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Evaluation and Enhancement of MassDOT Traveler Information Programs

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16. Abstract
The objective of this study is to develop a proposed structure of various transportation modal information platforms that could be integrated and supported by the latest traveler information technologies.

MassDOT's current traveler information program is provided through multiple outlets and platforms targeted to specific customer service groups who rely on different media for acquiring traveler information. These services are not consolidated or integrated and have been developed over time in different units to support public expectations, special projects, or specific requests for new approaches.

In this study the practices of various peer agencies are reviewed to help synthesize new agency strategies that involve the third-party community to disseminate traveler information. As a result, a set of recommendations were developed to inform the agency on enhancing its traveler information system and how a comprehensive set of multimodal transportation information services can be provided to meet the customer needs.

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Evaluation and Enhancement of MassDOT Traveler Information Programs

Final Report

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Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Massachusetts Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

The purpose of this report is to serve as a technical memo rather than an original research document. Therefore, in some circumstances, materials from the references were included through direct quotation to preserve the accuracy, which would serve the best interests of the readers. The authors do not claim the originality of materials in this report.

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Executive Summary

This study of "Evaluation and Enhancement of MassDOT Traveler Information Programs" was undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program. This program is funded with Federal Highway Administration (FHWA) State Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts transportation agencies.

The mission of MassDOT is "to deliver excellent customer service and safety to people traveling in the Commonwealth." From the point of view of the traveler, an important function is traffic management, including the dissemination of information. Information dissemination to travelers includes both pre-trip planning information, as well as real-time en-route information. Under 23 CFR 511, state DOTs [*1*] are required to establish Real-Time System Management Information Programs that take advantage of the existing traffic and travel condition monitoring capabilities, and build upon them where applicable. The CFR also establishes certain requirements for traffic and travel conditions to be made available by the real-time information programs.

The mechanisms by which travelers can get traveler information continues to grow, as dozens of permutations of new solutions, such as mobile apps and social media, are added. Current available platforms for information dissemination include:

- Public media – broadcast TV, FM and AM radio, including highway advisory radio (HAR)
- Interactive Voice Response Systems (IVR)
- In-vehicle infotainment systems (built-in and aftermarket)
- Social Media – e.g., Facebook, Twitter, Instagram, etc.
- Mobile devices – cellphones, smartphones and other smart devices (tablets, etc.)
- Desktop computers
- Infrastructure signage such as Dynamic Message Signs (DMS) and real-time transit information signs

Each platform has different benefits and is targeted to different traveler groups, e.g., commuters, tourists, commercial vehicles, travelers with or without access to the internet or to mobile devices, etc. While growth in newer solutions is increasing rapidly, evidence shows that the more traditional means of accessing information continue to have substantial use. In particular, some studies show TV, radio, and non-mobile websites are still being used the majority of the time for pre-trip review. Mobile devices are the leading source of en-route traveler information, followed by radio transmission and variable messaging signs. MassDOT uses all these means for information dissemination, but Traveler Information (TI) for different travel modes is not integrated into a single platform.

The objectives of this study are to identify Traveler Information (TI) elements that would benefit the users of the system but are not currently available, how these gaps could be filled

and how a comprehensive set of multi-modal TI services might be provided to meet needs and demands. More specifically the goals of the project are to:

- Assess gaps in the provision of service;
- Make recommendations on how those gaps in service can be met through specific program enhancements that consider information integration and dissemination through a single platform;
- Identify how this integration may or may not facilitate mode choice changes; and
- How TI elements (i.e., program enhancements) might augment changes in the way transportation organizations and potential business partners operate and provide service from different locations and through different means to a complex and diverse customer base.

The key findings and conclusions of this study are summarized in four chapters:

1. Literature Review

In the first part of this chapter, a number of important studies on Traveler Information Systems (TIS) and Next Generation TIS (NGTIS) sponsored by federal and state transportation agencies are reviewed. Since TIS technologies are evolving very rapidly, only recent studies published after 2010 are considered, to ensure that the findings are relevant.

In the second part of this chapter the TIS provided in Massachusetts is compared with several other states, with specific emphasis on the practices used with similar sized metropolitan areas like the Boston region included in this analysis.

States and regions considered include:

- California (San Francisco Bay Area),
- Florida (South Florida Area),
- Illinois (Chicago Area),
- Washington, DC Metro Area,
- New Jersey,
- New York,
- Pennsylvania (Philadelphia Area), and the
- I-95 Corridor Coalition - member states from Florida to Maine.

The main findings from this review are:

- Most states only provide TI for interstate and state highways and they use the 511 system (web, phone and in some instances mobile applications)
- Many highway agencies provide a comprehensive platform that shares TI for multiple travel modes (e.g., driving, biking, carpooling, transit)
- Some states provide parking, ridesharing and biking information (static).

- Providing real-time data feeds appears to be increasingly popular for both transit and highway agencies, and has resulted in numerous mobile apps.
- Several agencies are collaborating with companies such as Waze for exchanging traffic data.
- Most agencies do not provide predicted traffic information
- Very few agencies are assessing the effectiveness of their TIS
- Some states have formed regional TIS collaborations

2. MassDOT TIS Usage

The Highway Operations Center at MassDOT uses a number of different platforms for disseminating TI such as Variable Message Signs (VMS), the Mass511 system (website and phone service), and the MassDOT Traffic Map webpage within the MassDOT website. In this chapter of the report, the utilization of the Mass511 system and the MassDOT Traffic Map webpage are analyzed.

The key findings of this analysis are:

- The MassDOT Traffic Map webpage experiences less traffic than the Mass511 website. Nevertheless, the number of page views is significant. On average, there are 518 page views per day with a peak day view of 3,877.
- The Mass511 website experiences significantly higher traffic; on average 4,170 page views, with a peak of 78,730 views, over the period considered.
- Peaks in demand are associated with special events such as snowstorms or holidays.
- There is an increasing pattern in the number of users of the Mass511 website.
- A significant portion of users assesses the Mass511 website through mobile devices, most likely for en-route information. This is an indication that a mobile application of the website could be considered for development.
- There is a decreasing pattern in the number of phone calls over the period considered. However, the number of repeat callers is steady. Most likely it is users that still heavily rely on this service.

3. Gap Analysis

The information provided by MassDOT TIS could improve significantly with a number of modifications or additions in terms of the types of information and the level of detail, the information timeliness and accuracy, the delivery methods, integration of TI from other sources and the ability for customization.

The gaps identified include:

- Detailed lane information for events such as traffic indents and roadwork

- Time stamped information for traffic incidents, weather events, etc.
- TI across jurisdictions (in-state and cities) and across travel modes (i.e., highway and transit)
- Possibility to form coalitions with neighboring states
- Information on ridesharing, parking availability and airport/shuttle bus
- Metrics for performance of the TIS
- Capacity planning of web resources
- Ability to analyze/integrate traffic data from third party providers
- Assessing the impacts of connected autonomous vehicles (CAV) on TIS

4. Conclusions and Recommendations

The current TIS supported by MassDOT satisfies the requirements of 23-CFR-511. During special events, snowstorms, or construction projects usage of all components of the TIS (phone and web) surges, indicating the public's reliance on accurate TI from MassDOT. Based on the utilization of the different components of MassDOT's TIS, this research recommends that MassDOT can continue to offer the services of the Mass511 system (phone and web) and can continue supporting the MassDOT Traffic Map webpage. To cover the gaps that were identified a number of short-term and long-term recommendations are made, as summarized below.

In the short-term MassDOT can consider its ability to:

- Provide detailed lane information during traffic incidents and roadwork
- Provide time stamped information for traffic incidents, weather events, etc.
- Develop inter-jurisdictional TIS that covers both highways and local streets
- Include links to parking applications, roadside assistance, carpool/ and rideshare applications
- Include links to transit agencies (MBTA and regional transit authorities) and to Massport
- Include links to senior and ADA services
- Share TI on mobile devices, and
- Increase connection to social networks for sharing real time TI.

In the long-term MassDOT can:

- Reconsider the overall system structure to provide a fully integrated TIS that
  - Covers all travel modes
  - Covers multiple regions and jurisdictions
  - Provides information on parking, ADA facilities, availability of sidewalks, etc.
  - Provides tools to enable comparison and combination of different travel modes
- Reconsider the types of information provided to include

    - Current and predicted travel times
    - Parking availability, cost and online booking
    - Information on both state and local roads
    - Information on snow removal operations, potholes, and scheduled maintenance
    - Ridesharing
- Reconsider the methods of information delivery to include customized information based on user preference of modes or routes and taking into consideration departure times, weather and special events.
- Invest in traffic data analytics.
- Invest in workforce development.
- Develop performance metrics to evaluate user experience and system efficiency
- Reassess the role in providing TI; focus considerations on collection/analysis of data, deployment of instrumentation for collecting data and disseminating TI, ensuring quality and reliability of TI and ensuring that the public's interests are best protected.
- Take into consideration the impacts and needs of future TI around connected and automated vehicles (CAVs)

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List of Acronyms

Acronym	Expansion
AASHTO	American Association of State Highway and Transportation Officials
ACCS	Arlington County Commuter Services
ADA	American Disabilities Act
AMTRAK	National Railroad Passenger Corporation
API	Application Programming Interface
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management System
BART	Bay Area Rapid Transit
CAV	Connected Automated Vehicle
CCTV	Closed Circuit Television
CFR	Code of Federal Regulations
CHART	Coordinated Highways Action Response Team
CMAQ	Congestion Mitigation and Air Quality
CTA	Chicago Transit Authority
DMS	Dynamic Message Signs
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FRATIS	Freight Advanced Traveler Information Systems
GDOT	Georgia Department of Transportation
HAR	Highway Advisory Radio
HOC	Highway Operations Center
HOV	High Occupancy Vehicle
IDOT	Illinois Department of Transportation
ITS	Intelligent Transportation Systems
IVR	Interactive Voice Response System
KYTC	Kentucky Transportation Cabinet
LCS	Lane Closure System
MARC	Maryland Area Regional Commuter (train service)
MARTA	Metropolitan Atlanta Rapid Transit Authority
MassDOT	Massachusetts Department of Transportation
MBTA	Massachusetts Bay Transit Authority
MOD	Massachusetts Office on Disability
MTA	Maryland Transit Administration
MTO	Marine Terminal Operator
NCHRP	National Cooperative Highway Research Program
NGTIS	Next Generation Traveler Information Systems
NOVA	Northern Virginia Commuter Resources
PATCO	Port Authority Transit Corporation
PATH	Port Authority of NY & NJ
PDA	Probe Data Analytics

Acronym	Expansion
RITIS	Regional Integrated Transportation Information System
RTA	Regional Transit Authority
RTTM	Real Time Traffic Management
SEPTA	Southeastern Pennsylvania Transportation Authority
SOV	Single Occupancy Vehicle
SPR	State Planning and Research (funds)
TARS	Trucking Alternate Routing System
TDM	Transportation Demand Management
TI	Traveler Information
TIS	Traveler Information System
TMC	Transportation Management Center
TOC	Traffic Operations Center
USDOT	U.S. Department of Transportation
VDOT	Virginia Department of Transportation
VMS	Variable Message Sign
VPP	Vehicle Probe Project
VRE	Virginia Railway Express
VSL	Variable Speed Limit
XML	eXtensible Markup Language

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1.0 Introduction

University of Massachusetts Lowell conducted a study entitled "Evaluation and Enhancement of MassDOT Traveler Information Programs." The objectives of this study are to develop a proposed structure through which various transportation modal information platforms could be integrated and supported by the latest traveler information technologies.

MassDOT's current traveler information program is provided through multiple outlets and platforms targeted to specific customer service groups who rely on various media for acquiring traveler information. These services are not consolidated or integrated and were developed over time in different units to support public expectations, special projects, or requests for new approaches.

In this study a gap analysis of what is not currently being provided by MassDOT and the third-party community was conducted. A set of recommendations were developed to inform how those gaps can be filled and how a comprehensive set of multimodal transportation information services might be provided to meet customer needs and demands.

The strategic goals of the project are to:

- Assess gaps in the provision of service;
- Make recommendations on how those service gaps can be met through specific program enhancements considering information integration and dissemination through a single platform;
- Identify how this integration may or may not facilitate travel mode choice changes; and
- How TI modifications (i.e., program enhancements) might augment changes in the way transportation organizations and potential business partners operate, and to provide TI from different locations and through different means to a diverse customer base.

The resultant recommendations are also to serve as a basis for the next version of real-time information programs that states are required to provide under 23 CFR 511.

This report is divided into four chapters as outlined below:

- **Chapter 2 Literature Review**. In this chapter the research team examines how and what traveler information is assembled and disseminated in a number of states. Emphasis is given to practices of states with metropolitan areas similar to the Boston metropolitan area and regional agencies that offer best practices.
- **Chapter 3 The Massachusetts Traveler Information System (TIS).** In this chapter we review the characteristics of the existing TIS operated by the HOC at MassDOT and provide statistical data on its usage.
- **Chapter 4 Gap analysis**. In this chapter, we discuss gaps or potential shortcomings in the traveler information programs offered by MassDOT.

- **Chapter 5 Recommendations**. In this chapter, we provided short-term and long-term recommendations for addressing the gaps in the traveler information programs offered by MassDOT identified in the gap analysis. The recommendations are meant "to analyze and evaluate options for traveler information organization and coverage of gaps that provide valuable information for travelers."

2.0 Literature Review

The research team examined how and what traveler information is assembled and disseminated in Massachusetts and other states. Emphasis was given to practices from states and regional counterparts containing metropolitan areas similar to the Boston metropolitan area. The review that was conducted used the following methods: (1) internet search of published reports, papers, and traveler information dissemination websites (such as 511 websites); and (2) review of traveler information procedures at Highway/Transportation Operations Centers in other states, alliances and collaborations like the I-95 Corridor Coalition, and TI from major transit agencies.

Section 2.1 provides a general discussion on Traveler Information Systems (TIS) and Next Generation TIS (NGTIS). Section 2.2 provides a detailed description of TIS in other, similar states/regions, including California (San Francisco Bay Area), Florida (state-wide and South Florida District 6), Illinois (particularly Chicago), Washington, DC Metro Area, New Jersey, New York and Pennsylvania (including SEPTA – the Southeastern Pennsylvania Transportation Authority), and the I-95 Corridor Coalition. Section 2.3 provides a summary of the Literature Review.

2.1 General Discussion on TIS and NGTIS

TIS technologies are rapidly evolving. It is important for MassDOT to understand and utilize new TIS technologies to serve the traveling public of the Commonwealth in the best possible way. This research identified some important studies on Traveler Information Systems (TIS) sponsored by federal and state transportation agencies. The findings of these studies and the relevance to MassDOT are summarized in Appendix A. Since TIS has undergone significant changes due to technological developments (particularly due to smart phones) over the past decade, only studies published after 2010 are reviewed to ensure the findings are relevant today.

It is not surprising that many of the reviewed studies share similar findings, such as the trends of travelers' information needs and their preferences for Traveler Information (TI) dissemination venues. In particular, reliable and real-time TI allows the traveling public to make informed decisions regarding route, mode, and departure time. While individuals utilizing this information will attempt to optimize their own travel, transportation agencies can leverage the power of such information to optimize the performance of the entire system. In a nationwide survey of transportation agencies conducted in 2013, it was identified that:

- The majority of the surveyed agencies provide information on non-recurrent events such as traffic incidents and roadwork and use interactive maps and CCTV video streams to show traffic conditions.
- The most popular means for traveler information dissemination are Variable Message Signs (VMS), over the internet delivery including mobile applications, social media outlets and 511 systems.
- The most important information provided includes CCTV videos, maps with speed/incident information, travel times, parking availability, weather, special events and construction work.
- Most agencies believe that their TIS is effective. An exception to this is the highway advisory radio (HAR). Although extensively used, it is considered the least effective TI dissemination technique.
- Only a few agencies provide information for alternate routes.
- Most agencies rely on usage statistics of their 511 system for assessing the effectiveness of their TIS. Such statistics reveal for the most part rather limited information about the effect that the TI disseminated has on trip behavior.
- Several agencies indicated that detailed construction lane status information and multimodal and route trip planning are the most effective additions to the TI provided. [*2*]

In the same study [***Error! Bookmark not defined.***], surveys of the traveling public in six cities indicated that the most common source of TI were television, radio and websites. In case the information received resulted in changing a trip in the last three days, the most likely TI sources were radio and mobile apps (see Figure 2-1). With respect to the type of TI that affected the trip decision, information on traffic incidents, travel times and alternative routes were most frequently reported (see Figure 2-2). It is evident that a wide array of TI dissemination methods can be deployed [***Error! Bookmark not defined.***], since not all travelers have the same needs or gather TI in the same way. Transportation agencies should support a wide range of TI dissemination mechanisms in order to reach the maximum number of travelers. Agencies do not have to be responsible for all dissemination mechanisms. Instead, they can provide such information to third-party TIS developers.

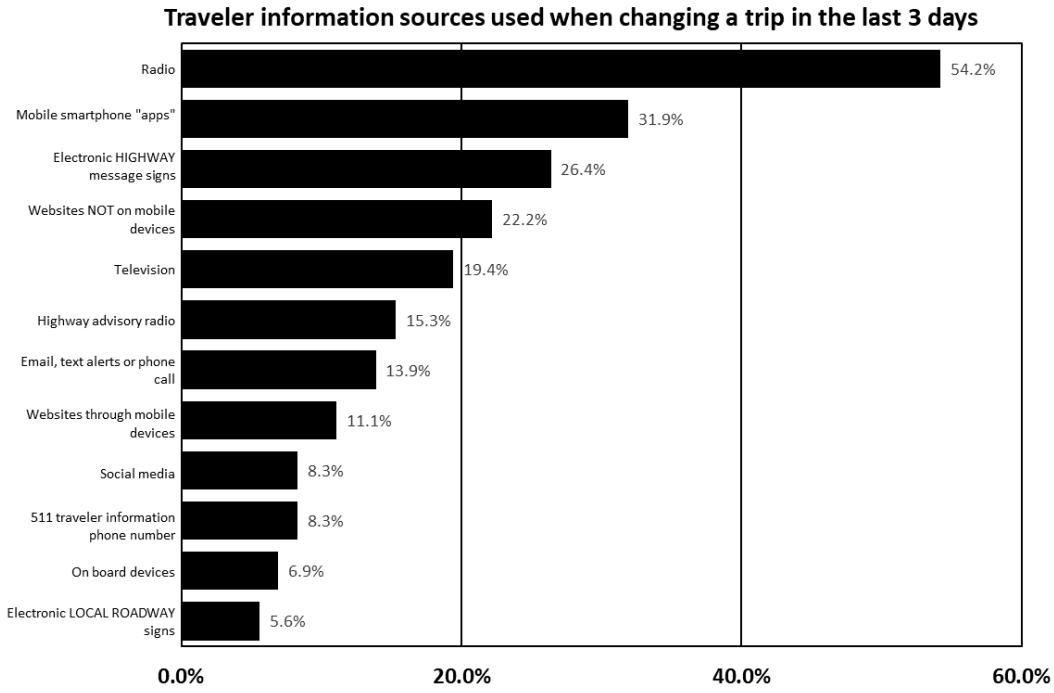

Figure 2-1: Information source used when changing a trip [Error! Bookmark not defined.**]**

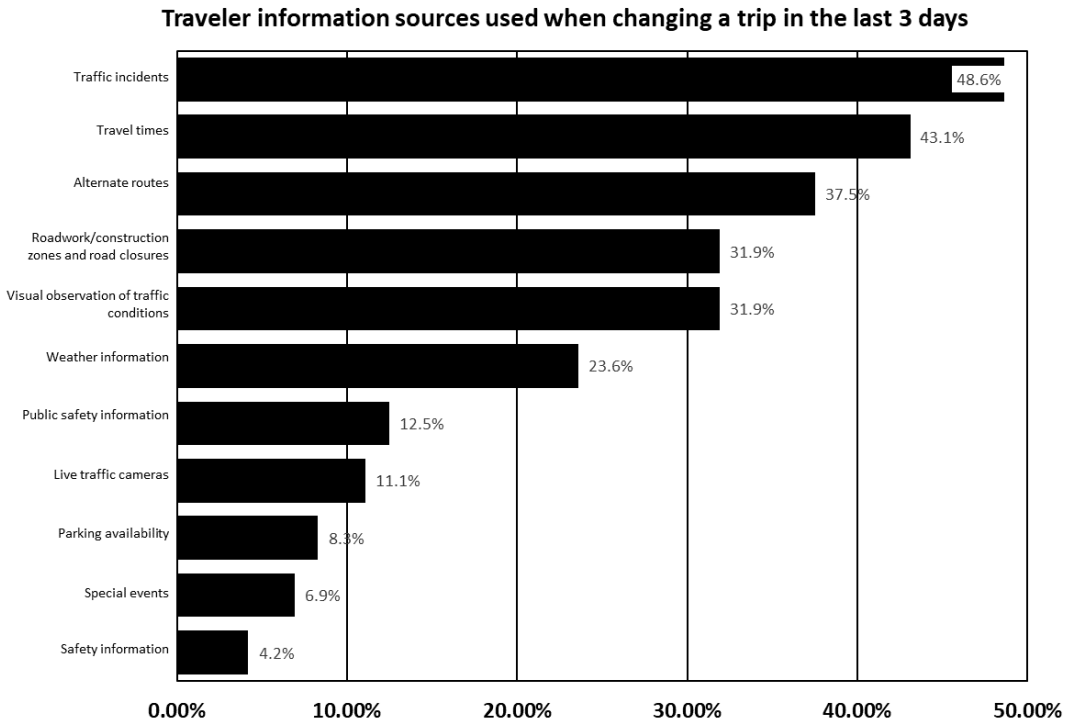

Figure 2-2: Information types used when changing a trip [Error! Bookmark not defined.**]**

Based on the surveys reported in the literature, an ideal TIS should include:

- Reliable, real-time, and accurate information
- TI tailored to the travel corridor of interest
- Detailed information such as specific lane closures, video images of traffic conditions, etc.
- Time-stamped information
- Automated alerts based on route or location of traveler
- Accessible from a variety of sources
- Alternate route and transportation information to improve decision-making
- Radio as a source of information should be included because it is accessible to almost everyone and more reliable in emergencies or places with cell signal obstructions
- Multimodal information, including transit
- Information provided at key decision points (e.g., before entering a highway)
- Dedicated apps, radio stations, and television stations
- Integrated information regardless of jurisdiction [***Error! Bookmark not defined.***]

2.2 Review of TIS in Selected States and Regions

2.2.1 California

The San Francisco Bay Area operates the 511 SF Bay system, which can serve as a model on how TIS can be comprehensively integrated, covering different modes and different types of information. Although there are other agencies in the same region that provide TI, such as the San Francisco Municipal Transportation Agency (SFMTA) website (https://www.sfmta.com/), most of the functions are provided by the 511 SF Bay system. The 511 SF Bay system (https://511.org/) has the following features:

1. The 511 website is a very comprehensive and well-integrated system. All transportation modes are integrated into one platform to provide comprehensive web-based interaction.
2. It covers different transportation modes, including driving, transit, carpooling/vanpooling, and biking. It includes detailed information such as travel time, departure time, and parking. Most information provided is in real-time.
3. The system actively promotes and supports carpooling/vanpooling.
4. Most services are available on the web and through phone text messages and email. There is no mobile version of the system.
5. The 511 system provides information dissemination on Twitter, Facebook, and Instagram.

6. The 511 SF Bay system has had extensive collaborations with the private sector. For example, the 511 website recommends applications for carpooling/vanpooling developed by private companies.

More specifically, the 511 SF Bay system provides the following major functions:

- Trip planner (similar to google map function): It provides travel time and routes. Users can choose different modes (driving, transit, walking, and biking), and choose "leave now" or "arrive by" options to plan trips. The functions provided and user-interface are similar to web-google map. It also provides a separate tab for Transit Departure, covering most transit carriers and operators, such as BART, Caltrans, and Valley Transportation Authority. Users can search based on agency or stop ID. The information provided is the planned schedule, and there is no real-time update.
- 511 Phone & Voice: The service covers the entire nine counties of the SF bay area, offering comprehensive service, including travel time (in real-time), departure time of transit, available transportation choices, and also shortcuts, such as traffic conditions on bridges, and traffic conditions at hot spots. The service is offered in multiple languages, including English, Spanish, and Chinese. It also offers Alexa voice service, which currently offers real-time transit departures and traffic conditions, and 511 plans to further expand the features.
- Alerts & News: It has sub categories, including critical alerts (like bus line closure), traffic (e.g., like incidents, constructions, and obstruction), transit (e.g., move of bus stop), and news and announcements (e.g., new transit service, and emergence). For emergency, it provides back up travel options in emergency and advises people to use 511 frequently.
- Transit: It provides transit related TI in several ways: (a) it provides static information for most (if not all) transit services on the website, such as agency routes and schedules; (b) it provides a transit tracker, with a web-based app that shares real-time departure time for customized stops; (c) it provides AllNighhter Service – the website provides a list of stations served by AllNighters and the schedules; (d) it provides guides during a transit disruption by advising people to use 511 for carpooling and providing links to commercial companies that can offer alternatives such as Zipcar, Scoot Networks, and Getaround.
- Carpool & vanpool: It provides comprehensive service, including helping users find a matching ride, operators that run carpooling/vanpooling, and promote carpooling/vanpooling. 511 SF Bay recommends three apps for carpooling: Scoop, Waze carpool, and the 511 ridematch service. Scoop and waze carpool are both operated by a third-party and available at the iPhone/android store. 511 ridematch is operated by 511 SF Bay, which offers on-demand service to help people find carpool, vanpools, or bicycle partners. 511 SF Bay also offers a variety of services for vanpooling. Specifically, it offers consultation to those who want to start a vanpool, and for those who want to join a vanpool; it provides a daily-updated list of vanpools with available seats and the 511 ridematch service. For those who want to sustain a vanpool, it offers resources like helping to recruit new passengers. Vanpools registered at 511 get free passage on toll bridges if they have 11-15 passengers.

- Driving: The TI provided includes information on express lanes (i.e., toll lanes) and parking information (through 511 parking). Users can get real-time information on the web or on the phone.
- Biking: It provides maps, road info (static), and Find a bike buddy via 511's free ridematch.
- Getting around: It provides links connecting to websites of local travel agencies (city/county/agency level) and airports. Also, under the option of "leaving the bay area", it provides links that connect to regional transit operators, and other 511 in the region and throughout the country.
- Commuters: It lists the commuter benefits program and describes the 511 service, including ride-matching, worksite events, rewards, vanpool formation and support.

2.2.2 Florida

The Florida TIS is comprised of two major systems: the Florida 511 system and the SunGuide system.

2.2.2.1 Florida 511 Traveler Information System

The Florida 511 Traveler Information System (TIS) provided by the Florida Department of Transportation is the state's official source for real-time traffic and travel information. The new Florida 511 app (https://fl511.com/app) provides door-to-door directions with travel times and alternate routes on most roadways throughout the state. Users can also get information on crashes, construction and closures on all of Florida's interstates, toll roads, and other major roadways.

A new feature of the Florida 511 system is the Drive Mode. Users can enter Drive Mode to get a quick view of local incidents and traffic speeds. They can enter their destination and receive up to three routes with travel times based on current traffic conditions. Drive Mode also provides to the driver audible alerts of incidents occurring along their route. Some important features of the Florida 511 app are:

- Drive Mode with interactive traffic map
- Up to three door-to-door routes provided per destination
- Travel times
- Real-time traffic conditions, including crashes, construction and closures
- Easily connect to the mobile website
- Traffic cameras
- Links to other travel or transportation related agencies

2.2.2.2 Florida District 6 SunGuide TMC

The FDOT District 6 SunGuide Transportation Management Center (TMC) is the regional command post that manages the ITS Program in densely-populated Miami-Dade County and Monroe County. The TMC collects real-time traffic information through a set of Intelligent

Transportation Systems (ITS) devices:

- Closed circuit television (CCTV) cameras allow traffic managers to monitor and verify traffic conditions from within the TMC.
- Roadway detectors collect traffic volume and speed data for traffic management purposes.
- Dynamic message signs (DMS) allow operations staff to post real-time traffic information to help motorists avoid delays and reduce congestion.
- Ramp metering is being used on portions of Interstate 95 in Miami-Dade County to decrease bottleneck conditions and increase throughput.

The main functions of the SunGuide® TMC operations are: (1) to publish traffic conditions to help drivers learn about upcoming delays via the DMS deployed along District Six, (2) to work with partner agencies to coordinate comprehensive message plans and keep motorists informed about travel lane blockage information, expected travel times, scheduled construction activities, safety messages and special events, and (3) to provide real-time online access to the cameras operated by the TMC.

2.2.3 Illinois

The Illinois TIS has three major components: (1) the Getting Around Illinois website (www.gettingaroundillinois.com) – an Illinois-based TIS; (2) the Travel Midwest (www.travelmidwest.com) website and app – a multi-state TIS; and (3) the Chicago Transit Authority (CTA) website (https://www.transitchicago.com/) and the Regional Transit

Table 2-1: Traveler Information Provided by the Getting Around Illinois Website

Type of Information	Additional Detail	Data Format
Construction	Construction zones, roadway closures, restriction zones	Map (line and point features)
Traffic counts	Traffic and truck volumes	Map (line)
Airports	Locations of commercial and public airports	Map (point)
Obstructions and Restrictions	Weight restrictions, etc.	Map (point)
Roadway Weather System	Weather information	Map (point)
Designated Truck Route	Truck Routes	Map (line and point)
E85 biodiesel stations	E85 Station locations	Provided by 3rd party in App, table, developer APIs formats
Rest areas	Rest areas	Map (point)
Roadway Functional Class	--	Map (line)
Emergency road closure	--	Text
Road closure due to flooding	--	Map

Authority (RTA) website (http://rtachicago.org/). The following subsections introduce each of them and summarize the highlights of the TIS in Illinois.

2.2.3.1 Getting Around Illinois

The information provided by the Getting Around Illinois website is shown in Table 2-1. Most of the information is provided in map format. Construction information is provided, but sometimes without mentioning when a project started and when it will be completed. The website does not display real-time traffic conditions such as speeds, a common feature of similar websites, but it does provide real-time weather information. It includes links to Twitter, Facebook, Instagram, and YouTube; however, it seems that traveler information is posted mostly using the Twitter account.

2.2.3.2 Travel Midwest website

The Travel Midwest website is a multi-state TIS, involving Michigan, Ohio, Iowa, Indiana, Wisconsin, and Minnesota. Compared to the Getting Around Illinois website, the Travel Midwest website provides more information including live camera streams, special events, dynamic message signs, highway and arterial constructions, travel time, color-coded congestion map, incidents, and weather conditions (see Table 2-2 below for a summary),. It also has an accompanying mobile app, which provides the following functionalities:

Table 2-2: Traveler Information Provided through the Travel Midwest Website

Type of Information	Additional Detail	Data Format
Cameras	--	Map and Table
Special events / AMBER	--	Map and Table
Dynamic Message Signs	--	Map and Table
Construction (for highways and arterials)	Location	Map and Table
Travel time and congestion (for highways and arterials)	Color-coded based on data provided by CTA bus tracker	Map and Table
Incidents	Only travelers who might be affected will be notified.	Map and Table
Weather sensors	--	Map and Table
Notices	Construction, weather, transit	Webpage
Alerts	Email, can be customized (e.g., a specific route)	Email, text message
Social media	Facebook, Instagram, twitter, YouTube	--

1. Real-time information available on the Travel Midwest website;

2. Links to notices about construction, transit, and weather information allowing users to define the area(s) of interest; and
3. Travel time and incident reports.

Third-party developers can sign up on the Travel Midwest website to periodically download travel time and congestion data, camera images, dynamic message sign legend information, lane closure and construction information, and incident data in XML format [*3*]. Theoretically, third-party developers could integrate such information into navigation applications. Both the Travel Midwest website and app include a link to transit alerts. Also, the bus location data from the Chicago Transit Authority (CTA) is used to derive arterial travel time and congestion information for the Travel Midwest website and app. Other than these integrations, the transit and highway traveler information systems remain separated.

2.2.3.3 Chicago Transit Authority and Regional Transportation Authority

The Chicago Transit Authority (CTA) website (https://www.transitchicago.com/) provides information on transit, and the Regional Transportation Authority (RTA) website (http://rtachicago.org/) provides integrated TIS around the Chicago region across several transportation modes. For trip planning, the CTA website directs users to the RTA website or to Google Maps.

The major features of the system are:

1. Accessibility and multimodal transportation options
    a. ADA accessible bus routes and train platforms
    b. Airport transit options
    c. Maps and schedules (including rail and transit operated by Regional Transit Authority)
    d. Transit Trip planner
    e. Link to bike sharing program Divvy, and park and ride information
2. Service updates
    a. System status and alerts (e.g., scheduled train and bus events, malfunction of an elevator and its location)
    b. Bus tracker (via mobile phone – real-time bus locations & real-time arrivals and email / text updates)
    c. Train tracker
3. Links to apps and data sharing interfaces
    a. Web/computer apps
    b. Phone/mobile device apps
    c. Dial-in apps
    d. Train tracker, bus tracker, and customer alerts (APIs available in XML and JSON formats for third-party usage)

Based on the APIs provided by CTA and RTA, many smartphone applications have been developed that provides passengers with bus and train arrival times, service alerts and arrival notifications. Also, some smartphone applications allow transit passengers to buy tickets on

their phones.

2.2.3.4 Future TIS for Illinois

The following items are taken from a request for information by the Illinois Department of Transportation (IDOT) titled "Travel Midwest / IDOT Advanced Traveler Information System (ATIS)". They provide interesting ideas for what a future TIS may or should look like [*4*]:

1. Provide an arterial construction tracking system (ACTS), lane closure system (LCS) and statewide construction information;
2. Integrate transit operations and performance data with Traveler Information Systems;
3. Explore and integrate private sector Traveler Information data exchange;
4. Provide ability to publish maps and other data to social media sites;
5. Integrate IDOT district ATMS and county and municipal ATMS/TMC/TOC systems; and integrate with Chicago Skyway and Illinois Tollway systems;
6. Data collection, validation, and reporting to meet new federal traveler information performance standards/requirements;
7. Integrate and support work zone safety and queue detection;
8. Connected Autonomous Vehicle (CAV) integration with Traveler Information Systems;
9. Improvements in the reliability of traffic incident detection, duration, and clearance data along with algorithms that would contain predictive modeling for such events and algorithms for travel time prediction;
10. Analysis of archived data to evaluate operation methods and resource allocation; and
11. Disseminate real-time information along selected corridors.

2.2.4 Washington, DC Metro Area

The District of Columbia is contiguous with two states: Maryland and Virginia. Thus, traffic information in the Washington, DC metropolitan area spans three jurisdictions and involves several services; the District of Columbia DOT, Maryland's Coordinated Highways Action Response Team (CHART) and the Northern Virginia Commuter Resources (NOVA) on the south.

2.2.4.1 District of Columbia Department of Transportation

The District of Columbia Department of Transportation offers traffic and road closure information on its website. It offers the following two links:

- DC Traffic Cameras – live feeds from cameras, and
- DC Traffic Advisories – a listing of work zones and lane closures.

In addition, there are additional Government Travel Information Links available for travelers in the region:

- Commuter Page: Current Traffic Conditions for the Washington DC Region (further details provided below).
- National Capital Region: News (TRANServe) – this is a dedicated site for government agency employees within the D.C. area who are entitled to a transit benefit as a subsidy. The site provides simplified access to transit authority information, electronic applications, how-to instructions and other resources that encourage use of mass transportation as the primary means of commuting from home to work.

2.2.4.2 Coordinated Highways Action Response Team (CHART)

CHART (*http://chart.maryland.gov/*) is a multi-jurisdictional program serving the entire state of Maryland. The CHART program is comprised of a number of sub-systems:

- traffic monitoring
- traveler information
- incident management
- traffic management

Traffic Monitoring (information input) is achieved though:

- Traffic speed detectors
- In-pavement loop detectors (for traffic counting)
- Closed Circuit Television (CCTV) cameras
- A cellular call-in system by which motorists can report disabled vehicles and accidents
- Reports from field units (state and local police, State Highway Administration units, commercial radio spotters)
- Pavement weather sensors (to detect freezing; provide temperature, moisture and degree of treatment)

CHART provides real-time information concerning travel conditions on the principal arterials in the primary coverage area. This traveler information program provides information on planned or non-recurring traffic disruptions, such as accidents, chemical spills, snow, ice, floods, major special events, seasonal recreational peaks, and roadway construction. CHART uses several ways to disseminate traveler information, including:

- Dynamic Message Signs (DMS), displaying real-time traffic information to motorists.
- Highway Advisory Radio (HAR) stations, low power radio stations that provide information on traffic conditions and special events.
- Commercial radio and television broadcasts - by providing accurate and timely information to commercial broadcasters, CHART reaches a wide audience of listeners and viewers.
- Travelers can also dial in to Maryland's 511 information service for the latest travel conditions

CHART also provides the key I-95 Corridor Coalition (described in Section 2.2.8 below) link in Maryland by coordinating the statewide and regional needs of travelers and Coalition agencies. This includes the coordination of incident management activities, dissemination of regional-oriented VMS and TAR messages, as well as the exchange of information with other Corridor agencies to address regional incidents along the corridor.

2.2.4.3 Northern Virginia Commuter Resources (NOVA)

The website offers information about construction zones, and traffic and weather information. The latter includes:

- Road conditions map
- Traffic cameras
- Evacuation routes
- Highway Advisory radio
- Commuting resources (Check an exit number, CommuterPage.com, Commuter Connections, HOV lanes, Virginia rideshare agencies, and Metro Trip Planner)
- Bicycling resources: information can be found at Bicycling in Northern Virginia
- Real-time traffic information through VDOT 511

Other commuter links include:

- Park & Ride Information
- E-ZPass automated toll collection
- Virginia Railway Express
- DASH- Alexandria's local bus service
- Fairfax County Department of Transportation
- Loudoun County Office of Transportation Services
- Prince William County Transportation Systems
- Washington Metropolitan Area Transportation Authority

Additional transportation options, other than driving alone, for the North Virginia/ Washington, DC area are given in the CommuterPage.com website. About forty percent of all trips in the area are made by some means other than single-occupancy vehicle (SOV) trips. Provision of this information assists in reducing the percentage of SOV trips even further, and increase the use of other transportation options, to avoid gridlock. Transportation options include:

- The Metro System –- Metrorail, Metrobus, and MetroAccess. Metro is a regional system serving the District of Columbia and jurisdictions in Virginia and Maryland and is operated by the Washington Metropolitan Area Transit Authority (WMATA).

- Local Bus Systems -- Each jurisdiction operates its own local bus system. In areas served by the Metro System, local bus routes supplement Metrobus and Metrorail service.
- Commuter Buses –- Longer bus routes designed to carry commuters from outside the beltway to and from jobs in DC and the close-in suburbs.
- Commuter Rail –- MARC and VRE rail service. MARC operates between Union Station in DC and points in Maryland. VRE operates between Union Station and points in Virginia.
- Intercity Rail & Bus -- Amtrak, Greyhound, Bolt Bus, etc. Long-haul bus service.
- Walking – An important alternative to driving.
- Bicycling & Bikesharing
- Multi-Use Trails -- Used by bicyclists and pedestrians.
- Telework -- Or telecommuting.
- Carpooling -- Carpooling, vanpooling, slugging.
- Carsharing -- Zipcar, Car2Go, Peer-to-Peer Carsharing.
- Taxicabs, Uber, Lyft -- Taxicabs and ride-hailing systems are important supplemental options.
- Paratransit & Accessible Transit -- Services for people with disabilities.

A mobile version of the CommuterPage.com site includes a suite of tools for web-enabled phones and other web-enabled mobile devices. Transit schedules are available for Northern Virginia transit systems, including Metrobus routes in Northern Virginia. The following Mobile Services Tools are available:

- D.C.-Area Transit Schedules: Schedules for area bus systems and VRE Commuter Rail.
- Point-to-Point Schedules: Combined schedules, regardless of transit system.
- ART RealTime Predictions: Real-time arrival information for the ART-Arlington Transit bus system
- Car-Free Near Me: Location-based transportation information.
- Car-Free Diet Calculator: Calculates how much you save, or could be saving, by using public transportation.

2.2.5 New Jersey

The review of the New Jersey TIS is based on information collected from the NJCommuter.com website (https://www.state.nj.us/transportation/commuter/) and the New Jersey 511 website. The NJCommuter.com website provides information for all modes of transportation including walking. The information for pedestrians is mostly safety related, such as safety tips, description of pedestrian traffic signals, etc. For public transportation, the site provides links to all transit agencies including those in neighboring states: Amtrak, MTA, NJ Transit, PATCO, PATH, and SEPTA. For motorist assistance, the state operates 125 permanent and more than 300 portable Dynamic Message Signs (DMSs) along freeways, providing up-to-date traveler information. DMS units along I-78, I-80, I-280, I-287, I-95, I-295 and on state highways Route 42 and Route 29 are used also in the Travel Time Systems

project (similar to GoTime in Massachusetts) displaying real-time travel times. Similar to many other states, the New Jersey 511 service offers both the free-phone and web service components. The website includes an interactive map on which the following information can be obtained:

- Traffic speeds (color coded)
- Weather conditions
- incidents
- congestion
- detours
- construction
- special events
- live traffic cameras

Additional information provided on the NJ 511 website includes:

- Severity alerts, a listing of major events such as weather-related events affecting traffic (salting and plowing), Public Safety and transportation related events, such as Amber Alerts or major construction projects.
- "Popular routes" travel times: a list of travel times for segments of the New Jersey Turnpike, Garden State Parkway, Atlantic City Expressway, I-80, I-78, I-287, I-295 and I-76/NJ42.
- Active construction projects
- Parking availability at airports (EWR, JFK, LGA)
- Transit trip planner
- Links to:
    - Neighboring state traveler information systems (511NY, 511PA, ConnDOT, DelDOT)
    - Public transportation services (NJ Transit, PATH, PATCO, SEPTA, AMTRAK, MTA)
    - Airports
    - Ferries

The 511 website also provides a personalized traffic alerts service to deliver customized traveler information to mobile devices or email of subscribers.

2.2.6 New York

The New York TIS is provided mainly through the New York 511 website (https://511ny.org). The 511 service is accessible through the phone and web. A personalized TransAlert subscription service provides notifications of major traffic incidents and roadwork and can be customized to give alerts by county. The 511NY website has integrated highway and transit information, but it can be used only for trip planning purposes. It uses an interactive map with several layers including specific information on transit:

- Traffic speeds on all highways, including major arterials (not only in New York City)
- Winter road conditions
- Incidents (roadway/transit)
- Construction (roadway/transit)
- Park and ride locations for carpooling and transit with static information about size of parking facility, fees and type of public transportation service available
- Closures (special events, construction, incident) indicating start and end dates for roadwork and special events or the type/severity of the incident
- Traffic cameras
- Dynamic message signs
- Weather alerts/forecasts
- Rest areas
- Truck restrictions/truck stops/truck rest areas
- Transit service for bus and rail transit showing on the map routes and stations (static)

Available on the NY511 website is a trip planner with options to drive or to use transit. The tool can be used to get the quickest trip or the trip with the fewest transfers. It provides three alternative routes to select from. Additional information available on the webpage include Alerts (weather, public safety of transportation related alerts) and News on upcoming construction projects or special events. From the 511NY page there are links to:

- Ridesharing (link to *511NY Rideshare, https://www.511nyrideshare.org/*), a website for finding carpool partners
- Eco-driving and alternative fuel locations
- Airports (general aviation and commercial aviation in NY and bordering states)
- Bicycling facilities
- Parking availability (through on-line parking search engines such as *ParkingCarma* and *BestParking* or municipal agencies)
- Toll charges
- Public transportation agencies and a transit trip planner, which includes: local buses, subway, commuter rail, intercity bus, paratransit, Amtrak, and airport transit connections

2.2.7 Pennsylvania

The review of the TIS in Pennsylvania covers the 511PA system, the Pennsylvania Turnpike website and app, and the Southeastern Pennsylvania Transportation Authority (SEPTA) website and mobile app.

2.2.7.1 511 PA System

The 511PA system provides: (1) 511PA Connect, (2) 511PA phone, (3) 511PA website, (4) 511PA mobile app, (5) 511PA social media, and (6) 511PA Developer Resources Documentation/API (live, planned, and winter events). The 511PA Connect is neither a

website nor a mobile app. It will only be activated during times of severe congestion and emergency situations. When activated, the Pennsylvania Emergency Management Agency (PEMA) will send notification messages by text, phone call, and webpage formats to all phones among subscribers in the incident area. These messages will help affected subscribers stay informed and make better decisions (e.g., rerouting). This notification system has won 5 awards, including the Institute of Transportation Engineers 2017 Transportation Achievement Award for Operations. The 511PA phone and personal alert system covers the core network (i.e., interstates, selected US and state highways), which comprise about 2,900 miles of facilities. Similar to other systems, 511PA phone system offers custom alerts. The 511PA website covers all state highways and the Pennsylvania Turnpike. The total length is about 40,000 miles. Traffic incidents and construction alerts are provided for all roadways, while traffic speeds are available for approximately 15,000 miles of roadway. The 511PA website does not cover arterials.

More specifically, the main information provided by the 511PA website includes:

1. Traffic conditions (e.g., speed)
2. Live traffic camera images
3. Highway construction updates
4. Locations of snow plows
5. Winter road conditions and alerts
6. Links to other travel resources (e.g., rest facilities, airports, park and ride facilities, ridesharing, bike, public transit)

The 511PA Mobile app mirrors the website's functionalities. In addition, it allows users to provide location data anonymously.

2.2.7.2 Pennsylvania Turnpike Website

The Pennsylvania Turnpike website provides similar information as the 511PA website, but adds additional information such as detour route and locations of dynamic message signs, service plazas, toll booths, and mile markers. The Pennsylvania Turnpike app is almost identical to the 511PA app in terms of user interface.

2.2.7.3 SEPTA Website and App

Similar to the Chicago Transit Authority (CTA), the Southeastern Pennsylvania Transportation Authority (SEPTA) website provides information such as service, schedules, fares, parking, maps and stations, system status, and connecting services. Such information is provided in static (instead of dynamic or interactive) form. SEPTA also provides a number of APIs for locations of buses and trains and encourages third-party vendors to develop apps. Providing real-time data feeds is a standard practice now for many public transit agencies.

2.2.8 The I-95 Corridor Coalition

Interstate I-95 stretches close to 2000 miles along the eastern seaboard from Maine to Florida. The I-95 Corridor Coalition is an alliance of transportation agencies, toll authorities, and related organizations, including public safety, located along I-95, from the State of Maine to the State of Florida with affiliate members in Canada. The I-95 corridor encompasses 21% of the nation's road miles and 35% of the nation's vehicle miles. It has an ADT of 72,000 vehicles, with a peak daily traffic of 300,000 vehicles. The ADT for truck traffic is over 10,000 vehicles, with a peak of 31,000 vehicles.

Coalition Member Agencies have designated primary focus areas where coordination among multiple modes and multiple jurisdictions would be beneficial for transportation systems management & operations (TSMO). The primary focus areas are: Traveler Information Services and Coordinated Incident Management.

2.2.8.1 Travel Information Services

The I-95 Corridor Coalition has developed a Travel Information Services program, providing data and tools for public agencies to assist with traffic management, infrastructure improvement planning, work zone operations, travel information dissemination, performance measures, and many other operational and planning functions. Many of these tools directly assist drivers (commercial and passenger vehicles) with route planning.

2.2.8.2 Coordinated Incident Management

A primary focus of the Coalition continues to be the efficient and safe response to highway incidents – especially those involving first responders from multiple jurisdictions. The Coalition has produced numerous training programs and studies on subjects such as significant event coordination, quick clearance, towing, evacuation, etc. The Coalition builds upon its extensive collaborations to better equip agencies and responders by sharing best practices and lessons learned.

The *Regional Integrated Transportation Information System* (RITIS) is an automated data fusion and dissemination system that provides an enhanced overall view of the transportation network. Participating agencies are able to view transportation and related emergency management information through visualizations and use the system to improve their operations and emergency preparedness. RITIS also uses regional standardized data to provide information to third parties, the media, and other traveler information resources, including web sites, paging systems, and 511. There are three main RITIS components: 1) real-time data feeds, 2) real-time situational awareness tools, and 3) archived data analysis tools (Figure 2-3: The RITIS System).

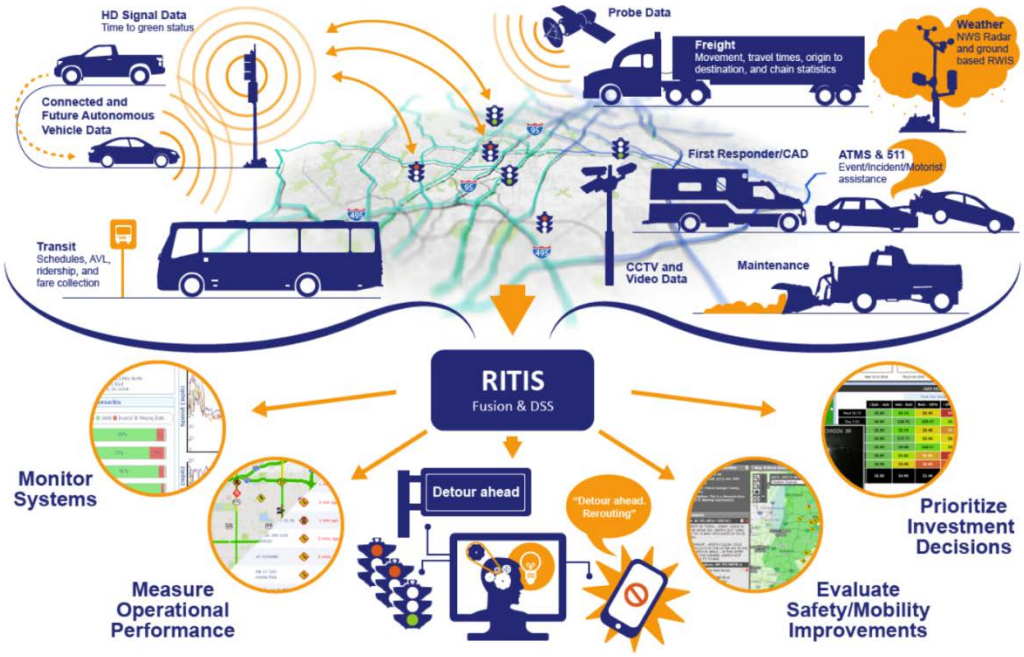

Figure 2-3: The RITIS System

2.2.8.3 Vehicle Probe Project (VPP)

The I-95 Corridor Coalition's *Vehicle Probe Project* (VPP) provides Coalition members with the ability to acquire reliable travel time and speed data without the need for sensors and other hardware. The VPP consists of a "traffic probe data marketplace," where three qualified vendors (HERE, INRIX and TomTom) were selected to provide data under a new contract. This structure gives agencies the opportunity to select the vendor that best suits their individual needs at a cost that was negotiated for the entire Corridor. All data, regardless of vendor, is available to each of the participating agencies and the data is subjected to rigorous validation for reliability.

2.2.8.4 Probe Data Analytics (PDA)

An optional component of RITIS, *Probe Data Analytics* (PDA), provide users with extensive capabilities to evaluate system performance in support of planning, operations, research and other activities. PDA uses 3rd party probe data fused with other agency transportation data to provide a true "big data" analytics platform. This data is then leveraged by nine different apps to generate actionable data summaries, maps, graphs, charts and unique visualizations for detailed analyses and reporting.

Some of the benefits of using PDA include:

- Enhanced real-time operating decision-making
- Better work zone monitoring
- Improved travel time and reliability analysis

- More robust after action reviews
- Comprehensive problem identification
- Cost-effective project program prioritization
- Improved before & after studies
- Extensive system performance reporting capabilities
- Demonstration of the economic impacts of user delay
- Compliance with MAP-21 reporting requirements

2.2.8.4.1 Traveler Information APPs Page

A single webpage has been launched on the Coalition website – as a "one-stop shop" for public agency links to traveler information pages and social media applications. The webpage includes agencies' links for traveler information on mobile operating systems, Twitter, Facebook, Pinterest, Flickr, YouTube, and RSS sites – as well as connections for e-mail and text alerts. One can see live traffic, CCTV feeds, and accident and events on the I-95 Live Traffic page. This new page allows the user to view traffic congestion and different types of incidents and events across a number of different states. One can also set up custom camera feed lists to monitor areas of interest. The user can also access a state 511/travel information website, by either clicking on the state in a map display, or on a link in a list of the corresponding state websites.

2.2.8.4.2 Intermodal Freight: Commercial Vehicle Operations Online Portal

The I-95 Corridor Coalition has developed an online portal to access information for motor carriers- Commercial Vehicle Operating, Credentialing, Registration, Taxation, and Permitting Requirements, Commercial Drivers Licensing, Traveler Information, Truck Parking and Weigh Stations, Tolling Information, and Motor Truck Associations for each of the I-95 Coalition Member States from Maine to Florida. The I-95 Corridor Coalition also launched a pilot Truck 'N Park Demonstration System. The Truck 'N Park will demonstrate an automated technology to advise en-route commercial vehicle drivers on the real-time availability of truck parking spaces at two public rest areas in Virginia and Maryland.

2.3 Summary

Based on the review of TIS of similar states and regions, it is concluded that:

- Many highway agencies provide a comprehensive platform that shares TI for multiple travel modes (e.g., driving, biking, carpooling). Although some static transit information is also integrated into highway TIS, highway and transit TIS are still largely separated.
- Several transit agencies provide Google Trip Planner on their websites. This is a promising way of integrating transit and highway real-time TI for making travel decisions.

- Providing real-time data feeds appears to be increasingly popular for both transit and highway agencies and has resulted in numerous mobile apps for disseminating TI. Some of the apps are not specifically for one state or city and can be used in other states/cities providing that relevant data feeds are available. Most of the apps developed by state DOTs do not have the navigation capability and can only be used to share TI, while apps developed by third-parties are often more user friendly. State DOTs should consider whether it is worthwhile to invest in a smartphone app that is only for a state, or if providing reliable data and data feeds to third-party app developers would result in more effective information dissemination.
- Most states only provide TI for interstate and state highways, and do not cover arterials. Some agencies utilize bus tracker data to estimate arterial traffic conditions, and others also display snow plow vehicle locations. Both ideas can be considered by MassDOT.
- Some states provide parking and biking information. However, such information in most cases is static. It would be helpful to show the number of available parking spaces, the price at each facility, and shared bikes in real time.
- Several TIS websites provide ridesharing information, in the form of external links.
- Most agencies focus on TI dissemination. Less efforts have been put on innovative data collection methods and data analytics. Most agencies do not provide predicted traffic information.
- More and more agencies are collaborating with third-party companies such as Waze for exchanging traffic data. Although there are a lack of formal studies on validating either Waze or DOT traffic data, data validation is on the radar of several DOTs.
- There is little research on assessing the performance of TI, including accuracy and reliability of different TI sources and the impacts of different TI delivery channels on user behavior.
- Some states (e.g., Illinois) have formed regional TIS collaborations to integrate TIS of different jurisdictions (e.g., cities and regions to the state's TIS).

For future traveler information systems, the trend is towards:

- Investing in traffic data analytics and provide more reliable current and predicted traffic information in real time.
- Expanding the coverage of TIS to non-interstate routes and providing alternate route, mode, and departure time information.
- Giving time-stamped information to increase users' confidence in the TIS.
- Automating the process of detecting and verifying incidents and posting alerts.
- Making TI accessible from a variety of venues, including 511 calls, radio, and television, and exploring new technologies for sharing TI.
- Integrating TI across jurisdictions and further integrating highway and transit TIS.
- Reassessing the role of DOTs in providing different kinds of TI and explore the best business models. For example, in some critical aspects, such as traffic alerts in emergency and work zone construction, the DOT may want to be *the major information provider* to assure information accuracy and reliability; while in the less critical aspects such as travel time prediction, DOT can collaborate with the private sector and *work as a promoter* for good quality service offered by the private sector.

- Taking the impacts of Connected Autonomous Vehicle (CAV) into account when enhancing TIS.
- Archiving and analyzing traffic data for evaluating traffic operation strategies and validating traffic data predictive models.

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3.0 The Massachusetts TIS

This chapter focuses on the traveler information system in Massachusetts supported by the Highway Operation Center (HOC) of MassDOT. First the overall structure of the MA TIS is discussed in Section 3.1. After that, the team conducted quantitative analysis on the usage of the main components of the TIS, which is presented in Section 3.2.

3.1 Introduction of TIS in Massachusetts

The MassDOT TIS is supported by the department's HOC and consists of the following main components:

- ***GoTime*** is a Real-Time Traffic Management (RTTM) system that consists of 146 Hybrid Variable Message Signs (VMS) and 291 Bluetooth Readers throughout the state along all interstate freeways and along several major routes. The system uses MAC addresses detected by the Bluetooth Readers to calculate average travel times which are posted on the VMSs. The system also has a mobile application that allow users to select and view the current display on the VMSs, see Figure 3-1). Travelers can identify congested corridors and make appropriate changes to their travel and can save routes allowing for future quick access to information.

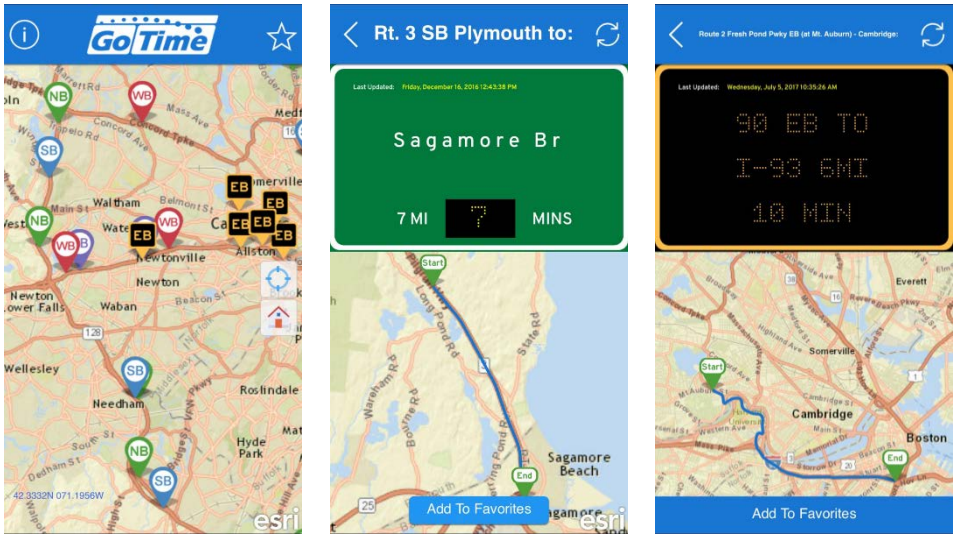


Figure 3-1: Example screens of the GoTime Mobile application

- The ***Mass511*** provides traveler information either over the phone or through its website.
    - The 511 phone service provides current and predictive information for interstate freeways and major routes on speed, traffic conditions and location of congestion or incidents, and travel times on a segment by segment basis.

Route preferences are saved for future use and users can be transferred to the 511 service for any of the neighboring states.
    - The Mass511.com website includes an interactive map with speed information for interstate freeways and major routes, live CCTV video stream, information on incidents, roadwork, closures, weather alerts and weather forecasts. Users can register to receive personalized information and alerts on selected routes. Alerts can be received on mobile devices. Speed information is displayed for freeways in Connecticut and Rhode Island as well, but is not currently available in other neighboring states: Maine, New Hampshire, New York and Vermont. Drive testing showed accuracy of 85% or higher.
- The ***MassDOT Traffic webpage*** (https://www.mass.gov/info-details/massachusetts-traffic-map) uses an interactive map to allow users to access real time traffic conditions and speed, traffic cameras, roadwork, and incident information on freeways and several major routes. Users can sign up for personalized alerts and traffic advisories for the Boston metropolitan area. Traffic cameras in New Hampshire can also be accessed through the map. A link to Park and Ride information is available, where a map of the location of Park and Ride facilities can be found imbedded on the website.
- ***Variable Message Signs***: over 400 permanent and portable VMSs are installed throughout the state that are used to keep drivers updated about traffic incidents, special events, or weather-related advisories.

The HOC via XML feeds disseminates information about planned construction, special events, weather and incident related traffic advisories to media outlets, social media, and third-party developers.

In addition to the in-house components, MassDOT has been building partnerships with the private sector. The purpose for such collaborations include:

- MassDOT shares camera feeds, data for travel times, construction events, and incidents on the MassDOT Developer Page for free.
- Crowdsourcing applications (e.g., Waze) are using the xml feeds and traffic advisories to enhance their service.
- MassDOT uses crowdsourcing applications and other social media to disseminate information including reports of incidents and hazards to support incident verification, response, and recovery.

All three TI components described above are for highway operations only and there is very limited integration of TI across modes. Travel information for other modes is available but the TI systems are mostly separate. Specifically, TI for transit is managed by the corresponding transit agency, such as the MBTA (websites and mobile applications are available); and for air travel information, it is provided through the MassPort website (https://www.massport.com/). The MassDOT Traffic webpage provides links to Park-and-Ride locations and *Ride Match*, which help to encourage less single-occupancy vehicle trips. It also provides links to Tandem Trailer Lots and GusBuddy, which helps trucking freight.

3.2 Utilization of MassDOT TIS

The MassDOT Highway Operations Center (HOC) is currently supporting the Mass511 service, including both phone service and information posted on the Mass511 website and the MassDOT Traffic Map webpage within the MassDOT website.

In this section, the utilization of the different components of the MassDOT TIS is discussed. The data obtained for the MassDOT Traffic Map webpage were for the period between January 1, 2018 and September 30, 2018. For the Mass511 service, utilization data were available for the period July 2016 to December 2018 for both the website and the phone service.

For the two web components of the MassDOT TIS, the MassDOT Traffic Map webpage and the Mass511 website, largely the information presented is similar, but there has been some hesitation to integrate them due to continuing usage of both. The metrics used for analyzing the utilization of these services are from Google Analytics, including Pageviews, Unique Pageviews, Sessions and Users.

According to Google Analytics support:

- *Pageviews* are triggered when a webpage is requested by the browser, including repeated views of the same page. If a user reloads or returns to the webpage after visiting a different page these actions are counted as additional pageviews
- *Unique pageviews* aggregate pageviews that are generated by the same user during the same session.
- A *session* is a group of interactions a user takes within 30 minutes; if a user leaves the site but returns within 30 minutes, this is counted as part of the original session. The initial session by a user during any given date range is considered to be an additional *session* and an additional *user*. Any future sessions from the same user during the selected time period are counted as additional *sessions*, but not as additional *users* [5].

3.2.1 The MassDOT-Traffic Webpage

Generally, the MassDOT Traffic Map webpage has lower usage than the Mass511 website. This could be due to a number of reasons, including: better recognition of the 511 system which is available in most states and the fact that more information is included in the Mass511 webpage. Nevertheless, the webpage does have a significant number of users. Since April 6, 2018, the website was migrated to a new server and since then there has been page views of roughly 2,000 per month.

As shown by Figure 3-2 and Figure 3-3 the monthly peak-day pageviews are significantly higher than the average, ranging between 1599 to 3877 or 1203 to 3018 for unique pageviews. Pageviews are not equivalent to individual user traffic. The same user can be counted several times if he or she refreshes the page or revisits the same page more than once. However, pageviews are representative of maximum demand that is being placed on a

server. Unique Page Views is a metric that tracks the quantity of individual users during a session independent of page refreshes or returns to that page.

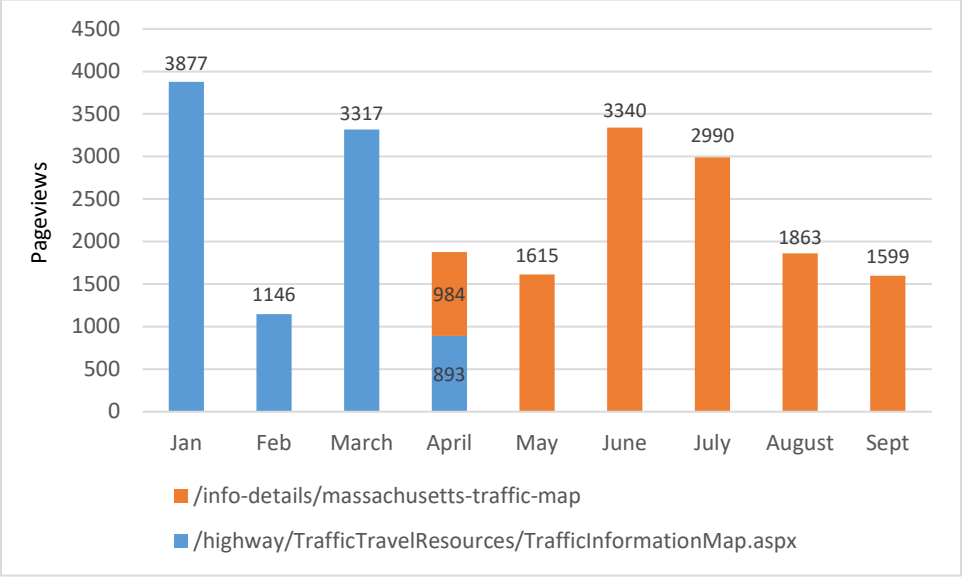


Figure 3-2: MassDOT Traffic Map webpage, Monthly Peak-Day Pageviews

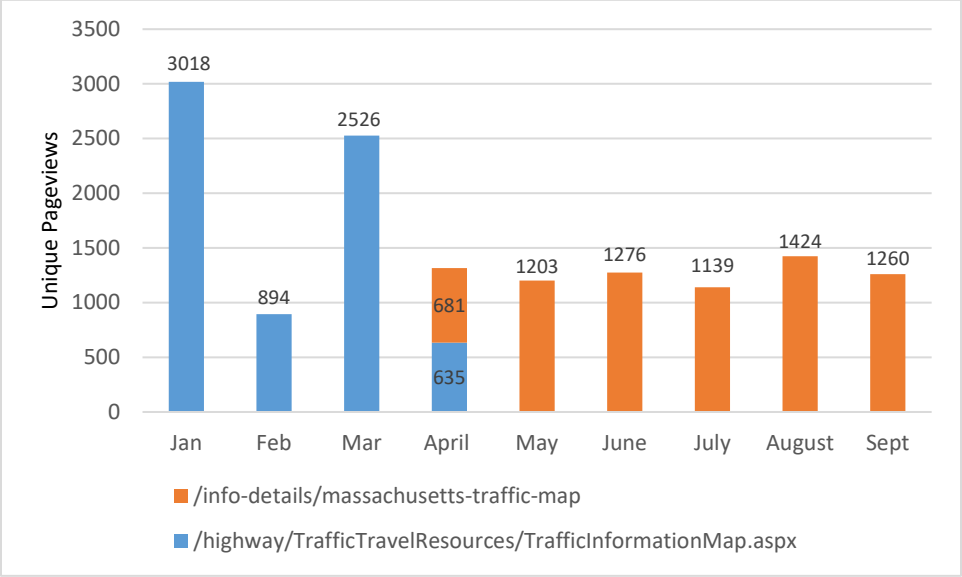
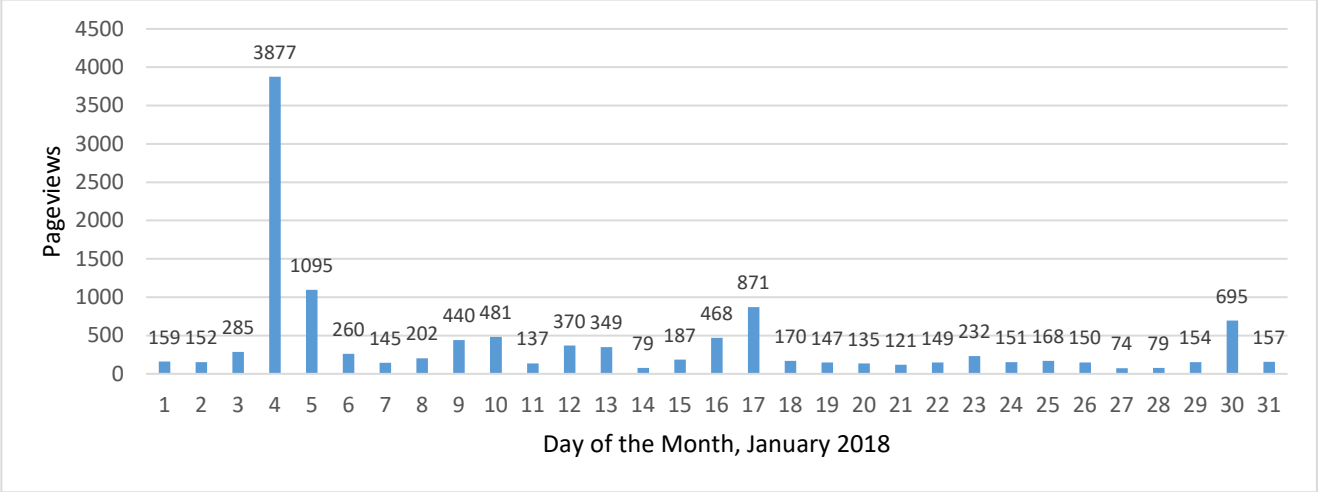


Figure 3-3: MassDOT Traffic Map webpage, Monthly Peak-Day Unique Pageviews

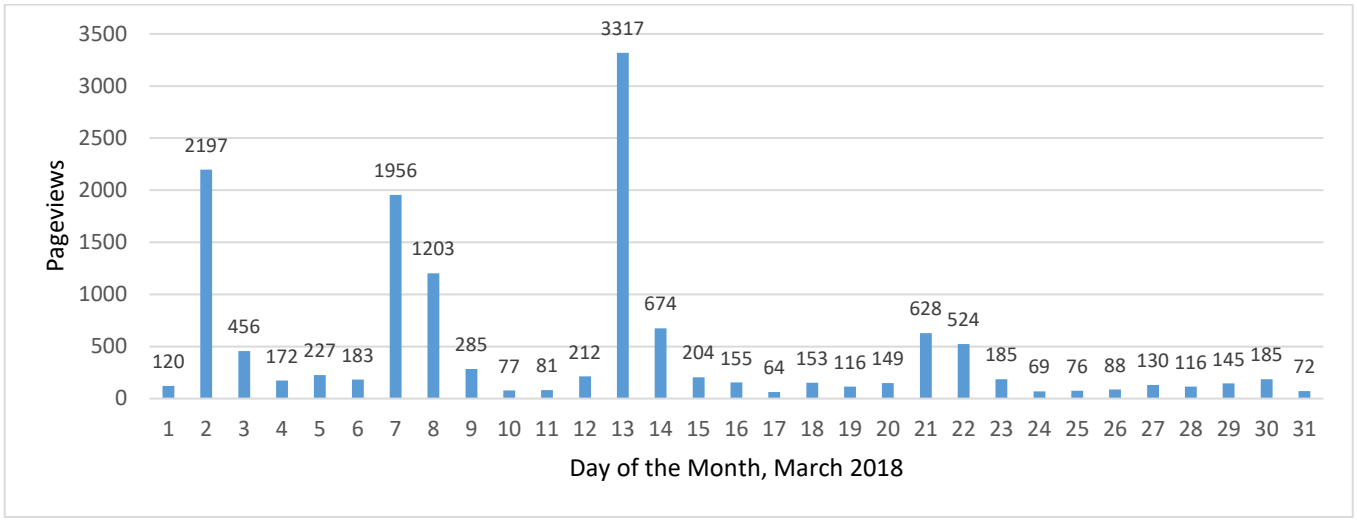
Many travelers using the website are looking for current traffic conditions and are less likely to be commuters, and more commonly seasonal travelers who seek TI in the case of special events, winter storms, before or during holidays, etc. During a regular day, people are far less likely to seek out the trip planning tools available. This is clearly illustrated in Figure 3-4 and Figure 3-5, showing the daily number of pageviews during the months of January 2018 and March 2018. All the peaks during these two months were due to predicted snowstorms

announced in the media.



- Between January 4th and January 5th an average of 9.20 inches of snow across Massachusetts with a max of 16.8 inches
- On January 17th an average of 2 inches of snow fell across Massachusetts with max of 7 inches.
- January 30th average snow fall was 1.5 inches, with max of 8 inches.

Figure 3-4: MassDOT Traffic Map webpage, Daily Pageviews for January 2018.

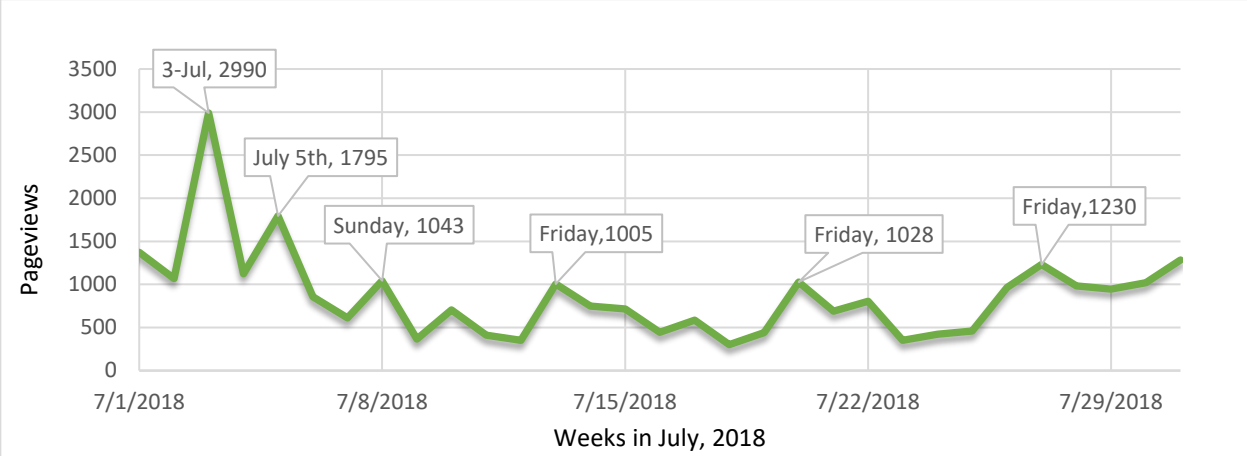


- March 2nd an average of .5 inches of snow fell across Massachusetts with max of 7.8 inches
- March 7th and 8th saw 0.28 and 6.96 inches respectively with max snow falls of 11.2 and 22.5 inches
- March 13th had a large winter storm with 23 inches max snow fall.
- March 21st and 22nd saw max of 0.2 and 3.8 respectively, but news reports called for more.

Figure 3-5: MassDOT Traffic website, Daily Pageviews for March 2018

Similarly, in July there was a peak in demand around the July 4th holiday (Figure 3-6). In

addition, during the summer months a pattern of increased demand was observed on most Fridays, a phenomenon most likely explained by drivers seeking information for weekend travel.



- July 4th holiday high demand levels started in late June and kept demand relatively high through July 5th
- Regular relative peaks every weekend starting in July and maintained throughout August

Figure 3-6: MassDOT Traffic website, Daily Pageviews for July 2018.

3.2.2 The Mass511 Website

The traffic on the Mass511 website was analyzed for the same period that data were available for the MassDOT Traffic Map webpage. The Mass511 website experiences higher traffic than the MassDOT Traffic webpage. The average number of daily pageviews and unique pageviews during this period is 4,170 and 1,155 respectively. Figure 3-7 and Figure 3-8 show the monthly peak-day pageviews and unique pageviews. A similar pattern of significantly higher webpage viewing traffic during specific days emerges from the Mass511 data as well. A noticeable difference however between the two sites is that while in the MassDOT Traffic website unique pageviews were about 80% of the number of pageviews, in the Mass511 site they are about 20%. This may be due to the Mass511 website including several pages which users visit.

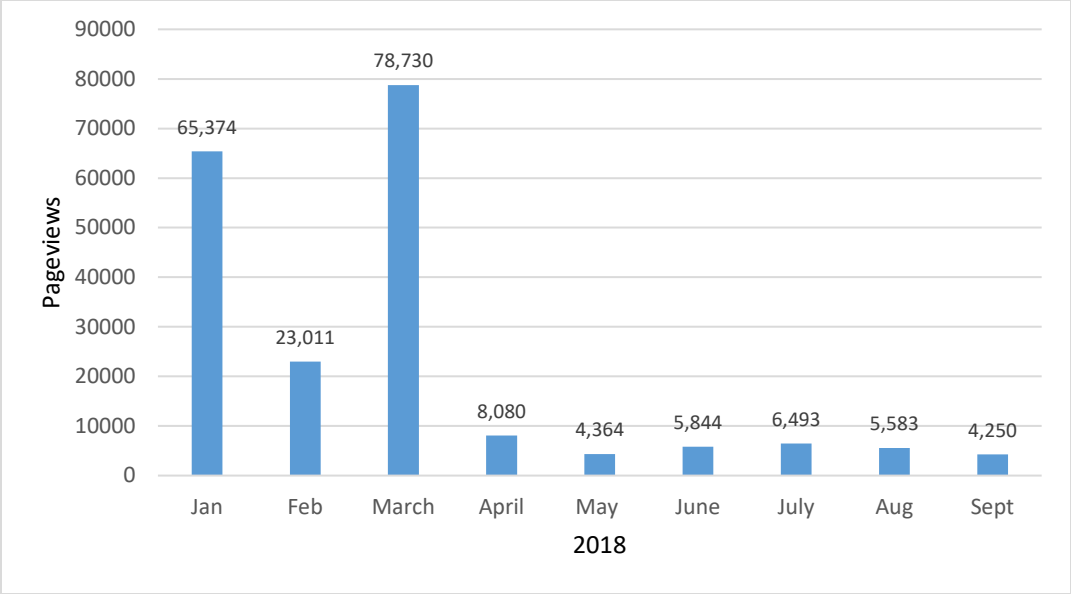


Figure 3-7: Mass511 website, Monthly Peak-Day Pageviews in 2018

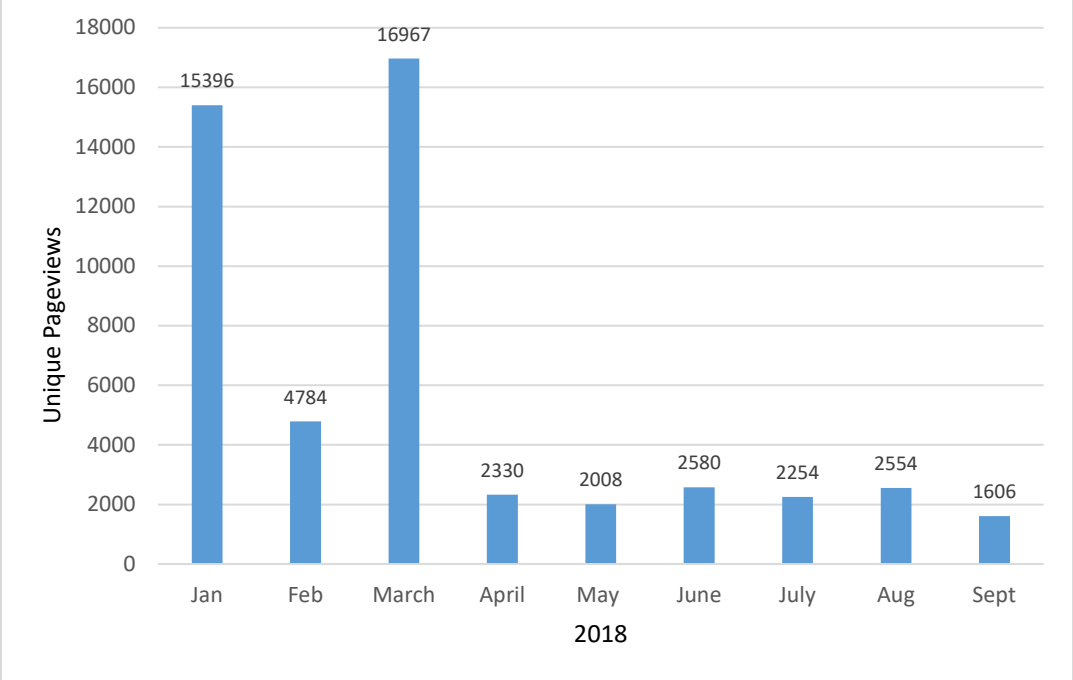
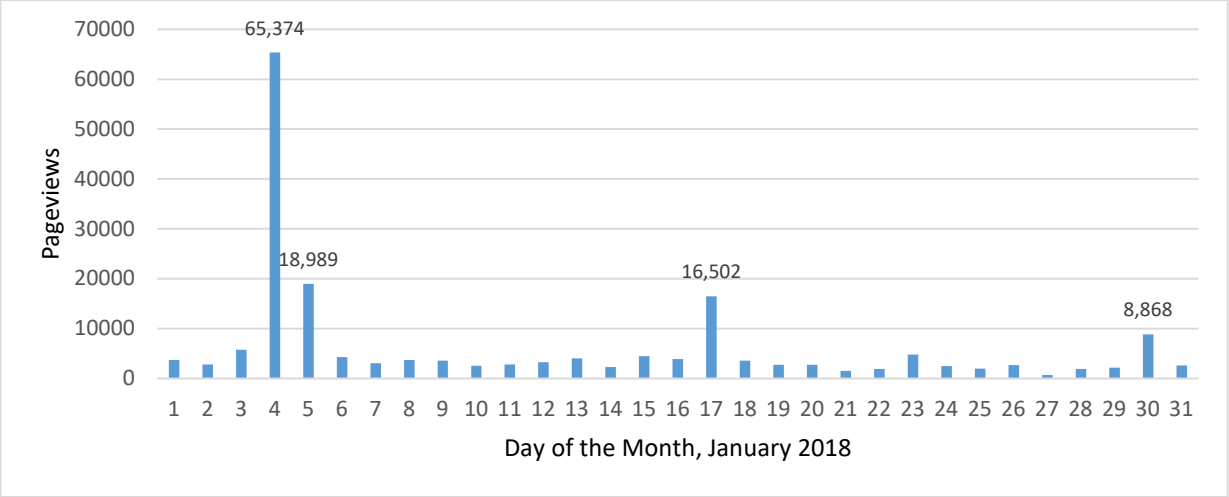


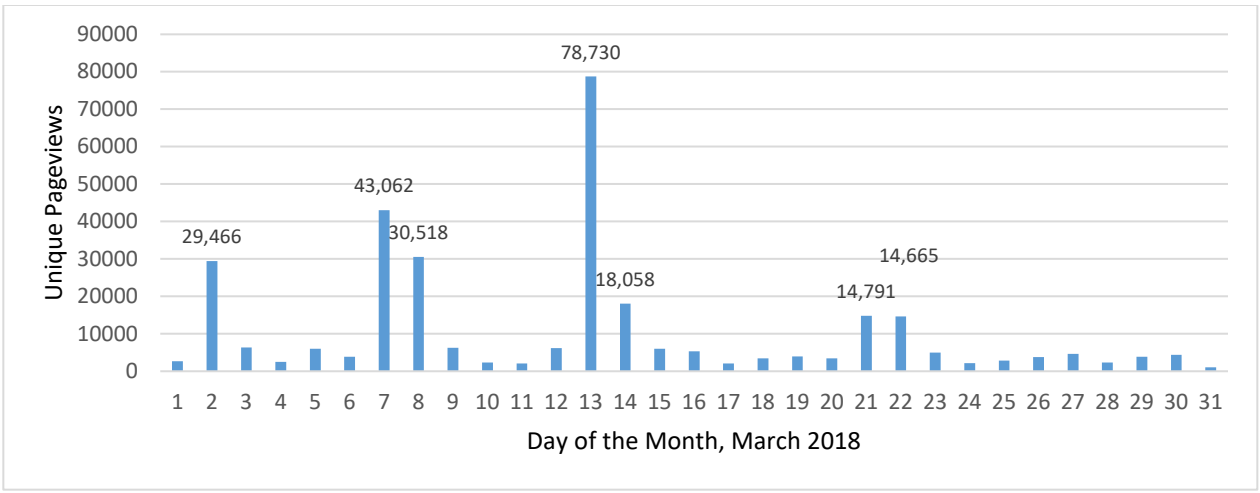
Figure 3-8 Mass511 website, Monthly Peak-Day Unique Pageviews in 2018

The same pattern of highly peaked demand during snowstorms or other special events identified in the MassDOT Traffic website is present in the Mass511 website as well, on exactly the same dates. For the months of January and March (Figure 3-9 and Figure 3-10) demand peaked during snowstorms.



- Between January 4th and January 5th an average of 9.20 inches of snow across Massachusetts with a max of 16.8 inches
- On January 17th an average of 2 inches of snow fell across Massachusetts with max of 7 inches.
- January 30th average snow fall was 1.5 inches, with max of 8 inches.

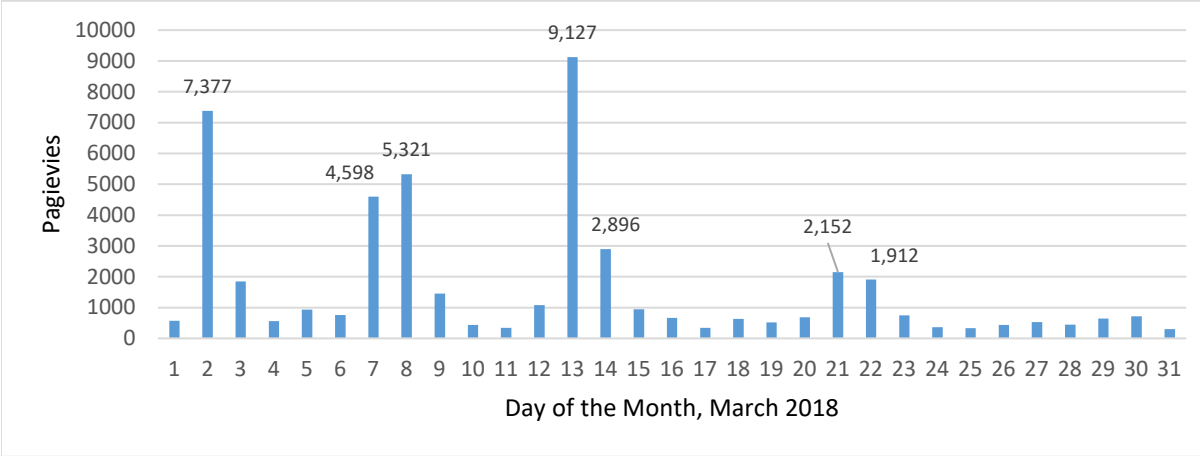
Figure 3-9: Mass511 website, Daily Pageviews for January 2018



- March 2nd an average of .5 inches of snow fell across Massachusetts with max of 7.8 inches
- March 7th and 8th saw 0.28 and 6.96 inches respectively with max snow falls of 11.2 and 22.5 inches
- March 13th had a large winter storm with 23 inches max snow fall.
- March 21st and 22nd saw max of 0.2 and 3.8 respectively, but news reports called for more.

Figure 3-10: Mass511 website, Daily Pageviews for March 2018

As mentioned before the daily pageviews statistic is not the number of users of the service. For example, the number of daily users of the site for March 2018 is shown in Figure 3-11. The pattern is very similar to the one exhibited for daily pageviews but the numbers are significantly smaller.
Table 3-1 shows the four metrics tracked by Google Analytics for the same period.



- March 2nd an average of .5 inches of snow fell across Massachusetts with max of 7.8 inches
- March 7th and 8th saw 0.28 and 6.96 inches respectively with max snow falls of 11.2 and 22.5 inches
- March 13th had a large winter storm with 23 inches max snow fall.
- March 21st and 22nd saw max of 0.2 and 3.8 respectively, but news reports called for more.

Figure 3-11: Mass511 website, Daily Pageviews for July 2018

Table 3-1: Mass511 website Pageviews, Unique Pageviews, Sessions and Users for March 2018.

Metric	Total number counted
Pageviews	321,891
Unique Pageviews	77,828
Sessions	60,638
Users	49,650

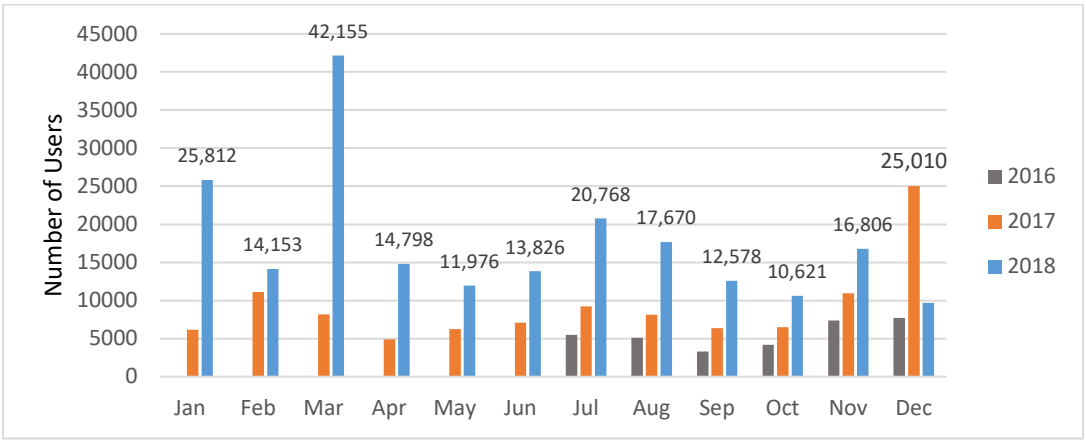


Figure 3-12: Mass511 website, Number of Monthly Users for July 2016 to December 2018.

Considering the number of monthly users for the entire period over which data was available for the Mass511 website there is an increase in the number of users from year to year. Anomalies to this trend, i.e. large number of users during December 2017, January and March 2018 are due to snowstorm events during these months.

For the summer months, while there is high demand around the July 4th holiday, there are a number of additional peaks (Figure 3-13). There are regular peaks of demand every weekend starting in July through August, but there also appears to be a significant surge in demand on the site on Tuesdays as well.

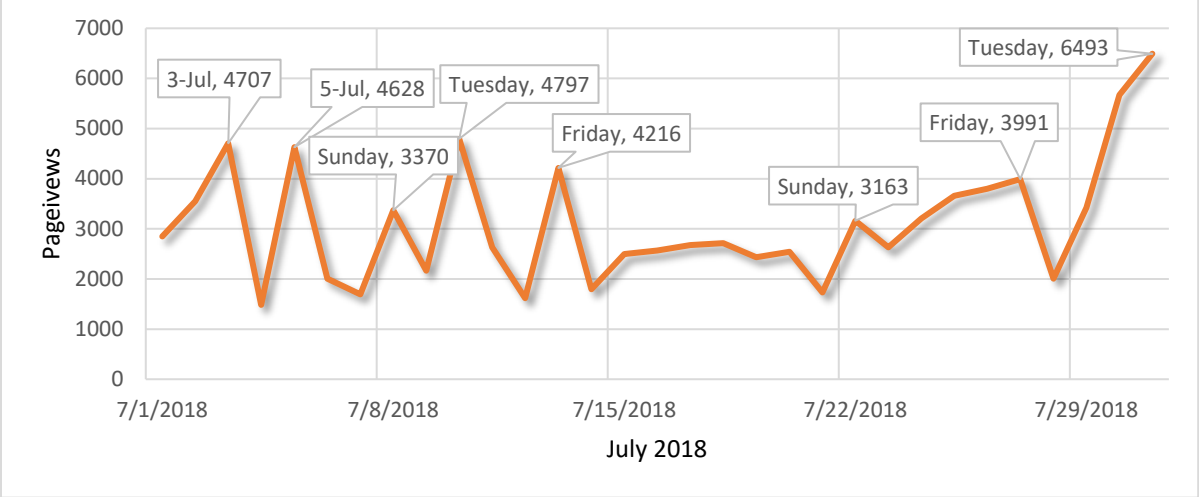


Figure 3-13: Mass511 website, Daily Pageviews for July 2018

Based on the user's location the majority of the users of the Mass511 website are local drivers. However, there is also a significant demand from the New York City area. For the months of January and March this corresponded to 45% and 57% of local drivers and 20% and 33% for drivers from the New York area. This pattern is consistent throughout the analysis period (Figure 3-14 and Figure 3-15). A significant portion of the users can be considered to be inconsistent users of the state network.

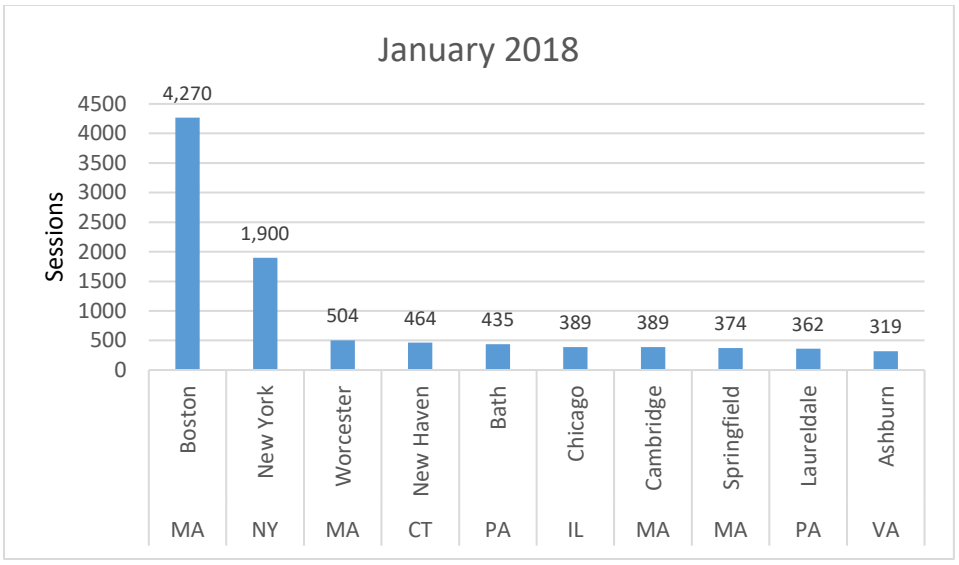


Figure 3-14: Mass511 website, Number of Sessions by User Location for January 2018

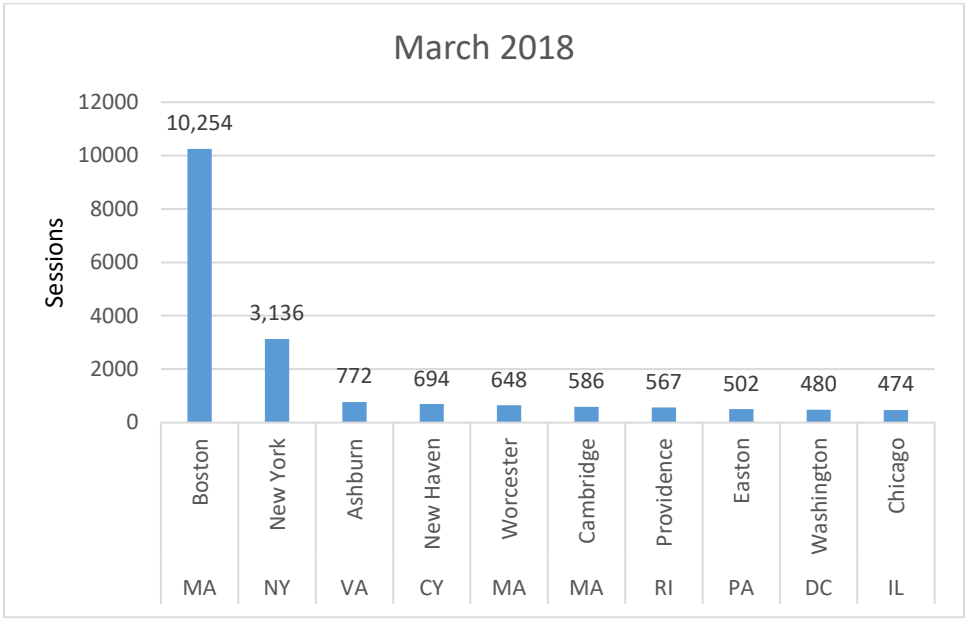


Figure 3-15: Mass511 website, Number of Sessions by User Location for March 2018

Finally, considering the device through which users access the Mass511 site, about 40% of the users access it through a desktop, i.e., to obtain pre-trip information, while 60% access it though tablets or mobile devices, most likely en-route. This is illustrated in Figure 3-16, for the entire period of analysis, although this pattern is consistent temporally through the data with seasonal variations during the year, as well.

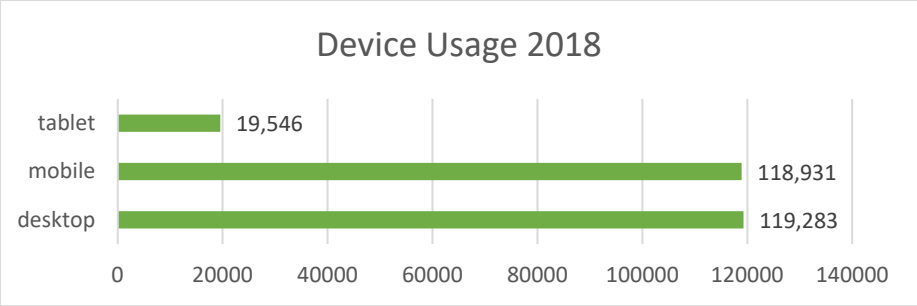


Figure 3-16: Mass511 website, Devices used per session for Jan.-Sept. 2018

3.2.3 The Mass511 Phone Service

The Mass511 phone service is an Interactive Voice Response (IVR) system that provides an important service to travelers in the Commonwealth that do not have access to the internet or to smartphone devices for en-route information. The data obtained are for the period from July 2016 to October 2018. The total number of incoming calls per month is shown in Figure 3-17. It seems that between July 2016 and November 2017 there is a drop in demand of as much as 50%. This pattern of reduced demand persists also between 2017 and 2018 although at a much lower rate. This could be for a number of reasons, e.g. increased desire to use the internet and smartphone devices to obtain information, or simply because when the service was introduced "customers" had to call more than once to receive the information they needed.

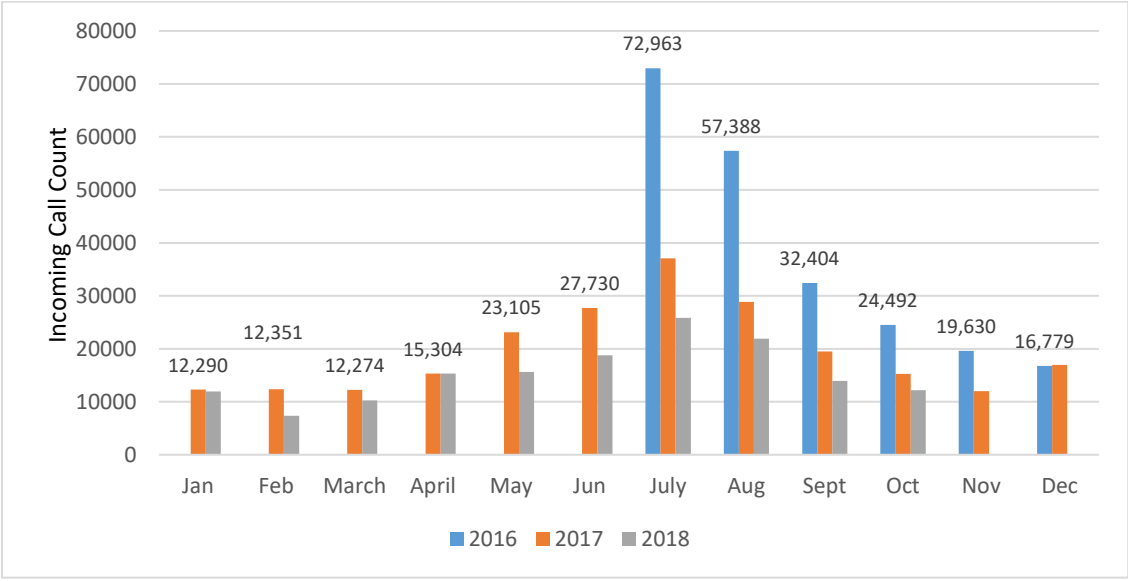


Figure 3-17: Monthly Call Volume

This is also illustrated in Figure 3-18, in the drop of average monthly new and repeat callers.

From 2016 to 2017 there is a significant drop of new callers, but repeat callers remain steady for the entire period.

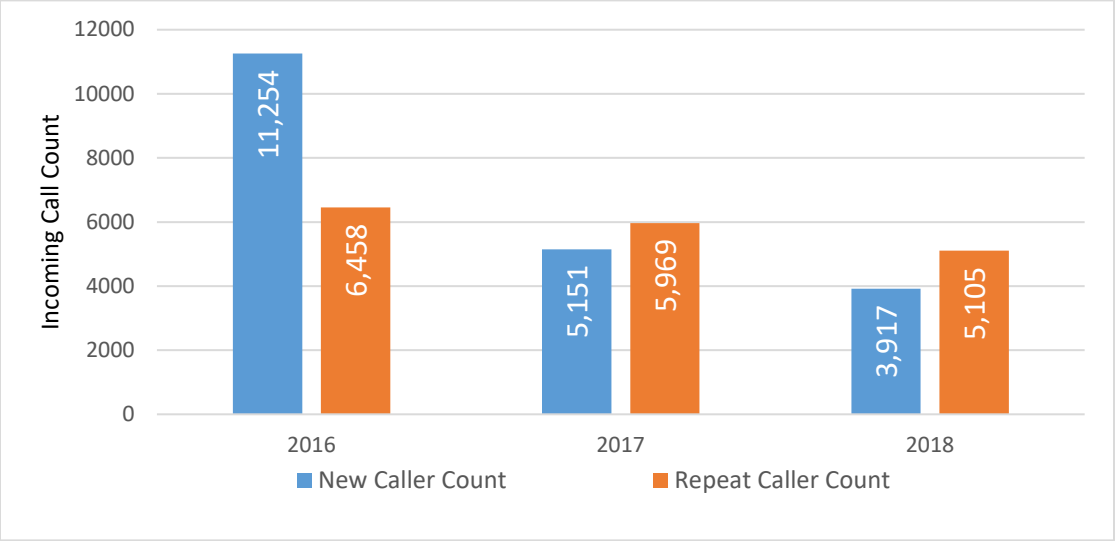


Figure 3-18: Mass511 IVR Service, Monthly New and Repeat Caller Counts

The daily volume of incoming calls for the same period that data for the MassDOT Traffic and the Mass511 websites were considered is shown in Figure 3-19.

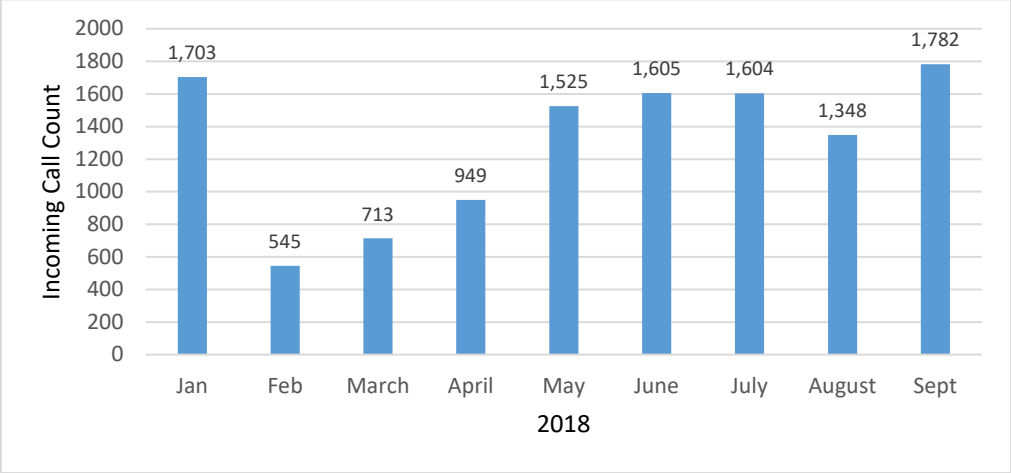
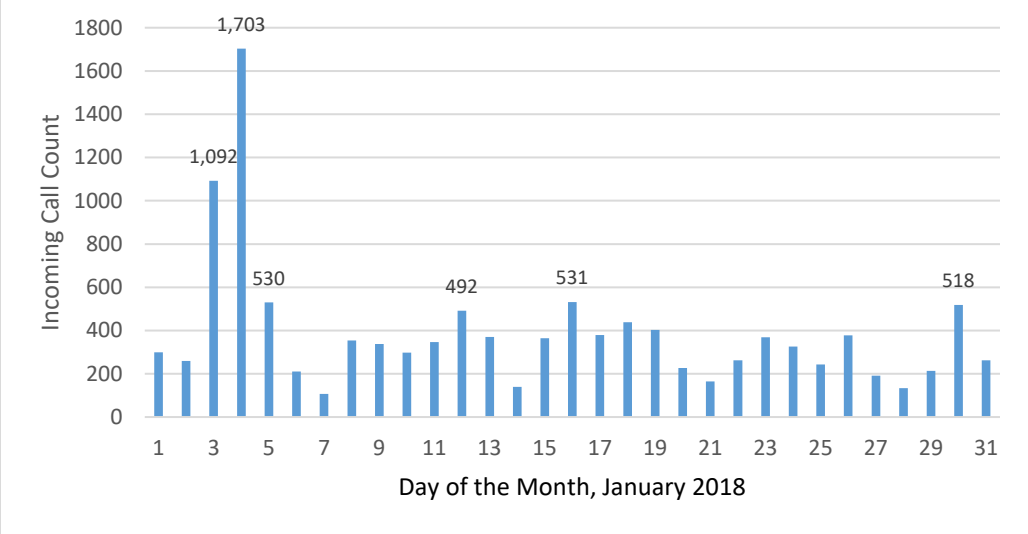


Figure 3-19: Mass511 IVR Service, Monthly Peak-Day Call Volume in 2018

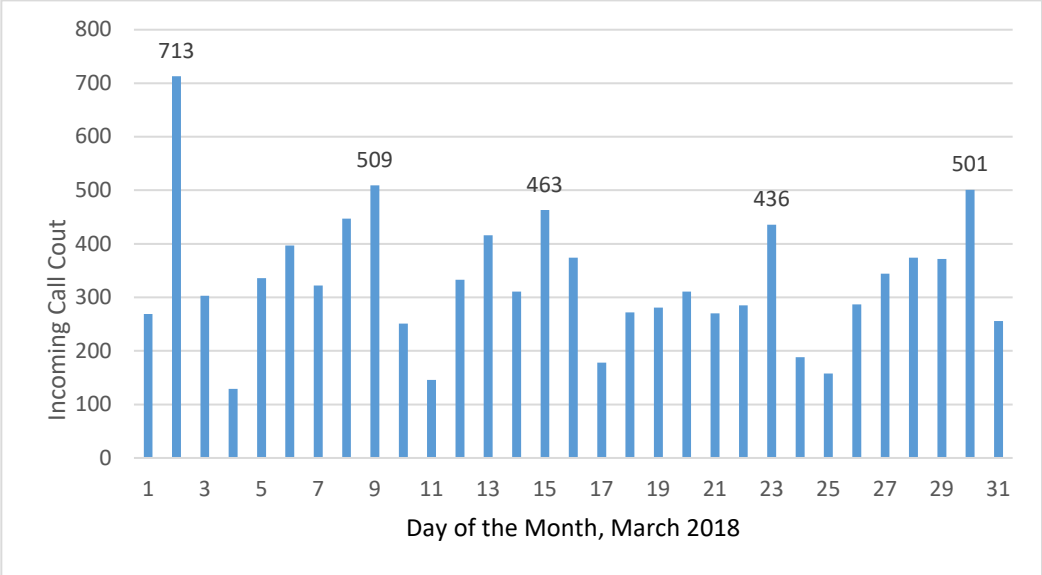
Similar to the website usage, the number of calls received is not uniformly distributed; events such as snowstorms or construction projects result in significantly higher demand for the service. This is illustrated clearly in Figure 3-20 and Figure 3-21 that show the daily number of calls during the months of January and March. During the month of January, there is clear alignment of peak demand days during snowstorms. For March this is not as obvious except for the peak demand day, March 2nd. This is an indication that the users of the phone service

are quite different than the users of the Mass511 website; many of these users are not commuters and during adverse weather they are more likely to consider alternative arrangements.



- Between January 4th and 5th an average of 9.20 inches of snow across Massachusetts with a max of 16.8 inches
- On January 17th an average of 2 inches of snow fell across Massachusetts with max of 7 inches.
- January 30th average snow fall was 1.5 inches, with max of 8 inches.

Figure 3-20: Mass511 IVR Service, Daily Call Volume for January 2018



- March 2nd an average of .5 inches of snow fell across Massachusetts with max of 7.8 inches
- March 7th and 8th saw 0.28 and 6.96 inches respectively with max snow falls of 11.2 and 22.5 inches
- March 13th had a large winter storm with 23 inches of max snow fall
- March 21st and 22nd saw max of 0.2 and 3.8 respectively, but news reports called for more.

Figure 3-21: Mass511 IVR Service, Daily Call Volume for March 2018

Finally, the routes for which users of the Interactive Voice Response (IVR) phone service during 2017 and 2018 (January to October) is shown in Figure 3-22 and Figure 3-23. For both years, the majority of request are for Massachusetts Route 6 (Cape Cod), I-90 (Massachusetts Turnpike) and I-495. During 2017, 16.5% of the total number of requests were made for TI on I-90, 15.5% for Massachusetts Route 6, and 14.5% for I-495. During 2018, for the period from January to October a similar pattern emerges with some increase in requests for Massachusetts Route 6: 16.8% of requests were for I-90, 18.8% for Massachusetts Route 6, and 14.3% for I-495.

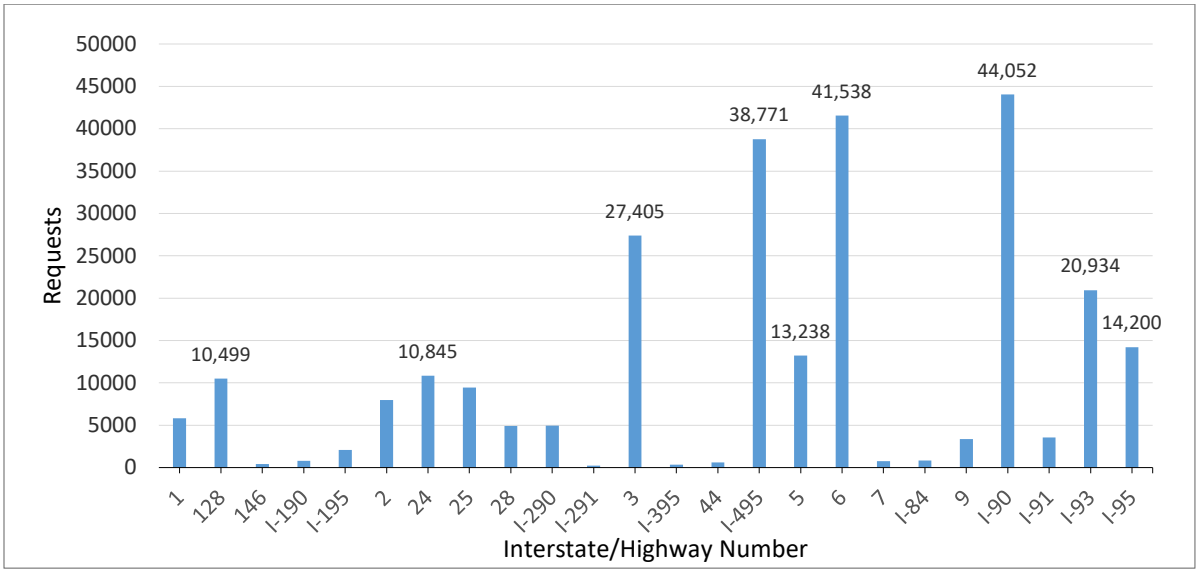


Figure 3-22: Mass511 IVR Service, Route Requests for 2017

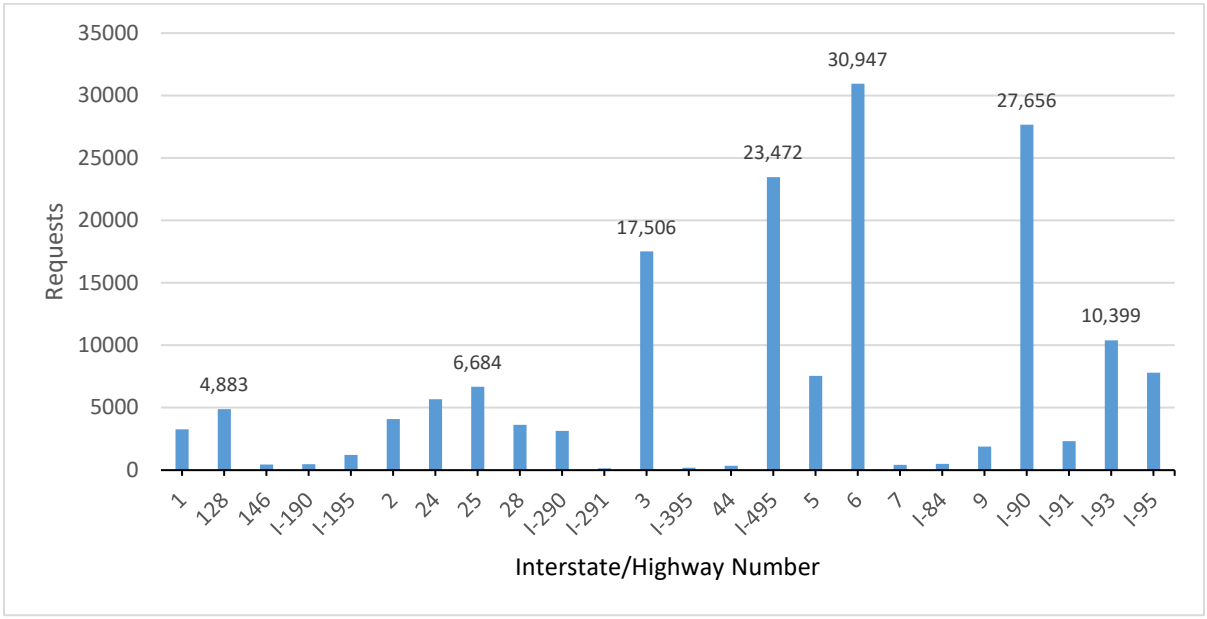


Figure 3-23: Mass511 IVR Service, Route Requests for January 2018 to October 2018

The monthly distribution of these requests for 2017 and 2018 is shown in Figure 3-24 and Figure 3-25 respectively. For Massachusetts Route 6 the demand peaks during the summer months, an indication that many of the requests are from vacationers. For I-90 and I-495 there is significant demand throughout the year, an indication that many of these requests are from commuters and commercial vehicle operators, since both these freeways carry a significant amount of truck traffic. A similar pattern of a more uniform monthly distribution exists also for highways with fewer requests, such as I-93 and I-95.

For most routes, the peak demand for the IVR service is during the summer months of July and August. From the total number of requests made for I-90 during 2017 (44,052 requests) 26.2% were made in this period. For the same year, for Massachusetts Route 6 out of the 41,538 request, 51.4% made during these months. In 2018 (January to October) 31.8% and 41.6% of the requests made for I-90 and Massachusetts Route 6 were during July and August. A notable discrepancy in this pattern is the peaked demand for TI on Massachusetts Route 6 in April 2018, during the Sagamore Bridge construction project.

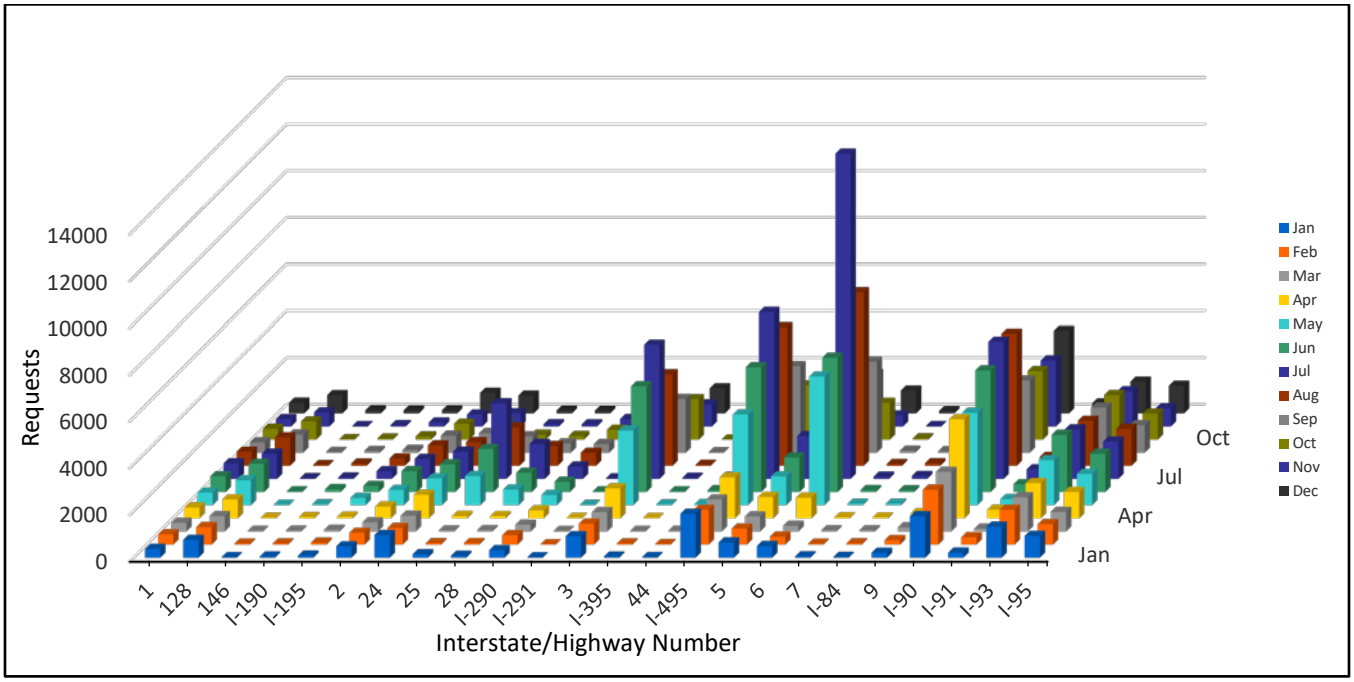


Figure 3-24: Mass511 IVR Service, Monthly Distribution of Route Requests for 2017

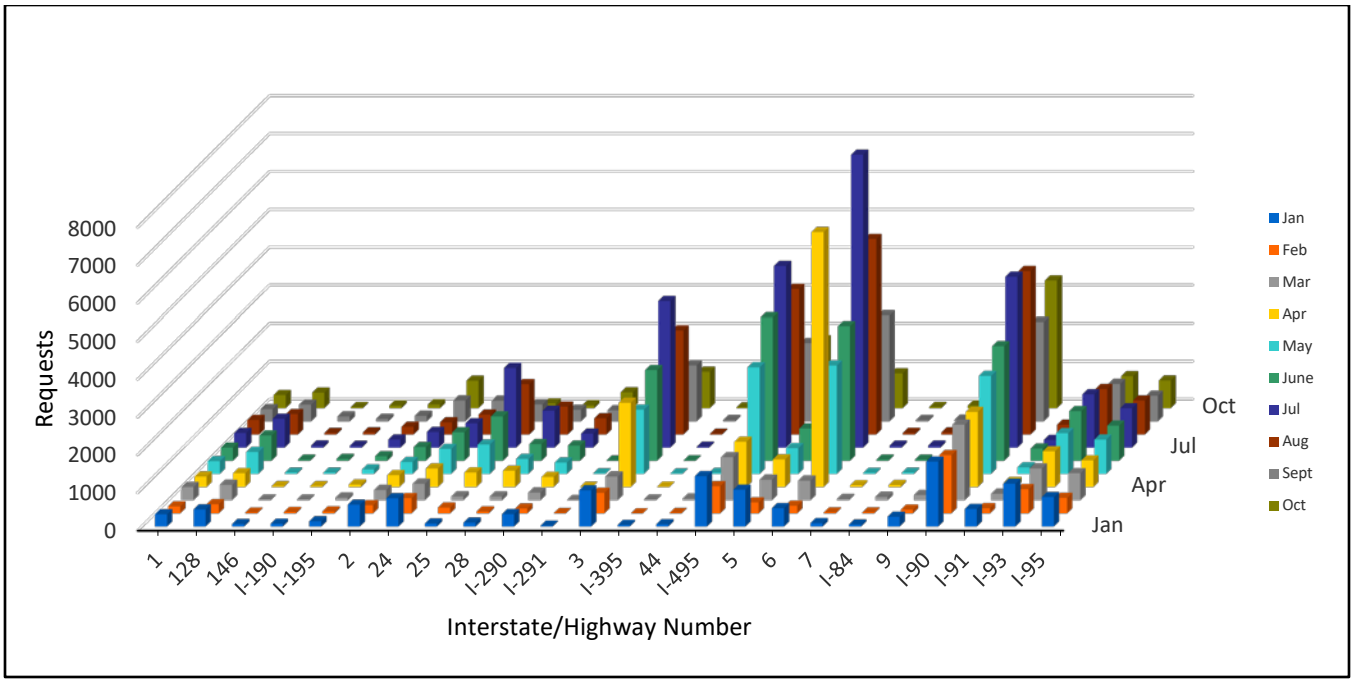


Figure 3-25: Mass511 IVR Service, Monthly Distribution of Route Requests for January to October 2018

3.3 Summary

The HOC at MassDOT utilizes a variety of platforms to disseminate TI. The focus of this chapter has been on analyzing the web traffic on the MassDOT Traffic Map webpage and the Mass511 website and the 511 phone service. This was achieved by using various metrics provided by Google Analytics for the web elements of the TIS and call volume for the phone service.

Summary of findings:

- The Mass511 website experiences much higher average daily usage as compared to the MassDOT Traffic webpage.
- Usage of both sites increases dramatically during weather events and holidays.
- The majority of Mass511 users are local; however, a significant number of users can be considered to be non-consistent users of the state network.
- About 46% of the users of the Mass511 website access it from desktop computers implying pre-trip planning. The rest use a mobile device or a tablet which is most likely for en-route TI inquiries.
- For the Mass511 phone service, although there is a significant decline in new callers, repeat callers remain steady across the period analyzed.
- Number of calls received peaks during weather events and construction closures.

- Users calling the 511 IVR service can request TI for a highway by its number. The majority of requests for the 2017-18 period were for I-90, I-495 and Massachusetts Route 6.
- For Massachusetts Route 6 the majority of the requests occurred during the summer months.
  For I-90 and I-495 there is significant demand throughout the year with relative peaks in the summer, implying both vacationers and commuters are using the service.

4.0 Gap Analysis

Based on the results of the literature review, the research team conducted a gap analysis for the Massachusetts TIS. The analysis identified specific areas to address, including:

- Manner of traveler information delivery
- Types of information
- Levels of detail
- Information accuracy and timeliness
- Information possibilities with connected and automated vehicles in the future
- New methods for obtaining transportation data
- Methods to analyze data from different sources
- Ability to generate useful and custom guidance information from the data
- How the information can be received by users

Particularly, the gaps were categorized into three classes:

- Details of traveler information provided;
- Integration of traveler information with other sources; and
- Venues utilized, performance measures and data organization.

4.1 Details of Traveler Information

4.1.1 Detailed lane information

Traffic incident and construction/roadwork activity information is extremely important to collect and disseminate. For roadwork, travelers want information about the location, the start and end dates of construction, and lanes to be affected. For incidents, similarly, travelers require information including the location, severity, lanes to be impacted, and the expected duration. Currently, MassDOT disseminates information on the locations of such non-recurrent events and start/end dates for roadwork constructions. Detailed lane closure information is not included, but it can be added by operators at the HOC monitoring these events.

4.1.2 Time-stamped information

Travelers want to know that the information provided is up-to-date and describes current traffic conditions on the roadways. Although the roadwork information presented by the MA511 system and MassDOT Traffic websites includes a time stamp, other types of information, such as traffic incidents and weather events do not.

4.1.3 Confidence level of information

Most existing 511 systems provide traveler information without giving a confidence level, although knowing this confidence level may significantly affect travelers' decisions. INRIX []provides qualitative confidence level information for travel speed estimates based on the input data sources (e.g., whether from real-time data or historic extrapolation). However, the detailed algorithm used by INRIX to determine the confidence level was not disclosed.

4.2 Integration Level of TI with Other Sources

4.2.1 Separation of TI across jurisdictions (e.g., in-state, cities) and between highway and transit TIS

Currently, MassDOT provides travel condition information for interstate and state highways. Although information for other high traffic volume roads is also important, in most cases such information is not available as these roads are maintained and monitored by cities and towns. Congestion on interstates and state highways due to incidents could benefit from diverting traffic to local parallel arterials and vice versa. It would be beneficial for MassDOT to work with cities and develop inter-jurisdictional TIS that covers both state and locally maintained roadway facilities. Such information would help travelers make better route, mode, and departure time decisions in case of major disruptions.

Transit passengers have different traveler information needs. These needs include various types of static information such as schedule, fare, accessibility, overall summary of services offered, and dynamic information such as real-time bus/train arrivals and service changes due to severe weather or outages. Also, travelers unfamiliar with the available transit services will benefit from a detailed trip planner. Most of the above information is already available on the MBTA website but is not available on the current MassDOT TI website. Integrating such information into the MassDOT TIS and providing a multi-modal trip planning service can help to facilitate the mode shift from other travel options to transit.

4.2.2 Lack of integration with neighboring states

Since many trips cross state lines, travelers will prefer that TI is integrated. The I-95 Corridor Coalition already does that to some extent. However, its live traffic coverage does not include Massachusetts. Travelers want accurate, timely, and reliable information in a form that is convenient to use. Examples include: camera views of traffic conditions on the Internet, travel time information that tells a traveler how long it will take between specific origins and destinations; for transit customers, knowing the location of buses and trains, times of departure or arrival, and operational problems is highly valued. For telephone-based services, such as 511, users want to be able to access their specific route information rapidly and get details on problems that occur.

4.2.3 Lack of integration with ridesharing

Ridesharing is the sharing of a vehicle journey so that more than one person can travel in the same vehicle, thus avoiding the need for several people to drive to the same location themselves. Ridesharing has seen an explosive growth with the emergence of ridesharing capabilities through transportation network companies (i.e., Uber and Lyft). The opportunity for real-time ridesharing is enhanced by three recent technological advances:

- GPS navigation devices to determine a driver's route and passengers' origins and destinations and to arrange the shared ride;
- Smartphones for passengers to request a ride from wherever they happen to be; and
- Social networks to establish trust and accountability between drivers and passengers.

Such resources are not presently available at HOC. It would be prudent to consider to what extent a public agency should be involved in providing or enhancing the provision of such information. Clearly, there is a public benefit in encouraging ridesharing if and where it can reduce congestion and provide for more efficient movement of people across the transportation network.

4.2.4 Lack of detailed parking information

Currently, MassDOT is providing static information on state-owned parking facilities on the MassDOT Traffic webpage. The time spent searching for available parking spaces can represent a cost to drivers, where parking is limited; in such cases, real-time information on parking availability can be very useful. There are some mobile applications and a number of providers that supply such information, although it requires the data to be collected, and it would be more likely this information can be shared for parking facilities that are state-owned or managed. One valuable source of parking information for the Boston region would be to feature parking facilities at MBTA transit and commuter rail stations. If parking facility information can be updated dynamically and featured on 511 it would both encourage people to take transit services when they travel to the rapid transit core of metropolitan Boston and help people to understand where parking would be available at transit locations to avoid people making car trips to areas where parking capacity is far more limited.

Additional information that travelers would like to have could include garage pricing, no-parking or tow-away zones and times that street parking changes to no parking. MassDOT can examine where travelers may expect the agency to provide information about parking, such as at airports, rail station facilities, and park and rides. MassDOT can provide this information on the 511 system where it can inform travelers of their options, particularly non-driving options that help to reduce congestion in urban areas of the state. It should be noted that parking availability at Logan airport can be accessed at http://www.massport.com/logan-airport/to-from-logan/parking/, but it is not connected to the Mass511 website.

4.2.5 Lack of integration with airport information/shuttle bus

Airports, particularly international airports such as Logan, are major traffic generators. Currently, the MassPort website (http://www.massport.com/) provides traveler information for airports overseen by MassPort, including parking and transportation options to/from airports. However, this website is run separately from Mass511. Users of MassDOT TIS will want access to such information. Such information can help travelers avoid delay (due to parking) at airports and promote public transportation for accessing airports.

4.2.6 Lack of integration of freight

Truck freight (e.g., generated at seaport terminals) is also a major contributor to traffic. TI, particularly on interstate highways, is important for truckers, who are interested in information such as rest areas, parking facilities, weigh stations, truck route restrictions, and work zones for trip planning. Although MassDOT is a member of the I-95 Corridor Coalition, currently neither the Mass511 nor the MassDOT website provides such freight TI.

4.3 Venues Utilized, Performance Measures and Data Organization

4.3.1 Limited access of TI from social media venues and limited TI provided

Currently, MassDOT uses a wide array of information dissemination media including the 511 phone service, public media, some mobile apps, HAR (active only for roadwork TI), the web, and XML feeds to third parties. Travelers have different information needs and not all travelers are likely to use every available dissemination mechanism. Therefore, an important feature of an effective TI program is diversity of dissemination venues. Currently, MassDOT has social media accounts on Twitter, Facebook, and Youtube, but not on other medias such as Instagram and Tumblr. Moreover, on the current social media channels available, the information is mostly static and used to inform of potential and actual disruptions. Real-time traffic condition information requires a separate platform to disseminate information.

It is important that MassDOT will keep exploring new technologies for sharing traveler information. The department does not have to be responsible for all dissemination venues. Data provided to third parties (such as Waze and Google) can improve TI dissemination to reach the traveling customer, even if they themselves do not use the 511 system. While having a variety of dissemination venues is important, the cost associated with maintaining such information outlets should be considered in relation to the benefits they provide to the traveling public.

4.3.2 Lack of TIS performance metrics

The importance of traveler information system performance metrics has been widely recognized by state DOTs and at the federal level. However, little has been done to evaluate the performance of TIS. Similar to many other states, MassDOT has collected data on TIS

usage (see analysis in Chapter 3), but it has not yet evaluated the performance of its TIS in many other important aspects, particularly the following:

- User experience: demographics of users, their preferences (e.g., who are they, what do they want) and how satisfied they are.
- System efficiency: evaluation on the *effectiveness, reliability, accuracy,* and *cost* of existing TIS.

User experience will serve as the basis for making future TIS investment decisions, such as adding/dropping features. System efficiency will help MassDOT evaluate the benefits and costs of different TIS features. Such analysis results should also be taken into consideration in future funding decisions and prioritize TIS projects.

4.3.3 Need better capacity planning of web resources

As with any web service, there is considerable volatility in the usage of the 511 service by the traveling public. During winter storms, or other emergencies, the demand for traveler information services spikes to levels that are many multiples above average usage. During the Winter of 2018, there were several snow storms in March, which resulted in a monthly aggregate demand for information (sessions, users, pageviews) that was three times the average in other months. Demands during particular days would be another multiple of the average on top of that; i.e., it could be 10-fold the demand on an average day. Hence, there is a requirement that the service capacity be sufficient to handle such peak demands. This is well-explained in *"The Art of Capacity Planing"* [*7*]:

First, the overall load and capacity requirements must be defined, based on peak-driven processing during peak usage. In our case, peak usage is exemplified by the spike in the number of pageviews/unit of time during major winter storms, emergencies, or during special events. For determining how much capacity is needed the efficiency of the current architecture, as well as, what will be needed for maintaining acceptable performance in the future must be considered. So far, the service capacity offered has met demand during events that generate high volumes of web-traffic, such as snowstorms. MassDOT should continue monitoring demand to ensure that the provided capacity meets needs.

4.3.4 Limited utilization of current traffic data

Collaborations with third-party data providers, such as Waze, INRIX, HERE and TomTom significantly increase the amount of data available to DOTs. MassDOT is in the process of validating the accuracy and effectiveness of these different sources. Moreover, while crowdsourcing data is available, there are data restrictions limiting MassDOT to its own use of the data. For example, Waze provides rich information, including incidents and real-time traffic, but MassDOT only uses it presently as one additional tool to disseminate information on incidents/events.

Drivers are increasingly relying on traffic information for making route and mode choice

decisions, particularly during congested conditions. Providing measured traffic information updated at fixed intervals can no longer satisfy drivers' needs in a dynamically changing traffic environment. The measured data can become outdated when traffic levels quickly change during any incidents. It is thus necessary to investigate algorithms to take data from multiple sources and potential driver responses into consideration to predict future traffic conditions.

Currently, MassDOT cannot fully estimate and predict traffic conditions based solely on data from DOT sensors. Our literature review suggests that the demand for 511 systems surges before and during hazardous weather conditions (e.g., snowstorm, hurricane). Unfortunately, in such conditions the amount of data provided by third-party crowdsourcing data vendors will be much less due to reduced travel. This requires that MassDOT has a sufficiently robust TIS.

4.3.5 Need to re-consider the role of DOT in providing TI

In TI provision, the roles of the DOT and the private sector provide their own advantages and disadvantages. Specifically, DOTs are in a better position to collect and provide information on planned events such as work zones, incidents or transit vehicle arrival time. Travelers, in general, perceive such information from DOTs to be more authoritative, meaning the reliability and accuracy of disseminated information is of upmost importance. For link travel time, parking, or real-time navigation, the private sector has clear technological and market advantages. Most travelers today rely on third-party websites or mobile applications (e.g., Google Maps and Waze) for obtaining traffic and transit information. Unlike DOTs that develop tools only for a specific state, third-party vendors benefit from a national and even global market. Their map products generate enough in revenues to support their growth and investments in research, development, piloting, integration, and deployment. It would be extremely difficult in a resource-constrained environment for DOTs to develop websites and mobile applications that can compete with third-party products in terms of performance, functionality and user interface.

Therefore, it is very clear that MassDOT has to reconsider its role in providing TI, particularly its relationship with private sector. MassDOT will need to further evaluate the capability of both the DOT and the private sector to provide TI in Massachusetts, including (1) conducting studies to evaluate the quality and reliability of the data provided by both parties, and (2) investigating terms of data sharing agreements with third-party vendors to ensure that the public's interest is best protected and served.

4.3.6 Need to understand and prepare for the impacts of Connected Autonomous Vehicle (CAV) on TIS

The USDOT has funded several Connected Vehicles pilot deployment studies. Among the three deployment sites (Wyoming, New York, Florida), the Wyoming site covers many aspects of traveler information systems, including (a) ingesting and processing CV data, (b) generating alerts and advisories, (c) brokering data between internal and external systems, (d)

collecting and distributing traffic information, and (e) storing data for performance management.

It is well recognized that CAVs will be introduced into the transportation system, and make use of the existing roadway network. Therefore, MassDOT will need to have good understanding of the impacts of CAVs on TIS and prepare for the changes, such as what kinds of data generated from CAVs can be available for DOT to extract and what kind of TIS can be provided to provide for a safer, more reliable transportation system with the introduction of CAVs on the nation's roadways.

4.4 Summary

The gaps identified can be categorized into the following three classes:

1. Level of details for the traveler information provided, which includes detailed lane information, time-stamped information, and the confidence level of TI provided;
2. Integration of traveler information with other data sources, which considers TI across different jurisdictions and different sectors (highway and transit), across Massachusetts and the neighboring states, and across different travel modes including ridesharing, parking, flight, and truck freight; and
3. Venues utilized, performance measures and data organization, which examines the TI accessibility (e.g., from social media), the performance metrics of TIS, the process of capacity planning of web resources, the utilization level of current data, the role DOT in providing TI and potential changes, and the potential impacts and needs of connected and automated vehicles.

Based on the gaps identified, both short- and long-term recommendations are provided in the next chapter.

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5.0 Recommendations

This chapter provides recommendations for MassDOT to address the gaps identified in the previous section of this report and to better serve the public's changing needs of for traveler information due to technological advancements. They are organized based on their applicable time frame into short-term and long-term recommendations.

Short-term recommendations include adding additional traveler information, expanding the coverage of the current TI, providing links to other traveler resources, and increasing TI dissemination venues. For the long-term, we recommend that Mass DOT consider enhancement and integration of the overall system, the different types of TI, and the methods of TI delivery; invest in traffic data analytics, workforce development, and the development of performance metrics for TI; and prepare for prospective changes in the role of DOT considering the impacts of CAVs.

5.1 Short-Term Recommendations

We propose short-term recommendations in four major categories to enhance the current TIS.

5.1.1 Additional Traveler Information

It is recommended MassDOT provide additional TI to enhance the current system. The following items are recommended:

- Detailed lane information. This includes information needed for traffic incidents and roadway construction: location, duration and lanes affected, which can be easily added on Mass511.
- Time stamped information. This includes when the event starts, ends (or anticipated end time), and when the information is posted. Such information is currently available for construction but not for traffic incidents.

5.1.2 Expanded Coverage

It is recommended MassDOT expand coverage of TI, including the following:

- Expand coverage of TI to include all routes of significance.
- Work with cities and local agencies to develop inter-jurisdictional TIS that cover both highways and major local road facilities and incorporate the expanded information into the existing system.
- Include links to parking information for transit facilities and consider if there is value to providing links to mobile parking applications on the Mass511 website.

-

5.1.3 Links to other Traveler Resources

Consider including on Mass511 website links to other transportation services to enhance the 511 system. The following links could be considered:

*5.1.3.1 Roadside Assistance (**https://www.mass.gov/roadside-assistance**)*

Provide a link to Roadside Assistance so travelers can be informed of the offerings of roadside assistance and have instructions available on what to do while waiting for the assistance.

*5.1.3.2 Massport (**https://www.massport.com**)*

Provide a link to Massport information on Boston Logan Airport, Flynn Cruiseport Boston, Conley Terminal, Worcester Regional Airport and Hanscom Field, including flights, parking and directions, public transportation links, shared ride services at Logan, etc.

*5.1.3.3 MBTA - The Massachusetts Bay Transportation Authority (**https://www.mbta.com/mbta-at-a-glance**)*

Provide a link for information on using the MBTA. The MBTA provides subway, bus, Commuter Rail, ferry, and paratransit service to eastern Massachusetts and parts of Rhode Island. The website provides information for:

- Subway Lines - The Red, Orange, Blue, and Green subway lines provide fast, easy connections to and from Boston and surrounding cities, including Cambridge, Newton, Revere, and Quincy.
- Bus Routes - The MBTA operates 177 bus routes and 4 rapid transit routes in the Greater Boston area, with connections to the subway and commuter rail.
- Commuter Rail Lines - The Commuter Rail connects eastern Massachusetts with transit hubs in Boston, including subway, bus, and Amtrak services.
- Ferry Routes - Boston’s commuter ferry service connects the inner and outer harbor with transport hubs in Boston at the Charlestown Navy Yard and Logan Airport.
- The Ride - The RIDE is the MBTA’s door-to-door paratransit service for customers who cannot easily use or access the T, whether they live in the Boston area or are visiting from out of town.

Integrate traveler information that would be of use to those traveling. For instance, parking information at park and rides and transit and commuter rail stations could be part of the 511 page or be linked to separately.

*5.1.3.4 Regional Transit (**https://www.mass.gov/info-details/public-transportation-in-massachusetts**)*

The MBTA and the 15 Regional Transit Authorities (RTAs) provide fixed route and paratransit services in communities across the state. Travelers can visit the transit authorities' webpages - or contact them directly - to learn what specific services they offer.

5.1.3.5 Senior/ADA service

Provide links that disabled travelers can use.

- Massachusetts provides different types of services for the aging and senior citizens, including Transportation. Information is available on the following website: http://www.caregiverlist.com/massachusetts/departmentonaging.aspx
- The Massachusetts Office on Disability (MOD) provides a number of services for people with disability, in particular, accessible Transportation Information is available on this website: https://www.mass.gov/topics/accessible-transportation

5.1.4 Increase TI Dissemination Venues

- TI in the current system is delivered either by dialing 511, or by accessing one of the two available websites. It is recommended to make the existing available TI accessible on mobile devices as well. To achieve that, a mobile application can be considered for accessing 511 information, including crashes, construction and closures.
- Allow users to access to traffic cameras through their mobile devices.
- Provide links to other travel or transportation related agencies.

Currently, MassDOT has accounts on facebook Twitter, Youtube, and Instagram, but these social media accounts are not used to post TI on real-time traffic conditions. It is recommended to use these social media accounts to post information relevant to traffic conditions in *real-time*.

- Facebook (MassDOT: https://www.facebook.com/massdotinfo/)
- Twitter (https://twitter.com/MassDOT)
- Youtube (youmovemass: https://www.youtube.com/channel/UCxp_mWe1uTbaDgw3MqSLb2g)
- Instagram (massdot: https://www.instagram.com/massdot/?hl=en0

5.2 Long-Term Recommendations

5.2.1 Overall System Structure

The future traveler information system should provide increased information on the various travel modes. Instead of simply providing links to websites for different travel modes, traveler information for different modes could be seamlessly integrated into one system. The collection and maintenance of data for different travel modes may still be separated. However, such data collection and maintenance details should be conducted in the back-end without being noticed by the end users.

Given the large amount of data related to various travel modes, the system should provide tools to facilitate the comparison of different modes as well as combinations of modes. A future TIS should not only help travelers find less congested routes, but also encourage them to choose travel modes that generate less roadway congestion. A traveler's daily activities may consist of several trip segments made by different modes and are subject to various time constraints. To help a traveler make optimal travel decisions, it is important to have a tool to compare different travel modes and combinations of travel modes.

For a future TIS, it is desirable for MassDOT to collaborate with neighboring states to coordinate their efforts, such as using the same standard format for data and developing a cost-effective joint TIS so that travelers do not need to go to multiple systems to obtain traveler information for a cross-state trip. One such example is that New Hampshire, Vermont, and Maine have collaborated and established a New England 511 system. A joint TIS is likely to give participating states more bargaining power when negotiating with third-party vendors for purchasing data and services.

5.2.2 Types of Information

A future TIS should be more inclusive and take the information needs of all travelers into consideration. For example, additional information related to travel, such as parking availability and cost, locations of ADA facilities, availability of sidewalk, average wait times at bus/train stops, and average wait times at airport security checkpoints could be provided for state-operated or owned facilities. MassDOT could collaborate with other agencies or vendors to acquire such data. When possible, MassDOT may also partner with vendors and add services such as parking space booking and ridesharing to its future TIS to attract more users.

Existing TIS mostly provides historical and instantaneous traveler information. For future TIS, it would be helpful to also include predicted traveler information. With better understanding of how users may respond to traveler information, the accuracy of predicted traveler information can be further improved. Sharing accurate predicted traveler information will help to improve TIS popularity.

MassDOT should continue to remain as the authoritative source for information that it has advantages over the private sector, such as special events (e.g., ball games), scheduled

roadway and transit station (e.g., elevator) maintenance, and snow removal. MassDOT can further partner with the private sector and provide travel information for both state and major roadway facilities. It is important for MassDOT to continue to invest in and maintain its own sensors, and to avoid relying completely on private sector data, such as crowdsourced data. With severe weather events, the crowdsourced data can be unreliable due to a reduced sample size.

5.2.3 Methods of Information Delivery

It is anticipated that the traditional 511 phone service usage will continue to decline. MassDOT should consider discontinuing this traditional 511 phone service or upgrading it using artificial intelligence technologies. With such advancements and potential demographic changes, MassDOT could consider providing TIS in multiple languages.

A future TIS can be made more personal, provide tailored travel information and be able to suggest travel options to individuals based on their preference of modes/routes, health condition, origin and destination, weather, real-time and predicted traveler information, daily activity schedule, etc. For example, it may recommend an earlier departure time or a different travel mode due to a traffic accident impacting roadway travel. The recommendation can be triggered based on predicted traveler information and a traveler's daily activities retrieved from his/her smartphone calendar given that privacy and security are properly taken care of. Although tailored TIS is technologically feasible, MassDOT can further investigate whether the private sector could lead its development and promotion, with MassDOT ensuring the accuracy and reliability of data reported on incidents.

Cybersecurity and privacy issues will become increasingly important as TIS becomes more personal and relies more on mobile devices. MassDOT should also invest in these areas to ensure that travel information is properly protected and other systems, such as variable message signs, are protected against malicious intrusions.

5.2.4 Traffic Data Analytics

MassDOT can invest in data analytics to develop accurate methods for predicting traffic information and fuse data from various sources (e.g., MassDOT sensors, crowdsourced data). In addition, limited research has been done to understand how TI should be best presented and how TI is perceived by drivers and affects their choices (e.g., route, mode, departure time). MassDOT could invest in and follow research on these topics. The results of these studies could allow MassDOT to use its TIS as an active traffic management tool.

5.2.5 Workforce Development

A future TIS can be built upon advanced sensors, math and statistical methods, artificial intelligence, computer vision, communications, cybersecurity, and traffic engineering domain knowledge. It requires engineers with a versatile background and the ability to adapt to new

skills quickly. It is important for MassDOT to invest in workforce development, such as offering training opportunities to existing employees, providing internships and co-op positions to students in relevant disciplines, engaging students in funded TIS research, and encouraging students to consider TIS topics for their research.

5.2.6 Performance Metrics

The importance of measuring TIS performance has been widely recognized, but very few state DOTs have done so. MassDOT can: (1) develop performance metrics to assess the *effectiveness*, *reliability*, *accuracy*, and *cost* of TIS; and (2) collect data to evaluate system users' experience and understand their needs and preferences. The performance metrics could go beyond counting the number of webpage visits and the number of 511 phone calls received. In addition, the ultimate impacts of TIS on delay, safety, energy consumption, etc. could be considered, which may require collecting additional data or relying on unconventional data sources.

In addition to serving travelers, the collected data for the TIS can also be used to generate useful information for various MassDOT divisions. For example, the data can be used to identify and prioritize bottlenecks for improvements, quantify the impacts of traffic improvement strategies, and investigate the relationship between accidents and microscopic and mesoscopic traffic flow parameters.

5.2.7 Role of DOT

MassDOT should clearly define its core TIS responsibilities in the context of what is required by federal and state regulations. This will help MassDOT shape its future TIS. Beyond meeting the core TIS responsibilities, MassDOT can add TIS features that may contribute to the agency's mission, goals and objectives.

The private sector is playing an increasingly important role in providing travel information. MassDOT and the private sector each has their own strengths and weaknesses. For example, MassDOT owns many traffic sensors, but these sensors only cover limited locations (mainly on state-maintained highways). The private sector has access to a vast amount of user-contributed data that covers almost the entire road network. However, the quality of such data is unclear and the private sector relies on DOTs to provide scheduled road construction and maintenance activity data.

It is recommended that MassDOT reassess its role in providing TI, and leverage the resources provided by the private sector when appropriate. For example, it makes little sense for individual state DOTs to develop their own mobile navigation applications, since most travelers use free navigation applications that are highly user friendly. On the other hand, MassDOT should not overly depend on the private sector to provide its core TIS services. An extreme case is that if MassDOT relies entirely on crowdsourced data for obtaining traffic information, during winter storms the traffic information is likely to be inaccurate or even unavailable due to insufficient user reporting. Thus, MassDOT should:

- Continue to invest in sensors and equipment strategically and make sure they are well maintained;
- Investigate cost-effective approaches to collect and archive data and innovative analysis methods to turn data from various sources into useful and reliable information;
- Continue to investigate innovative and cost-effective means of distributing TI to users; and
- Conduct studies on the quality and reliability of the data provided by both MassDOT sensors and the private sector, to ensure that the future TIS works reliably under all weather and traffic conditions.

5.2.8 Impacts of Connected and Autonomous Vehicles (CAVs)

The USDOT recently funded three major connected vehicle pilot deployment studies in Wyoming, New York, and Florida. In particular, the Wyoming pilot deployment site covers many aspects of TIS. The preliminary results of these studies show that connected vehicles have potential to generate detailed traffic information and serve as a reliable platform to distribute such information in real time. In addition, autonomous/self-driving cars can provide not only their trajectory information, but also the surrounding traffic along their routes. Similar to CAVs, transportation network companies, mobile carriers, large logistics companies , and crowdsourcing companies are all generating an enormous amount of traffic data by the minute.

Given these new developments, MassDOT should think strategically about how to invest resources in TIS hardware and software, avoid soon-to-be-obsolete technologies, and investigate terms of data sharing agreements with third-party vendors to ensure that the public's interest is best protected and served.

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6.0 Conclusions

The key aspects of a traveler information system provided by MassDOT that demonstrate its importance are:

- According to 23-CFR-511, the federal government requires state DOTs to provide some form of TI. The elements of the current TIS do satisfy this requirement.
- While many users use applications/websites from the private sector, those applications/websites may not be reliable in inclement weather. Most private-sector applications rely on crowdsourcing data. However, in inclement weather, there may be only a small number of users on the roads and thus the TI provided may be unreliable. For instance, Waze users may report inaccurate information.
- Users of the Mass511 system and the Mass DOT website surge around snow storms, which indicates the public's reliance on and expectation of reliable TI from the DOT.
- When there are emergencies or special events, TI provided by MassDOT (either the 511 system or the DOT website) is likely to be more reliable and accurate than TI from the private sector. For example, when there are incidents on highways, the DOT has more accurate information of when and where the incidents occur and when they get cleared by the highway patrol. However, applications from the private sector, such as Waze, may continue to show incidents in locations after such incidents have already been cleared. Having the agency provide inaccurate information, even if it's from a third-party, would diminish the public's trust in the traveler information system and undermine normal traffic operations.
- A significant number of travelers still regularly use TI provided by MassDOT, either through Mass 511 or the MassDOT website. There are travelers that cannot or do not like to use mobile applications or third-party websites and prefer to use the conventional TI platforms. For example, senior citizens may find mobile applications and websites difficult to use and prefer the traditional phone system with which they are familiar.

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7.0 Appendix

Table 7-1: Summary of TIS Studies

Report Title (Year)	Prepared For/By	Key Findings/ Recommendations	Relevance to MassDOT
Development, Use and Effect of Real-Time Traveler Information Systems (2012) [*2*]	NCHRP	Key Findings • Many agencies are worried that accidents and other traffic events were not loaded in a timely manner onto their websites, potentially leaving the public without knowledge of incidents. • Others felt that state-maintained maps quickly grew outdated and 511 systems are often underfunded, and that using Google Maps for their base layers would greatly improve users' experience. • Some agencies reported struggling with data integration. • Surveys indicated that people most frequently received traveler information from the radio, followed by smartphone apps, highway variable message signs, and websites. • The likelihood that individuals will change their trip plans is more associated with traffic incidents, travel times, alternate routes, construction zones and lane closures, and is far less likely to be affected by traffic cameras, special events, and safety information. This study conducted public surveys and asked what features people wanted in a real-time traveler information system. Among the features cited were: • Reliable, real-time, and accurate information • Information available for specified travel corridors • Automated alerts • Suggestion of alternate routes to improve decision making • Information available from a variety of sources	• See the recommendations in this NCHRP report.

Report Title (Year)	Prepared For/By	Key Findings/ Recommendations	Relevance to MassDOT
		• Dedicated apps, radio stations, and television stations • Time-stamped information • Detailed information on lane closures and viewable traffic cameras • Access to multimodal and transit information Recommendations • Enhancing public agencies' capacity to supply accurate and reliable data they collect to the public. • Exploring public-private partnerships (P3s). • Seeking out new sources of data and explore partnerships with other transportation agencies. • Continuously improving the quality of traveler information and how the information is distributed. • Devising performance measures that help agencies evaluate the user experience of traveler information systems	
Next Generation Traveler Information System: A Five Year Outlook (2015) [*8*]	FHWA	Key findings • Some populations are still relying on IVR systems. 511 phone systems are nearing the end of their lifecycle. The exact timing of shifting the old technology will need to consider the needs of key traveler populations. • Trend of travelers' information need, which users expect: ➢ Anytime/anywhere availability ➢ Contextual filtering – "exactly what, when, and where " ➢ Ability to integrate – e.g., multimodal data • Trend of information type needed by users: the increased availability of data has led to expanded delivery, with traveler information systems adding new features, such as predictive highway travel time estimates as well as information on parking	• Assess the performance of the TIS provided by the DOT and by third parties. Use consistent metrics so that the DOT can decide the value of collaborating with private sector. • Investigate new business models for future ATIS and consider public-private partnerships. One

<table>
<tr><th>Report Title (Year)</th><th>Prepared For/By</th><th>Key Findings/ Recommendations</th><th>Relevance to MassDOT</th></tr>
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Trend of data collection/aggregation: data collection has a new emphasis on mobile sensors for (e.g., smartphone data, vehicle data). DOTs need to monitor performance, including indicators on quality, reliability, and cost. Aggregation of data should be used for analysis in improving end product functionality.
Trend of technology deployment – cell phone and vehicle-based data are growing. In the table below, green – high momentum, Red – declining, Blue – emerging.

<table>
<tr><th>Communications Channels</th><th>Hardware Platforms</th><th>Presentation Software</th><th>Offering Notes</th></tr>
<tr>
<td>Radio (AM, FM, & Radio Data System – Traffic Message Channel)
Broadcast TV
● Cellular
Landline telephone
Cable/fiber</td>
<td>▲In-vehicle infotainment
In-vehicle connected safety
● Smartphones
Cellphones
Smart Devices
Wireless roadside devices (e.g., DMS)
Desk phone
Desktop
Wired roadside devices
TV sets</td>
<td>▲Vehicle-based applications
● Mobile applications
● Networked applications (e.g., social media, crowdsource)
Interactive Voice Response (IVR)
Website</td>
<td>■ Highway Advisory Radio (HAR) is AM version of this
511 as brand (vs. technology)
■ 511 (traditional landline phone-based)</td>
</tr>
</table>

Performance measurement is critical for the many third-party traveler information apps like Waze and Google Maps. DOTs will also need that to decide where, when, and how they can collaborate with the private sector.
The future role of the public sector providing TI must be reconsidered. It is recommended that agencies

Revisit core goals
Build and monitor a roadmap

</td>
<td>
option is to identify different purposes that TIS serve (e.g., emergency, regular congestion control) and adopt different models.

Invest in data analytics
Consider additional features, such as parking and predicting travel time on various segments.

</td>
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</table>

Report Title (Year)	Prepared For/By	Key Findings/ Recommendations	Relevance to MassDOT
		➢ Standardize wherever possible ➢ Measure, measure, measure • Roles in the traveler information value chain will likely change in the future. Private traffic data providers have the technology to process large volumes of new traffic data and develop profitable business models. Public authorities will, however, retain a key role in assuring societal interests in the value chain.	
Synthesis of Kentucky's Traveler Information Systems (2016) [*9*]	Kentucky Transporta-tion Cabinet (KYTC)	Key Findings • The number of 511 phone calls received has dropped sharply since the mid-2000s. The amount of traffic handled by websites and mobile apps has increased. • 511, website, and mobile app receive the most traffic during the winter months. • Phone system will be less relevant — although necessary to maintain, particularly in rural areas. • Services such as Google and Waze are popular for retrieving maps and driving directions, while television and radio play an important role still, especially for the dissemination of information during hazardous weather. • Some states are debating whether state DOTs should become a data broker rather than a traveler information system provider. The third-party apps do not (are not obligated to) summarize traffic information (incident, construction) at the same level of detail as on the state's websites and apps, and often depend on app users to report incidents. Kentucky's 511 system is far better at reporting winter driving conditions. Based on a survey of stakeholders, it is concluded that:	• Reduce the TI system's reliance on manual data entry. • Public agencies should play a role in delivering authoritative traffic information. • Timeliness and accuracy of traveler information remain issues. • Identifying measures that provide accurate interpretations of system performance remains challenging. • Partnership with third-party developers is important. • Integration of Waze data can be improved,

Report Title (Year)	Prepared For/By	Key Findings/ Recommendations	Relevance to MassDOT
		• KYTC should continue to have a role in delivering authoritative traveler information to consumers; • Kentucky's traveler information systems have improved in quality, although enhancements are still possible; • Manual data entry sometimes prevents the Cabinet from getting information out as quickly as it could; • Identifying performance measures remains a challenging but also worthwhile task; • KYTC's partnership with Waze has improved the delivery of information to consumers, but that there are areas in which it could be improved; • The importance of the 511 phone system will continue to decline, although maintaining it will be important for the state; • Availability of real-time information on KYTC's traveler information systems should increase; • Metrics to verify the performance of Waze should be developed; • Have the Cabinet increase its efforts to distribute the data it collects to private, third-party vendors; • Develop marketing campaigns to increase the public's awareness of the traveler information systems Kentucky offers; and • Improve public-facing products to encourage wider adoption.	and Waze also needs to do a better job to integrate planned construction and closure events into it. • The use of 511 phone systems will continue falling, the state still needs to maintain it. • Increase the availability of real-time incident information. • Develop measures to validate the accuracy of Waze data. • Increase efforts to facilitate the data sharing with third-party developers. • Further improve public-facing products and develop marketing campaigns to raise public awareness and encourage more use.
State DOTs Social Media Usage Survey	AASHTO	• Every year, AASHTO takes surveys to ask state DOTs a series of questions related to the adoption of social media tools. In 2017, 40 states and District of Columbia responded to the survey.	• DOTs may want to measure the usage of social media (e.g.,

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–2017 (2017) [*10*]		• Use of online social media tools has become standard business practice for state DOTs. 98% of state DOTs use Twitter, while just four use Snapchat. The ways, and the types of tools, in which state DOTs engage vary greatly. Only a few state DOTs plan to develop new social media tools in 2018. • Some DOTs hire social media managers, while other states train all communications officers to handle aspects of online engagement. • More interest exists in tracking social media outreach. • The public increasingly expects to find their transportation agencies in the social media space, putting increasing pressure on state DOT communication teams to generate new and current content.	demographic features, purpose, frequency) to decide whether to allocate more resources. • Research on how TI delivery (e.g., via 511 web and social media) affects traveler behavior is needed.
Using Freight Advanced Traveler Information Systems to Promote Urban Freight Mobility (N.D., should be after 2014) [*11*]	FHWA	• FRATIS is being tested at Los Angeles-Gateway Region, Dallas-Fort Worth, and South Florida • FRATIS improves productivity and efficiency of the fleet • Receive real time notifications of trucks heading towards their facilities with estimated time of arrival • Reduce waiting time and turnaround time at the facility • Improve air quality by reducing CO_2 emissions	• FRATIS may not be a major concern to MassDOT at this moment, but can be considered in the future.
Iowa 511 Traveler Information System User Analysis (2015) [*12*]	Iowa Department of Transporta-tion	• Statistics indicated that use of Iowa's 511 system peaks during the winter months. Correlation analysis revealed these peaks occurred simultaneously for all mediums. • Of the 850 survey respondents, 598, or 70%, had never used Iowa's 511 services. Among the 30% of respondents who reported using the 511 system, 51% had visited the state's 511 websites, 37% use both	

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		the phone and the web services, and the rest said they had only used the phone service.	
A Next Generation Non-Distracting In-Vehicle 511 Traveler Information Service (2014) [*13*]	Minnesota Department of Transporta-tion	• Researchers looked at 511 systems in 26 states and Google maps, Waze, etc. Their pros and cons are summarized. • The overall recommendation is for Minnesota to integrate a low-distraction navigation system and to convert to a text-to-speech based system.	• It is questionable whether it is economically and technologically sustainable for state DOTs to invest in navigation apps.
Strategies for Improving Traveler Information (2011) [*14*]	Michigan Dept. of Transporta-tion	• Continue investments in Dynamic Message Signs (DMS) • Continue to follow the evolution of social media, but do not expand for real-time usage • Concentrate on the quality and dissemination of information that is of the highest priority to the public: construction and incident data. Should reach out to third-party to develop incident management data standards. • Commit resources to marketing MDOT ATIS efforts • Put real-time traveler information at MDOT rest areas • Create mechanisms for third-party developers to create content based on MDOT data • Develop a mechanism to actively manage and evaluate MDOT's ATIS Efforts	• Concentrate on providing accurate data in real time. • Continue the efforts of providing data portal and encouraging third-parties to develop apps using MassDOT data • Conduct studies to validate third-party data and develop performance measures
Freight Advanced Traveler Information	By Productivity Apex, Inc.	• FRATIS consists of the following modules: Marine Terminal Operator (MTO) operation optimization, Drayage Optimization, traveler information, and information exchange between MTO and Drayage Fleet Operators	• Paul W. Conley Container Terminal launched a mobile app called Forecast Mobile

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System (FRATIS) - Background and Overview (2015) [*15*]	for a conference	• It can also be applied to other intermodal facilities	Lite, which "will provide customers, primarily trucking companies and drivers, access to container availability information in real time on their smartphones before they arrive at the terminal, saving time and avoiding potential issues at the terminal gate." Other opportunities for FRATIS could exist at additional terminals.
I-81 Coalition The Smart Freight Route (2017) [*16*]	By Virginia Tech and CDM Smith for a conference	• Proposed a (FRATIS-P) Freight Advanced Traveler Information System + Truck Parking Concept • Truck Parking Information Services (TPIS) ➢ Network of commercial and public facilities ➢ Real-Time Information on availability ➢ Truck Parking Reservations ➢ Information on availability pushed to driver • Truck Alternate Routing Services (TARS) ➢ Truck-specific GPS navigation solution that accounts for truck-restricted and prohibited roads ➢ Provide safe and reliable navigation around congestion and accidents	• Investments in connected infrastructure can produce efficiencies in the movement of freight. • Investments in FRATIS-P could help to improve air quality and traffic operations, while better utilizing

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		• Truck Travel Predictive Services (TTPS)
		  ➢ Predicts travel distance and arrival time and distance based on driver's current location, current traffic conditions, temporal trends (construction), dynamic trends (weather), etc.
		• Truck Road Weather Travel Services (TRWTS)
		  ➢ Pushes road weather link-specific information to drivers
		  ➢ Provides road weather alerts and warnings within a short time horizon of adverse conditions
		• Funding Opportunities
		  ➢ National Highway Freight Program
		  ➢ FASTLANE Grants
		  ➢ TIGER Grants
		  ➢ CMAQ
		  ➢ Technology and Innovation Deployment Program
		  ➢ Accelerated Innovation Deployment Demonstration (AID)
		  ➢ Advanced Transportation and Congestion Management Technologies Deployment
			existing infrastructure capacity.

Wyoming I-80 Connected Vehicle Pilot - Talking Freight Webinar (2018) [*17*]	Conference presentation by USDOT	• CV will provide I2V Situation Awareness, Work Zone Warning, Spot Weather Impact Warning, etc.
		• The collected CV data will support TMC in
		  ➢ VSL, Closures, Restriction Management
		  ➢ Traveler Information Updates
		  ➢ Commercial Vehicle Operators Portal Updates
		  ➢ Thirty-Party Interface
			• MassDOT should further look into potential impacts of CV applications on traveler information.
			• MassDOT may need to further research ATIS under inclement weather conditions.
			• Investigate how ATIS data can support

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			MassDOT traffic operations.
Technology Scan of Future Traveler Information Systems and Applications in Georgia (2013) [*18*]	Georgia Department of Transporta-tion	• Georgia's TIS is called NaviGAtor and is intended to be a resource for all travelers in Georgia, by combining the state-generated information with congestion and incident information from many local jurisdictions. However, the current TIS is fragmented and no integration across state highway routes (DOT-managed), the Atlanta region's transit system -MARTA, Hartsfield-Jackson Atlanta International Airport, and local municipalities. Also, its trip planner was found not to be user friendly. – Many of these findings remain the case in 2018. • Recommendations for GDOT: ➢ Use third-party data from major routes not yet served by infrastructure. This takes advantage of new technology that can improve traveler information for those using Georgia's facilities. ➢ Create a method for data integration using web API's among different public transportation agencies. That includes data from MARTA and Hartsfield-Jackson Atlanta International Airport. ➢ Upgrade the existing system (NaviGAtor) to become an inclusive data source for publicly generated information. ➢ The NaviGAtor system should include an open, web-friendly API. This will encourage web developers to use the data. Having more websites and apps will lead to greater public use of the data. ➢ Agencies are encouraged to actively interact with and support the developer community. Clear and concise documentation of the data is important. An open dialogue between agencies and developers can also help to understand respective needs.	• The report's recommendation emphasizes on leveraging third-party data and creating an open, web-friendly API to promote third-party and public usage of data from GDOT. This approach is cost-effective for DOTs and it would involve collaborations with the private and public sector.

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		➢ Overall, the target is pursuing an open data platform. DOT will be in a better position to benefit from third-party applications that find innovative ways to deliver its data to a broad range of travelers.	

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