Integrating Computer-Aided Dispatch Data

WITH TRAFFIC MANAGEMENT CENTERS

U.S. Department of Transportation
Federal Highway Administration

FOREWORD

The Federal Highway Administration's (FHWA) Office of Operations has actively engaged in the national deployment of Traffic Incident Management (TIM) programs since the office was deployed. TIM programs can improve coordination, communications, and effectiveness of the various agencies—departments of transportation (DOTs), law enforcement, fire, tow operators, emergency medical services providers, and public works departments—as they respond to roadway incidents. The use of Computer-Aided Dispatch (CAD) by those agencies is integrated between police and traffic management centers, then potentially other responder agencies can provide several benefits that can mitigation of roadway incidents. This Primer describes how integrating data from law enforcement and public safety CAD systems with transportation operating systems can improve incident response, help to save responder lives, and improve safety for travelers on the network.

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16. Abstract

This Primer describes how integrating data from law enforcement and public safety computer-aided dispatch systems with transportation operating systems can improve incident response, help to save responder lives, and improve safety for travelers on the network. It presents several successful case studies of data sharing partnerships that have resulted in improved operational information as well as improved decision-making data for travelers. The Primer presents several practices that have advanced data sharing relationships between public safety agencies and transportation operating agencies.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L are shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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List of Acronyms

APCO	Association of Public-Safety Communications Officials
ATMS	Advanced Traffic Management Software
AZDPS	Arizona Department of Public Safety
CAD	Computer-Aided Dispatch
CCTV	Closed-Circuit Television
CHP	California Highway Patrol
CJIS	Criminal Justice Information System
CLEAN	Commonwealth Law Enforcement Assistance Network
DMS	Dynamic Message Sign
DOT	Department of Transportation
EDC4/6	Every Day Counts (Fourth and Sixth Rounds)
FDOT	Florida Department of Transportation
FHP	Florida Highway Patrol
FHWA	Federal Highway Administration
FIRST	Freeway Incident Response Safety Team
FSI	Focus States Initiative
GIS	Geographic Information System
HIPAA	Health Insurance Portability and Accountability Act
IDS	Incident Detection System
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JOPS	Joint Operating Policy Statement
JPO	Joint Program Office
LEISP	Law Enforcement Information Sharing Program
LEITSC	Law Enforcement Information Technology Standards Council
MnDOT	Minnesota Department of Transportation
MSP	Minnesota State Patrol
MWCOG	Metropolitan Washington Council of Governments
NCHRP	National Cooperative Highway Research Program
NOCoE	National Operations Center of Excellence
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
ODOT	Oregon Department of Transportation
PII	Personally Identifiable Information
RITIS	Regional Integrated Transportation Information System
RMS	Records Management System
RTMC	Regional Traffic Management Center
SSP	Safety Service Patrol

TIM	Traffic Incident Management
TMC	Traffic Management Center
TMDD	Traffic Management Data Dictionary
TMS	Traffic Management Systems
TOC	Traffic Operations Center
UAS	Unmanned Aerial Systems
USDOJ	United States Department of Justice
USDOT	United States Department of Transportation
VDOT	Virginia Department of Transportation
WSDOT	Washington State Department of Transportation
WSP	Washington State Patrol

Chapter 1. Introduction

The Federal Highway Administration (FHWA) defines Traffic Incident Management (TIM) as the coordinated detection, response, and clearance of roadway incidents in a way that is safe for motorists and responders. Proper TIM limits exposure (risk) of those entities responding to roadway incidents, reduces the potential for secondary crashes, and helps to facilitate effective incident clearance to mitigate congestion.

The FHWA has placed significant emphasis on TIM to improve safety for responders, promote increased collaboration among incident responders, provide multi-agency training, and support States and regions in elevating the focus on TIM performance analysis. In addition to improving responder processes and multi-discipline coordination during incident response, one of the most effective TIM strategies is the improved and enhanced situational awareness gained through sharing real-time incident data and incident information. Public safety agencies, like law enforcement, use Computer-Aided Dispatch (CAD) systems to catalog and coordinate activities. This makes CAD one of the richest sources of real-time incident information, since most road incidents are initially detected through 9-1-1 calls. This CAD information supports incident detection, notification, and response activities of critical public safety and emergency responders.

Sharing real-time CAD incident data has yielded quantifiable benefits, demonstrated by the following findings throughout the United States:

- After implementing integrated data sharing and coordination procedures between the Oregon State Police and the Oregon Department of Transportation (ODOT), there was a 30 percent reduction in incident response time and a 38 percent reduction in incident duration.
- In Minnesota, more than 70 percent of events to which Minnesota Department of Transportation (DOT) responded come through their integrated CAD data sharing with the State Police. The Minnesota DOT is able to mobilize and respond faster to incidents and support responder personnel on scene.
- In Florida, 42 percent of incident notifications in the State DOT's traffic management system originate from the Florida Highway Patrol (FHP) CAD system.
- Florida's success is evidenced in the fact that approximately 42 percent of the more than 91,000 annual traffic crashes in the Florida Advanced Traffic Management System (ATMS) originate from FHP CAD.

Real-time incident data has key benefits for several entities involved in incident response:

- For law enforcement, fire and other responders, the availability of real-time data from more reliable sources can help to accelerate overall incident response and clearance activities, which ultimately reduces the amount of time responders are on-scene and exposed to risks.
- Reducing the time to respond to and clear incidents also reduces the potential for secondary crashes. The potential for a secondary crash increases by 2.8 percent for each minute the primary incident continues to be a hazard. Extended time to respond to an incident poses a significant potential risk to responders and other travelers.[1]
- Transportation operations and management agencies benefit from an increased awareness of incidents, their location, and severity. Better information provided by law enforcement helps to inform transportation agencies of response resource needs for traffic management and scene clearance.
- Timely incident notifications are a critical part of traveler information systems, which help to alert travelers to an incident or closure on their route.

In addition to documented benefits during incident detection, notification, and response, CAD data provides agencies with accurate and more complete data to support TIM performance measures and performance analysis. This data set and the resulting performance measures can help to better inform resource needs and allocation, identify critical TIM gaps, and provide important justifications for future TIM investments. TIM data helps to educate agency leadership and can convey positive results of State and local TIM investments.

Integrated Public Safety-Transportation Agency Data

There are many benefits to integrating public safety CAD data with transportation agency operating systems like Traffic Management Centers (TMC). More than half of State DOTs have indicated that they have some form of access to real-time public safety CAD data. This data access ranges from manual incident notifications between public safety agency dispatch centers and TMC operators, to view only access of filtered CAD data feeds to fully integrated CAD and TMC data exchanges.

Over the last 15 years, there have been several efforts focused on improving real-time data sharing between CAD systems and TMC traffic management systems. Experiences in States such as Minnesota, Maryland, Washington, Oregon, and Florida provide valuable lessons learned and have helped to pave the way for showing how States can address both the

[1] FHWA Focus States Initiative: On the Road to Success, Fact Sheet, FHWA-HOP-10-009.

technical and institutional needs for sharing real-time CAD. There are also examples of implementations of CAD data sharing at the local level. One example is from Phoenix, Arizona, where local fire and police agencies are sharing filtered CAD data with a regional data system, which then disseminates this information to media, traveler information systems, and transportation agencies. Although the Arizona Department of Public Safety shared data with the State's Traffic Operations Center (TOC), there was a gap for arterial incident information; this was addressed through data sharing agreements and data interfaces with Phoenix and Mesa Fire agencies. In Wisconsin, the Milwaukee County Sheriff shares CAD data with the Wisconsin DOT Statewide TOC through a data sharing portal.

While there have been some major success stories in CAD-TMC data sharing and data integration, having full integration between these systems is not a common practice among States, and is therefore worthy of review.

Primer Objectives

The FHWA has placed a significant focus on helping States better utilize data to tell a more complete story of how TIM programs are helping to save responder lives, time, and money. Recognizing that strong performance data is the key to a successful business case for integrating CAD data with transportation operations, this document has been developed to highlight:

- Specific benefits that sharing CAD data can provide to support a more robust TIM strategy.
- Benefits for both law enforcement and transportation operations as a result of sharing real-time CAD data.
- Successful practices of early adopters of CAD-TMC integration, including State and local agency examples.
- Strategies for improving program business cases through more complete and quantitative performance data.
- Methods for overcoming institutional and technical challenges to facilitate system-to-system CAD data exchanges.
- Strategies and resources that are available to advance CAD integration.

Chapter 2. Sharing Data to Improve Traffic Incident Management

Incident Data

Public safety agencies, and particularly law enforcement, collect a wide range of data, both real-time and historical. While a computer-aided dispatch (CAD) event is active, data is dynamic and updated continuously to capture time stamp and additional details as they become available. Time-based data from public safety agencies is viewed as the most accurate depiction of incident events and activities. Modern CAD systems can integrate location-based data, such as caller location (using Geographic Information Systems (GIS) capabilities and linking to cell phone tower locations[2]), and apply Artificial Intelligence capabilities, including audio analysis, speech-to-text, automatic call/incident categorization, and other functions. There are tools within today's CAD systems that help to supplement operator interactions and data entry, such as automatically populating standard data fields. These tools can also be used to better understand key words and phrases used by callers, as well as generate detailed trend and analysis reports based on incident types, incident locations, and other parameters.

The CAD systems are rarely standalone communications tools, and they are typically linked within a broader suite of Record Management Systems (RMS) that includes crash reporting, evidence management, external database queries, mobile data device systems, and other functions. These systems usually offer some degree of customization to meet specific agencies and data fields needed.

Public safety CAD can provide such a wealth of timely and accurate incident data that stakeholders seek ways to better share and use that information, specifically with transportation data systems, like Advanced Traffic Management Software (ATMS) used in Traffic Management Centers (TMC). ATMS systems are analogous to public safety CAD, just with a transportation angle. Systems used by transportation agencies are also event-based, extensively using location and time data elements to coordinate activities, but primarily limited to roadways.

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[2] Scott Harris, "RMS/CAD: Exploring Technology Brings the Future to the Present," Product Feature, The Police Chief (December 2017): 64–66. Accessed via www.policechiefmagazine.org, April 2020.

Incident Data Standards and Data Interoperability

In addition to agency-written CAD programs, there are dozens of different vendors that provide and support CAD and RMS systems for public safety agencies. Voluntary data standards and specifications can help provide a common platform of functionality and support interoperability, such as center-to-center communications, including those operated by State Departments of Transportation (DOT). Standards help to promote consistent data formats and structures, and support greater automation of data queries and improve automated data sharing processes, thereby limiting the amount of customized or proprietary data integration and management that would otherwise be required. Using standards helps promote both cost and resource efficiencies. CAD standards efforts that are improving data access, storage and data management efficiencies for law enforcement agencies include:

- The United States Department of Justice (USDOJ) led efforts to define standards and specifications for CAD and law enforcement Records Management Systems (RMS) through the Law Enforcement Information Sharing Program (LEISP) and the Law Enforcement Information and Technology Standards Council (LEITSC). The USDOJ program was to advance the ideals of data sharing and the council was a grant-funded committee to execute guidance.
- While the LEITSC standards are not mandatory, they further the USDOJ objectives and information sharing mandates. Criminal justice organizations have embraced national data exchange standards for law enforcement, to promote data sharing and consistency across critical law enforcement information systems. These efforts resulted in the Standard Functional Specifications for Law Enforcement Computer-Aided Dispatch Systems,[3] which serves as a basis for CAD system development.
- The Association of Public-Safety Communications Officials (APCO) has established CAD standards, known as the Multi-Functional Multi-Discipline Computer-Aided Dispatch Minimum Functional Requirements, which identify the minimum functional requirements that a CAD system shall include. In the 2015 APCO CAD standards, there are no specific requirements or considerations for transportation uses and needs related to a CAD system.[4]

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[3] Standard Functional Specifications for Law Enforcement Computer-Aided Dispatch (CAD) Systems, Law Enforcement Information Technology Standards Council, 2006.

[4] ANS 1.110.1-2015 Multi-Functional Multi-Discipline Computer-Aided Dispatch (CAD) Minimum Functional Requirements, Association of Public-Safety Communications Officials International, 2015.

The transportation community has also been active in developing standards to promote data sharing and interoperability. Standards that are relevant to Traffic Incident Management (TIM) include:[5]

- The Institute of Electrical and Electronics Engineers (IEEE), created a group of standards known as the Common Incident Management Message Sets for Use by Emergency Management Centers, which provides a set of basic messages, fields, and information to describe traffic incidents, closures, traffic control equipment and other relevant details.[6]
- The Institute of Transportation Engineers (ITE) has established the Traffic Management Data Dictionary (TMDD) for center to center communications[7], which facilitates data sharing between centers (such as CAD systems and TMC operating systems).
- The National Transportation Communications for Intelligent Transportation System Protocol (NTCIP) provides rules, protocols, and a standard vocabulary for several standards for how objects are to be defined and how information can be communicated and shared between systems.

By leveraging available standards, both CAD and ATMS system developers can create innovative technology solutions that can support interoperability and information exchange across platforms.

Key Benefits of Sharing Computer-Aided Dispatch Incident Data

Sharing CAD data can be mutually beneficial for public safety and transportation operations, and has been shown to reduce time to respond to and clear incidents and reduce risk of secondary crashes. The primary benefit of reducing incident response and duration times is the improved safety for and reduced risk to responders, including law enforcement, fire, emergency medical, transportation operations and tow operators. Specific benefits cited by several case

[5] United States Department of Transportation, Intelligent Transportation Systems Joint Program Office, ITS Standards Program, Incident Management Application Areas https://www.standards.its.dot.gov/ApplicationArea/3 (accessed April 2020).
[6] Institute of Electrical and Electronics Engineers, https://standards.ieee.org/standard/1512-2006.html (accessed October 2020).
[7] Institute of Transportation Engineers, https://www.ite.org/technical-resources/standards/tmdd/ (accessed October 2020).

studies[8] show demonstrated improvements to safety, reduction in incident clearance time, and improved resource efficiency, including:

- Oregon DOT (ODOT) calculated a 30 percent reduction in incident response time and a 38 percent reduction in incident duration after implementing integrated data sharing and coordination procedures with the Oregon State Police.
- ODOT also found that, after integrating their TMC systems with the law enforcement CAD system, there was a 60 percent reduction in the number of calls to which ODOT TMC operators had to respond, which allowed them to have more time monitoring and coordination procedures with the Oregon State Police.
- Eighty-eight percent of crashes in the Virginia DOT (VDOT) traffic management system now come from State Police CAD. Without integrated CAD information, VDOT would be unaware of or far behind on most crashes on VDOT's roadways.
- In metropolitan Phoenix, Arizona, a data sharing arrangement between Phoenix and Mesa Fire agencies shares arterial incident data through a CAD data feed to a regional data management system. Agencies report that they now have access to real-time information for over 90 percent of incidents impacting arterial roadways in the metro area.

Chapter 4 provides additional details on key benefits of CAD integration and data sharing.

Relevant Data for Transportation Operations

Data within public safety CAD systems is generally robust and covers a wide range of incidents and call types. Transportation operating agencies, and TMCs in particular, are not typically interested in those incidents that do not directly relate to traffic or road impacts, so the amount of data sought by transportation agencies is a fraction of what is contained within the CAD systems. Transportation operating agencies are primarily interested in the following types of data:

- Location of incident (road, direction, milepost, interchange or other geographic identifier).
- Time an incident is reported and verified.
- Responders and arrival times (including response agencies and towing).
- Incident details (incident type, severity).

[8] Federal Highway Administration, Expanded Use of Integrated Computer-Aided Dispatch, Current Practices in Integrated CAD/TMC Systems, Contract No. DTFH61-16-D-00051, 2019.

- Updates to incidents as the response unfolds.
- Lane blockage and when lanes are opened.
- Secondary crashes that occur near the primary incident.
- Time(s) responders leave.

Public safety dispatchers gather this information from 9-1-1 callers, on-scene personnel, and allied agencies. Automated data types assigned in CAD include location, incident type, creation time, dispatch, arrival, and clearance times of the units to which the CAD owning agency is connected. Information such as lanes blocked, lanes cleared and secondary crashes require a manual entry and will not be automatically logged unless entered by a dispatcher or an officer in the field. Law enforcement CAD will not include data from other agencies about arrivals, on-scene response activities or clearance times; that information will be captured in that responding agency's corresponding CAD system. Unless there is a CAD-to-CAD interface to share that data, it will not be integrated with law enforcement CAD data.

Dispatchers update CAD systems as the incident is managed and until it is cleared. Information about any potential support resources from the State DOT, such as service patrol, hazardous materials (HAZMAT) or other response teams could be relayed and requested from on-scene personnel and could be transmitted via a CAD message or through direct request from field personnel or dispatch centers to TMC staff.

Information from CAD can also be valuable post-incident, in that it provides an important record of the incident and its impacts. Minnesota DOT noted that it uses CAD data to retrieve case numbers for incidents that cause damage to State property. This information is helpful for any insurance information or restitution billing needs.

The TIM timeline, shown in figure 1, identifies the chronology of a traffic incident from when an incident occurs until the time when traffic conditions return to normal. Along the timeline are milestones, including T0 (incident occurs) through T6 (traffic conditions return to normal). The goal of TIM is to shorten the duration between T0 and T6. Incident data sought by transportation agencies aligns with the TIM timeline.

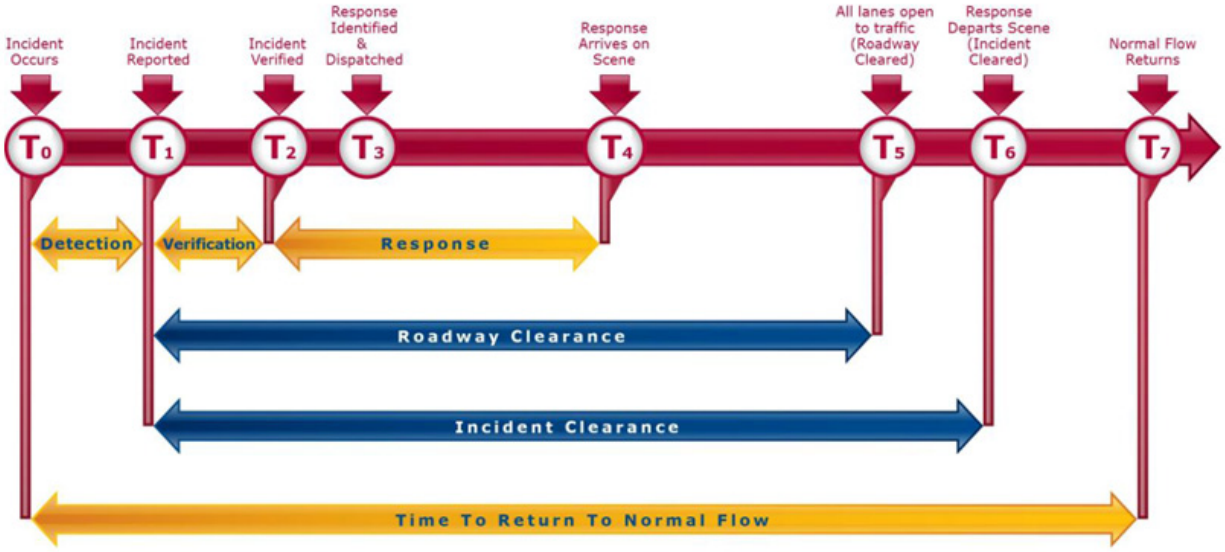

Figure 1. Diagram. Timeline of traffic incident elements.
(Source: U.S. DOT Intelligent Transportations Systems Joint Program Office (ITS JPO).)[9]

Methods for Sharing Incident Data

There are many ways that agencies can share CAD data. This section describes the levels of incident notifications and CAD data sharing as a function of how it is shared, from a simple phone call to advanced approaches that move data between systems without human intervention. Figure 2 shows the range of methods for sharing incident data between public safety agencies and TMCs, from basic to advanced. The corresponding sections that follow provide a description.

[9] "Transportation Management Center Data Capture for Performance and Mobility Measures Reference Manual," March 2013. [Online]. Available: www.its.dot.gov/research_archives/data_capture/pdf/data_capture_reference_manual.pdf (accessed October 2020).

Method	Attributes
1. Radio monitoring and manual notifications	Incident information is provided through a phone call, manual email, or TMC staff monitoring public safety dispatch radio communications
2. View only access	TMC operators can view a CAD data feed and enter data into TMC software
3. Data verification required	CAD data is provided to a TMC and requires operator to review, accept or retype into TMC operating system
4. Automated data transfer	Data is automatically transferred from CAD to TMC systems and creates an event within TMC software

CAD: Computer-Aided Dispatch; TMC: Traffic Management Center

Figure 2. Diagram. Methods of computer-aided dispatch data sharing.
(Source: Federal Highway Administration.)[10]

Level 1

TMC operators are notified of incidents through manual methods, such as a call from a public safety dispatch center or an email alert. Level 1 also includes TMC being made aware of an incident through monitoring public safety communications radios. This method can result in inconsistent notifications, and there could be a delay in obtaining information of the incident, which leads to delay in notifying travelers or dispatching State DOT support resources. At this level, incident updates also are provided (or monitored via radio) and updated manually. TMC operators translate the information that is being provided dispatchers or interpreted from radio communications and enter the information into TMC software to generate an incident event within CAD.

Level 2

TMC operators have access to a CAD data feed, which could be through a dedicated computer screen or terminal, or a windowed viewer. In some instances, there is a CAD terminal in the TMC but viewing is limited to law enforcement personnel who can then relay notifications to TMC operators. In other instances, the TMC operators can view a filtered data feed that does not include any sensitive incident information. This process relies on co-located communications

[10] I-95 Corridor Coalition (now Eastern Transportation Coalition) CAD and TMS Integration Workshop Summary Report, April 2018.

between on-site officers and TMC operators, or on TMC operators to actively check for incidents and updates. TMC staff must enter information into TMC software to generate an incident event.

Level 3

CAD data is sent to the TMC and will appear as an alert that the operator needs to acknowledge. This eliminates the need for operators to check a separate window or system for incident alerts or incident updates, but still requires operator action, depending on how the TMC software is configured. TMC staff is typically required to copy and paste relevant CAD details to create an ATMS event. Systems might be configured to automatically interpret some of the fields, such as displaying incident location on a map of assets such as dynamic message signs (DMS).

Level 4

At this level, the existing traffic management software brings in CAD data with minimal operator action or intervention. Delay between the incident being reported to police and shared with the TMC is minimal. Again, the TMC software may display incident details automatically as alerts or on status maps to assist operators in responding. As the incidents are updated in CAD, details may be automatically shared and updated with TMC systems. In some cases, such as in Minnesota, the TMC can serve as an allied agency with (limited) access to CAD, and the ability to create and manage events within CAD. This option limits the potential for errors or missing data.

Traffic Management Center Functions that Rely on Traffic Incident Management Data

TMCs are hubs for real-time information about the transportation network. They house a wide range of systems that enable real-time monitoring of systems and roadways, allow operators to enter and track information on planned and unplanned closures, and these systems enable operators to control various intelligent transportation system (ITS) devices, such as closed-circuit television (CCTV) cameras and DMS. The typical role of a TMC is also to facilitate notifications, coordinate among agencies and distribute alerts through traveler information systems.

During traffic incidents, TMCs serve a critical function in verifying incidents, assessing impacts to the road network, dispatching State DOT resources (such as incident response teams, hazardous materials crews or safety service patrols), and disseminating information to warn other travelers. A TMC is often responsible for issuing notifications to other agencies and services about the incident and its impacts. TMCs typically include a grouping of individual workstations where operators can monitor and manage multiple systems. A video wall allows several operators to monitor a network, and if there is an incident at a particular location, this can be

displayed on the video wall for broader monitoring by State DOT staff in the TMC. Figure 3 shows a typical TMC workstation in an operations room.

Figure 3. Photo. Traffic management center workstation at the Freeway and Arterial System of Transportation traffic management center, Nevada.
(Source: Federal Highway Administration.)

Access to real-time incident data is critical to many TMC functions. Because the majority of incidents are initially detected through 9-1-1 calls, the initial incident notification will set a series of processes into motion at the TMC. These processes include TMCs assessing what types of State DOT resources could be needed to support incident response and clearance, assisting the primary responder agency with confirming incident locations, and which alerts and notifications to send to agencies and other motorists through traveler information tools like 5-1-1, social media and traditional media outlets. Other key incident details that enable faster and more effective incident response processes at TMCs include:

- Incident location.
- Times responders arrive and leave the scene.
- Type of incident (property damage, injuries, fatality), as this could provide an indicator as to how long the incident might impact travel lanes.
- Debris located in travel lanes.
- Status of incident response and clearance.
- Lanes and direction of impacted lanes.
- Time that lanes are cleared.

These details are important to a wide range of State DOT response processes, and access to continually updated CAD data can improve the quality and accuracy of information with which the TMC is working, limit the need for the TMC to coordinate with busy law enforcement dispatch centers, and enable better resource mobilization of State DOT resources needed to support the incident response. TMC operators that are manually updating information as it unfolds are at risk of not entering pertinent details, missing updates to information, and are already busy monitoring multiple systems during incidents. Integrated CAD data provides a win-win for both public safety and for transportation operations.

Chapter 3. Evolution of Computer-Aided Dispatch Data Sharing

Efforts to integrate computer-aided dispatch (CAD) data with traffic management center (TMC) systems date back to the early 2000's. As TMCs and traveler information systems expanded to include data sources beyond the agency intelligent transportation systems (ITS) and networks, and as transportation operations agencies recognized the critical role that law enforcement and public safety data played in incident management response processes, there was increasing interest in facilitating more efficient ways to obtain this important CAD data. This chapter presents how CAD data sharing capabilities between public safety and transportation operations have evolved and includes case studies of successful data sharing relationships.

Early Computer-Aided Dispatch Traffic Management Center Data Sharing Studies

A foundational study conducted by the National Cooperative Highway Research Program (NCHRP) in 2004 identified strong synergies between public safety and transportation operations for common goals of safer response to incidents on the road network and that information sharing was a mutual core value of both public safety and transportation operations. The study found that even manual efforts to share traffic incident management (TIM) data between responder agencies and transportation operations agencies fostered greater cooperation and collaboration.[11] At the time of that study, information sharing included co-located law enforcement and transportation operations for in-person coordination, some sharing of common radio systems, and shared CAD data with view-only access to limited CAD details. State DOTs that were interviewed as part of the NCHRP study cited proprietary systems (for law enforcement and transportation operations), lack of CAD data sharing standards, and institutional barriers as key challenges impacting data sharing. This study led to two field operational tests in Washington State and Utah.

Current State of the Practice

More than half of State DOTs reported that they have access to some level of law enforcement incident data. This includes a range of methods to access this CAD data, including view-only access

[11] NCHRP Report 520, Sharing Information between Public Safety and Transportation Agencies for Traffic Incident Management, 2004.

to CAD data feeds, manual notifications of incidents, or through direct CAD data feeds to TMC software. Figure 4 shows the current status of CAD data sharing throughout the United States.

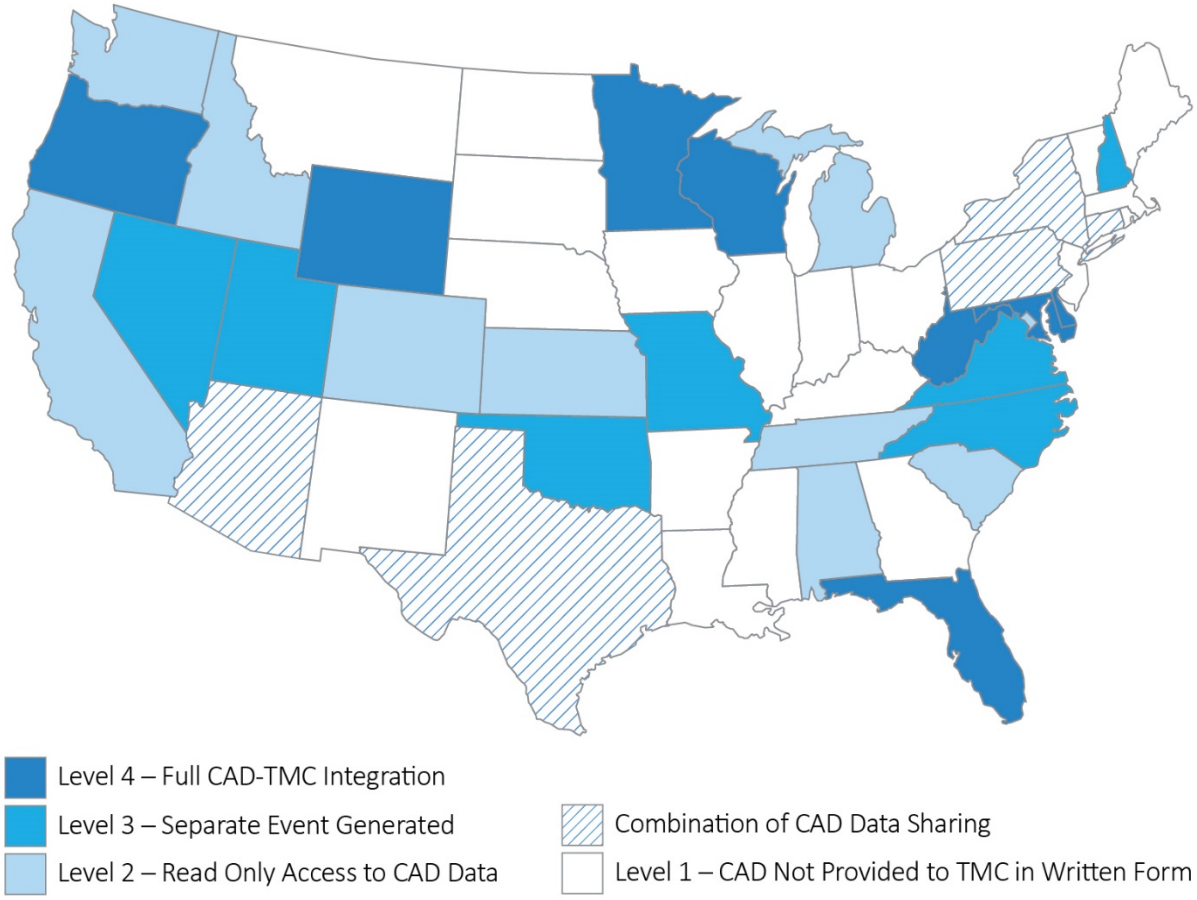

Figure 4. Map. Current status of Computer-Aided Dispatch (CAD) and Transportation Management Center (TMC) integration.
(Source: Federal Highway Administration[12])

Past challenges and barriers have often pointed to several potential issues that have impacted agencies' abilities to share CAD data, including:[13]

- Technology integration issues, including proprietary systems used by law enforcement and transportation operations.
- Lack of policy or institutional framework to support data sharing.

[12] Federal Highway Administration, Expanded Use of Integrated Computer-Aided Dispatch, Task 3: Business Case, April 2019. Map updated in 2021.
[13] Federal Highway Administration, Expanded Use of Integrated Computer-Aided Dispatch, Task 3: Business Case, April 2019.

- Data compatibility concerns between CAD systems and transportation agency Advanced Traffic Management Software (ATMS) policy issues.
- Uncertainty about financial responsibility to enable or maintain a data feed.
- Concerns about data security and TMC operators and transportation agency staff accessing sensitive data contained in CAD.
- Physical and virtual security of the entire CAD system and its components (networks, hardware, servers and devices).
- Lack of leadership support for sharing data or champions no longer in an influential role.

Security of Sensitive Computer-Aided Dispatch Data

Today's CAD and TMC software can largely address prior technology compatibility and data integration challenges, and voluntary data standards promote greater interoperability of data between law enforcement and transportation systems. There remain challenges with information sensitivity and data security. For example, Criminal Justice Information Systems (CJIS) and the Health Insurance Portability and Accountability Act (HIPAA) have provisions for handling or limiting access to personally identifiable information (PII), some of which might be contained in public safety CAD incident details. There are usually standard menu data fields, but many CAD systems also include freeform text entries where dispatchers capture varying levels of incident information. These free-form fields could contain potentially sensitive information.

Limiting access at TMCs to pertinent transportation-related data can help to alleviate concerns regarding CJIS and HIPAA requirements, as can proper training of TMC operators who will be accessing CAD data. For example, the Federal Bureau of Investigation's CJIS Security Policy describes how data exchange agreements are used to outline specific data that is to be shared, how this data will be transmitted, and any limitations on use of data by the recipient (in this case, the TMC).[14] Establishing these parameters helps to safeguard CJI data security requirements can limit liability of the transportation operations agency.

Another strategy to mitigate CJIS concerns is for law enforcement to provide TMCs with a data feed that only includes traffic and vehicular incidents and limits the data fields shared to incident type, types of vehicles involved and location, but limits details such as severity, injuries, license plates, and other potentially sensitive data. Some States, such as California, require additional background checks for TMC operators that will have access to incident data generated by CAD systems. Many CAD system vendors provide training materials and resources that can support

[14] Criminal Justice Information Services (CJIS) Security Policy, version 5.9, 6/01/2020, p. 15, https://www.fbi.gov/services/cjis/cjis-security-policy-resource-center.

training program, including basic security awareness training, and specific training for IT and network management personnel.

The following case studies highlight how Minnesota and Florida have focused on increasing and improving CAD data sharing between State Police agencies and transportation operations. These examples show how both States leveraged technology enhancements as well as collaborated to find solutions to address some of the common challenges that impact CAD data sharing. Additional brief case study examples are also included.

Successful Practice: Minnesota Shared Computer-Aided Dispatch System

The Minnesota DOT (MnDOT) and the Minnesota State Patrol (MSP) have a long history of collaborating to improve incident detection, response, management, and performance analysis. MnDOT and MSP have incrementally increased the CAD-TMC integration over the last 20 years. In 2001, MnDOT had a view-only CAD terminal at its TMC where operators could view MSP incidents. In 2003, the Regional TMC (RTMC) was built in Roseville, which co-located MnDOT TMC operations, MSP dispatch, and MnDOT maintenance. Co-locating these agencies provided a strong foundation for ongoing system and operational collaboration.

In 2008, MnDOT and MSP implemented a full TMC integration with the MSP CAD. MnDOT was expanding its traffic management system coverage area and responsibilities but was not increasing the number of operations staff; integrated CAD provided an added level of efficiency for TMC staff. Software privileges allowed MSP to filter which information TMC operators could view and access, which maintains the privacy of sensitive CJIS and HIPAA data. As part of the agreement with MSP for the TMC to be fully integrated, the MSP allowed the TMC staff and Freeway Incident Response Team (FIRST) staff to view and enter specific comments into MSP-created CAD events which the TMC could use at later points to obtain benchmark times. The MnDOT TMC and the FIRST staff can create their own events within the MSP CAD system, such as FIRST service patrol responses and service calls. A 2012 enhancement allowed for more automated data export to MnDOT's ATMS, traveler information services and data analysis tools.

MnDOT funded several technology enhancements that enabled increased CAD usage by MnDOT staff, including TMC and FIRST. This included computers and software on board the FIRST vehicles, the CAD mobile software license and other supporting infrastructure to allow FIRST vehicles to run and access the MSP CAD. FIRST and TMC uses the same hardware and software as MSP, but MSP troopers have access to more data within CAD which is filtered from FIRST and the TMC. Figure 5 shows an active FIRST response unit.

Figure 5. Photo. Minnesota Department of Transportation Freeway Incident Response Safety Team response team.

(Source: Minnesota DOT.)

The TMC also monitors the MSP radio dispatch and can immediately use closed-circuit television (CCTV) cameras to verify, confirm, and assess incidents. Valuable information about the incident scene and exact locations can be relayed to responders en route, helping them to formulate strategies even before they arrive to better position themselves at the incident scene. Real-time views through CCTV supports the ability to upgrade or downgrade response and communicate that information to responders.

With this integration and agreement between the agencies, MnDOT became an allied agency on MSP's CAD system. The live data feed and the incident comments field are actively shared between the agencies, providing a two-way street for including relevant response and incident details. Information provided in the real-time feed includes latitude/longitude, event type, start and close times, real-time location of response vehicles, and TMC operator-entered remarks. Integrated CAD in Minnesota has allowed for more robust performance tracking and access to important reference points. MnDOT Maintenance uses CAD data to retrieve case numbers for incidents that have caused damage to state property. Having the specific case number and details about the incident has helped to support restitution billing through insurance. Another key example is the capability for FIRST SSP to track which vehicles they have assisted and frequency of assists. This has helped to identify individuals that have repeatedly availed themselves of the state's emergency roadside assist program.

Successful Practice: Florida Integrated Computer Systems

Florida has worked with a shared view of CAD since the early 1990s. Co-location of dispatch and TMC began in the mid 1990s, and the first iteration of shared CAD information was a media viewer, which provided filtered details but refreshed only every five minutes. The Florida

Highway Patrol (FHP) deployed a new generation of CAD in 2001, and while the updates were still not real-time, the event list was heavily relied upon by the Florida DOT (FDOT) TMCs.

In 2005, the CAD vendor developed and deployed a new CAD viewer that improved the incident data refresh rate to every minute. The next iteration of CAD in Florida provided interactive incident mapping to the public. Technology improvements allowed location information to be more precise, and the freeway service patrol (Road Rangers) also began contributing information to the CAD system. The FDOT created an Incident Detection System (IDS) to handle CAD content and automatically create alerts for TMC operators who would be informed of CAD incidents, based on their geographic location. The alerts allowed CAD incidents to create ATMS events with the push of a button, populating relevant data fields for event type, location, time stamps, etc.

Florida faced some technological challenges integrating and distributing data from seven separate regional FHP servers and 12 Regional TMC servers. The IDS helped the agencies solve the challenges presented by distributed systems and geography. An example of alerts FDOT TMC operators receive from the FHP CAD system is shown in Figure 6.

Florida's success is evidenced in the fact that approximately 42 percent of the more than 91,000 annual traffic crashes in the State DOT ATMS originate from FHP CAD.

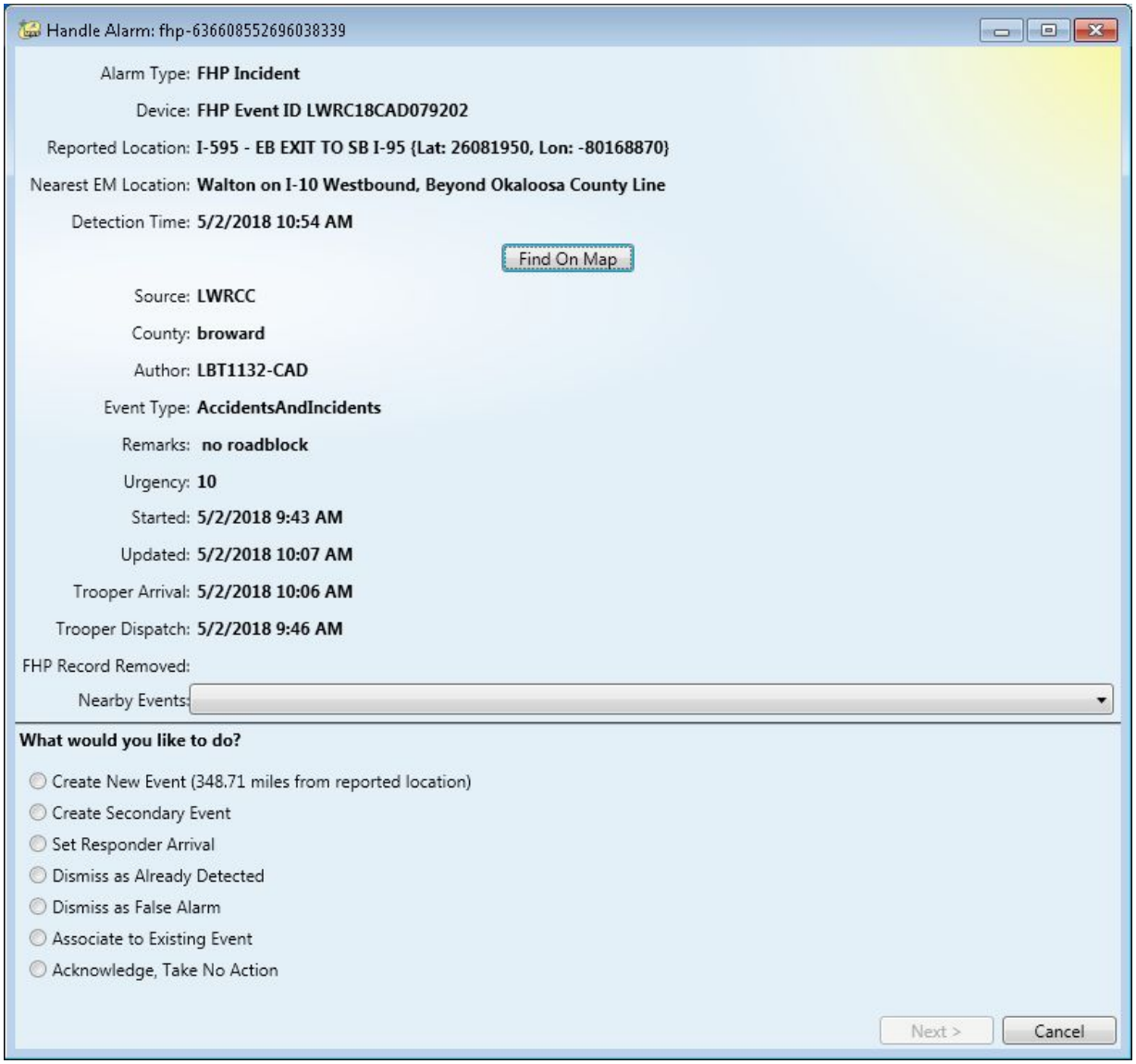

Figure 6. Screenshot. Example alert sent to Florida Department of Transportation Traffic Management Center (TMC) from Florida Highway Patrol Computer-Aided Dispatch (CAD).
(Source: Federal Highway Administration.)

Additional Successful Practices

- **Arizona**—Maricopa County, which includes the Phoenix metropolitan area, includes nearly 30 cities and towns, three Tribal nations and the County. The Arizona Department of Public Safety (AZDPS) is responsible for incident response on freeways, but there are numerous law enforcement agencies that respond to arterial incidents. Phoenix Fire dispatches for more than 20 cities in the Phoenix metropolitan area. Maricopa County established a data feed from Phoenix Fire CAD which provides real-time data about

arterial incidents that previously had not been shared with transportation operations. Arterial incidents from the Phoenix Fire CAD system are updated in real time and shared across several agency and private sector data feeds. The Maricopa County DOT also established a CAD feed to Mesa Fire, which is one of the few agencies not dispatched by Phoenix Fire. By connecting to the Fire CAD data feeds, more than 90 percent of arterial incidents in the metropolitan area is shared with State and local transportation agencies.

- **California**—Several California Highway Patrol (CHP) dispatch centers are co-located with Caltrans TMCs in many of the State's 12 Caltrans Districts, which supports a strong working relationship between these two State agencies. In addition to sharing space, the CHP shares incident information such as incident type, location, and timestamp for incidents on State highways, via a near-real-time xml feed. This public data feed can be used by TMCs and other sources of traveler information, such as radio stations and mobile apps. CHP has a longstanding history of making filtered CAD data available to support Caltrans operations and response as well as public and private traveler information systems. CHP also requires additional security screening and background checks for any TMC operators that will be utilizing CHP CAD data for traffic operations.

Ongoing Efforts to Expand Computer-Aided Dispatch-Traffic Management Center Data Integration

The Federal Highway Administration (FHWA) and other agencies continue to focus on expanding awareness of the benefits of CAD integration. Through industry forums, multi-agency meetings, national webinars and project activities, there continues to be a growing body of research and support for sustaining investment in CAD data integration.

Every Day Counts

As part of the fourth round of the Every Day Counts program (EDC4), one of the strategic focus areas centered on TIM data and using TIM data for more robust performance measures. EDC4 emphasized the importance of data to current and future TIM programs, including integrated CAD, electronic crash reporting and tools to streamline data collection and analysis. Three key TIM measures that would showcase the value of the TIM data: Roadway Clearance Time, Incident Clearance Time, and Secondary Crashes were central to the EDC4 TIM data innovation. The EDC4 TIM data initiative emphasized how relatively low-cost technology investments, such as enhancing existing CAD systems, improving mobile data and strategies for harnessing existing data could boost agencies' ability to track and report on key performance measures. TIM measures have

the potential to pinpoint where specific investments—such as TIM strategies, partnerships, and resources—could have the most impact in improving safety and mobility.[15]

The EDC6 program launched in late 2020 and includes a Next-Generation TIM focus, emphasizing training, technology, and data to improve TIM on local roadways.[16] The EDC6 Next-Generation TIM innovation builds on efforts by the FHWA, state and local agencies and the responder community to integrate proven, yet under-utilized approaches to advance TIM. CAD integration, Unmanned Aerial Systems (UAS), video sharing, and responder to vehicle alerts are examples of technology approaches that can help agencies improve efficiency of their TIM programs and activities. New and innovative TIM training and distribution approaches supports institutionalizing national best practices among responder groups, including agencies that work on local and rural roads.

The Eastern Transportation Coalition

The Eastern Transportation Coalition (formerly known as the I-95 Corridor Coalition) has a long history of collaborative, multistate TIM initiatives. In October 2017, the Coalition hosted a webinar attended by more than 40 agencies, software developers, universities, and consultants to discuss lessons learned and challenges surrounding CAD-TMC data integration. Following the webinar, a two-day workshop was held in 2018 and brought together 20 transportation operating agencies to identify successful practices and strategic focus areas to advance CAD-TMC integration. All participating States reported some level of communication/coordination between public safety agencies and State DOTs on incident management, including via voice, phone call, and radio. Experiences were shared from those States with automatic CAD data feeds into TMC systems and those in various stages of planning for CAD integration. Key benefits identified included:

- Improved responder and road user safety.
- Improved situational awareness, including faster incident notifications and an improved ability to respond to incidents more efficiently.
- Improved incident data collection and availability for performance tracking and management.
- Reduced duplication of efforts, including reduced call volume and streamlined data entry.

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[15] Federal Highway Administration, Every Day Counts: An Innovation Partnership with States, EDC–4 Final Report. April 2019. https://www.fhwa.dot.gov/innovation/everydaycounts/reports/edc4_final/

[16] Federal Highway Administration, Every Day Counts 6, Next Generation TIM, https://www.fhwa.dot.gov/innovation/everydaycounts/edc_6/nextgen_tim.cfm

- Increased support for investments in safety and incident management.
- Improved traveler information.

Challenges and barriers identified by workshop attendees included willingness and support from public safety agencies for sharing data, lack of formalized partnerships or guidance for data sharing, CJIS requirements for handling sensitive data, and funding.

Talking Traffic Incident Management Webinar Series

In partnership with the National Operations Center of Excellence, FHWA moderates monthly TIM-focused webinars that highlight innovative practices, State and regional TIM program advancements, and TIM training updates. There is a key recurring focus on sharing information on TIM data and performance analysis. Topics have included emerging data sources for TIM (such as crowdsourced data), States' approaches to crash analysis, CAD-TMC data integration, cross-cutting TIM performance management programs, and other related topics.[17]

[17] National Operations Center of Excellence, Talking TIM Webinar Series, https://transportationops.org/tim/talkingtim. (Accessed October 2020.)

Chapter 4. Making the Case for Computer-Aided Dispatch-Traffic Management Center Integration

There have been some positive strides toward data sharing for Traffic Incident Management (TIM) over the last several years, and these examples point to the need for continued focus and collaboration for system-to-system data integration between law enforcement Computer-Aided Dispatch (CAD) systems and transportation operations. Sharing real-time CAD data has direct impact on agencies' ability to detect, respond to, and clear incidents in a safe manner, reducing the overall incident duration and the time responders are exposed to risks by being on-scene. In 2019, there were 44 responders who lost their lives in the line of duty responding to traffic incidents.[18] These include law enforcement officers, fire, emergency medical services, tow operators, Department of Transportation (DOT) safety service patrol incident response teams, and others.

Sharing real-time CAD data has key safety benefits for traffic incident stakeholders like responders, transportation agencies and roadway users, including:

- Reduced time on-scene means reduced risk of exposure TIM responders.
- Reduced overall incident time reduces the risk of secondary crashes.
- Improved traveler information and alerts to motorists can provide advanced warning of incidents and inform traveler decision making.

There are also important mobility benefits, agency operating efficiencies, and enhanced capabilities for analyzing performance that result from sharing this data.

There are also benefits for law enforcement by being able to leverage the TMC systems and staff, namely access to video images, to be able to confirm incident locations and better understand what is happening at the scene before responders arrive. The TMC can provide law enforcement (and other responders) with more precise information about lane impacts, restrictions and other important details while they are en route. This helps responders start to formulate strategies for where to safely park in relation to the incident.

[18] Emergency Responder Safety Institute, 2019 Fatality Report, https://www.respondersafety.com/Struck-By-Incidents/2019-ERSI-StruckByVehicle-Fatality-Report.aspx

Table 1 shows a summary of key benefits that can be realized by law enforcement and transportation operations as a result of sharing real-time CAD data.

Table 1. Benefits of integrated Computer-Aided Dispatch (CAD).

Benefits for Law Enforcement Agencies	Benefits for Transportation Agencies
• Increased officer and responder safety during incident response. • Minimal cost or changes to law enforcement agency processes. • Reduced coordination time and distraction for dispatchers at communications centers. • Streamlined and improved analysis and reporting for Traffic Incident Management (TIM) performance measures. • Reduced requirements for law enforcement agencies to notify other agencies and travelers.	• Increased awareness of and faster verification of incidents. • Faster mobilization of State Department of Transportation (DOT) response resources to road incidents. • Improved incident response and clearance times. • Expanded depth and accuracy of data for TIM performance analysis. • Stronger justification for TIM resources through performance analysis. • Improved traveler information. • Increased efficiency and accuracy of Traffic Management Center (TMC) operations.

Benefits of Computer-Aided Dispatch Integration for Law Enforcement and Public Safety Agencies

One of the primary benefits of CAD integration for law enforcement, public safety, and incident responders is accelerating the overall time to respond to and clear incidents from the roadway. Doing so reduces the time required for responders to be on-scene, which promotes safety for both responders and travelers. There are several other important benefits, many of them focused on resource efficiencies and improved processes and tools for performance analysis.

By integrating CAD data with TMCs, law enforcement agencies provide data access to a valuable partner that can help to streamline efforts of law enforcement staff, often at very little cost and with limited process changes on the part of law enforcement agencies. Law enforcement agencies can often obtain several benefits just by partnering with transportation agencies and without having to bear many of the costs, in terms of both financial and personnel resources. Several important benefits are discussed below.

Faster Department of Transportation Response for Safer Incident Scenes

CAD data sharing can improve overall response to incidents by expanding TMC situational awareness and, in turn, faster mobilization of State DOT response resources. The partnership between law enforcement and transportation management agencies allows State DOTs to provide key support for law enforcement on-scene, which is enabled much faster when incident notifications to State DOTs are accomplished quickly. Faster notifications through CAD integration can result in State DOTs being able to set up traffic control on scene, activate traveler information systems to warn motorists, and get specialized incident response crews (including hazardous materials team or maintenance) to scenes faster.

State of the Practice Highlight: After integrating CAD data with the Virginia DOT (VDOT), Virginia saw a 34 percent reduction in incident clearance time on a 67-mile segment of I-95. The Oregon DOT established an integrated data sharing strategy with the Oregon State Police and calculated a 30 percent reduction in incident response time and a 38 percent reduction in incident duration.

Expand Opportunities to Improve Law Enforcement Systems

Integrating public safety CAD and TMC systems can create opportunities for public safety agencies to upgrade and improve their systems. Transportation agencies might have access to regional, State or Federal grant funding mechanisms, and by partnering, a combined funding proposal could be strengthened by demonstrating a coordinated and collaborative approach. Furthermore, State DOTs and local transportation agencies recognize the value that the CAD data brings to many of their TMC operating processes and their operations mission. There is often a willingness to share costs or provide additional funding for strategies that will help automate CAD data being provided to the TMC.

Improved Performance Analysis

Sharing CAD data with TMCs can streamline and enhance process for TIM performance tracking and reporting by combining CAD data with other operational data to create a robust set of performance reports. Law enforcement and public safety agencies can have the most accurate and complete data from which to do a detailed assessment of TIM performance. Providing CAD data to external agencies enables a robust performance management program; it can be combined and linked to other transportation operations data to create compelling information to support data-driven decision making. Improved data and performance tracking

can provide public safety agencies, and transportation operations, with the ability to better plan for and justify key investments in their TIM programs.

State of the Practice Highlight: Minnesota agencies used the combined incident dataset from CAD integration to analyze and compare TIM performance across different incident types. Data showed that the average clearance time for most incident types decreased or generally held steady over the six-year period, where the average clearance time for a specific type of incident (spinouts) was increasing over that same period. Prior to the CAD integration, TMC operators created event records based on what they were able to see on closed-circuit television (CCTV). The CAD data provided a more accurate and robust data set. Furthermore, the Minnesota State Police (MSP) CAD data captured wrong-way vehicle reports in a more accurate way than the crash reports. This information provided MPS and the TMC with more precise information of locations and frequency of wrong-way crashes.

Reduce Coordination and Notification Responsibilities

Providing CAD data to TMCs can help to reduce the burden on law enforcement of multi-agency notifications when there are incidents on the road network. Law enforcement dispatchers are busy coordinating with responders in the field and may lack the capacity to simultaneously notify and update other agencies as the incident progresses. CAD data can provide near-real-time updates to TMCs as new incident details are available. TMCs are a natural hub for multi-agency communications and coordination, and many TMCs already have built-in processes to distribute alerts to key agency partners. There are fewer chances for conflicting information or miscommunications when all parties are working from the same dataset and processes can be automated.

State of the Practice Highlight: The California Highway Patrol (CHP) created an xml data feed of incident notifications that the Patrol makes available to media, the public, transportation agencies and third-party mobile application developers. The media version of this data feed contains limited details such as incident type, location, and timestamp. While TMCs will often want additional details to be able to make decisions, the information is valuable for broader public consumption to promote awareness of incidents. The result was a significant reduction in incoming calls to CHP dispatchers and allowed dispatchers to focus on incident response coordination.[19]

[19] Federal Highway Administration. Considerations of Current and Emerging Transportation Management Center Data. FHWA-HOP-18-084. July 2019.

Benefits of Computer-Aided Dispatch Integration for Transportation Operations

Transportation agencies and TMCs are focused on processes and information that directly affects mobility and safety on the road network. Many of the systems used by TMCs are designed to directly support situational awareness, detect anomalies in traffic flow and traffic patterns, alert operators and agency staff to issues on the network, and communicate warnings and alerts to travelers.

Improved Awareness of Incidents

TIM data is an integral component to transportation operations' overall mission. Having access to CAD data can greatly speed up the time it takes to become aware of an incident on the road network. By having more advanced notification of incidents, TMCs can put processes in motion to verify incidents and monitor conditions near the incident scene, begin notifying State DOT response team of incidents and support needs, and issue warnings to other agencies and to travelers. Accurate and complete incident data is a key part of many TMC functions and roles.

State of the Practice Highlight: VDOT indicated that 88 percent of crashes in the VDOT Advanced Traffic Management Software (ATMS) are a result of the CAD data provided by the State Police. Similarly, Minnesota DOT indicated that more than 70 percent of events that the DOT responds to are from the State Police CAD system, compared to less than 10 percent detected through CCTV cameras. In metropolitan Phoenix, State and local agencies have access to 90 percent of the arterial incidents in the metro area through an interface with the Phoenix Fire CAD and Mesa CAD systems.

Improved Department of Transportation Response and Incident Clearance

Accurate and more complete information provided from CAD systems to TMCs results in faster assessment of potential State DOT response resources that are needed. TMCs can quickly dispatch service patrols, hazardous materials teams, and incident response units who will get to the scene faster, establish traffic control and help to protect responders and other motorists. Safe, quick clearance is the result of a combination of strategies working together, and agencies look to leverage any opportunity to reduce the time to respond to and clear incidents faster and more safely. This reduces the time all responders are on scene, limits risk and exposure to dangerous situations, and helps to reduce the risk of secondary crashes.

Secondary crashes pose a significant risk. The FHWA Focus States Initiative for Traffic Incident Management Performance Measures[20] recommended that the number of secondary crashes be among the three critical TIM performance measures that agencies should be collecting. The other program-level performance measures recommended by the FSI were roadway clearance time and incident clearance time.

Expanded Performance Measures

Agency ATMS data combined with integrated CAD data creates a rich pool of data from which to track, measure and report on performance. While real-time data supports critical operations functions, more complete historical information obtained through detailed CAD data provides the foundation for a robust performance management strategy. Law enforcement and public safety CAD data can provide the most accurate incident data including timestamps that are critical for incident response and duration tracking, incident types and severity, incident impacts, and responder activities. When combined with additional data elements from DOT ATMS and event reporting systems, which could include traffic volumes, queue length, devices used and activated, and DOT response team details, there is a more complete dataset from which to perform a variety of analyses.

This data can support a wide range of performance analysis and reporting, including detailed after-action debriefs and reports, resource utilization, analyses at each stage of incident response, and incident traffic impacts. This information can be used to identify gaps in TIM response coordination processes and can identify key trends that can help to inform where specific investments might be needed to address TIM performance objectives. Detailed analysis of different stages of TIM response—including incident identifications, agency notifications, response times of different responders, and stages of incident clearance—is greatly aided with a complete data set provided through CAD integration.

Stronger Justification for Traffic Incident Management Resources

Performance data enabled through integrated CAD also helps transportation agencies to identify where additional resources are needed and provide the necessary quantitative back-up to support those requests. Understanding where resources are having a positive impact improving TIM responses processes can inform planning and programming needs, as well as identify where funding could best be targeted. Without a complete understanding of

[20] Federal Highway Administration Focus States Initiative: Traffic Incident Management Performance Measures Final Report, 2009. https://ops.fhwa.dot.gov/publications/fhwahop10010/fhwahop10010.pdf

performance outcomes, and reliable data to support funding requests, these resource needs could be challenging to justify.

State of the Practice Highlight: Using a combination of TIM performance data, Utah was able to determine that their incident response teams were responsible for reducing average clearance times by 5 percent. This data helped to justify doubling the size of the Utah incident response teams from 12 to 24 employees. Similarly, Florida was able to justify additional funding for Road Ranger service patrols by using TIM data to run predictive models for incidents and show the benefit of having additional service patrols.

Enhanced Traveler Information

Integrating CAD and TMC systems allows TMCs to provide accurate and more complete traveler information to motorists. Using tools such as dynamic message signs, 5-1-1 systems, mobile alerts, and other strategies, TMCs can disseminate traveler information about incidents ahead, lanes impacted, and potential delays. This allows travelers to be prepared for potentially hazardous conditions on their route or allows them time to make alternate route decisions.

TMC systems can be configured to display only pertinent incident details as part of traveler information that is distributed to the public. While TMC ATMS and event management systems might have numerous fields for various incident details, a limited amount of relevant information can be pushed to 5-1-1 systems, social media alerts, websites, and mobile applications. This provides enough information to alert travelers to incidents ahead without overloading them with too many details.

Increased Efficiency for Traffic Management Centers

TMC operators are often monitoring multiple data sources, terminals, video feeds, and fielding calls and notifications when incidents are reported. Seeking information or checking for updates during incident response can be distracting and there is a risk of missed information. Integrating CAD data into TMC operating systems pushes information directory to operators, rather than relying on manual processes to identify and interpret details. Furthermore, TMC operators often interact with multiple different systems, which can result in the need for duplicate data entries and require them to monitor and update incident details across several different databases.

Streamlining this process by providing a complete and integrated data feed from CAD systems helps to minimize errors, reduces risk of missed information, and allows TMC operators to focus on essential notifications and TMC incident management functions. Improved data sharing also

provides for more efficient assessments of DOT resource activity, such as number and frequency of SSP motorist assists.

State of the Practice Highlight: Because of improved CAD data sharing, Oregon DOT estimated that TMC operators spent 60 percent less time on the phone obtaining details about incidents and could focus more of their time on incident management functions.[21] Minnesota was able to use CAD data to track vehicle assists and frequency of assists, helping to identify drivers who were repeatedly using the state's roadside assistance program.

Enabling Successful Computer-Aided Dispatch Integration

Previous sections have highlighted several successful CAD integration case studies. Today's technology, including CAD systems and TMC ATMS systems, allow for much easier data exchanges between law enforcement CAD systems and transportation operations software than older-generation systems. Today's voluntary data information-sharing standards also help to facilitate easier automated data exchanges than were possible even 10 years ago. There are likely some configuration requirements for data fields to enable ATMS systems to accurately translate CAD data into TMC system events and prepare the data to be used by external systems. These changes can be coordinated through ATMS vendors and application developers, with little effort needed on the part of law enforcement other than a willingness to share CAD data.

Where direct CAD to TMC interfaces could pose challenges, such as TMCs needing feeds from multiple CAD systems, there are several examples of solutions that have been developed to successfully harness CAD data so that it can be used by TMCs and used to support performance analysis. These are described below.

Wisconsin WisTransPortal and InterCAD

A partnership of Wisconsin DOT, the University of Wisconsin-Madison and numerous law enforcement agencies (including the Wisconsin State Patrol, Milwaukee, Waukesha and Dane County Sheriff Departments established the InterCAD system. This system uses an xml data feed from law enforcement CAD systems, filters out sensitive data, and makes pertinent incident information available to the Wisconsin Statewide (TOC) ATMS system. The WisTransPortal is the central repository for the CAD data and is used to support Wisconsin's Traffic Incident

[21] CAD and TMS Integration Workshop: Summary Report. I-95 Corridor Coalition (now the Eastern Transportation Coalition). April 2018 Workshop Proceedings.

Management Enhancement program, including TIM performance measures.[22] The InterCAD system processes approximately 5,000 CAD messages per day, including incident notifications and updates. This information is made available to the TOC operators to support WisDOT's statewide incident management functions. This CAD data is also supporting emerging research by the university and Wisconsin State Patrol to enable predictive analytics of crash risk and crash potential.

Metropolitan Washington Council of Governments

The Metropolitan Washington Council of Governments (MWCOG), the Metropolitan Planning Organization for the Washington, DC area, uses the Regional Integrated Transportation Information System (RITIS) data platform to support a wide range of planning and operations needs. RITIS is a tool initially developed for the Eastern Transportation Coalition, but its data management and processing capabilities are being used by States and regions throughout the United States. RITIS provides a platform to aggregate CAD data from Virginia and Maryland law enforcement CAD systems. The MWCOG is able to leverage the ongoing development of the broader RITIS platform to access multiple data sets, including law enforcement CAD, to support their analysis needs. Sensitive data can be filtered from the CAD data feeds before it is integrated with other transportation applications.

[22] University of Wisconsin-Madison, WisTransPortal overview. https://transportal.cee.wisc.edu/about/ accessed April 2020.

Chapter 5. Challenges

While there are many compelling safety, mobility, and efficiency benefits of law enforcement agencies sharing Computer-Aided Dispatch (CAD) data with transportation operations, there are States and regions that have challenges advancing this key data sharing partnership. In some cases, there have been technology and data compatibility issues cited as a primary reason for not being able to share CAD data; in other instances, agencies have noted a concern over transportation agencies obtaining access to sensitive information contained in CAD data entries.

In nearly all instances, if there is a willingness to share data, and leadership support to work toward CAD integration, solutions can be put into place to address technical challenges and mitigate data security concerns.

This section presents some of the more common barriers agencies have cited to facilitating CAD data integration and highlights alternatives or solutions to addressing those challenges. Innovative strategies and best practices are highlighted to show where agencies have collaborated to be able to successfully integrate CAD data with Traffic Management Centers (TMC).

Overcoming Institutional Barriers and Processes

Leadership support for sharing data is one of the key influences that will help to advance CAD integration between law enforcement and transportation operations agencies. Champions can help to identify the needs and business case, generate momentum, and work through technical issues encountered, but without agency leadership buy-in, many States find it challenging to fully implement CAD integration.

Top-level support is needed to help institutionalize and formalize this data sharing partnership and ensure that CAD data sharing continues long after champions transition. With strong executive support, there is an added level of motivation at other levels within law enforcement and Department of Transportation (DOT) organizations to find solutions to any technical or data issues that might impact a successful CAD integration endeavor. Formalizing this relationship, through a policy or memorandum of understanding, can further help to institutionalize CAD integration. Ongoing demonstration and documentation of the benefits of integrated CAD will further support the continued sharing of CAD data with transportation operations.

State of the Practice Highlight: In Washington State, a Joint Operations Policy Statement (JOPS) was signed between the Washington State Patrol (WSP), Washington State DOT (WSDOT), and the Washington Fire Chiefs. This policy outlines common traffic incident management (TIM) expectations and objectives, and also includes provisions for sharing CAD

data to support TIM program needs. This strong support from three agencies has helped to elevate Washington's TIM program and created a strong foundation for sustaining collaboration. The JOPS model established by Washington has been applied in several other States.[23]

Addressing Data Security and Access to Sensitive Data

Law enforcement and public safety agencies are specially trained in handling sensitive data and applicable information security requirements of the Criminal Justice Information Systems (CJIS) and the Health Insurance Portability and Accountability Act (HIPAA). The CJIS Security requirements govern data storage and access (including storage on servers, cloud-based systems, and transmission to internal and external systems), and these requirements are intended to protect sensitive information that could be contained in CAD data. The Eastern Transportation Coalition summarized these requirements and acknowledged that there is limited guidance available from CJIS regarding CAD to TMC standards, but the CAD-to-CAD integration can be referenced as a starting point.[24]

There is a similar concern with HIPAA compliance in that there might be personally identifiable or sensitive information contained in free-form CAD data fields. Information such as names, medical conditions or extent of injuries could be information protected from disclosure under HIPAA. Limiting the amount of free-form text that is provided from a CAD system through an external data feed, such as to a TMC, can mitigate the risk of transmitting sensitive data.

State of the Practice Highlight: Many agencies will filter out, firewall, or separate the CJIS-related data. Information such as incident location, incident type, and incident severity are the primary data elements desired by TMCs to support transportation operations and traveler information. The Pennsylvania Turnpike Commission is a registered user of the state's CAD system and has access to all CAD data and uses the CAD system to actively manage incidents. The Turnpike requires specific training and certification for TMC operators. All TMC operators are required to have the Association of Public-Safety Communication Officials (APCO) 40-Hour Basic Telecommunicator course prior to applying for an operator position. Once hired, the TMC operators go through an in-house training program which covers access and handling of CAD data. The Turnpike Commission's TMC operators are certified to access the Pennsylvania State

[23] Joint Operations Policy Statement, Washington State Department of Transportation, The Washington State Patrol, and the Washington Fire Chiefs, 2018. https://www.wsdot.wa.gov/publications/manuals/fulltext/M3102/JOPS.pdf accessed April 2020.

[24] I-95 Corridor Coalition (now the Eastern Transportation Coalition), CJIS Considerations for CAD Integration, 2018 https://i95coalition.org/wp-content/uploads/2018/06/I95_CJIS-Considerations-for-CAD-Integration-Full-Background.pdf?x70560 accessed May 2020.

Police Commonwealth Law Enforcement Assistance Network (CLEAN), and this certification must be renewed every two years.

Overcoming Data and Technology Compatibility Challenges

As data standards have evolved, and as there continue to be more examples of successful CAD integration with TMCs, there are fewer technical barriers to integrating CAD data. It is important to engage both CAD vendors and Advanced Traffic Management Software (ATMS) developers to work through any issues with importing data and populating fields within the TMC ATMS software systems. If there is a willingness to share the CAD data from law enforcement, regardless of what form that data takes, there is usually a good solution within the ATMS to be able to process it.

It is important to consider the full breadth of technologies that both CAD and TMC must interface. On the law enforcement side, there are often mobile technologies and systems linked to CAD, remote sensing, Geographic Information System (GIS), or video applications that could potentially be linked with CAD. TMC software will also typically include links and data feeds to and from other devices, data feeds from external entities (public and private), and data feeds out to publicly accessible traveler information systems. ATMS software is often aggregating multiples sources of data to provide TMC operators with usable and comprehensive real-time information.

Understanding the full complement of the different systems that are linked and potentially providing data—for CAD and for TMC systems—can help to uncover any potential technology conflicts that could be addressed during planning for CAD integration or as part of future enhancements. Engaging Information Technology staff early in the process can also help to identify specific security concerns or requirements and help facilitate a project that complies with agency Information Technology policies and needs.

Summary of Innovative Approaches to Addressing Challenges

This section has presented some innovative solutions and approaches that have resulted in successful CAD integration efforts in States and regions throughout the United States. There are numerous examples of creative approaches that have been implemented to overcome challenges and barriers, resulting in win-win data sharing programs that benefit both law enforcement and transportation agencies. Table 2 below summarizes some important considerations and alternatives for addressing potential challenges and barriers.

Table 2. Summary of Computer-Aided Dispatch (CAD) integration needs and solutions.

Needs	Solutions
Agency support and willingness to share Computer-Aided Dispatch (CAD) data	• Demonstrate value of integrated CAD through performance measures. • Limit law enforcement resources needed to facilitate data exchange through cost share or Department of Transportation (DOT) taking the lead.
Institutionalize data sharing roles and responsibilities so that it is not dependent on individual champions	• Develop formal policies and memoranda of understanding to define roles and responsibilities. • Promote ongoing training and awareness of data sharing relationship. • Garner leadership support for sustaining commitment to sharing CAD data. • Develop a maintenance plan to guide future expansion, enhancements and ongoing operations of data sharing strategy.
Address concerns with Traffic Management Centers (TMC) accessing sensitive data and comply with CJIS requirements	• Provide training to TMC operators on Criminal Justice Information System (CJIS) requirements and handling of sensitive data. • Obtain CJIS certifications for TMC operations staff. • Filter, firewall or encrypt any sensitive data from CAD data feeds before data is ingested in TMC software. • Develop data safeguards for incident information that is shared externally through publicly available traveler information systems.
Address Health Insurance Portability and Accountability Act (HIPAA) regulations on personally identifiable information	• Standardize text fields and message structures to limit the amount of free-form text that could be transmitted to TMCs. • Understand HIPAA requirements and protections provided to dispatch staff under Federal law.

Table 2. Summary of Computer-Aided Dispatch (CAD) integration needs and solutions (continuation).

Needs	Solutions
Data compatibility between CAD and TMC systems	• Use established standards for descriptions, data formats, and location identifiers. • Use common map coordinates and mapping processes. • Establish appropriate filters for data being sent to TMC systems. • Formalize agreements on what data needs to be shared. • Modifications to crash form to address unique data requirements. • Provide training to law enforcement personnel on crash form definitions. • Engage CAD vendors to enable CAD data streams that can be easily ingested by Advanced Traffic Management System (ATMS) and TMC systems. • Engage ATMS developers to implement appropriate configurations within ATMS software.
Technology compatibility among multiple platforms	• Engage a broad range of stakeholders and agency groups, including Information Technology staff, to understand the required technology and system interfaces. • Develop a neutral platform with a common format to facilitate data sharing, such as from multiple CAD systems.

Chapter 6. Strategies to Advance Computer-Aided Dispatch Data Integration

The examples and strategies contained in this primer have highlighted numerous successful Computer-Aided Dispatch (CAD) integration efforts throughout the country. There are many positive case studies of how law enforcement and transportation operations have made CAD integration a priority and have worked through institutional and technology challenges. These States and regions are also able to demonstrate benefits of integrating CAD data, and there are quantifiable performance outcomes that show:

- Reduced time to respond to and clear incidents as a result of CAD integration.
- Reduced risk of responder exposure to hazards because of faster incident clearance times.
- Accurate location information which provides responders with better information to position response vehicles before getting to the incident scene.
- More efficient time management for law enforcement dispatch and Traffic Management Center (TMC) operations through integrated CAD data sharing.
- Robust data to support Traffic Incident Management (TIM) program investments and resource needs.
- More complete performance reporting and analysis capabilities gained through CAD data integration.

For agencies that are just getting started with initiating conversations about CAD integration to agencies that need to plan for future enhancements to existing CAD integration strategies, there are several steps that can be taken to support continued advancement of data sharing relationships.

Track and Report on Traffic Incident Management Performance

The foundation of a strong business case for CAD integration starts with good data. Agencies that have started to track and report on TIM performance are likely to identify performance gaps that were previously not known or known but not quantified with reliable data to support them. Recognizing that CAD data can help to address current gaps in performance management is a positive step forward. Data and infographics provide powerful communication tools to engage agency leadership and other stakeholders to garner support for future integration strategies.

Establish a Business Case for Computer-Aided Dispatch Integration

There are several examples and case studies within this primer document that can help to support a business case for integrating CAD data. It is important that the business case point to needs and priorities that are specific to a State or region. Identifying the specific problems that can be addressed through CAD integration can make the business case more meaningful and compelling for agency leadership. Case studies can provide some helpful data points and lend credibility to a localized business case, but using local issues and local data, and identifying specific local benefits, will help to strengthen the overall approach. A business case should identify:

- What problems are driving the need for integrating CAD data.
- How law enforcement, public safety, and other agencies will benefit from the investment of time and resources to integrate CAD.
- What benefits agencies can expect to see on the transportation system.
- How benefits translate into specific responder safety and responder efficiencies outcomes.

Outreach and Engagement

Being proactive in engaging representatives of law enforcement, public safety, responders, transportation operations, planning, and others can help increase awareness of the importance of CAD data integration. TIM coalitions, Intelligent Transportation Systems (ITS) and Operations committees, and even professional organizations provide additional opportunities to increase awareness of the issue. Focused outreach strategies and messages to agency leadership highlighting the safety and economic benefits, efficiencies in leveraging current technology investments, and other key elements from the business case can help to garner their support. Figure 7 shows a recent multi-agency public safety training session that brought together numerous TIM stakeholders to discuss multi-agency best practices.

Figure 7. Photo. Multi-agency working session.
(Source: Federal Highway Administration.)

There are many opportunities to promote the benefits that could be realized by focusing on advancing CAD integration:

- Multi-agency events like the Eastern Transportation Coalition CAD Integration workshop can bring together key stakeholders to discuss strategies, concerns and develop solutions.
- 9-1-1 working groups, TIM Coalitions, transportation operations/Intelligent Transportation Systems (ITS) committees, and other similar groups will have a connection to some element of system performance or system operations and can be made aware of efforts to try to advance CAD data sharing.
- Complex corridor projects, such as Integrated Corridor Management planning, major construction/reconstruction projects, and other project opportunities could be important catalysts for advancing discussions on the importance of sharing real-time data. These efforts also help to promote awareness and importance of real-time CAD data and how this valuable data can be used as part of a suite of ITS and technology solutions. By including CAD data as a foundational component of operations strategies, there is also the potential to leverage cost-sharing or provide opportunities through ITS funding to assist public safety agencies in upgrading and enhancing CAD systems.
- Professional societies, including State and local chapters of ITS America, Institute of Transportation Engineers (ITE) and similar societies could benefit from hearing how CAD integration could be advanced in their local areas.

Peer Exchanges and Site Visits

Agencies that have successfully advanced and sustained CAD integration may be willing to share their firsthand experiences of how they garnered internal support, how they modified processes to enable data sharing, stakeholders they engaged, and the benefits they are getting as a result of their efforts. An in-person or virtual peer exchange can promote dialogue and sharing of ideas, best practices, what challenges were faced, and how those challenges were addressed. Hearing directly from peer agencies, including law enforcement, technical/Information Technology staff, transportation operations, and procurement or other groups can provide tremendous value in garnering support from local stakeholders. Figure 8 shows how events such as TIM Awareness Week can bring about attention to issues such as CAD data sharing.

Figure 8. Photo. Traffic Incident Management Awareness Week.
(Source: Federal Highway Administration.)

Agencies can reach out to the Federal Highway Administration (FHWA) or the National Operations Center of Excellence (NOCoE) for help in identifying potential peers and setting up peer exchanges, virtual meetings or site visits. Law enforcement or transportation agencies that are willing to serve as peer examples can also contact the FHWA or NOCoE to actively engage with peer organizations that could benefit from their expertise and experiences.

Standards Organizations

Helping to shape technology and data compatibility strategies is an integral part of ensuring that CAD-TMC integration continues to benefit from streamlined and automated information exchanges. Organizations such as ITE, Association of Public-Safety Communications Officials

(APCO), Institute of Electrical and Electronics Engineers (IEEE), American Association of State Highway and Transportation Officials, and others are all actively engaged in standards developments and updates. There is a strong need for active practitioner engagement in defining and revising standards that support continued CAD data integration.

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