification, and agile development of mission-based solutions will enhance unified response.

- **Stakeholder Driven**: Participate in a whole-of-nation COI focused on unified response to enhance the resilience of our transportation systems through innovative policies, procedures, and capabilities. This COI will define whole-of-nation engagement strategies to prioritize solutions by leveraging existing and diverse expertise, systems, and data.
- **Scenario-Based**: Identify and prioritize scenarios that pose significant risks to national transportation systems. These scenarios will describe sufficiently narrow challenge sets that will inform requirements for initial solutions. Through a series of workshops and exercises, the COI will identify key decision makers, data requirements, existing systems, and information exchange requirements across stakeholders using mission- and model-based systems engineering.
- **Innovation and Mission Focused**: Guided by the stakeholder needs and selected scenarios, quickly release and evaluate policy, COP, and decision aid capabilities with minimal functionality, referred to as minimally viable products. With this approach, the COI will gather valuable feedback and learn what works and what does not. This knowledge will assist in making informed decisions about the evolution of a mission-based solution and enable responders to make quick, well-informed decisions while understanding impacts and trade-offs.

ABOUT MITRE

MITRE's mission-driven teams are dedicated to solving problems for a safer world. Through our public-private partnerships and federally funded research and development centers, we work across government and in partnership with industry to tackle challenges to the safety, stability, and well-being of our nation.