CENTER FOR COLLABORATIVE SYSTEMS FOR SECURITY, SAFETY AND REGIONAL RESILIENCE (COSSAR)

UNIVERSITY of WASHINGTON

BEYOND INCIDENT RESPONSE

MITIGATING IMPACTS OF MAJOR TRAFFIC INCIDENTS IN THE SEATTLE I-5 CORRIDOR

MOBILITY INNOVATION CENTER at the UNIVERSITY of WASHINGTON

CENTER FOR COLLABORATIVE SYSTEMS FOR SECURITY, SAFETY AND REGIONAL RESILIENCE (COSSAR)

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INTRODUCTION

At 10:30 a.m. on February 27, 2017, a tanker truck hauling propane overturned on southbound I-5 in Seattle, completely closing I-5 in both directions for about eight hours. Public transit delays were more than 90 minutes, and major gridlock spread throughout Seattle as traffic was forced onto city arterials. Even after the tanker was finally cleared and traffic around the incident started moving, gridlock continued (as a general rule, every minute of lane blockage results in 4-10 minutes of travel delay after the incident is cleared.[1]) Frustrated tweets, blog posts, and articles referencing #SeattleTanker continued for several days.

Photo credit: Chopper7/KIRO 7 News

And Seattle was lucky.

No propane caught fire and exploded. No one was killed. No sections of the freeway collapsed from intense heat, as happened a month later in Atlanta at a point in the Interstate that regularly carried a quarter million vehicles a day.

BACKGROUND

Led by the Washington State Department of Transportation (WSDOT), Washington State is a national leader in intelligent transportation systems and traffic demand management, but the mobility challenges of the Seattle area are daunting. According to the latest U.S. Census Bureau figures, between July 2015 to July 2016, Seattle was the fastest growing city in the U.S., with a net gain of nearly 21,000 people or 57 per day, on average.[2] With this considerable influx of residents comes an increased volume of vehicular traffic, further exacerbated by a geographically restricted mobility infrastructure. Rush hour times have become extended, with Seattle ranked fourth among U.S. cities for the worst overall congestion levels. Seattle commuters spend approximately 40 extra minutes per day (152 hours per year) sitting in traffic congestion.[3] With the growing strains on regional infrastructure and increasing demands on transportation-related agencies, entities such as regional planners, governmental leaders and nonprofit organizations are exploring alternatives for alleviating the impact of traffic congestion on the region.

The focus of this research is not on normal, daily congestion, but rather on the under-studied area of traffic incident-related congestion. Nationally, roughly 25% of total congestion is due to traffic incidents.[4] On a regular basis, incident-related congestion contributes to travel delays, secondary collisions, increased fuel consumption, and air pollution. The Federal Highway Administration (FHWA) estimates that the U.S. loses 1.3 billion vehicle hours of delay due to incident-related congestion each year, at a cost of almost $10 billion annually.[5]

[1] https://www.usfa.fema.gov/downloads/pdf/publications/fa_330.pdf

[2] https://www.seattletimes.com/seattle-news/data/seattle-once-again-nations-fastest-growing-bigcity-population-exceeds-700000/

[3] https://www.tomtom.com/en_gb/trafficindex/city/seattle

[4] Federal Highway Administration. (2012, June). Analysis, Modeling, and Simulation for Traffic Incident Management Applications (Rep.). Retrieved November 16, 2017, from U.S. Department of Transportation website: https://permanent.access.gpo.gov/gpo45386/fhwahop12045.pdf

[5] https://www.usfa.fema.gov/downloads/pdf/publications/fa_330.pdf

FHWA, through its Emergency Transportation Operation programs, provides tools and guidance for Traffic Incident Management (TIM), defining TIM as "a planned and coordinated multi-disciplinary process to detect, respond to, and clear traffic incidents so that traffic flow may be restored as safely and quickly as possible."[6] However, major highway incidents--such as the overturned propane truck--result in major regional impacts beyond the incident site. These impacts from associated congestion must be addressed in coordination with TIM operations, despite often having little to do with the process of "clearing the incident" itself. We need to extend traffic incident management to incorporate the related but separate operational activities known as congestion management (CM).


Photo credit: Thomas Griesbec

Like TIM, congestion management is a complex multi-agency, multi-jurisdictional activity involving State and city agencies, such as law enforcement, fire, transit, emergency management, and transportation departments. Unlike TIM, managing incident-generated congestion continues after the incident is cleared, involves a more-diverse group of stakeholders, and covers not only a greater portion of the freeway, but also the interconnected arterials and alternate modes of transportation, as well as the people, facilities and services that rely on transportation infrastructure.

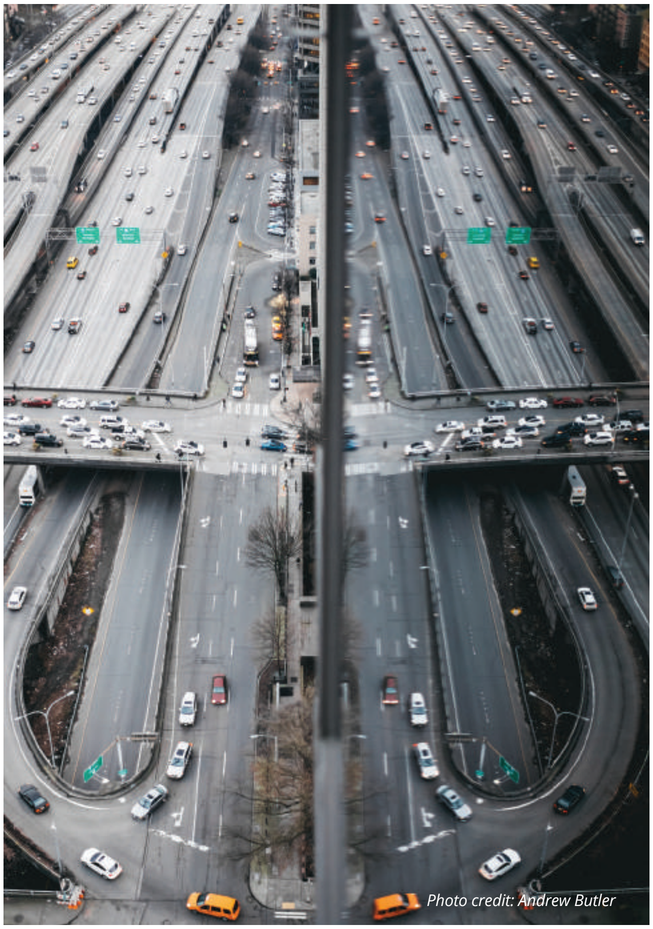


Photo credit: Andrew Butler

This wider congestion management perspective must not take away from the urgent life-saving and incident-clearing activities of the incident response team, but it does call for greater coordination across traffic incident management and congestion management operations.

The project reported on here was initiated through a meeting of WSDOT, SDOT, King County Metro Transit, and Challenge Seattle. The research was conducted through the University of Washington's Mobility Innovation Center (MIC) and Transportation Research Center (TRAC), and led by the UW Center for Collaborative Systems for Security, Safety and Regional Resilience (CoSSaR). This project identifies opportunities for enhancement of regional incident response to incorporate congestion management processes via enhanced strategic and operational coordination, supported by innovative technologies.

Together, we label this direction "TIM-CM" and view this work as Phase 1 of an ongoing regional TIM-CM effort.

[6] https://ops.fhwa.dot.gov/eto_tim_pse/about/tim.htm#ti

IDENTIFYING THE OPPORTUNITY

Phase 1 of TIM-CM began with working group meetings that encouraged stakeholders to take a holistic, multi-agency, system approach to incident management. After several meetings focused on coordinated incident response, the working group concluded that the greatest regional benefits could be achieved by expanding the focus from incident response to include managing the associated impacts of major incidents, which went well beyond the site of the incident itself. Incident response operations were well established and functioning efficiently; management of incident-generated congestion was far less established and understood. The working group agreed that a focus on mitigating congestion resulting from a major incident along the I-5 corridor was highly innovative and could greatly enhance mobility while reducing social and economic impacts on Seattle area residents and businesses. TIM-CM was born.

In a conference room at the University of Washington, police, fire, transit, State Patrol, state and city departments of transportation (DOTs) and other key regional traffic incident management and congestion management leaders gathered to engage in a TIM-CM use case exercise (similar to a tabletop exercise). The goal was for this incident management community to reexamine how it manages major incidents in the Seattle I-5 corridor, and identify opportunities for enhancing this highly complex and collaborative operation. The use case, extrapolated from actual occurrences, began with a broken down school bus on I-5 near Safeco Field. Then, after traffic had backed up for 15 minutes, the big one hit. An open topped truck carrying animal parts, known as a rendering truck, swerved to avoid the building congestion and overturned, spreading its contents across the freeway under the Convention Center.

The first step in improving a complex system is to understand how the current system works.

Two teams were established to work the incident.

(1) a TIM team consisting of players from Washington State Patrol (WSP), Seattle Fire Department (SFD), the Incident Response Team (IRT) from WSDOT and WSP 9-1-1 dispatch.

(2) a CM team consisting of players from WSDOT Traffic Management Center (TMC), SDOT Transportation Operations Center (TOC), Seattle Police Department (SPD) Traffic division, and SPD 9-1-1 dispatch.

Photo credit: Joshua Hoehne

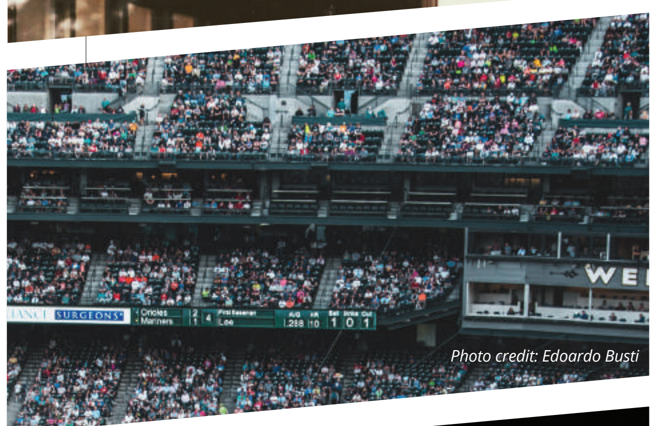


Photo credit: Edoardo Busti


Photo credit: Marc Sendra Martorell

TRAFFIC INCIDENT MANAGEMENT

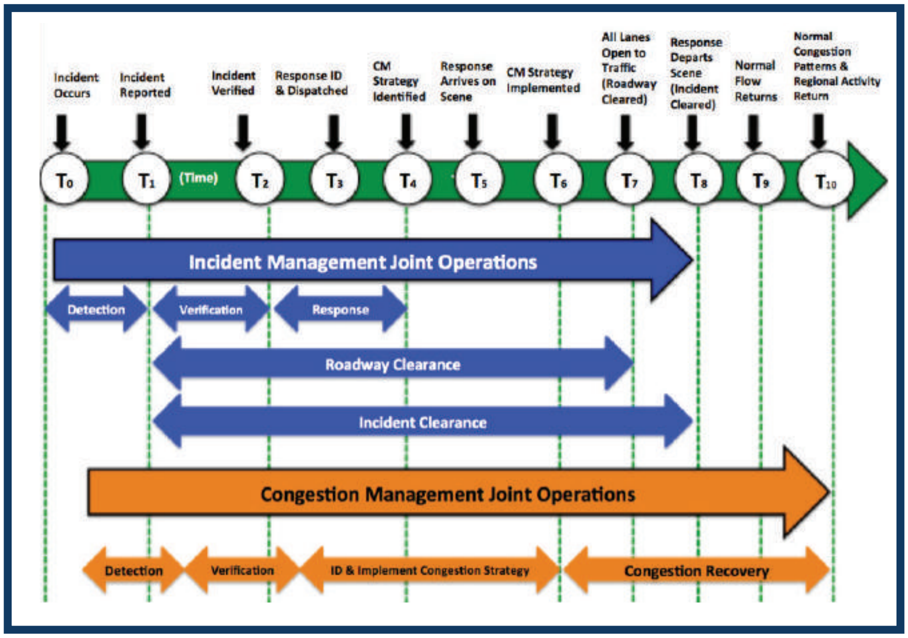
Photo credit: Andre Benz

TIM: Washington State Patrol (WSP), Seattle Fire Department (SFD), Incident Response Team (IRT) from WSDOT, WSP 9-1-1 dispatch.

CONGESTION MANAGEMENT

Photo credit: Matthew Hamilton

CM: WSDOT Traffic Management Center (TMC), SDOT Transportation Operations Center (TOC), Seattle Police Department (SPD) Traffic division, and SPD 9-1-1 dispatch.



As TIM and CM leaders worked this simulated sequence of incidents, facilitators modeled the "as-is" system and, later, led group discussion to refine the model and identify opportunities for enhancement. Following were general conclusions from this first "as is" exercise:

There are limited options for information sharing across TIM and CM.

CM information flow occurred primarily in a hub-and-spoke model with stakeholders responsible for TIM at the center. Understandably, the TIM group focused almost exclusively on their immediate life-saving response issues and pushed out information to CM stakeholders as a secondary priority. TIM stakeholders receive real-time incident information first-hand on-scene, augmented by video cameras focused on the incident and from dispatch systems such as the Washington State Patrol's (WSP) Computer Aided Dispatch (CAD) system. While all CM stakeholders are able to access video cameras to view the incident in real-time, some CM stakeholders (such as SDOT) have limited access to on-scene responders, as well as limited or no access to WSP CAD, thereby limiting their ability to respond proactively to the building congestion. There were barriers to information sharing between law enforcement (LE) and non-LE agencies (i.e., transportation agencies). For example SDOT was unable to access Seattle Police Department (SPD) CAD, which inhibited coordination. Throughout the as-is exercise, the CM team was forced to postpone some actions until someone on the TIM team provided updates and information needed to manage the building congestion.

CM has less defined command structures and processes than TIM.

During the as-is exercise, the TIM team immediately began operations to manage the incident scene. They were guided and driven by pre-existing operational protocols and structures that enabled them to act swiftly and collaboratively. They assessed the situation, reviewed their options, derived an operational plan, and launched into its execution. Some members of the CM team could not immediately devise and launch an operational plan for managing congestion, in part because they lacked key information, but also because they lacked enabling structures, processes, and policies. For example, policy prevented the CM team from rerouting freeway traffic through city streets.

Information sharing systems for CM do not generally support feedback.

The TIM information sharing process is primarily in one direction (i.e., there is no formal feedback loop) and assumes that agencies will use that information for their particular needs. As a result, the TIM team has no way to know if the information they are providing is useful to CM efforts or how TIM decisions are impacting the CM team. Due in part to the lack of formal feedback mechanisms, TIM and CM occurred largely in isolation from one another.

Communication opportunities with transit providers, industry, and employers are underdeveloped.

This relates to the need for multimodal and other demand management solutions. Simply rerouting existing traffic is not a complete option. The CM stakeholders expressed a desire for better communication and coordination with Metro Transit, private transportation systems (i.e., those operated by Microsoft and Google), and ride hailing companies to better address congestion issues. In addition, there was not an effective means to coordinate with regional employers to address incident impacts on their employees. The Challenge Seattle partnership can be leveraged to facilitate coordination between transportation agencies and regional employers during a major traffic incident along the I-5 corridor.

Existing solutions can be expanded.

Regional transportation agencies have a long history of operational innovations to help ensure that people and goods move safely and efficiently in Washington State. These Intelligent Transportation Systems (ITS), which get data from field sensors, such as traffic detectors, Closed Caption Television (CCTV), ramp meters, and information service providers, provide a rich view of the traffic situation in any area at any time. There are many opportunities to go beyond these current ITS and take advantage of the latest research on driver behavior, private/public partnerships, and emerging technologies.


Photo credit: Lukas Robertson

An automated, data-driven approach to CM is desired.

There was discussion of an automated, data-driven approach to CM involving a decision support tool. This tool could provide pre-planned CM options based upon a congestion index algorithm that would indicate when a given threshold of congestion was reached. In addition to this tool, participants discussed an enhanced information sharing system for real-time data acquisition and data sharing across the TIM and CM teams.

Having worked together to clarify what the current TIM system “is” and the opportunity spaces that existed, the team turned to the design challenge of conceiving what the system “ought to be.” TIM and CM leaders discussed the current “pain points” and opportunities for system enhancement. They explored possible interventions to enhance the system. While innovative technology was not assumed to be that intervention, it was ever present in the minds of participants.

Photo credit: WSDOT

On December 18th, 2017, as the final draft of this report was undergoing review, Amtrak Cascades passenger train 501 on its inaugural run over the new Point Defiance Bypass derailed over I-5 near DuPont, Washington. The world watched intently as train cars hung over the busy Interstate, while heroic responders addressed life-threatening human impacts and conducted massive efforts to clear the extensive wreckage. Far less visible, but no less beneficial, were associated regional efforts to adapt to this massive hit on our mobility. These efforts, aimed at mitigating the impacts of mounting congestion, provided examples of the importance of an extended and prepared TIM-CM community as discussed in this report. Key preparation included formal chartering by the State Secretary of Transportation, the Chief of the Washington State Patrol, and the Commanding Officer of Joint Base Lewis-McChord (JBLM) of a regional multi-agency joint operations group (JOG) that shared multi-agency experience and training, integrated innovative technology, and planned joint operations and policy development.

Expanded collaborative efforts to minimize congestion during the derailment tragedy pointed us towards promising future directions. There was the use of drones and innovative sensing for shared situational awareness, seen in a new State Patrol capability, UAV 3-D mapping, that was shared to speed up road clearance. There was active dissemination of guidance to the driving public through diverse electronic media, from the WSDOT Traffic Management Center's work with media, web, radio and phone, to private mobile services like WAZE. While there are many opportunities to expand inter-agency and public-private coordination in areas such as technology innovation and delivery of route guidance, these efforts during the three days of southbound I-5 lane closures significantly reduced travel delays. Travelers following WSDOT guidance for a trip from Tacoma to Olympia, for example, took around two hours for a trip that usually took 30 minutes, but this 90-minute delay would have been many hours longer without combined regional congestion management efforts.

Prior to the incident, JBLM JOG members worked together, put shared policies and technologies in place, and practiced in responding as a multi-agency team. An Emergency Response Coordination Workshop and Tabletop Exercise, organized by JOG partners, brought together representatives from local, state and federal agencies for a full day of training focused on response to a train derailment on the new Bypass. Moreover, Amtrak facilitated more than a dozen trainings of local and JBLM police and fire response teams that they cited as invaluable when responding to the derailment and organizing the command center.

Within hours after the incident, the JOG had opened a public emergency route through JBLM, monitored by military police, which helped relieve the pressure from vehicles trapped in and around the mounting I-5 tie-up. This detour was the direct result of extensive mutual pre-planning, facilitated by formal agreements, shared technology, and previous cooperative work. The JBLM JOG participated in the TIM-CM project and served as a model for the Seattle Area Joint Operations Group (SAJOG) charter recommended in this report by participating agencies.

While the JBLM detour route is not a specific solution for the Seattle area, it is relevant to Seattle because the detour would never have come into play if not for the formal pre-existing relationships and agreements established and maintained through the JOG. This demonstrates the need for additional formalized and empowered multi-agency consortia, ready to work together on all aspects of whatever is thrown at them. In numerous ways, the situation in and around Seattle is far more complex than that in the JBLM area, but this makes it even more imperative that we charter a Seattle consortium that represents an extended TIM-CM community. Moving forward, the SAJOG will be a critical addition to the fabric of our city's preparedness, resilience and ability to act as a coordinated community in the face of tragic events.

Photo credit: Alice Wu

DESIGNING AN ENHANCED SYSTEM FOR INCIDENT-RELATED CONGESTION

By now, what had been a gathering of TIM and CM stakeholders began to function as an extended TIM-CM community. Participants drafted a Charter to establish a regional Seattle Area Joint Operations Group (SAJOG) to collectively design and implement a regional strategy for enhancing mobility and reducing impact when a major incident drastically reduces capacity along the Seattle I-5 corridor. The evolution of this expanded collaboration, captured in the SAJOG charter, was one of the most significant outcomes of this initial TIM-CM phase, as it defines a joint regional framework for operations, information sharing, technical environment, and policies that can be built upon for future coordinated TIM-CM operations. There is an ongoing effort to formalize this agreement, establish facilitation by UW, articulate a coordinated TIM-CM command structure, and expand and develop additional partnerships with Challenge Seattle and other regional stakeholders.

Based on the "as is" use case exercise, the TIM-CM team articulated three potential system enhancements that would address the opportunities identified in the current operational model. These were:

1. **A Congestion Analysis Engine (CAE)** that assessed the status of real-time congestion,

2. **An Enhanced Information Sharing System (EISS)** that shared real-time data across the TIM and CM teams, and

3. **Pre-Planned Options** to facilitate the implementation of planned TIM-CM strategies such as rerouting or signal timing. Nine pre-planned options were developed.

These enhancements were not designed at the level of how they would be built, but more generally at the level of what they would do. In complex multi-stakeholder systems, it is critical to get stakeholder buy-in and uncover potential unintended consequences of an intervention before moving on to specific technical design and implementation details.

The TIM-CM team was now ready for a second use case exercise. This second "ought to be" exercise introduced the use of the three new potential systems through the following mechanisms: 1) An SDOT representative, serving as the Congestion Analysis Engine, provided congestion status throughout the exercise, and exercise participants could approach the congestion analysis engine at any time to clarify congestion related questions or issues; 2) A representative from WSDOT, playing the role of the EISS, could be approached by any of the participants at any time to ask for incident data, and 3) Nine pre-planned option cards were developed. Participants could play a pre-planned option card to propose a specific action (i.e., re-route traffic, close ramps, change traffic signal timing) to reduce congestion. If an individual chose to use one of these options (or a threshold on the congestion analysis engine was reached), the rest of the participants stopped working the scenario to discuss the implications of the option and vote. The votes were evaluated and a decision was made about whether or not the option was implemented.

This second "ought to be" exercise was based on the same use case scenario as the first exercise involving the stalled school bus and overturned rendering truck. It differed, however, by incorporating the three operational enhancements and the use of feedback periods to discuss the desirability and complications of using the new interventions. In this way, the team gained a shared understanding of the impacts of these new capabilities and how they might move the system towards greater mutual success. This also brought out interdependencies that could produce potential unintended consequences when stakeholder activities are impacted by the intervention.


Photo credit: Jim Z.

The "ought to be" exercise was eye-opening in the way that it involved the players working as a whole, without individual TIM or CM silos.

During the exercise, there were several instances where participants needed information on variables such as congestion status, assets en-route to the scene, or environmental factors. The EISS tool provided a single portal for answering these questions (sometimes with, sometimes without being prompted) and minimized the amount of time participants would have expended trying to individually clarify such details. Furthermore, the ability to use "pre-planned option" cards led to dialogue and cooperation about possible courses of action for CM. This option gave all players a standardized and flexible format for bringing forth options for CM. In addition, the ability to "vote" or weigh in on such options proved to be useful, in that different perspectives on alternative options were shared and analyzed by both TIM and CM team members.

For example, early in the exercise a manager from Metro Transit chose to play an option to close an I-5 exit ramp in order to facilitate traffic flow on city bus routes. This led to considerable group input, especially from State Patrol whose job it would be to close the exit and manage the resulting impact on incident response and freeway congestion. There were a number of striking aspects of this particular group dynamic. First, the very notion of an early CM strategy being considered by the incident managers was completely new and not even possible in the "as is" exercise. Second, the collaborative exchange that followed led to greater shared awareness and an expanded understanding of other stakeholders' perspectives. The State Patrol's initial response to this option was to reject this option, due to lack of resources and time; however, State Patrol agreed to address this need later on as resources become available. With a shared understanding of others' roles and responsibilities, issues changed from disagreement to balancing evolving priorities and identifying needed additional resources.

Thus, there were dramatic differences between how regional TIM and CM participants managed the "as is" and "ought to be" use cases. (See Table 1 on the next page.)

Overall, the operation went from two groups operating fairly independently to a single group collaboratively considering the impact of their operations on both TIM and CM. Below are additional impacts of the innovations introduced in the "ought to be" use case:

The Congestion Analysis Engine: The CAE was available to both CM and TIM stakeholders, but it was primarily used by CM stakeholders as it met their critical need for real-time congestion status updates and alleviated their dependence on the TIM participants for information. This indirectly benefited the TIM stakeholders who were busy responding to the incident, while allowing the congestion managers to be proactive rather than wait on information from incident responders.

An Enhanced Information Sharing System. The EISS facilitated coordination between the TIM and CM components of the team. There were several instances where participants needed information on items such as congestion status, assets en-route to the scene, or environmental factors. The EISS tool proved to be useful in clarifying such items, and minimized the amount of time that would have been expended trying to clarify these details with partners who were busy with their own tasks.

Pre-Planned Options for Congestion Relief. The CM stakeholders took particular advantage of playing "pre-planned option" cards to request possible courses of action during the exercise. When they did, the ensuing dialog among all participants was effective in exploring the impacts of these possible courses of action on the operations of other stakeholders. In particular, those responsible for TIM were better able to understand how their actions affected upstream congestion management, while CM participants were better able to see the impacts of their desired options on the incident response operations. This dialog also emphasized that pre-planned options must not limit the flexibility of operations in response to a complex, dynamic situation.

Interactions among incident and congestion managers were greatly enhanced by the operational enhancements of the second exercise. In subsequent discussion, the TIM-CM team agreed that a second phase to design and test working enhancements was desirable.

	AS-IS FINDINGS	TO-BE FINDINGS
1	TIM and CM occurred largely in isolation from one another	TIM and CM worked in a coordinated fashion
2	There were limited options for information sharing across TIM and CM	A "just in time" information sharing mechanism enhanced coordination
3	Information sharing systems for CM did not generally support feedback	Facilitating feedback enhanced coordination
4	CM had less defined command structures and processes than TIM	CM was improved by pre-defined processes and ways to implement them
5	CM team postponed actions until TIM provided updates and information	CM initiated actions as events unfolded
6	TIM's focus on urgent incident needs rarely considered CM	TIM team worked in parallel with CM team
7	Barriers to information sharing and coordination between law enforcement (LE) and non-LE agencies inhibited coordination	Exposed the LE / non-LE barriers to be primarily about resources and priorities that could be negotiated with CM

TABLE 1: Summary of Difference between Use Case Exercises

KEY CHALLENGES AND RECOMMENDATIONS

Phase 1 of TIM-CM identified the following challenges and opportunities for enhancing regional TIM to incorporate CM via strategic and operational coordination, supported by innovative technologies.

CHALLENGE: Both incident and congestion management are complex multi-agency, multi-jurisdictional activities that are interdependent yet with distinct goals, methods, and stakeholders.

Historically, the focus of post-incident operations has been on the urgent needs stemming from the incident itself, such as clearing the incident blockage to address life-threatening injuries, fires, and environmental hazards. While this certainly is necessary, the management of wider regional impacts stemming from major incidents, such as long-term congestion and economic immobility, has been less organized or coordinated, and has had to wait for critical information and direction from the incident managers.


Photo credit: Dan Gold

CM involves numerous entities beyond those who operate at the incident site and affects not only the freeway itself, but also the interconnected arterials and alternate modes of transportation, as well as the facilities and services that depend on this mobility. Transportation and emergency agencies need to widen their understanding of post-incident actions and strategies, so as to coordinate within the larger context of TIM-CM activity by allied agencies and stakeholders.

RECOMMENDATION: Create the appropriate TIM-CM joint operations command structure.

A coordinated CM response requires a joint regional framework for operations, information sharing, technical environment and related policies. One regional example is the I-5/Joint Base Lewis-McCord (JBLM) Corridor Joint Operations Working Group. This working group supports multi-agency emergency response for all types of freeway incidents on the corridor of I-5 through JBLM. We recommend that the stakeholder agencies responsible for TIM and CM along the I-5 Seattle corridor ratify the Seattle Area Congestion Management Joint Operations Working Group (SAJOG) charter drafted during this project.

CHALLENGE: Overcome information sharing barriers across TIM-CM agencies.

Inter-agency sharing of transportation data has the potential to improve the TIM-CM process; however, there are barriers to information sharing that must be overcome. These barriers are not only due to technical issues such as the lack of an enterprise architecture, but also to practices and policies such as those that inhibit non-LE agencies from gaining access to useful LE information.

RECOMMENDATION: Enhance the information-sharing environment (ISE) across TIM and CM processes.

Begin by conducting further analysis of the current ISE--you cannot improve a complex system without first knowing how it currently works. Then identify opportunity spaces and engage in an iterative and participatory co-design process to design ISE enhancements for those spaces. Co-design methodologies should consider the entire TIM-CM socio-technical system and environment.

Consider implementing an enterprise architecture to support enhancements. This architecture should allow each agency to participate under their own rules of engagement, yet enable increased operational information sharing. Other desirable features include: feedback loops for real-time cross-agency collaboration, a component that facilitates communication to the public, integration with existing commercial traffic information providers, and interoperability with current information sharing systems (i.e., systems used at SDOT and WSDOT Transportation Management Centers).

Consider policy enhancements in support of interagency sharing (i.e., memorandum of agreement across law enforcement and non-law enforcement entities so that during an incident, certain potentially sensitive information can be shared as needed.

CHALLENGE: Enhance TIM-CM communication with the public, and engage commuters as stakeholders in the design of TIM-CM enhancements.

RECOMMENDATION: Gather insight into current Seattle commuter behaviors and preferences. (Build on similar studies of Seattle commuter decision-making conducted previously.) [7,8]

Better understand how commuters currently get information about traffic (i.e., mobile apps, social media, television), the factors influencing route choices,

[7] Wenger, M., Spyridakis, J., Haselkorn, M., Barfield, W., & Conquest, L. (1990) Motorist Behavior and the Design of Motorist Information Systems, Transportation Research Record No. 1281 (Human Factors and Safety Research Related to Highway Design and Operation), National Research Council, pp.159-167.

[8] Conquest, L., Spyridakis, J., Barfield, W., & Haselkorn, M. (1993) The Effect of Motorist Information on Commuter Behavior: Classification of Drivers into Commuter Groups. Transportation Research-C, Vol. 1, No. 2, pp. 183-201.

use of multi-modal transportation preferences, etc. Include representative commuters in the co-design of future TIM-CM enhancements. Where possible and appropriate, build on existing TMC tools and strategies.

Consider enhancements that will help keep drivers (i.e., PM commuters) off the roads after an incident has occurred. While changing behaviors of some drivers will not be possible (i.e., those who need to pick up children from school or childcare may need to depart regardless of incident-related congestion), there may be opportunities to affect behaviors of those drivers with more flexibility.

Explore partnerships with major Seattle area employers and private information providers such as Google Maps and Waze. For example, during the overturned propane tanker incident, the email below was sent to all employees of the University of Washington's Applied Physics Laboratory:

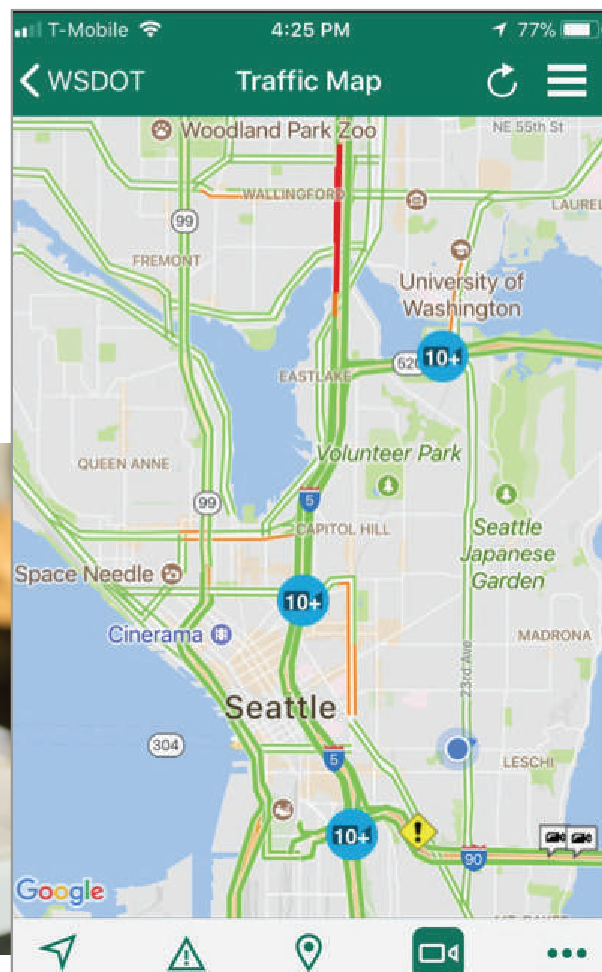
"All Hands,

I've just been informed that all lanes (both directions) of I-5 are closed between I-90 and the West Seattle Bridge exit due to an overturned tanker truck. There is no estimate as to a reopening time according to Seattle DOT. Please take this information into account and work with your supervisor as appropriate in planning your evening commute."

For those drivers who are not yet on the road, communicating the impacts of the incident and persuading them to remain at their current location until after congestion clears, or to use alternative modes of transportation, can help to reduce the congestion that results from major traffic incidents.

While providing guidance can impact commuter behavior, further incentives may be useful in persuading drivers to stay off the roads during major incidents. Working with city employers to develop and promote these incentives is an area Challenge Seattle could help to facilitate. These incentives might include: partnering with local restaurants to offer free or discounted menu items to encourage drivers to postpone their trips; partnering with employers to pay for extended parking and encourage the use of public transit or ridesharing; partnering with transit agencies to provide commuters with free rides and enhanced pick-ups during the incident; and partnering with ride-hailing services to provide discounts on their services. All of these incentives can be facilitated by online delivery.


Photo credit: Rawpixel.com



THE WAY FORWARD

Managing incident-generated congestion and mitigating its regional socio-economic impacts requires an enhancement of regional traffic incident management to incorporate congestion management processes. Phase 1 of the TIM-CM effort has been extremely successful, largely due to the creation of an extended regional TIM-CM community that is ready to enhance and increase coordination of its efforts during major incidents.

A follow-up Phase 2 will build on the momentum generated by this community. Below is an outline of suggested activities under the next TIM-CM Phase.

STAGE 1—Formalize, Empower and Facilitate the Seattle Area Joint Operations Group (SAJOG):

Finalize agency approvals of the SAJOG Charter produced under TIM-CM Phase 1. Establish SAJOG structure and facilitate activities of working groups in support of TIM-CM Phase 2 (i.e., give ownership of Phase 2 Stage activities to the SAJOG working groups). Stage 1 will be ongoing throughout all stages of Phase 2.

STAGE 2—Expand Stakeholder Partnerships and Analyze the Opportunity Space:

Engage the broader business community to explore employer-based programs that provide incentives to employees to avoid the central business district (CBD) not only during major traffic incidents, but also during high-impact days (events, holiday season, etc.). Engage the commuting public to understand how they currently get and use information about daily congestion and major incident-related congestion (i.e., mobile apps, social media, television), factors influencing route choices, use of multi-modal transportation preferences, decision processes, etc. Explore a coordinated approach that lightens the demand load on typical days, but will also benefit the area when the transportation system is compromised by major traffic incidents. These efforts should address significant system issues and are likely to include technical, organizational, policy and legal issues. Select the one or two most promising opportunity spaces and conduct further analysis to expand our understanding of the payoffs and challenges of these selected opportunities.

STAGE 3—Understand the ISE:

Building on the findings of TIM-CM Phase 1, continue working with stakeholders (expanded to include non-governmental partners and commuters) to complete and analyze the system model of current work processes and information-sharing associated with regional congestion management during major freeway incidents. How does the TIM-CM community acquire, analyze, share, use and store information? How does this community attempt to move backed up vehicles through and around the congested areas? How does it try to keep people from adding to the problem? How does it attempt to minimize economic and other negative regional impacts? The system model should integrate work processes and information flows, not only of public agencies, but also of relevant non-governmental stakeholders.

STAGE 4—Iterative Design of Prototype Solutions:

Working with all stakeholders, iteratively co-design prototype system enhancements that address the opportunities selected in Stage 3. Work with the SAJOG Policy working group to address interagency policy issues such as those identified in TIM-CM Phase 1 (i.e., appropriate sharing of Law Enforcement information; information sharing solutions that support agency-specific rules of engagement).

STAGE 5—Build and Test Prototype Solutions:

Build/enact prototype solutions and test under simulated conditions.

CONCLUSION

Based on this initial TIM-CM effort, the stakeholder team articulated the following mission:

> ***To collectively design and implement coordinated strategies that enhance mobility and reduce regional impacts when capacity along the Seattle I-5 corridor is drastically reduced by a major incident.***

To achieve this mission, regional stakeholders came together to articulate a shared vision that builds on past accomplishments, works beyond agency silos, and embraces opportunities offered by new technological capabilities.

This group now is prepared to expand and continue its innovative efforts to make Seattle and surrounding areas a safer, more resilient place for people, businesses, and the services they rely on.

Photo credit: Alex Mertz

About the Center for Collaborative Systems for Security, Safety and Regional Resilience (CoSSaR)

The Center for Collaborative Systems for Security, Safety and Regional Resilience, established in 2014 and housed in Sieg Hall, is a joint venture between the University of Washington's Applied Physics Laboratory (APL), the College of Engineering, and the Department of Human Centered Design and Engineering (HCDE). CoSSaR is a multidisciplinary facility and environment where professionals from a wide range of entities (Federal, State, County, City, Tribal, International, Public and Private) team with university experts to align strategies, processes and investments in systems for security, safety and resilience. Our mission is to lead innovation in the design, development and use of systems that support regional collaboration in these areas.

About the Washington State Transportation Center (TRAC)

The Washington State Transportation Center (TRAC) is a cooperative, interdisciplinary transportation research center, linking the University of Washington (UW), Washington State University (WSU), and the Washington State Department of Transportation (WSDOT). TRAC was formed in 1983 to coordinate transportation research efforts in the state and acts as a link among government agencies, university researchers, and the private sector.

About the Mobility Innovation Center (MIC)

A partnership between Challenge Seattle and the University of Washington, the Mobility Innovation Center tackles specific transportation challenges, using applied research and experimentation. Housed at CoMotion, University of Washington's collaborative innovation hub, the multi-disciplinary center brings together the region's leading expertise from the business, government, and academic sectors to use technology and innovation to find transportation solutions. Challenge Seattle is a private sector initiative led by many of the region's CEOs working to address the issues that will determine the future of our region—for our economy and our families.

> depts.washington.edu/cossar
> depts.washington.edu/trac
> mic.comotion.uw.edu