ITS Heartland Multistate Corridor Operations and Management Program Grant

Concept of Operations

FINAL November | 14 | 2016

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1 Scope

1.1 Identification

This document is the Concept of Operations (ConOps) for the Intelligent Transportation System Heartland Corridor Coalition (ITSHCC) Multistate Corridor Operations and Management Program (MCOMP) Grant Award. A ConOps describes the purpose, characteristics, operations, and applications of a system as it relates to its users, interfacing systems, and stakeholders.

1.2 Document Overview

The structure of this ConOps is generally consistent with the outline of a System Operational Concept document described in Annex A of ISO/IEC/IEEE Standard 29148:2011. A document following that outline is called a "Concept of Operations" in prior versions of the IEEE standard and in U.S. transportation systems engineering practice. A ConOps document customarily follows the guidelines below:

Section 1 defines the scope of the ConOps.

Section 2 describes the current situation with respect to processes and systems to be affected by the ConOps.

Section 3 identifies the need for changes from the current situation.

Section 4 describes the concept for the new system capabilities and their operations.

Section 5 presents operational scenarios.

Section 6 summarizes operational and organizational impacts that may result from the development of the selected applications.

Section 7 provides an analysis of the expected improvements and disadvantages or limitations that may occur following deployment.

Section 8 provides lists of reference documents.

Note that Appendix A contains a list of acronyms used in this ConOps.

1.3 System Overview

1.3.1 Background

The Federal Highway Administration (FHWA) awarded a grant (herein called the "MCOMP grant") to the ITS Heartland (ITSH) chapter, which is an official chapter of ITS America. This grant is intended to fund two projects aimed at providing greater information sharing between the five ITSH state transportation agencies (Missouri, Iowa, Nebraska, Kansas, and Oklahoma) and their respective customers. The ITSHCC member agencies proposed the scope and objectives of the grant, and they prepared and submitted the MCOMP grant application to the FHWA. The scope and terms of the grant award are described in the *ITS Partnership Agreement* between the FHWA and the Missouri Highways and Transportation Commission, acting by and through the Missouri Department of Transportation on behalf of the ITSHCC member agencies.

The ITSH MCOMP grant application was submitted to FHWA as a means of obtaining support for improved corridor operation throughout the ITSH states. As stated in the *MCOMP grant application*, "As this group [i.e., the ITSH Operations Working Group] has matured over the past six years, they have desired to bring corridor operations to a new level within the region through the programming of projects that benefit all of the states in the Coalition as well as private businesses and travelers who live, work or pass through this region. Their goals are to improve the movement of commercial vehicles, provide better traveler information systems, and cooperatively plan operations support throughout the region." The grant application then goes on to identify three operational goals and two strategies for achieving each goal to which the MCOMP grant funds might be applied.

The FHWA award for the MCOMP grant identified two of the MCOMP grant application projects as the basis of its award:

A. **Provide Real-Time Traveler Information on Rural Freeways:**
    a. Completion of a feasibility study in which adequate data sources and data dissemination opportunities are identified
    b. Integration of real-time data feeds into existing agency tools for disseminating information to external customers
    c. Publication of a final project evaluation report

B. **Develop a Regional Data Aggregation and Data Warehouse Service:**
    a. Completion of a feasibility study to investigate which data are most beneficial for internal sharing, identify options for integrating the data into one location, and identify any necessary performance reports needed for sufficient data analysis
    b. Integration of the identified datasets into the central data warehouse
    c. Development of specialized performance reports for the data, if identified
    d. Publication of a final project evaluation report

The ITSH chapter board of directors therefore established an MCOMP grant executive committee charged with making decisions regarding the grant. The committee consists of six members: the current ITSH board vice president along with a representative from each of the five ITSH state member agencies.

1.3.2 Purpose

The purpose of the MCOMP is to fulfill the intent of the MCOMP grant for the two funded projects in demonstrating the feasibility of, developing, and evaluating the integration and sharing of system management and operations data across the Heartland states. The program is structured around the FHWA's systems engineering process for Intelligent Transportation Systems (ITS). The program is divided into a grant administration effort to assist ITSH in program administration and systems engineering tasks, and development efforts to be completed by implementation contractors.

This ConOps is the first and highest level of systems engineering document for the MCOMP. The ConOps describes the objectives and context for the program; captures the user needs and use cases; describes the MCOMP concept as it might be developed into the downstream project(s); develops scenarios describing potential uses of the system; describes its potential impacts on stakeholders and their processes; and provides an analysis of its eventual benefits, advantages, limitations, and disadvantages relative to the current state.

2 Referenced Documents

1. *MCOMP Grant Application*, ITS Heartland Corridor Coalition.
2. *ITS Partnership Agreement* between the Federal Highway Administration and the Missouri Highways and Transportation Commission.
3. *ITSH MCOMP Grant Project Plan.*
4. *Systems and Software Engineering – Life Cycle Processes – Requirements Engineering,* ISO/IEC/IEEE Standard 29148.
5. *IEEE Guide for Software Verification and Validation Plans*, IEEE Standard 1012-2013.
6. *IEEE Standard for Software and System Test Documentation,* IEEE Standard 829-2008.
7. Institute of Transportation Engineers *Traffic Management Data Dictionary (TMDD) Standard for the Center to Center Communications - Volume II: Design Content v3.03* http://www.ite.org/standards/tmdd/3.03.asp, accessed 2016.09.22.

3 Current State

This section of the ConOps describes the current situation with respect to processes and systems within the scope of the project's purpose and objectives.

3.1 Background, Objectives and Scope

ITSH member states have been actively deploying ITS for over 20 years. As described in the MCOMP grant application, these deployments were begun, as in most parts of the U.S., in urban metropolitan areas. Heartland states have continued, however, to deploy ITS along interurban corridors to provide data collection, operations support, and traveler information across their expansive rural areas. Operations support for these ITS assets is provided by a mix of the urban/metropolitan and regional transportation management centers (TMCs). Traveler information systems have similarly expanded from coverage of metropolitan areas to virtual statewide coverage in each of the Heartland states.

Traffic and weather, however, do not respect jurisdictional boundaries. Weather systems moving across the plains and prairies of the Heartland states can quickly degrade travel and traffic conditions across the entire region. Transportation systems management and operations need to similarly have access to road, traffic, and weather information across the region and to be able to inform the public of what to expect as they travel across the region. To that end, the goals of the ITSHCC as described in the MCOMP grant application are to "improve the movement of commercial vehicles, provide better traveler information systems, and cooperatively plan operations throughout the region." For the MCOMP grant application, the focus of these goals is on the network of interstate corridors that tie the region together.

The ITSH MCOMP grant identifies two projects to be developed and deployed. The first of these two, which is to provide real-time traveler information on rural freeways, is to some extent being addressed in parallel to the MCOMP grant effort by the ITSH member states in their continuing deployment of ITS assets to support ongoing statewide operations. The second project, which is to develop a regional data aggregation and data warehouse service, begins in large part with recognizing the existing deployments of metropolitan and regional TMCs that are already aggregating traffic, road, and weather condition data.

The scope of reviewing the current state of ITS deployments in the Heartland states therefore encompasses ITS assets collecting data, providing operations decision support, and providing traveler information in metropolitan areas and along the interstate corridors. In that respect, the scope is similar to that needed to meet the intent of the FHWA's Office of Operations Real-Time System Management Information Program (RTSMIP), which is derived from Section 1201 of the SAFETEA-LU federal transportation funding and authorization bill. Complying with the Section 1201 rule requires acquiring and managing roadway weather condition information, information on incidents blocking roadway lanes, information on construction activities with closures, and travel time information on interstate highways and limited access routes of significance. In addition, the Regional ITS Architectures shall feature the components and functionality of the real-time information program.

3.2 Description of Current Situation

Agencies receiving federal highway trust funds for ITS projects are required to use a systems engineering analysis in delivering those projects. The guiding 23CFR940 regulations also require states to establish regional ITS architectures as an overall framework for ITS projects and systems to be deployed in each state. These regional ITS architectures provide descriptions of systems administered and used by the state transportation agencies and identify interfaces to other agencies' systems providing data to that agency. In particular, these architectures identify categories of key "market packages" that provide interfaces and sets of information for ITS applications. For the MCOMP projects, the market packages of interest are those identified as Advanced Traveler Information Systems (ATIS) and Advanced Traffic Management Systems (ATMS). Reviewing the components related to the ATIS and ATMS market packages in each ITS architecture provides a broad description of the systems available across the Heartland region.

3.2.1 Existing State Conditions

Each Heartland state has existing organizations, plans, procedures, assets, and systems that are used within the state to support transportation operations and management. These resources are already used to collect, use, and disseminate traffic management data that are then used in traveler information and operations and could be the sources of greater regional interstate operational coordination and regional traveler information. This section summarizes this existing condition among the Heartland states.

Available Data

All ITSH states use a hybrid approach to traffic data collection, using a combination of agency-owned data acquisition devices (such as roadside vehicle detectors) and third-party probe data. Table 1 summarizes the third-party vehicle data status for each state.

Table 1. Third Party Data Summary

Third Party Data Summary		
State	**Third Party Service**	**Data Sharing Allowed**
Iowa	INRIX	No
Kansas	*	
Missouri	HERE	No
Nebraska	INRIX	No
Oklahoma	HERE	Yes

*Kansas uses HERE real-time traffic tiles through their ArcGIS Online subscription with ESRI

Table 1 shows each of the five Heartland states' restrictions on whether or not data can be shared with other agencies. In the cases of Iowa, Missouri, and Nebraska, the existing third-party contracts may need to be modified to allow data sharing outside of the contracting agency. These third-party data agreements in some cases also restrict sharing data with the public. Missouri, which receives data from HERE, is prohibited from disclosing or reproducing any of the data obtained. Nebraska is also restricted from disclosing data with users other than other INRIX customers. According to Iowa's agreement, data obtained is nonexclusive, nontransferable, and non-sub licensable; however, aggregated data may be sharable.

ATMS

Each Heartland state operates with either multiple regional ATMS or a single statewide ATMS as shown in Table 2. ATMS software is generally used to support and coordinate real-time operations and management, and it is typically used to feed information to an ATIS. The ATIS is used to provide real-time traveler information and consists of data that travelers can use to make informed travel decisions.

Table 2. ITSH States ATMS and ATIS Systems

<table>
<tr><th colspan="8">ATMS/ATIS</th></tr>
<tr><th>State (Region)</th><th>ATMS Software</th><th colspan="2">ATIS Name</th><th colspan="2">ATIS Website Name</th><th colspan="2">ATIS Vendor/Maintainer</th></tr>
<tr><td>Iowa</td><td>TransSuite</td><td colspan="2">CARS</td><td colspan="2">511ia.org</td><td colspan="2">Castle Rock</td></tr>
<tr><td>Kansas (Wichita)</td><td>MIST</td><td colspan="2">KanDrive</td><td colspan="2">www.kandrive.org</td><td colspan="2">DTS</td></tr>
<tr><td>Missouri (Kansas City)</td><td>TransSuite</td><td>Kansas City Scout</td><td rowspan="3">MoDOT Traveler Info. Website</td><td>kcscout.net</td><td rowspan="3">traveler.modot.org/map</td><td>TransCore</td><td rowspan="3">MoDOT</td></tr>
<tr><td>Missouri (St. Louis)</td><td>TransSuite</td><td>Gateway Guide</td><td>gatewayguide.com</td><td>Vector Communications</td></tr>
<tr><td>Missouri (Springfield)</td><td>TransSuite</td><td>Ozarks Traffic</td><td>ozarkstraffic.com</td><td>Americaneagle.com</td></tr>
<tr><td>Nebraska</td><td>IRIS</td><td colspan="2">CARS</td><td colspan="2">hb.511.nebraska.gov</td><td colspan="2">Castle Rock</td></tr>
<tr><td>Oklahoma</td><td>Developed in-house</td><td colspan="2">N/A</td><td colspan="2">oktraffic.org</td><td colspan="2">ODOT</td></tr>
</table>

As shown in Table 2, a variety of ATMS and ATIS systems are used across the region. Deployed ATMS include both commercial systems and systems developed by the agency. ATIS include agency-branded websites provided by information service providers and systems supported directly by the agency or its contractors.

Traveler Information

The intent of each Heartland state's ATIS is to provide travelers with information regarding traffic operations within those states. All states offer general traveler information, independent of mode, while Iowa offers an alternative website and mobile app with information customized to commercial vehicles. In addition, Missouri offers alternative routing information to commercial vehicle operators through their Motor Carrier Services group via radio communication. The types of data disseminated are summarized in Table 3.

Table 3. Traveler Information Provided in Each State

		Traveler Information Provided				
		States				
		Iowa	Kansas	Missouri	Nebraska	Oklahoma
All Travelers	Speeds	X	X	X	X	X
	Incidents	X	X	X	X	X
	Winter Road Conditions	X	X	X	X	X
	Cameras	X	X	X	X	X
	Electronic Signs	X	X	X	X	X
	Road Work Activities	X	X	X	X	
	Rest Areas	X				
	Restrictions	X	X		X	
Commercial Vehicle Specific	Height/Weight restrictions	X	X	X		
	Winter Road Conditions	X	X	X		
	Weigh Stations	X				
	Towing Prohibited Areas	X				
	Routing Information		X	X		

Information is generally available to third parties through external system interfaces and provided through traveler information services, as shown in Table 3.

Outbound Data Feeds

Some states are also providing traveler information through data streams to other entities. This information is provided from either the ATMS or ATIS. Table 4 outlines which states are providing outbound data feeds and who is receiving these feeds. Some states are already providing data streams with traveler information data.

Table 4. Outbound Data Feeds in Each State

Outbound Data Feeds					
	States				
	Iowa	Kansas	Missouri	Nebraska	Oklahoma
Entities receiving data	Many (+100)	Publicly Available	HERE	INRIX, SpeedInfo, Google	None
Data Provided					
Speeds	X		X	X	
Incidents	X			X	
Winter Road Conditions	X	X		X	
Cameras	X				
Road Work Activities	X	X			
Restrictions	X	X		X	

ITS Architectures

Agencies receiving federal assistance funds for ITS projects are required to maintain an up-to-date ITS architecture to provide a framework for ITS projects and systems within each state. These documents provide descriptions of systems administered and used by the state transportation agency and identifies interfaces to other agencies' systems providing data to the agency.

Most state ITS architectures already include provisions (inventory elements and service packages) that encompass the deployment of regional traveler information systems and data warehouses. Those states whose architectures need to be updated to include this data are already working to add them. This information is summarized in Table 5.

Table 5. State of Architecture for Each State

State	Condition of Architecture
Iowa	Covered
Kansas	Covered
Missouri	Statewide ITS architecture that is posted on MoDOT's Engineering Policy Guide (EPG) and Springfield regional architecture were updated in approximately 2009-2010 and need to be updated. Kansas City and St. Louis regional architectures are updated.
Nebraska	Covered
Oklahoma	Need to define inventory items and stakeholder information.

3.2.2 Other Regional Operations and Traveler Information Efforts

Besides the travel information efforts within individual states, there are several other regional efforts across the U.S. similar in scope to the ITSH MCOMP grant project. Many of these efforts are working to create connectivity across their regions through data aggregation.

Great Lakes Regional Traffic Operations Coalition MCOMP

The Great Lakes Regional Traffic Operations Coalition (GLRTOC), in which Iowa, Missouri, and Kansas departments of transportation (DOTs) are participants, is a coalition made up of 14 agencies within the Great Lakes region. This coalition is working toward initiatives for improving transportation operations across its region. Because GLRTOC has established a megaregion approach to transportation, it is able to improve coordination across the region in transportation data, operations, and management. The coalition has compiled a traveler information website (travelmidwest.com) by gathering information from state agencies in its region. The website displays real-time data on congestion, incidents, construction, events, and weather as well as other useful road condition information.[1] The following is a link to GLRTOC's traveler information website:

http://www.travelmidwest.com/lmiga/home.jsp

GLRTOC is working on a connected centers project[2] to improve operations center connectivity that is similar in scope to the ITSH MCOMP grant project to develop a regional data aggregation and data warehouse service. Tasks in the GLRTOC effort are also similar to those in this ITSH MCOMP grant project. As such, results of the GLRTOC effort will be instructive to this project, and any system(s) and data service(s) developed by the GLRTOC may provide interfaces useful to the ITSH MCOMP system(s).

North/West Passage Corridor Coalition

The North/West Passage Corridor Coalition (NW Passage) is focused on developing methods to provide integrated traveler information along the Interstate 90 (I-90) and I-94 corridors between Wisconsin and Washington. To meet these goals, the coalition initiated the Operations and Travel Information Integration Sharing (OTIIS) project. Similar to ITSH, OTIIS was selected to receive funding through the MCOM program. With this funding, N/W Passage implemented a corridor-wide traveler information website, roadtosafediscovery.com, that displays traveler information along I-90 and I-94 between Wisconsin and Washington to assist travelers in the North/West Passage states in trip planning especially through possible extreme winter weather conditions. The website allows users to view potential hindrances to their trips such as road work, incidents, and weather and provides the locations of possible traveling stops such as national parks, historical landmarks, and truck parking zones. N/W Passage collects this data from the states' DOTs, National Oceanic and Atmospheric Administration (NOAA), National Park Service (NPS), state recreation departments, developers, and private companies. Below is a link to the roadtosafediscovery.com website.

https://www.roadstosafediscovery.com

I-80 Winter Operations Coalition

During the winter months, portions of I-80 along Nevada, Utah, Wyoming, and Nebraska often experience extreme weather conditions affecting the mobility of travelers. In an effort to maximize seasonal mobility and improve the quality of information provided to travelers, the affected states formed the I-80 Winter Operations Coalition. State agencies within the coalition are required to gather and share collected data with each other. The coalition focuses on

[1] http://www.glrtoc.org/about/, accessed 07/26/2016
[2] http://www.glrtoc.org/projects/connected-centers/, accessed 11/30/2015.

creating consistency and improving quality in traveler information shared between agencies. As such, this coalition's efforts could be instructive in determining how data will be shared for the ITSH project.

MAASTO Truck Parking Project

Eight states within the 10-state Mid America Association of State Transportation Officials (MAASTO) region are working on a joint implementation of a truck parking information project. These states include Kansas, Iowa, Minnesota, Wisconsin, Michigan, Ohio, Indiana, and Kentucky. At present, these states have agreed to provide data feeds to any data users or information services, and they have reviewed the possibility of building a central data repository. The group has not yet determined whether data will be processed in house or by a third-party provider, and this may be left up to each individual state. The group has determined to not build a centralized informational website, but instead to make the data available and rely upon third-party websites and applications to integrate and disseminate it. If a central data repository is created, it would not be used to relay information between states but instead would be used to store data and provide the five years of performance measures required by the federal grant. However, if the group does not decide to create a central data repository, they will rely on a peer-to-peer approach where each state relies on existing statewide ATIS websites, third-party websites, and data feeds for information.

3.2.3 National Traveler Information Services

Some traveler information services gather data from multiple sources across the country to provide a more expansive national view for the U.S.

RITIS

The Regional Integrated Transportation Information System (RITIS) provides situational awareness, performance measures, and communication information between agencies and to the public[1]. Data is provided by multiple agencies and integrated in a central data warehouse from where it can be accessed by researchers, third parties, and traveler information outlets. RITIS data feeds are also designed to allow integration of the RITIS data back into third-party systems for dynamic mobile application development. Situational awareness tools within RITIS enable authorized users such as public safety or DOT employees to interact with real-time travel data. Authorized users also have access to a wide variety of archived data within RITIS. RITIS's website can be found at the following link:

https://www.ritis.org

SafeTravelUSA

SafeTravelUSA is a centralized informational website that offers users the ability to select any of the 50 states within the U.S. and transfers the user to a website with that state's real-time travel data. The link may transfer the user to that state's DOT website, a 511 website, or a different website supported by an independent traveler information service provider. The data on each of the websites is collected and provided by each state agency. Each of the websites contains information on roadway incidents, construction zones, weather advisories, and traffic flow of the

[1] http://www.cattlab.umd.edu/?portfolio=ritis

major roads. Some of the websites include both still and video cameras, message signs, and the speed limits of major roads.[1] The centralized website can be found at the following link:

https://www.safetravelusa.com

3.2.4 Commercially Available Traveler Information Sources

Traffic data and traveler information are available from some commercial vendors for agency applications and to the public through websites or applications.

Google Maps / Waze

Google Maps and Waze receive data primarily from individual users, but they also receive data from many other sources, including traveler information available from state and other agencies. In addition to information received through data feeds or ATIS, Waze has the ability to receive real-time location data from users and enable user engagement along their routes. Using this data, users can access the fastest dynamic routing when navigating with the Google Maps and Waze applications. The following is a link to Google Maps:

https://www.google.com/maps

Waze can be found at the following link:

https://www.waze.com/livemap

INRIXTraffic

INRIXTraffic.us provides real-time travel data to transportation agencies for use in operating, managing, patrolling, and planning major highway systems. The service covers over 200,000 miles of current traffic flow conditions for all of the states in the continental U.S. INRIX traffic is partnered with the I-95 Corridor Coalition, an organization made up of transportation agencies in states along the east coast.[2] Participating agency users can access real-time traffic flow information through INRIXTraffic's website at the following link:

www.inrixtraffic.us

HERE

HERE provides real-time traffic information to the public through both website and application interfaces. The service collects specific map data from satellites, global positioning system (GPS) data points, their fleets of vehicles, and local field offices. HERE's traffic data is updated on their interfaces every minute by gathering information from GPS probe points and over 100 other sources. HERE also provides predictive traffic services in order to assist travelers in planning journeys up to 12 hours in advance. The predictive service factors in real-time traffic, historical data, and seasonality to produce estimated times of arrival. HERE helps travelers, but it is also useful for enterprise and government customers looking to access archived data in order to analyze specific trends. Transportation agencies are also able to view trip data to

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[1] http://www.safetravelusa.com/, accessed 7/26/2016
[2] http://inrix.com/resources/traffic-for-public-agencies-na/ 7/20/2016

understand travel behavior and the use of transportation resources.[1] HERE's live map can be viewed at the following link:

https://maps.here.com/

3.3 Users and Other Involved Personnel

Transportation system operators at TMCs use information collected on road and weather conditions to monitor the state of the network, post traveler information to signs and websites, exercise traffic controls, inform emergency services, and dispatch motorist assistance and road maintenance crews. Data and images used by the operators may come directly from system field devices, from third-party information services, or even from social media. The data are then used in their own operational systems and in generating traveler information for the public.

Information service providers may get real-time data from the state agencies to blend with data from other sources to support their data services, applications, and websites. They use the information to create value-added traveler information, dynamic routing, and quick navigation for their users. Services such as Google Maps, Waze, and INRIX enable travelers to access real-time traffic information across the Heartland region without respect to which agency originated the data.

Travelers are able to view road and weather condition information data across the Heartland region by accessing the interfaces for each TMC or state traveler information system or by viewing a third-party information service provider interface. Travelers may access the information before leaving for their trips, or they may access information en route to make more dynamic routing decisions.

3.4 Operational Policies and Constraints

The five Heartland states have a diverse set of data publication and sharing perspectives. As shown in Table 3, all of them provide traveler information to the public, but the types of information and even the target traveler demographics vary among the states. This diversity is more pronounced when providing interfaces through which other parties can access traveler information data feeds, as shown in Table 4. Some of the states do not provide any third-party data feeds, and some provide open access. The purposes and reasons behind these patterns of access seem to be equally diverse, depending on multiple policy, financial, and technical factors.

Sharing of access to data for operations is much less diverse among the states. Information sharing generally occurs between operations personnel in different agencies on an as-needed basis and does not flow directly between systems. Unusual and extreme events—like the 2011 Missouri River flooding that affected Iowa, Nebraska, and Missouri—require and lead to significant cross-border operations coordination.

The KC Scout situation is different because it monitors conditions across the Kansas City metropolitan area across the state line. The Scout TMC operators support both the Kansas Department of Transportation (KDOT) and the Missouri DOT (MoDOT), even to the extent of monitoring I-70 operations from the St. Louis metro border to the Kansas-Colorado state line. The differentiating factor in this cooperation is clearly that the information is captured in a single system that is accessed by both states.

[1] https://company.here.com/here/, accessed 7/27/2016

4 Justification for and Nature of Changes

This section of the ConOps describes the challenges in the current situation and the opportunities for improvement. Many of the relevant operational challenges were described in the MCOMP grant application as part of identifying the regional goals and strategies, and those are used in this section as starting points for more detailed descriptions of the data and system needs.

4.1 Justification for Changes

As described earlier in this ConOps, the member states of the ITSHCC have recognized that many of their operational challenges, particularly those associated with interurban corridors, are shared challenges. Traffic and weather have no respect for jurisdictional boundaries. As such, the coalition provides a means of cooperatively addressing emerging operational challenges and coordinating development and deployment of solutions in program planning. The grant application identified three specific areas of challenge: commercial vehicle movement, traveler information, and corridor planning.

4.1.1 Commercial Vehicle Movement

Commercial vehicle movement is a primary consideration in Heartland corridor operations and a priority for this MCOMP project. Heartland regional roadways carry high volumes of truck traffic through the center of the United States, particularly relative to the region's population and passenger vehicle traffic. Figure 1 and Figure 2 illustrate truck volumes on U.S. highways in 2011 and 2040, respectively. Portions of the key Heartland corridors—I-35, I-44, 1-70, and I-80, in particular—show both high volumes and a high proportion (red) of truck traffic in 2011, with almost all Heartland corridors showing high proportions of truck traffic (green) compared to much of the nation. By 2040, almost all Heartland interstate corridors are affected with high volumes and high proportions of truck traffic. The MCOMP grant application noted that Heartland roadways will need to accommodate a 25–40 percent increase in truck traffic over the next 20 years.

Resources to manage and support the projected increase in commercial vehicle movement have not been keeping pace with demand. Funding is a perpetual challenge, but technical and policy issues may be just as difficult. Acquiring rights of way, developing new river crossings and alternative corridors—all of these have significant associated planning and social consequences for developing new capacity. Developing technological alternatives to expanding the physical infrastructure, however, does not have so many social challenges. As such, the coalition is looking to better management and operational technologies to help bridge the gap between the demand and capacity for accommodating the region's expanding commercial vehicle movement needs.

4.1.2 Traveler Information

As described in Section 3: Current State, all of the Heartland states provide traveler information through their own websites, on roadside variable message signs in critical locations, and through third parties. This information is generally associated with a TMC/ATMS that collects the data and provides the means of distributing the messages. Statewide systems may coordinate between TMCs in the same state.

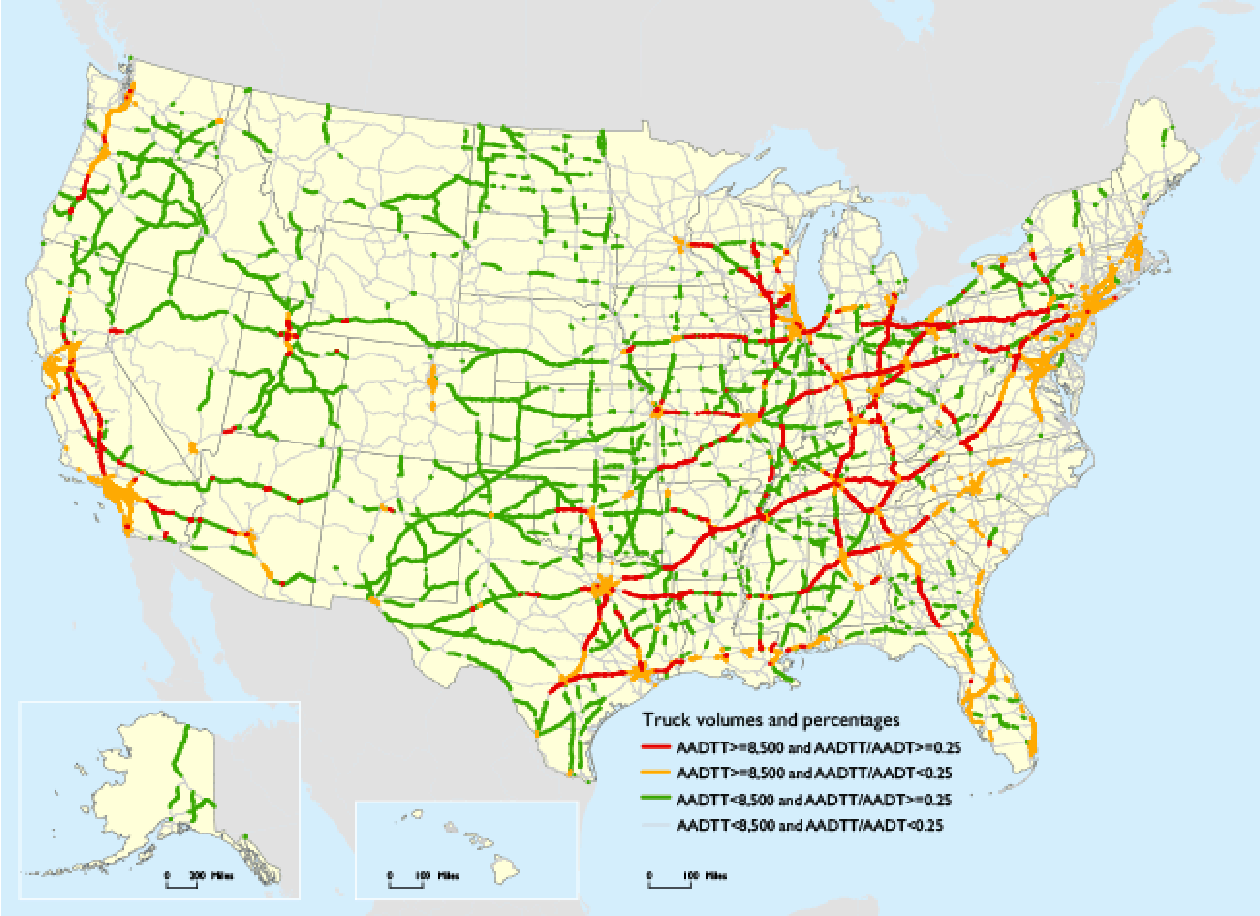

Figure 1. Average Daily Long-Haul Truck Traffic in 2011

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, *Freight Analysis Framework*, version 3.5, 2015.

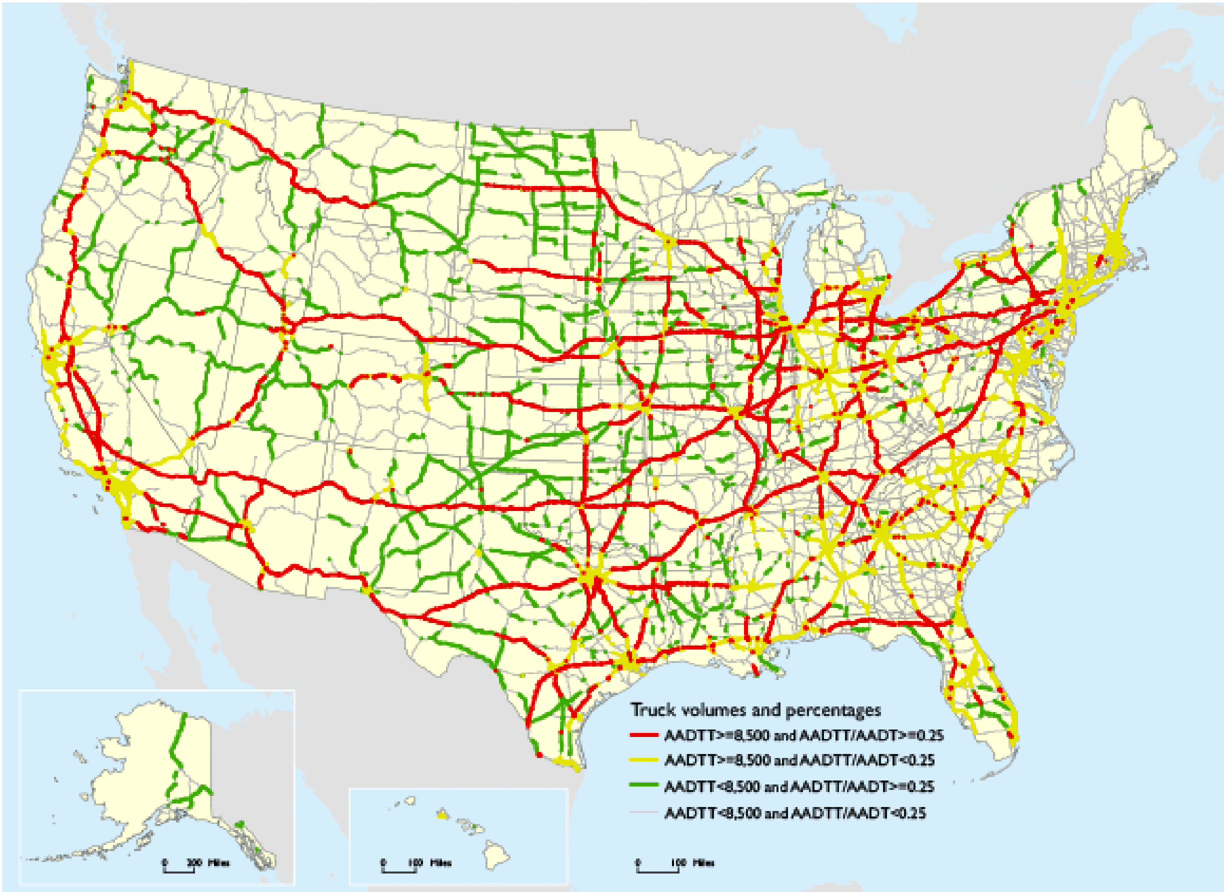

Figure 2 . Average Daily Long-Haul Truck Traffic in 2040

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, *Freight Analysis Framework*, version 3.5, 2015.

The transportation system in the Heartland states can be affected by weather and environmental events such as storms, flooding, and even earthquakes. Operational responses to these events can redirect traffic, but they cannot affect the underlying event. Traveler information is essential to managing the operational response to these types of events, but the operational response messages are challenging to create because the weather and environmental events are so dynamic and widespread.

Traveler information is not generally integrated between TMCs in different jurisdictions. Even if TMCs exchange operational data, such as construction zones and incidents, they may not be coordinating the traveler information and messaging. This potentially creates gaps for travelers passing from one jurisdiction to the next along their trip. Third-party services may pick up data from multiple jurisdictions and provide consistent traveler information, but utilizing an additional service can create a disconnect for travelers because it requires them to use multiple systems that may provide inconsistent messages.

Traveler information may also be inconsistent because of the challenges in gathering data for and disseminating traveler information in rural areas. These areas tend to have fewer automated ITS gathering traffic and road condition information. Rural communications tend to have lower bandwidth and longer latencies and may be more expensive.

Heartland states that already have outbound traveler information data feeds for third-party services could offer those feeds to neighboring states in order to reduce development work and to accelerate data sharing. States that do not have an ATMS/ATIS with an outbound data feed might want to develop this functionality.

4.1.3 Corridor Operations and Planning

Corridor operations and planning among the coalition members are currently coordinated through ITSH, the ITSH Operations Working Group, and existing agreements between states for operations during storms and natural disasters. The Heartland states would like to enable closer cooperation through corridor planning by coordinating construction schedules, executing technology deployments, tying communications infrastructure together, linking TMCs, developing mutual-aid agreements, and communicating traveler information to commercial vehicle operators and travelers more efficiently.

4.2 Description of Desired Changes

The initial focus of data integration efforts will be on providing capabilities to support operations planning, improving the movement of commercial vehicles, and providing better traveler information. Future developments based on the data integration efforts could provide real-time traveler information on rural freeways throughout the ITSHCC, integrate real-time data feeds into existing agency systems, provide interfaces to shared data, and provide integrated corridor performance measures as appropriate.

Operators need more complete data sets and operational interfaces to support those regional objectives. Operators need to have access to traffic information, operational and traffic controls, and weather data from across the region, with a data density proportional to the traffic volume and risk. These operator data needs are currently met for conditions within the operators' operating domains and jurisdictions. Regional operational perspectives, however, need data from across the region at consistent densities.

Operator interface needs include interfaces for viewing and assessing risks and for enabling interventions. They also require interfaces to provide actionable traveler information, enact appropriate traffic controls, and respond to events through dispatch of emergency services and maintenance operations. These interface needs are also met within the operating domain, but they are not currently fulfilled with interfaces that extend the operator's view across the region. Interfaces could be enhanced to provide traveler information on events across the region and to request traffic controls, emergency services, and maintenance operations in other domains.

Travelers' needs include actionable information on traffic, road, and weather conditions for pre-trip planning and for updates during trips at critical route decision-making points. Travelers must also know how to enact their decisions. For instance, an alternative route should be provided when a diversion is suggested.

Traveler information is already broadly available from agencies and third-party sources, but the situation would be improved by extending the range of data available from individual sources. For example, state traveler information sources should not only be available within that specific state, because travelers frequently cross state boundaries on trips. Traveler information may also be improved by providing consistency across sources. The same type of data and alerts should be available along the length of a trip, with similar data latencies and update intervals. An agency's "operations perspective" can be helpful when providing information on controls and operations. Third-party information sources can observe; however, since they do not manage the transportation system, they may not have access to the complete situational picture.

Taken together, these operational needs and desired changes suggest some particular enhancement strategies and objectives.

- The ITSH states could accommodate anticipated growth in commercial vehicle traffic and manage commercial vehicle corridors more effectively. They need to use technology to operate and manage major commercial vehicle corridors in a more efficient manner to accommodate a 25–40 percent increase in truck traffic over the next 20 years.
- In order to maintain movement through and around traffic and weather events, the ITSH states could coordinate operations and traveler information across the entire corridor and present the traveler information in a timely manner. The states also need to keep the infrastructure in good operating condition and keep the roadways open and passable in inclement weather. They must inform users in real time of closures, alternative routes, weather, incidents, and anticipated travel times.
- The ITSH states should seek to align technology and communications infrastructure to support coordinated operations. They could execute corridor planning by coordinating construction schedules, executing technology deployments, tying communications infrastructure together, linking TMCs, developing mutual-aid agreements, and communicating traveler information to commercial vehicle operators and travelers more efficiently.

4.3 Analysis of Alternatives

Analysis of the alternatives for addressing the needs for change should also consider the impacts of *not* implementing any changes. Table 6 below shows the strength, limitations, opportunities, and challenges of supporting regional operational interests with the existing ITS systems. This “make no changes” strategy minimizes the costs to each state of implementing system changes and information exchange protocols, but it would not address the intended MCOMP objectives.

Table 6. Analysis of Making No System Changes

Data Model	Interface Model	Strengths, Limitations, Opportunities, and Challenges		Relative Cost
Existing ATMS/ ATIS	Existing ATMS/ ATIS	S	Systems would not change; operators would continue with the existing call lists and information exchange protocols. Travelers would use the existing traveler information services. Links to other sites could be implemented, but would not change the data or interface models.	-
		L	Staying with the current state would not address the intended MCOMP objectives. The public would not be served as well as they could be with the data and resources available.	
		O	Staying with the current system limits the expenditure of public funds; There would be limited risk of creating	

			a system that would go unused, use public funds and cause agency criticism.	
		C	Staying with the current system forces states to rely on strong physical communication links with each other to coordinate operations.	

Consideration of changes that could be made to meet the MCOMP objectives can be divided into two aspects—the data model and the interface model. In this perspective, the data model describes the means by which data is shared between Heartland states; the interface model describes the means by which the data is made available to operators, travelers, and commercial vehicle operators. Table 7 illustrates options for both the data and the interface models.

Data integration generally takes one of three forms. Data can be shared through a peer-to-peer exchange in which each TMC gathers data directly from other TMCs. Alternatively, a central data repository can be used to share their road and weather condition information and also collect information from other TMCs in one place. Finally, agencies can use a third-party service to collect data from each state, and then each state can gather the data from the same service.

Interface model options follow a similar pattern. In the first interface model option, each agency can extend their own interfaces to cover the region of interest and meet the needs of the designated system. Alternatively, the agencies could build a new integrated interface from which users could obtain road and weather condition information across the region. Finally, a third-party service could be used to share the information among agencies and with users.

Table 7. MCOMP Options

		Interface Models		
		Extend Existing Interfaces	**Build New Operations and Travel Information (Ops/TI) User Interface**	**Use Third-Party Services**
Data Models	**Peer-to-Peer Exchange**	**Exchange and Extend.** Each ATMS needs interfaces to other ATMSs to get data. The geoscale of each ATMS/TI interface is extended to cover the region of interest.	**Build a Shared Interface.** A new shared Ops/TI user interface is built, for which data is obtained from each ATMS as needed through their existing interfaces.	**Outsource TI**. Agencies directly share data for operations. Data is provided to third parties to build the regional view through third-party interfaces.
	Aggregation	**Share and Extend.** A central data base is built; each ATMS implements interfaces to the central data base. The geoscale of each ATMS/TI interface is extended to cover the region of interest.	**Build a Central System.** A central data base is built with shared Ops/TI user interfaces.	**Standardize Data Provision**. States/TMCs aggregate their data feed to third-party systems to use in interfaces.
	Get Third-Party Data	**Extend with External Data.** Each state gets data from a third-party service. The geoscale of each ATMS/TI interface is extended to cover the region of interest.	**Build Interfaces on External Data**. Data is obtained from a third-party service for all states for presentation through new shared Ops/TI user interfaces.	**Depend on Third-Party Services.** All states depend on third-party data collection and presentation for regional operations.

4.3.1 Option 1. Exchange and Extend

Figure 3 represents using a peer-to-peer data model with an extended interface model. In this option, each TMC would be able to gather data from other TMCs and allow users to view the information by extending their interface. This alternative would require each TMC to maintain several connections, but it would allow them to continue to have control over their own data.

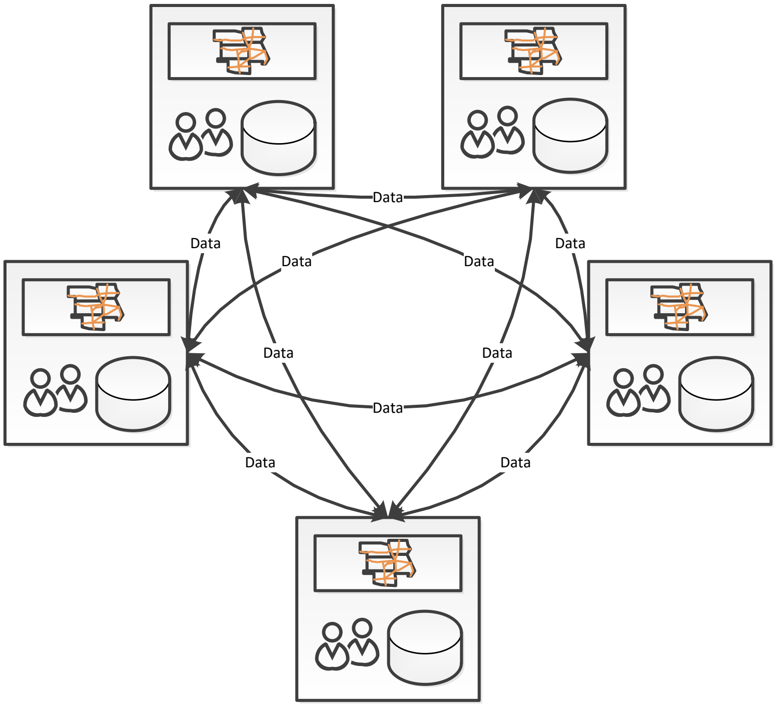

Figure 3. Peer-to-Peer Data with Extended Existing User Interface

Solution Option	**Exchange and Extend**
Data Model	Peer-to-Peer Exchange
Interface Model	Extend Existing Operator and Traveler Information (Ops/TI) Interfaces
Description	Each TMC gets data from other TMCs and extends their existing data base and interfaces to cover the corridors of interest.
Strengths	Each agency maintains control over its own data; each agency funds only what it needs/wants.
Limitations	Adding a new data service requires that each TMC make a new connection; the total number of connections to maintain goes up as n(n-1) (one each way between centers).
Opportunities	Each TMC only has to get data it needs/wants; not all connections have to be implemented.
Challenges	Costs could be high for both the extensions and for building and maintaining so many data connections.
Costs	$$$
Example	None identified.

4.3.2 Option 2. Build a Shared Interface

In the option represented by Figure 4, data is collected from each ATMS's existing interface by a new interface. This option requires sharing costs for the creation and design of a new interface and is dependent on the weakest link of the whole system.

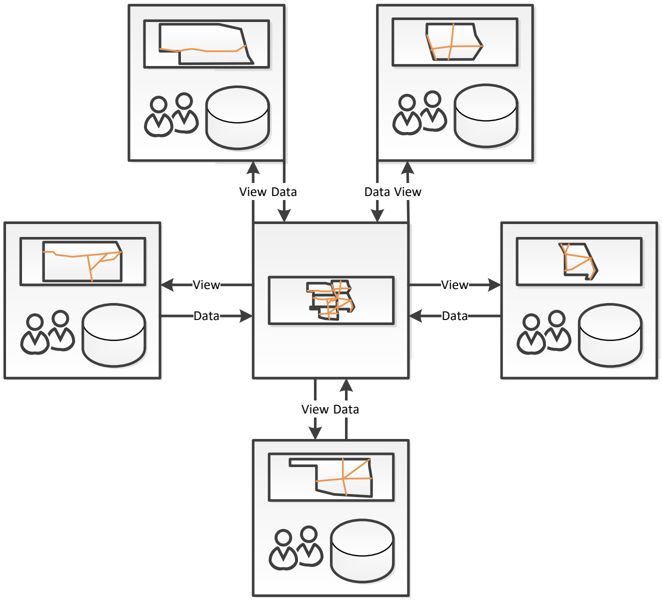

Figure 4. Build a Shared Interface

Solution Option	Build a Shared Interface
Data Model	Peer-to-Peer Exchange
Interface Model	Build/Borrow Operations and Travel Information Interfaces
Description	A new shared Ops/TI user interface is built, for which data is obtained from each ATMS as needed through their existing interfaces.
Strengths	All stakeholders see a shared regional interface.
Limitations	The performance of the whole system depends on the performance of the weakest link. Some shared financing is necessary to support the shared interface.
Opportunities	Costs could be lower than a completely new system since there is no shared data repository.
Challenges	Individual system interfaces and data connections have to be maintained at all times to assure current data is being shared. Changes to the shared interface need agreement from all stakeholders. A change at one contributor site incurs shared cost to update the shared interface.
Costs	$$$
Example	None identified. This is not a practical solution since it depends on remote data access to support the user interface.

4.3.3 Option 3. Outsource Traveler Information

Figure 5 shows the MCOMP option of using a third-party interface to display information that is shared between the states and with the third-party service. TMCs do not have as much control over data sharing in this option, but it is of no cost to the agencies.

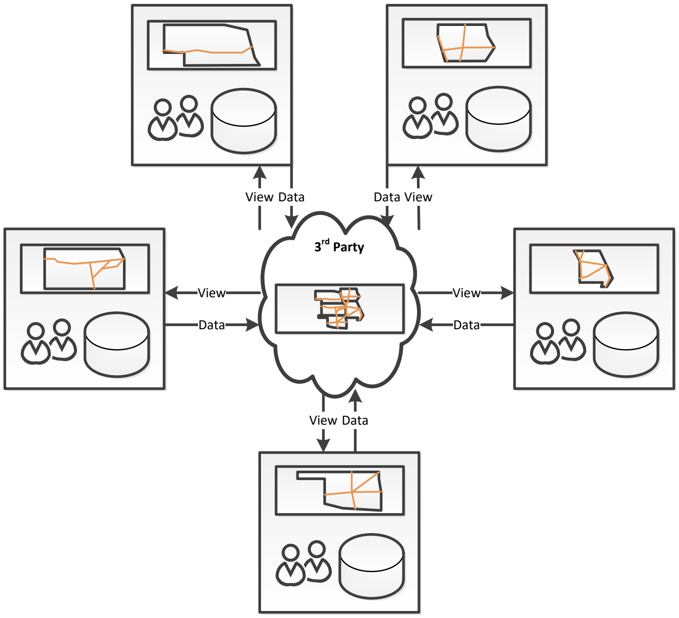

Figure 5. Outsource Traveler Information

Solution Option	Outsource Traveler Information
Data Model	Peer-to-Peer Exchange
Interface Model	Third-Party Services
Description	Data is exchanged among agencies and to third-party systems. The regional view is available through third-party interfaces.
Strengths	No cost to the agency.
Limitations	The only agency control is over what data are provided to the third-party data aggregator. There is no direct sharing of data.
Opportunities	Improvement in information available to the public is driven by a competitive marketplace.
Challenges	Data availability, quality, and timeliness are not assured.
Costs	Minimal, for potential administrative costs only
Example	None identified. Third parties providing a regional view consistently appear to keep their own data repositories.

4.3.4 Option 4. Share and Extend

In the "Share and Extend" option shown in Figure 6, a central data aggregation service is used to collect data from each of the TMCs. The TMCs can draw the data from the aggregation service and then display it on their own interfaces if they have been extended to be able to share the information gathered. This allows the states to continue using familiar interfaces. It may be a slower process, though, because the data is no longer kept remotely.

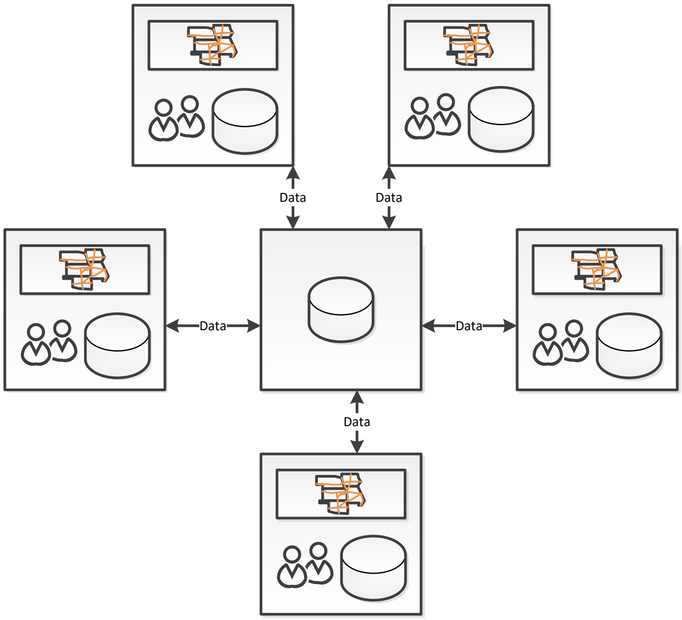

Figure 6. Share and Extend

Solution Option	Share and Extend
Data Model	Centralized Aggregation
Interface Model	Extend Existing Operator and Traveler Information Interfaces
Description	A central data aggregation service would collect data from all the coalition TMCs. Each TMC could draw on that data to populate its own extended interfaces.
Strengths	Data is standardized across the region, but each agency keeps familiar interfaces.
Limitations	Pooled funds would be needed to develop and maintain the aggregated data service. Remote data access could be slower than keeping it local to the existing interfaces.
Opportunities	Individual agencies could enhance their own systems to the shared data standard.
Challenges	Each TMC would probably still need some local data base changes to support the extended interfaces.
Costs	$$$
Example	None identified.

4.3.5 Option 5. Build a Central System

Figure 7 shows a system in which an entire central service is built. This would allow users to view the same interface across the Heartland states. The funding and designs of the new system would be shared between the states.

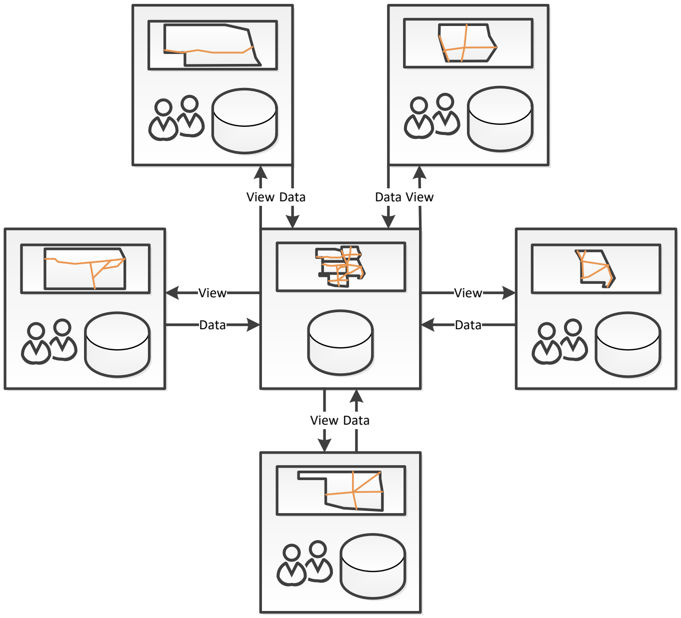

Figure 7. Build a Central System

Solution Option	**Build a Central System**
Data Model	Aggregation
Interface Model	Build/Borrow Operations and Travel Information Interfaces
Description	A central data aggregation service would collect data from all the TMCs and support user interfaces for operators and travelers.
Strengths	Operators and travelers see the same view across the region; system management and operations is centralized.
Limitations	All agency stakeholders have to agree on system features, look, and feel. Costs and administration are similarly held in common.
Opportunities	Costs would be lower than the peer-to-peer solution since fewer data interfaces would be needed and would be lower than extending the existing systems since a new interface would be shared by all.
Challenges	Any operating decisions have to be agreed to by all parties.
Costs	$$$
Example	GLRTOC/Travel Midwest: http://travelmidwest.org/lmiga/home.jsp I-95 Corridor Coalition: http://i95coalition.org/trafficview/ North/West Passage: http://roadstosafediscovery.com/

4.3.6 Option 6. Standardize Data Provision

Figure 8 represents the option of aggregating the data and then making it available for presentation using third-party services. In this option, the agency does not have direct control over how the data they provide is presented, but the interface is developed and maintained at no direct cost to the agency.

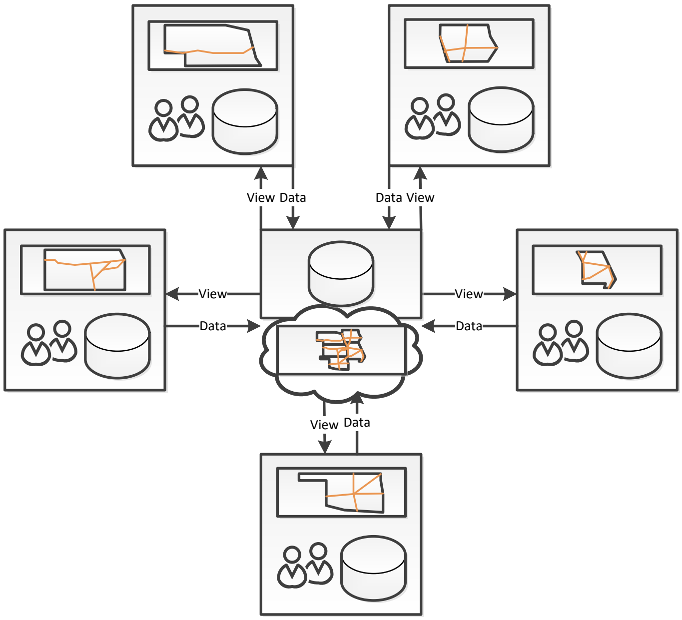

Figure 8. Standardize Data Provision

Solution Option	Standardize Data Provision
Data Model	Aggregation
Interface Model	Third-Party Services
Description	States/TMCs aggregate their data feed to third-party systems to use in interfaces.
Strengths	No cost to the agency for the interface.
Limitations	There is no incremental value to aggregating the data feed since the only agency control is over what data are provided to the third party, not over its use or presentation.
Opportunities	Improvement in information available to the public is driven by a competitive marketplace.
Challenges	Data availability, quality, and timeliness are not assured.
Costs	$$
Example	None identified.

4.3.7 Option 7. Extend with External Data

The “Extend with External Data” option shown in Figure 9 uses a third-party service to collect the data and presents the data on each TMC’s extended interface. This option does not require any agreements between states, but it does require each state to extend its own interface.

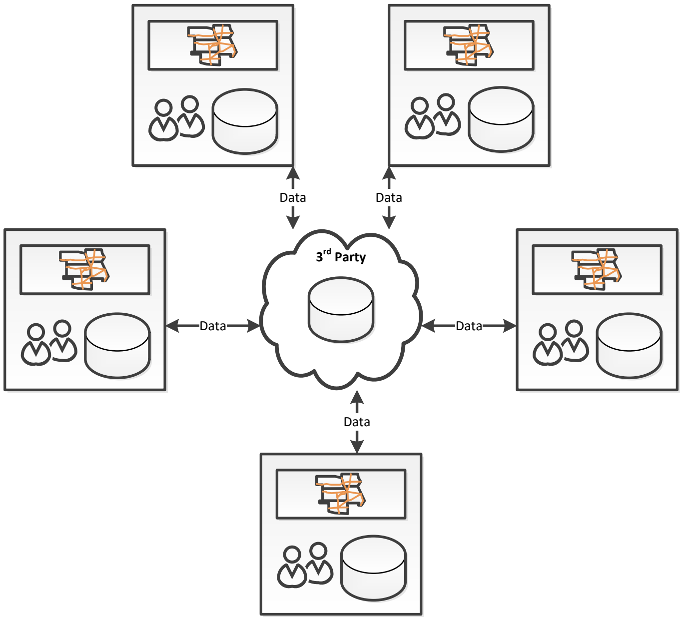

Figure 9. Extend with External Data

Solution Option	**Extend with External Data**
Data Model	Third-Party Services
Interface Model	Extend Existing Operator and Traveler Information Interfaces
Description	Data would be provided to and retrieved from third-party services by each of the TMCs for use in their extended ATMS/ATIS interfaces.
Strengths	The data comes from a single third-party feed and is extensible; agencies may already be paying for the data. No interstate agreements are needed.
Limitations	Agencies have to pay for the data and extend their own interfaces.
Opportunities	
Challenges	Costs for external data in this application are unknown. Reuse and publication of the data and limitations on changes to the third-party data feeds are controlled through contractual terms of service.
Costs	?/$$
Example	KC Scout presenting third-party traffic data: http://www.kcscout.net/

4.3.8 Option 8. Build Interfaces on External Data

Figure 10 represents a system in which each TMC shares its travel information with a third-party service and then the information is shared on a new interface that is created specifically for the purpose of sharing the travel information in the Heartland states.

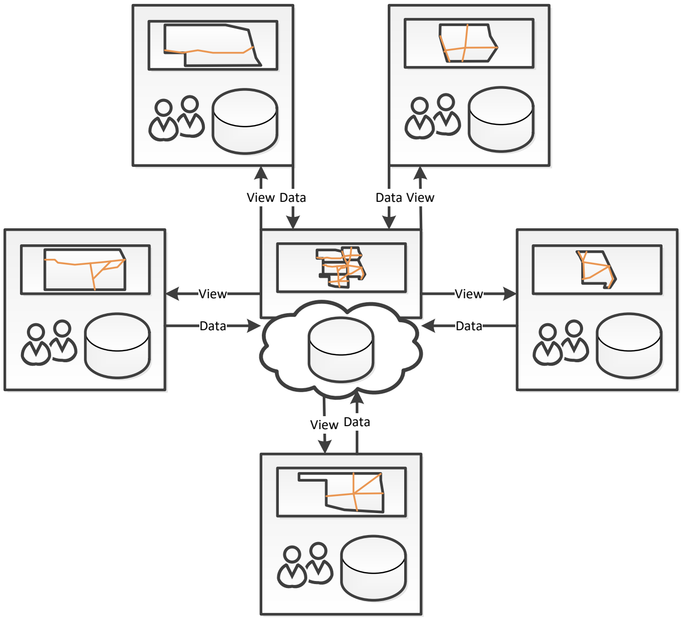

Figure 10. Build Interfaces on External Data

Solution Option	Build Interfaces on External Data
Data Model	Third-Party Services
Interface Model	Build/Borrow Operations and Travel Information Interfaces
Description	Data would be provided to third-party services by all TMCs and retrieved from third-party services for use in new central ATMS/ATIS interfaces.
Strengths	Would enable Heartland to develop and use its own operator and traveler user interfaces.
Limitations	Potential data providers may have other user interfaces available as part of their data service offerings; developing a new user interface might represent a cost with lower return than using the third-party interface.
Opportunities	Existing TMCs would be unaffected.
Challenges	Costs for external data in this application are unknown.
Costs	?/$$
Example	None identified.

4.3.9 Option 9. Depend on Third-Party Services

Figure 11 illustrates a system integration reliant on third-party services. The travel information from each TMC would be provided to and presented by a third party. The state agency would not exercise direct control over the content and presentation of the traveler information.

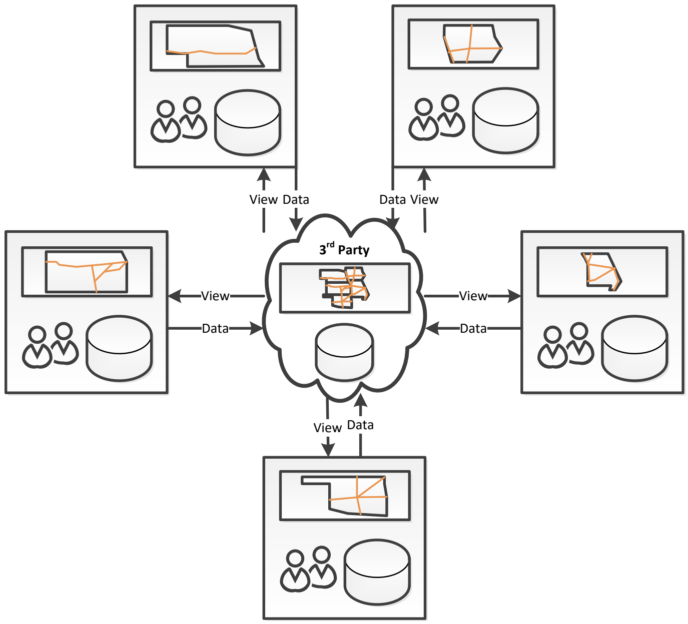

Figure 11. Depend on Third-Party Services

Solution Option	Depend on Third-Party Services
Data Model	Third-Party Services
Interface Model	Third-Party Services
Description	Data would be provided to third-party services by all TMCs and retrieved from third-party services for use in new central ATMS/ATIS interfaces.
Strengths	Cost for publishing the data are nil. No inter-agency agreements are needed. No shared funding is needed.
Limitations	Lack of any agency control over traveler information content and presentation; options for operations integration represent ongoing service costs.
Opportunities	Very low cost dissemination of traveler information.
Challenges	Ongoing data service costs.
Costs	?
Example	Google Maps/Traffic Waze INRIX Traffic Apps: http://inrix.com/mobile-apps/ INRIX Agency Applications: http://inrix.com/industry/public-sector/

4.3.10 Preferred Alternative. Data Aggregation with Open Interfaces

Over the course of several extended discussions, ITSHCC stakeholders determined that the preferred alternative for the MCOMP integration is to proceed with developing an integrated data repository with a data interface open to other systems wanting to provide a user interface. This solution is most similar to Options 4 and 6, in that each agency could expand its own interfaces to use the integrated data and that it would be open to third-party interfaces. It is unlike Option 5, in that it specifically does not call for developing an integrated regional user interface. It therefore facilitates the benefits of Options 4 and 6 without incurring any direct additional costs associated with Option 5. The concept for and implications of this approach are described in the next sections of this document.

5 Concepts for the Proposed System

This section of the ConOps describes concepts for developing and deploying a system that needs and fulfills the opportunities described in the prior section. The concepts are described here from system architectural, policy, operational, user, and system environmental perspectives.

5.1 Background, Objective, and Scope

In the grant application, the ITSHCC goals for MCOMP are to "improve the movement of commercial vehicles, provide better traveler information systems, and cooperatively plan operations throughout the region." Several alternatives were analyzed to determine a solution for best reaching these goals. The alternatives can be seen in Section 4.3.

Many travelers are affected by the roads and weather in more than one single state and often times are affected by the conditions across a region. In order for the public to be able to view the weather and road systems moving across the region, transportation systems management and operations need to have access to traffic information beyond their state's borders.

5.2 Description of the Proposed System

The analysis of alternatives presented in Section 4.3 sparked extensive discussions among the ITSHCC stakeholder team. As described there, the stakeholders determined that the preferred approach is building a central data repository to aggregate information from the five Heartland states while enabling the agencies and third-party information service providers to access the information for their own user interfaces. In this scenario or alternative, each agency TMC would share their real-time road and weather condition information with the central repository. The TMCs would have the option to collect the other TMCs' information from the repository and share it on their own interfaces. Other users such as information providers and research institutions would have access to the central repository for real-time and archived weather and road data.

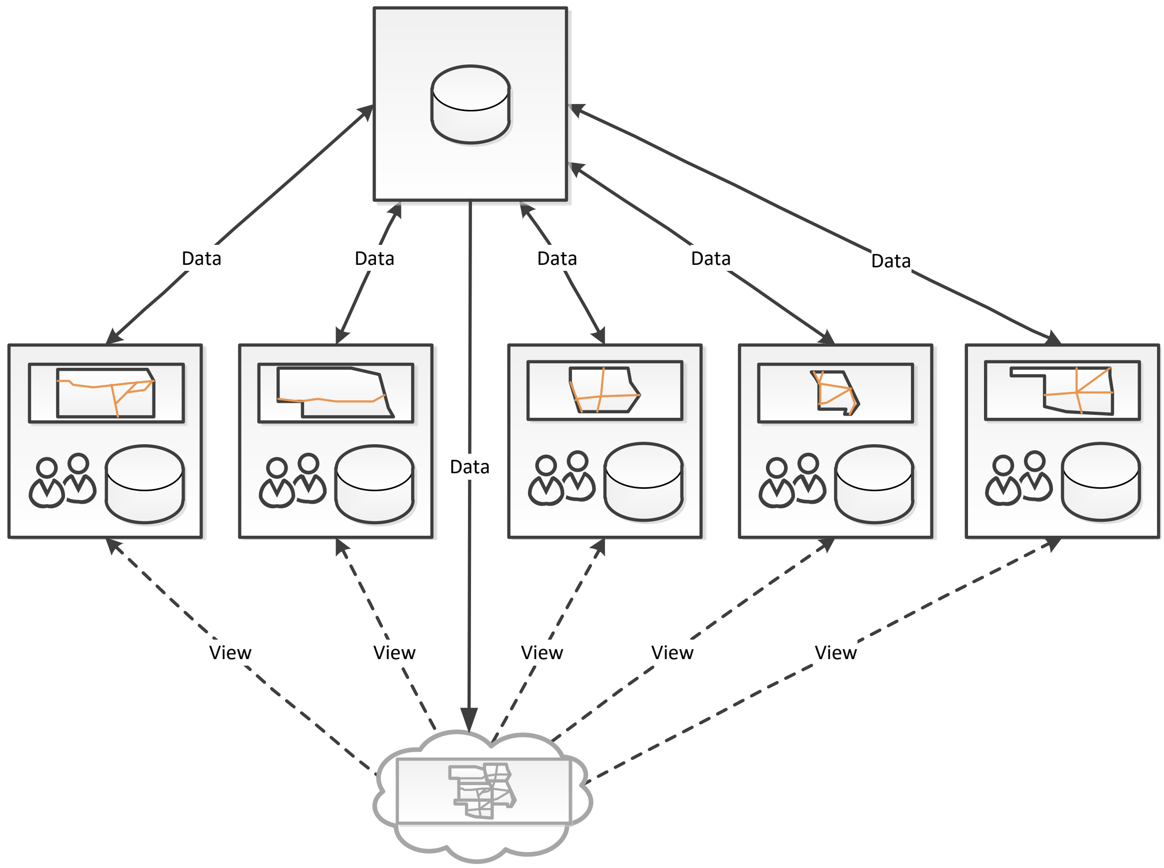

Figure 12. Preferred System Concept

This concept fulfills ITSHCC's goal of giving transportation systems' management and operations access to road, traffic, and weather information across the region and the ability to inform the public of what to expect as they travel across the region. The goals described in the MCOMP grant application to "improve the movement of commercial vehicles, provide better traveler information systems, and cooperatively plan operations throughout the region" will be met in this concept when the opportunity to share information is enabled by a central repository and by agency and third-party systems taking advantage of the data availability.

In this concept, data across the region is pooled and standardized. Systems gathering information from the data repository will gain reliable information that is consistent among the agencies and their TMCs. This concept also enables each TMC to continue using its own familiar interface and does not require the TMCs to create or learn a new interface system for reading and displaying information. The new concept gives them the opportunity to expand their interfaces, taking advantage of the shared data to better meet the needs of their users.

5.3 Users and Other Involved Personnel

With the proposed concept, TMCs within each of the Heartland states would provide real-time road and weather condition information to the central data repository. This information would include (but would not be limited to) traffic conditions, construction zones, and weather conditions collected by each TMC's ITS or by contracted services on their behalf. Data collected in the shared repository would be normalized to a common standard (for example, data definitions described by the Traffic Management Data Dictionary[1]) to ensure consistent and accurate information across the region.

If they chose to, the TMCs could then extract information from the central repository and extend their native operator and traveler information interfaces to include other state's road and weather condition information. Standardization of the data in the central repository would reduce or minimize the effort necessary to interpret the data feed for presentation.

Information providers could gather information for each of the Heartland states from the central repository for presentation on their interfaces. The aggregation and standardization of the data would reduce the investment needed to access and interpret the information, which could in turn encourage additional service providers to find new applications.

Aggregation of operations data in the central repository could create new research opportunities. In addition to real-time applications, data coming into the repository would be archived for later access. Universities and other research institutions would be able to obtain archived information from the central data repository for research and for applications development.

If TMCs decided to include information from other states in their own interfaces, travelers would be able to view multiple states' road and weather condition information from a single interface, simplifying the process of finding appropriate traveler information. This would enable travelers to use familiar interfaces for trips outside a single agency's context and open up an agency's data to new users.

5.4 Operational Policies and Constraints

The concept and implementation of operational data sharing may spark a variety of security, privacy, liability, and other institutional concerns within a transportation agency. As noted in the Section 3 (Current State), for example, traffic data obtained from information service providers might be subject to contractual restrictions on redistribution. Traffic camera images are not saved by some agencies and may not be available for sharing or archive. The variety of potential issues and diversity among the Heartland states suggests that a more thorough review of applicable operational policies and constraints would be needed as part of the system design process.

5.5 Modes of Operation

A system's modes of operation describe the overall state of its operations based on the state of its input, processing, and output. The characterization of these modes may be helpful in understanding user expectations and in specifying system requirements.

Normal – The system is operating as expected. Data are being provided by the prescribed sources to the central data repository.

Degraded Function – One or more of the system functions are not working properly or may not be available. Data providers may be unable to insert data, or users may be

1. [1] Institute of Transportation Engineers *Traffic Management Data Dictionary (TMDD) Standard for the Center to Center Communications - Volume II: Design Content v3.03* http://www.ite.org/standards/tmdd/3.03.asp, accessed 2016.09.22

unable to collect data from the repository. Some type(s) of malfunction may be known through system monitoring, but the system will require administrator intervention to restore to the normal mode.

Degraded Data – One or more sources are not providing the expected data to the repository. As a result, data collection and provision is incomplete. Restoring service to a normal mode may depend on restoration of external data sources.

Maintenance – System maintenance may remove some components from normal operation for finite intervals. Other components that are active during that time will continue to operate normally but suspend their interaction with the component(s) in maintenance mode.

Shutdown – The system is not operational and is unable to provide real-time data. Archived data may continue to be available.

For the MCOMP repository, the system's mode of operation will depend on its data sources as well as its own state and capabilities. Changes in the availability or interfaces of the source systems may drive the collective capabilities from normal to a state of degraded data or function. System requirements should address the expected response to off-normal operating states.

5.6 Support Environment

The Heartland MCOMP data repository represents a new capability and as such does not have any existing system components or support environment. System requirements will specify support environment performance requirements including but not restricted to items such as data storage capacity, access bandwidth, and number of simultaneous users. Development and implementation of the data repository will be performed in a follow-on procurement, and the details of the environment and services to support the design will be defined at that time.

6 Operational Scenarios

Scenarios are used to describe how the system would operate and interact with its users and other systems. The scenario descriptions are informative rather than normative. MCOMP scenarios include both a narrative and an explanatory description.

6.1 Sharing Information

Due to icy weather conditions, a major multi-vehicle incident with fatalities occurs on I-29 in northwest Missouri. Multiple cars are piled up, blocking all traffic moving north. The pile-up may take up to four or five hours to clear. Because the traffic will be stopped for quite some time, many travelers on I-29 may be affected by the incident. The incident is posted to the MoDOT traveler information map and shared with the Heartland data repository. Kansas, Iowa, and Nebraska are then able to get the incident information from the data repository, post appropriate messages on their Dynamic Message Sign, and share the data on their traveler information sites and apps. Travelers from all four of the states that may be affected by the incident are able to make arrangements to delay travel or utilize alternative routes.

The new data repository created by ITSHCC gives the five Heartland states the opportunity to share information about the condition of the roads with the other Heartland states. The states will provide real-time data from their TMCs about road incidents, construction, traffic flow, and weather conditions within their data-collecting area. The data repository allows the other states that may be affected by this information to collect the data and share it with their interface users. In this example, many travelers within the entire Heartland region are affected by the incident on I-29, so the aggregated data repository was crucial for travelers in each of the states.

6.2 Info Provider

In order to display road and weather conditions through their website internationally, RoadInfo collects data from several different sources, including some of the Heartland states. They are able to quickly gather consistent information on traffic flow from all five Heartland states through the MCOMP data repository, which saves them time and resources. They do not have to access each individual state's data repository in order to collect condition information.

The MCOMP data repository is a convenient resource for information providers to be able to gather the information for five different states from one interface using a standard interface. The information across these states is accurate and consistent.

6.3 Traveler

A trucker is hauling freight from Las Vegas, Nevada, to Jersey City, New Jersey. He is currently entering I-44 after passing through Oklahoma City and is only about four hours away from reaching his allotted 11 hours of driving for the day. If driving conditions are "normal," this should put him somewhere near Springfield, Missouri, by the end of the four hours. However, the roads on his trip have already been a bit icy, and he predicts that the roads may continue to ice over as night falls. The trucker needs to know what road conditions are like and how far he will be able to travel on I-44 over the next four hours so he can find a place to park his truck and get some rest for the night.

Not only does the trucker need the road conditions for Oklahoma, but he also needs the conditions for Missouri. Fortunately, he is able to pull up the Oklahoma road condition interface when he reaches the next rest stop and view the conditions for both Oklahoma and Missouri. He sees that there is some ice on I-44 in western Missouri between Joplin and Springfield. He also notices that the traffic flow in that area is considered slow. It looks like the slow traffic and the icy conditions will slow him down by at least 30 minutes. The trucker pulls up a trucking parking application and chooses a truck stop near Joplin, Missouri, where he can stop in order to avoid the icy conditions and the risk of not making it to another truck stop by the time his 11 hours expires.

Through MCOMP, citizens traveling across the country may have access to road and weather condition information for all of the Heartland states from any of the Heartland states if they choose to include information from the central data repository on their interface. Any traveler information shared with the central data repository can be available in each of the other state's interfaces. In this example, a traveler moving from one end of the country to the other was able to view information for multiple states on his trip and view the details on a single interface, which saved him time and energy. Most trips across the country include at least one Heartland state, and many of them include multiple states, so MCOMP is not only beneficial for travelers in the Heartland states themselves, but it is also beneficial for many other travelers in the U.S. Travelers as the end users of MCOMP can view traffic flow, weather conditions, road construction, and incidents.

6.4 University/Research Institution

The Transportation Research Center at Heartland University is doing research that requires consistently archived road and weather information from across several states in the Midwest. The research center is able to use the MCOMP data repository to pull up data on the conditions of the roads in the five Heartland states over the last several years. They can use the data to produce an accurate representation of the actual conditions and can easily compare the data because each state provides the same type of information for the central data repository.

The MCOMP data repository archives all of the real-time information it receives from each of the Heartland states and stores the data for future use by organizations such as research institutions. Consistent information across the states is gathered, so the same type of data for each state is available for use. This body of normalized, consistent data provides a unique resource for researchers needing a broad data perspective over a long time period.

7 Summary of Impacts

7.1 Impacts during Development

Implementing a new system typically does not have significant user impacts during development since there are—by definition—no existing users to be inconvenienced.

Specification and development of a Heartland MCOMP data repository may require some time and attention from operators and administrators of the Heartland states' existing systems. Developing a system architecture and design will require a detailed understanding of the existing systems' data and interfaces. System operators and administrators typically have knowledge of the system that goes beyond the system documentation and will be very helpful to the data repository developers.

7.2 Operational Impacts

The agency TMCs and traveler information systems in the Heartland region may be affected by the new repository if they choose to extend their interfaces to take advantage of the new data source. If a TMC decides to add the road and weather condition information of the other states in the region to its own interface, then operational adjustments may need to be made within the TMC.

7.3 Organizational Impacts

The new system to be implemented by ITSH is unlikely to have organizational impacts on the agencies and TMCs in the region. It is conceivable that additional staff to monitor and respond to the additional MCOMP-derived data might be desirable during, for example, severe weather events or long-term operational emergencies.

8 Analysis of the Proposed System

An analysis of the alternatives considered for the conceptual system is provided in Section 4.3 of this document. As stated previously, ITSHCC has chosen to move forward with creating a centralized data repository and decided against creating an integrated interface. An integrated data repository for road and weather condition information from the Heartland states was perceived as having potential value to a broad group of stakeholders, while the large number of existing traveler information systems argued against creating yet another repository. In particular, there may be potential to use the new data repository in collaboration with the MAASTO Truck Parking Project.

8.1 Disadvantages and Limitations

Development and maintenance of a central data repository represents a shared interest and cost for the Heartland member states. A continuing institutional commitment to the repository's management and operations will be needed to assure that it stays open and relevant to its potential stakeholders. The lack of commitment to a unified interface, however, is likely to make it more difficult to do so. The system's effectiveness is ultimately predicated on a presumption that third parties will want the system's data and use its interfaces to provide the data to the traveling public. There are, however, no guarantees or control over that outcome.

8.2 Benefits and Opportunities

By creating a new centralized data repository, ITSHCC will be giving the Heartland region the opportunity to aggregate a standardized set of data in a single source. The data repository will provide a consistent set of data for all five states and will be open to the states, information providers, research institutions, and other users. Because the ITSH Operations Working Group will be creating a new data repository and not a new interface, each TMC will be able to continue using its own familiar interface rather than learning how to share and display information on a brand new interface. The new data repository gives the Heartland states the opportunity to expand their own interfaces as new needs arise.

APPENDIX A

List of Acronyms and Abbreviations

ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
ConOps	Concept of Operations
DMS	Dynamic Message Sign
DOT	Department of Transportation
FHWA	Federal Highway Administration
GLRTOC	Great Lakes Regional Traffic Operations Coalition
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization of Standards
ITS	Intelligent Transportation System
ITSH	Intelligent Transportation Society Heartland
ITSHCC	Intelligent Transportation Society Heartland Corridor Coalition
KDOT	Kansas Department of Transportation
MAASTO	Mid America Association of State Transportation Officials
MCOMP	Multistate Corridor Operations and Management Program
MoDOT	Missouri Department of Transportation
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
N/W Passage	North/West Passage Corridor Coalition
OTIIS	Operations and Travel Information Integration Sharing
RITIS	Regional Integrated Transportation Information System
RTSMIP	Real-Time System Management Information Program
TI	Traveler Information
TMC	Transportation Management Center