

# **Requirements for a Nationwide Intermodal Trip Planner in the US**

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## **ABSTRACT**

Presently, the United States has yet to achieve the 1991 Intermodal Surface Transportation Efficiency Act's (ISTEA) goal of creating a seamless intermodal transportation system. In addition to the dearth of connections, the nation's poor transportation information systems limit intercity intermodal transportation. Travelers lack awareness of available transportation options and face too many separate portals for trip planning that both consume time and present inadequate information.

This paper posits that the creation of an efficient and extensive web-based door-to-door intermodal trip planner can solve these problems. The proposed system will present travelers with a single portal to meet all their trip planning needs. Upon selecting specific trips, travelers can then decide to be directed to operators to make a purchase. The system will include operators from the major modal groups including intercity buses, intercity rail, commuter rail, transit, and airlines. It will also include taxis due to the disjointed nature of the US public transportation system and the need to connect users who are far from stations.

The requirements to create this trip planner are explored, including the support systems, potential legal issues, and suitable entities for administration and management. A survey of 39 transportation system users revealed the existence of redundant and inadequate trip planners and that the lack of sufficient information on public transportation options is driving travelers to private vehicles for shorter distances even for those who prefer public means of transportation. Analysis of the costs and benefits of implementing the proposed system is drawn from interviews with key personnel within the transportation industry, and a review of nationwide trip planners in European countries. Finally, a roadmap is presented on how best to implement the system with inputs from both the public and private sector. Recommendations include the establishment of an industry-wide data standard, a national interagency database, and a cooperative structure that entices major players within each mode to participate in the system. Also suggested are incentives from the DOT and interested private sector members to encourage more operators to participate in the system.

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## LIST OF ABBREVIATIONS

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ABA	American Bus Association
APTA	American Public Transportation Association
ARRA	American Recovery and Reinvestment Act of 2009
ATIS	Advanced Traveler Information System
BTS	Bureau of Transportation Statistics
CMAP	Chicago Metropolitan Agency for Planning
DOT	United States Department of Transportation
FTA	Federal Transit Authority
GDS	Global Distribution System
GTFS	General Transit Feed Specification
ISTEA	Intermodal Surface Transportation Efficiency Act
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
IVR	Interactive Voice Response
JPO	Joint Programs Office
LA Metro	Los Angeles County Metropolitan Transportation Authority
MBTA	Massachusetts Bay Transportation Authority
MERITS	Multiple European Railways Integrated Timetable Storage
MPO	Metropolitan Planning Organization
NEMA	National Electrical Manufacturers Association
NTCIP	National Transportation Communications for ITS Protocol
NYMTC	New York Metropolitan Transportation Council
PRIFIS	Price and Fare Information Storage
PTA	Public Transportation Authorities
RITA	Research and Innovative Technology Administration
SCAG	Southern California Association of Governments
TCIP	Transit Communications Interface Profile
TEA-21	Transportation Equity Act for the 21 <sup>st</sup> Century
UIC	International Union of Railroads
US G.A.O.	US Government Accountability Office
WMATA	Washington Metropolitan Area Transit Authority
WMCOG	Washington Metropolitan Council of Governments
XML	Extended Markup Language

# CHAPTER 1 - INTRODUCTION

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## BACKGROUND

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In 1991, the enactment of the Intermodal Surface Transportation Efficiency Act (ISTEA) [1] allowed the federal government to take numerous steps to promote intermodal transportation, defined as the use of multiple modes of transportation in a single trip or journey.<sup>1</sup> At that time, the nation's leaders recognized the need for an improvement in the nation's intermodal transportation system. They reasoned that creating a transportation system that incorporated multiple modes would not only make the system more efficient, but would also allow for equity. ISTEA aimed to develop a unified and interconnected national intermodal transportation system that was "economically efficient and environmentally sound" and one that would "move people... in an energy efficient manner" [2].

However, over 20 years since the enactment of the legislation, the nation does not have a seamless and unified public transportation<sup>2</sup> system that takes advantage of the abundance of passenger

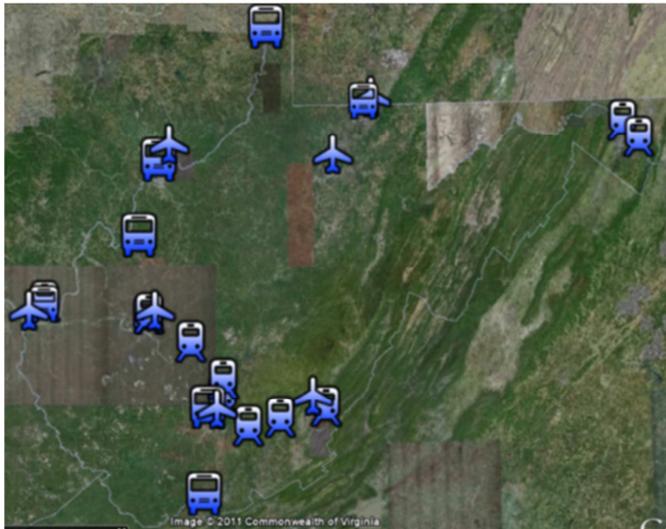


FIGURE 1: A map of West Virginia showing locations of major transportation facilities. While only Greyhound is shown for intercity buses the figure shows the relative breadth of traveling options even in a sparsely populated state.

modes available. In Figure 1, a map displays the transportation facilities available in a sparsely populated state such as West Virginia. Commercial airports number 7, Amtrak stations number 10, and intercity bus stations number at least 7, all in a state with a population of 1.8 million and cities and towns of 50,000 or less in population, according to 2010 US Census. For clarity, only one state is presented but the situation is similar in other sparsely populated states such as Wyoming and Montana. The US has a relatively extensive collection of transportation resources and a breadth of options for traveling throughout the nation. However, despite the abundance of transportation facilities and a series of legislative actions meant to foster a connected system, each carrier's system essentially exists as a separate entity, with the exception of the airline industry since each aircraft must actually land

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<sup>1</sup> In order to clarify with respect to terminologies, intermodality is a subset of multimodality. While multimodality can be applied to any transportation-related issue that is characteristic of multiple modes, intermodality refers to the usage of multiple modes on a single trip. It includes an approach to planning, building, and operating a transportation system with an emphasis on optimal utilization of resources and connections between modes in order to achieve quality of service.

<sup>2</sup>For the entirety of this paper, public transportation will be defined as transportation that is not directly owned or operated by the customer and will encompass airlines, intercity rail, intercity bus, and all local transit modes including rail and bus.

at publically-owned commercial airports. On the other hand, intercity bus operators are virtually free to locate their stations wherever they can find a location. Some intercity buses do not even stop at stations but rather at a designated outdoor location. This is characteristic of intercity bus companies that operate so-called curbside bus services. In addition to the discontinuity between operators within modes, there is also a lack of an extensive connection between different modes. The closest distance between two stations in the map of West Virginia is 4 blocks even though many stations coexist in the same city or town. This is the case throughout the US although the intensity of discontinuity varies by location. Data compiled by the Bureau of Transportation Statistics (BTS) reveals that when local transit systems are excluded, only 38% of terminals for all intercity operators across the nation provide intermodal connections to other systems [3]. Additionally, a survey [4] conducted by the US Government Accountability Office (US G.A.O.) of all large and medium airports in the US discovered that only 90% of those 72 airports had direct connections to either a local rail or bus system, with some airports having direct connections to only one type of ground transportation. Moreover, less than a third of these airports had direct connections<sup>3</sup> to either an intercity bus or rail system. Although all cities surveyed benefited from a station served by an intercity bus operator, Figure 2 shows that only 12 airports had direct connections to intercity bus service such as Greyhound. A few of these airports include Atlanta’s Hartfield-Jackson, New York’s LaGuardia, and Miami International Airport. A direct connection also existed at 13 airports to Amtrak. It is important to know that, of all these direct connections, none are accessible by walking and travelers must take a shuttle. However, one airport, Newark Liberty Airport, does have an automated people mover connection to the rail terminal.

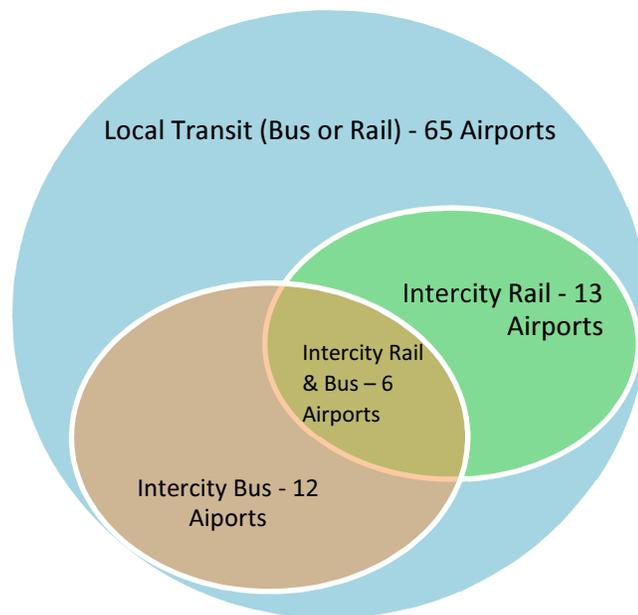


FIGURE 2: Venn diagram of transportation connections at US airports. The diagram shows direct local and intercity transportation connections at 72 large and medium US airports.

These statistics demonstrate that while the US is relatively abundant in transportation facilities, especially given the sparse dispersion of population in many regions, the infrastructure system retains a general lack of connectivity and coordination, within modes and also across modes.

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<sup>3</sup> The authors of the survey defined as a direct connection transfer points which were convenient for an average adult with luggage to travel by foot, a people mover that was available to transport passengers from the transfer point to the airport terminals, or if a regular fixed-route shuttle service carried passengers from the airport terminals to the transfer point.

## CURRENT STATE OF THE NATION'S TRANSPORTATION INFORMATION SYSTEM

Besides the lack of connections, another reason why intermodal transportation is still unsatisfactory has been the lack of information. This lack of information exists not only at terminals where passengers often do not know what transportation options are available in terms of transferring from one mode to another. It may be even more restrictive and noticeable during the trip planning period, when those attempting to travel are not aware of their options and may forego their plans because of the perceived lack of services to their destination. While direct connections may not exist in abundance between various modes, indirect connections may be available and travelers without time constraints are often willing to use these means. However this creates a complexity for a passenger traveling with baggage and in an unfamiliar area.

In an age dominated by information technology, Advanced Traveler Information Systems (ATIS), as part of the Intelligent Transportation Systems (ITS) scheme, are being used extensively to allow passengers to plan and obtain information about their trips prior to arriving at terminals and also even while en route. Major transportation providers within the various modes provide trip planning systems to customers for use prior to arriving at stations. Amtrak [5], Greyhound [6], and all the airlines [7] have online trip planners that assist passengers to plan their journeys. Additionally, all large agencies and most medium and small transit agencies offer their own trip planners. Despite the existence of these separate web-based systems for various modes, there is a serious lack of any intermodal trip planner within the US. While such integrated systems exist in a few European countries, it is non-existent in the US outside of metropolitan regions. Major operators within each mode do not provide or share information about intermodal connections. The closest semblance to a nationwide trip planner for intermodal passenger transportation is provided by third party trip planners. The most complete in terms of the amount of agencies and operators included is Google Transit and even that system contains many discontinuities because of the absence of major operators of crucial modes. Even with the recent addition of Amtrak



FIGURE 3: Map showing trip planned by Google Transit superimposed by Megabus option. The black dotted line shows a trip planned from Washington, DC to Harrisburg, PA through Megabus of 3 hours' duration while the blue line Google Transit's option that takes 7 hours.

information to the database, intercity trip planning by Google Transit is still disjointed in that one cannot plan a trip from one city to another in most cases.

In cases where it is possible, the option presented tends to be unreasonably long since Amtrak is the only intercity carrier involved. Figure 3 presents a case of planning a trip from an address in Washington, DC to Harrisburg, PA. The only intercity operator included in Google Transit is Amtrak; consequently, the option provided directs the traveler to board the Northeast Regional train to Philadelphia before transferring to the Keystone Service train to Harrisburg. This option will take approximately 7 hours. However, there is another option for traveling that is much faster and cheaper. The traveler can decide to travel by intercity bus operator Megabus and arrive within 3 hours. Such is the dearth of information on all available

transportation options within existing systems such as Google Transit.

## LINX COOPERATIVE

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Besides these systems mentioned, which mostly cover metropolitan areas and include only transit and Amtrak options, there have been very few attempts or trials of trip planning systems that seemed to attack some of the biggest obstacles to having a nationwide trip planner or at least combining several areas. One of these efforts is currently taking place in the Yellowstone region in Wyoming, Idaho, and Montana and aims to connect transportation operators in the area, including intercity bus operators and local transit agencies. The cooperative, known as Linx [8], aims to improve mobility in the Greater Yellowstone region and allow transportation service providers to collaborate to make the system more efficient. A result of such efficiency could allow for the elimination of duplicate services to reduce waste for financially constrained service providers and the allocation of new locations in need of service. The program included both transportation service providers as members and also other businesses in the area. An extensive feasibility study [9] was conducted where demand, projected revenue, potential marketing efforts, and benefits were researched. Aiming to provide real-time information, Wi-Fi availability, and the ability to scan and process electronic tickets on buses, the cooperative pursued the development of their system. However, with a launch date originally scheduled for July 2011, the project appears stalled due to concerns over the trip planning system. The system providing the routing algorithm was cited as not being robust enough to handle too many simultaneous requests.<sup>4</sup> The project is still in its beginning phase and is being watched closely as it is the first of its kind to attempt a regional traveler information system in the rural parts of the US that allows intercity buses to collaborate with each other and other modes. The cooperative would not have been possible had it not benefited from a \$535,000 grant from the American Recovery and Reinvestment Act of 2009 (ARRA). The case shows that while certain transportation operators might favor collaboration, the costs of participating in a collaborative trip planner can be quite prohibitive if these businesses are not huge entities like the airlines that already have funds dedicated to such costs. In light of these inadequate systems, it is clear that no nationwide intermodal door-to-door trip planner exists in the US as it is in most Western European countries where single web-based trip planners are often available to plan trips throughout those respective countries.

## NATIONWIDE TRIP PLANNERS IN OTHER COUNTRIES

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Europe happens to be the only region where nationwide intermodal trip planners exist although incidence of completely integrated nationwide trip planners is only restricted to a few countries. The most notable of them are Denmark, the Netherlands, Germany, Finland, the Czech Republic, and Sweden, with most of these countries being located in Western and Northern Europe. The largest of these countries, Germany, is comparable in size to the US state of Montana. Besides the most obvious difference of size, there also seems to be a relative strong public sector presence within the transportation industry within the European countries.

### SWEDEN'S RESROBOT

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Of these systems, the most complete in terms of the range of modes included in the system is Sweden's ResRobot [10]. The system incorporates all major modes of transportation within the country, including air, car, high speed rail, commuter rail, regular intercity rail, express buses, rail transit, bus transit, trams, ferries, and walking. This is the only trip planner worldwide discovered by this research to incorporate airlines in addition to surface public transportation means. Samtrafiken, the managing

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<sup>4</sup> In a conversation with a Yellowstone Business Partnership representative, the cooperative was now aiming at using an open source system provided by the non-profit organization Open Plans.

organization, notes that the system contains about 50,000 stations and includes 99% of domestic public transport [11]. While the ticketing system is not directly connected to the trip planner, there are links to the sites of individual service providers where users can obtain tickets. Resplus [12] exists as a single ticket established as a means of paying for trips on multiple participating operators where advanced ticket purchase is required. The trip planner, shown in Figure 4, is extensive and has a lot of features that facilitates intermodal travel including a showing of the various waiting times relative to the travel time, an option to let you select origin or destination by map, and a limit on the maximum number of transfers.

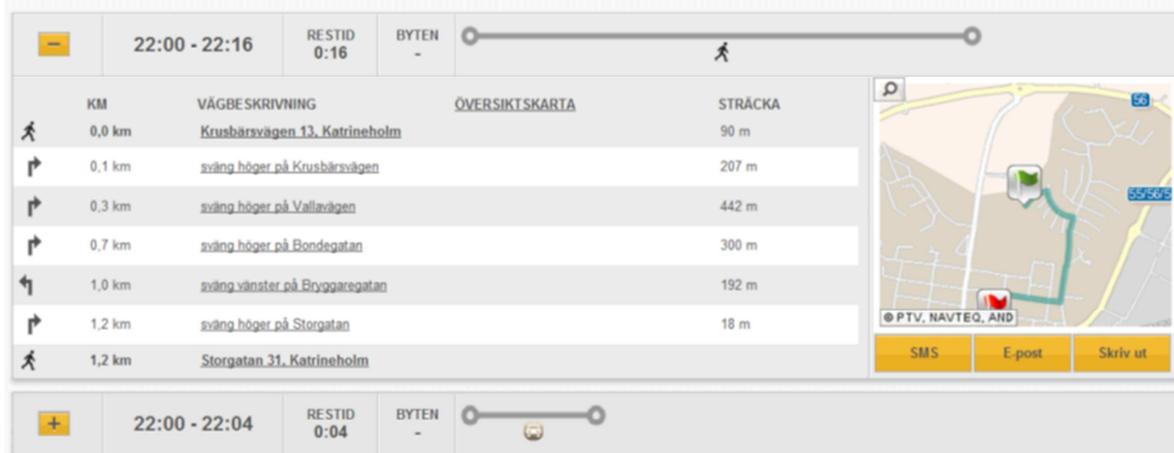


FIGURE 4: A screenshot showing a trip planned using Sweden's ResRobot trip planner.

The Swedish system was initiated and is owned by, a non-profit conglomerate of the 21 public transit authorities and rail, bus, and ferry operators. All organizations participating in the collaboration are completely doing so voluntarily although the airlines do not participate in the Resplus single ticket scheme. The system only costs 4 million euros to operate yearly [13]. In a country where public transportation retains a modal share of only 17% [14], it was relatively easy to persuade the operators of public transportation services that participation in the system would increase the attractiveness of public transportation to the general public. It is also useful to note that deregulation of the transportation industry in Sweden occurred as recently as the mid-90s. Prior to that, most public transportation services were publically owned and run. Deregulation began in most European nations in the late 80s and 90s at the urging of the European Union and may explain why many operators are more predisposed to focusing on serving the public. Additionally, because deregulation in many of these countries consisted of the public sector offering concessions (a right to operate a route for a period of time) to private operators, government authorities still retain some level of control over these private companies. In many cases, operators cannot cut or add service without approval.

## THE NETHERLANDS' OV 9292

The Netherlands was one of the first, if not the first, of the European countries to have a nationwide door-to-door intermodal trip planner. The country, slightly less than twice the size of New Jersey, initiated a nationwide integrated fare and ticketing system in 1981 while its transportation systems were all still publically owned. In order to achieve efficiency, the public transportation industry was liberalized which meant that private operators now have to compete for specific concessions. The planning philosophy applied was to approach liberalization cautiously in order to maintain network integration. The concessions are awarded to private operators by local Public Transportation Authorities (PTA) in each respective area. These PTAs also supervise the private operators and are responsible for creating new routes or changing schedules. The cautious approach has made it continuously possible to

travel throughout the Netherlands using one ticket since 1981. The nation has had a national schedule available since then and subsequently a nationwide intermodal door-to-door trip planner, 9292 OV [15]. Unlike the case of Sweden's ResRobot, no airlines are integrated within this system. As of 2006, the public transportation system consisted of 19 PTAs, 15 operators and Dutch Railways [16], which operates 98% of all train services [17]. Contracts for operators are based on performance, where bonuses are awarded and penalties are inflicted based on performance.

## GERMANY'S DEUTSCHE BAHN

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Germany is another European country with an extensive public transportation system, mainly serviced by the national rail, Deutsche Bahn. In fact, intercity bus carries only 1% of total passenger traffic in Germany [18] because of a ban designed to encourage rail use. While the company operates independently, the government is a majority shareholder and can influence decisions. The rest of Germany's transportation system is composed of PTAs and other railways. As in other parts of Europe there are certain localities where private companies compete for concessions to operate local transit systems and longer distance rail lines, although there are no subsidies provided for operating longer distance rail lines. Germany's transportation system is heavily dominated by Deutsche Bahn and the company's website serves as the main nationwide trip planner [19]. All local transit systems within the country exist on the trip planner [20] which also includes options such as biking and walking.

In addition to serving as the primary source of information on door-to-door nationwide intermodal travel, Deutsche Bahn also includes information from other European rail networks. However, for those cases, door-to-door planning is only provided from the German side because the local transit networks do not exist within the database. The scheme under which Deutsche Bahn is able to provide information on other European railways' systems was initiated by the European members of the International Union of Railroads, as mentioned in a European Railways Approach. Besides this scheme, there isn't any intermodal trip planner that covers the entire EU or a majority of countries. Rather, there are trip planners which may cover one entire country, and swathes of areas in nearby countries.

## BACKGROUND ON WEB-BASED TRIP PLANNERS

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As a result of the proliferation of the internet and information technology, web-based trip planners are a common feature associated with many companies involved with the transportation or even more generally the travel industry. With regards to the public transportation industry, a trip planner is a tool that a transportation operator or a third party provides users as a means of helping them plan their trips by reviewing available options for traveling from one specified location to another. Most trip planners in the US (excluding those associated with transit systems<sup>5</sup>) allow users to not only examine trips but also purchase their tickets electronically. For these systems, the primary goal of the trip planner is to serve as a distribution channel for tickets rather than simply serving as a source of information. Web-based trip planners can also be referred to as journey planners or online travel agents and in some cases, along with real-time travel information are collectively referred to as wayfinding systems.

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<sup>5</sup> Most large transit agencies do allow the purchase of fare through online portals. However this would only be available to travelers with a registered fare card. Whereas machines at airlines, buses, and trains may be able to read barcodes or numbers that come with electronic ticketing, transit agencies use different forms of tickets or cards with magnetic strips or microchips. It is not feasible for travelers to print these tickets at home.

Various trip planners can differ in what specific features or options are available for users to base their decisions upon. However, they all allow users to input their origin and destination and date/time of intended departure and/or arrival. Of the most popular trip planners available these additional features include the ability to select based on the carrier if multiple carriers exist (Bing Travel [21], Orbitz [22], etc.) Users can also view their options based on travel time, monetary cost, and number of transfers. Trip planners serving transit users usually include an option for the user to view their options based on the distance users would have to walk to transit stops (WMATA, Google Transit, MBTA). Some rare options include Bing Travel's airfare price prediction that shows users the trend of fares and the likelihood of prices increasing or decreasing.

Nowadays, because of the ease of implementation, virtually every operator that offers a fixed-route public transportation service has a trip planner built into its website, although the intercity bus industry lags in this aspect. Generally, the website serves as an interface to obtain the user input and convert that to a specific format in order to send that information to a server which uses a complex optimum route selection algorithm to determine the best route(s) based on the options selected by the users and the information held within a database containing route information. That information containing the best options is then fed back to the website in an understandable format for the user. A simple diagram of this process works is presented in Figure 5.

While most, if not all, trip planners function in this way, they differ in how their database server is operated and maintained, depending on the mode of transportation and the specific preference of the company. In addition to this and of course the typical telephone and physical agents, some can also distribute their tickets and information through other trip planners that serve as aggregators for multiple operators.

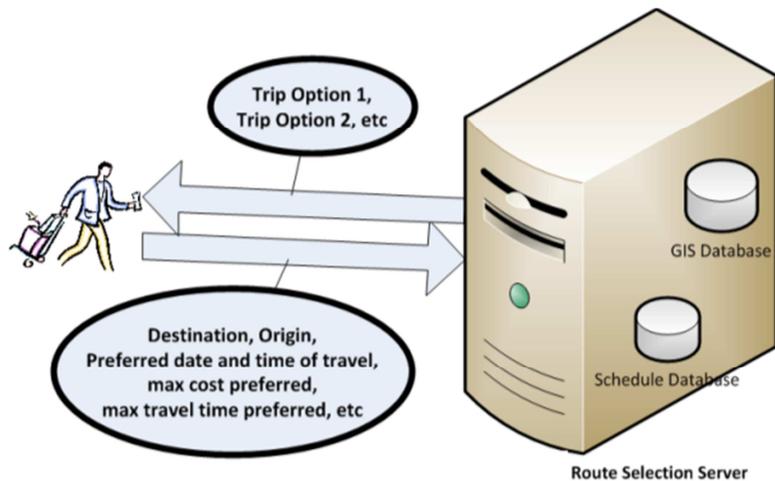


FIGURE 5: A simple diagram of the process of a user querying a trip planner. Users submit their preferences through a web interface (not shown) which the server uses to produce options that meet the user's criteria.

## MAINTENANCE AND OPERATION

There are four major approaches which are taken by transportation operators that explain how their trip planners operate on the back-end including how they supply their scheduling and ticketing information. These approaches are classified here based on the number of transportation service providers included in each approach, the amount of the Global Distribution System (GDS) approach used by most airlines, the approach used by the European consortium of the International Union of Railways (UIC), the general approach used by most US transit agencies and intercity bus operators, and a collaborative approach that has one portal but many participants who do not pay, such as Google Transit.

## GDS APPROACH

In the 70's, with the advent of new computer technology, Global Distribution systems (GDS) were created by airlines with the goal of automating the process of distribution fares and tickets to travel

agents. These proprietary systems now serve as databases from which travel agents and trip planners get information to sell to travelers. There are four major GDSs that dominate the market (Sabre, Amadeus, Galileo, and Worldspan) and most airlines use at least one as a means of distributing their tickets. Although initially created by the airlines for their own benefit, GDSs also hold data for other businesses related to the travel industry including hotels and rental car companies. Since the late 1990s and early 2000s when the airlines divested of ownership [23], GDSs have operated in an oligopoly because of their wide reach and the high cost of entering the market. Airlines generally pay a fee to include their products in GDSs. The advantage to airlines is that GDSs have existed for so long that airlines will be guaranteed that their products will be distributed to a large variety of customers through many offline travel agents and websites that serve as trip planners. These systems are also equipped with complex routing algorithms to analyze and return ticketing information based on the input of the user. Because GDSs are entrenched in the industry and have connections with many agents both online and offline, they often charge a high price to airlines to distribute their products. In fact, airlines are encountering problems trying to distribute their products efficiently and for less cost. For most airlines, distribution services tend to be the 3<sup>rd</sup> largest cost after labor and fuel, even though they no longer offer commissions to travel agents [24]. In 2005, the GDS industry enjoyed a 30% return on capital while airlines struggled to even make profits [25]. As a result of the high costs of maintaining a presence on GDSs, some airlines have begun reevaluating continuing to use these distribution services. Within the past year, American Airlines decided to terminate its usage of Sabre. Other airlines like Southwest, Jetblue, and other low-cost airlines already don't exist on GDSs. However, because of the dominating role these systems play in the transportation industry, a huge amount of tickets sold by the US airline industry are still distributed by GDSs – some estimates put this number at 54% in 2005 [25] although it is likely the figure is now lower.

## EUROPEAN RAILWAYS APPROACH

Just as the GDS approach is a major way of managing and maintaining data for trip planners and is in heavy use in the airline industry, a whole host of European railways participate in a system which presents another major approach to managing data for trip planners. The approach of the European railways was inspired by the common goal of connecting passengers and making traveling easier. Because of the fragmentation of travel information, travelers in each country would not have adequate information to railways that operated outside of the country. Additionally, they were often confused by the complexity of the system which left them with limited choice. The effort to integrate transportation information systems was led by the railroad industry body, the International Union of Railways (UIC). UIC affiliates note that, in order to make it easier for passengers to travel across countries and various rail companies, the organization recognized that they needed interoperable distribution – i.e., other European railways needed to be able to distribute information and tickets about other railways, to make it easier for their passengers to make connections. To ensure that this was possible, the body established standards by which the member railways would abide to allow for interoperability. A single format is used to supply and extract data, called EDIFACT. There is also an interface software program available for railways that need to convert to and from proprietary formats. Two main databases are used to store information regarding the fare and timetable information. MERITS (Multiple European Railways Integrated Timetable Storage), which contains timetables of 32 railways, allows companies to have easy access to scheduling data needed for their trip planners [26]. The PRIFIS (Price and Fare Information Storage) is the other database that contains the price and tariff data. Both databases allow the railways to update their information on a regular basis and do away with a high amount of multilateral exchanges that would have otherwise been required [27]. With regards to settlement and transfers of payments, the UIC has its own clearinghouse that deals with the settlement process between railways and ensures that monthly financial flows are timely. Moreover, for railways that permit it, GDSs used mostly by airlines can also distribute railway products [28].

## TYPICAL US TRANSIT APPROACH

Generally, the two aforementioned approaches are used by railways (in Europe) and airlines. Most other transportation companies tend to use a simpler approach which normally consists of developing the web interface on their own sites and contracting out the algorithm development and data storage to a third party. This generally tends to be necessary because most transportation companies do not have the resources to develop a sufficiently robust in-house algorithm for optimum route selection. Within the US, transit agencies, intercity bus operators, and a few small airlines use this approach. The one notable exception is Amtrak, which developed and maintains its own trip planner. However, when the aforementioned approach is used, the 3<sup>rd</sup> party may develop its own proprietary formats and standards or accommodate a few common standards which the transportation agency needs to abide by in order to submit and update scheduling data.<sup>6</sup> Nowadays, agencies seeking trip planners but yet do not want to pay for a third party's services have the option of using an open source trip planner called OpenTripPlanner [29].<sup>7</sup> In addition to the trip planner, if the transportation service provider allows sales of tickets, then another system would need to connect to the trip planner in order to process payments.

## COLLABORATIVE APPROACH

Becoming more common nowadays is the approach where operators provide their information in a specified format to a central database for use in a trip planner along with data from other operators. Google, Mapquest, Bing and Hopstop are among the companies that use this approach to establishing a trip planner. In the US, transit agencies and Amtrak are the only participants in these programs and data is provided voluntarily. However, in certain European countries, namely the UK and the Czech Republic, operators are required to provide their data to the central database. For participants of this approach, the main goal is to allow passengers to plan trips across agencies with ease. Participating operators submit their data to the database and their trip planner is maintained and operated by a 3<sup>rd</sup> party usually from one website, as opposed to the European Railways approach where one operator can sell tickets for another.

## STANDARDS AND INTEROPERABILITY

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As is evidenced above from the myriad of means through which transportation service providers can provide their trip planners, there are no universal standards that allow interoperability between modes and various companies. Each company or group of companies, such as the European railways that participate in the MERITS/PRIFIS system and airlines involved with the GDSs, has come up with its own standards based on its needs. Because of this, integration of data would not be currently feasible unless a common set of standards were created that would apply to all modes of public transportation and allow for easy integration and interoperability of many systems. A single standard should not only suffice specifically for trip planners but they also need to allow for interoperability with other standards that exist for other systems used by these operators to allow ease in transfer of information between systems. An example of this is illustrated in the case with transit agencies where there are many different systems that make use of information technologies and it is often impossible or disadvantageous to have all systems

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<sup>6</sup> Third-party trip planner suppliers such as Trapeze Group tend to accept data in their own proprietary format (Trapeze also sells scheduling systems which has its own formats) and the General Transit Feed Specification (GTFS)

<sup>7</sup> The free 3<sup>rd</sup> party multimodal trip planner accepts data in the GTFS format, shapefiles, and from the National Elevation dataset. The service is provided by OpenPlans, a non-profit that uses technology to help public agencies better manage data and serve their populations.

serviced by a single vendor. As shown in Figure 6, a trip planner for a typical large transit agency ultimately gets its information from the scheduling system by means of the agency database. However, other systems also pull data from the agency database and that data must be in a usable format. Interoperability between systems will ensure that when scheduling information is updated, these changes are automatically available for use by the trip planner instead of the need to manually transfer specific information to conform to the format of the trip planner every time there is a change in the schedule.

Given the increased proliferation of ITS technologies within transportation systems, it is easy to see how standards can play a strong role. For that very reason, the American Public Transportation Association (APTA) created an extremely robust standard for transit agencies, TCIP (Transit Communications Interface Profile). TCIP not only aims to satisfy conditions for the transit industry but it is also interoperable with other general standards of the National Transportation Communications for ITS Protocol (NTCIP) which was developed in collaboration with related stakeholders, including NEMA (the trade association of the electrical manufacturing industry) and the Institute of Transportation Engineers (ITE) [30] [31].

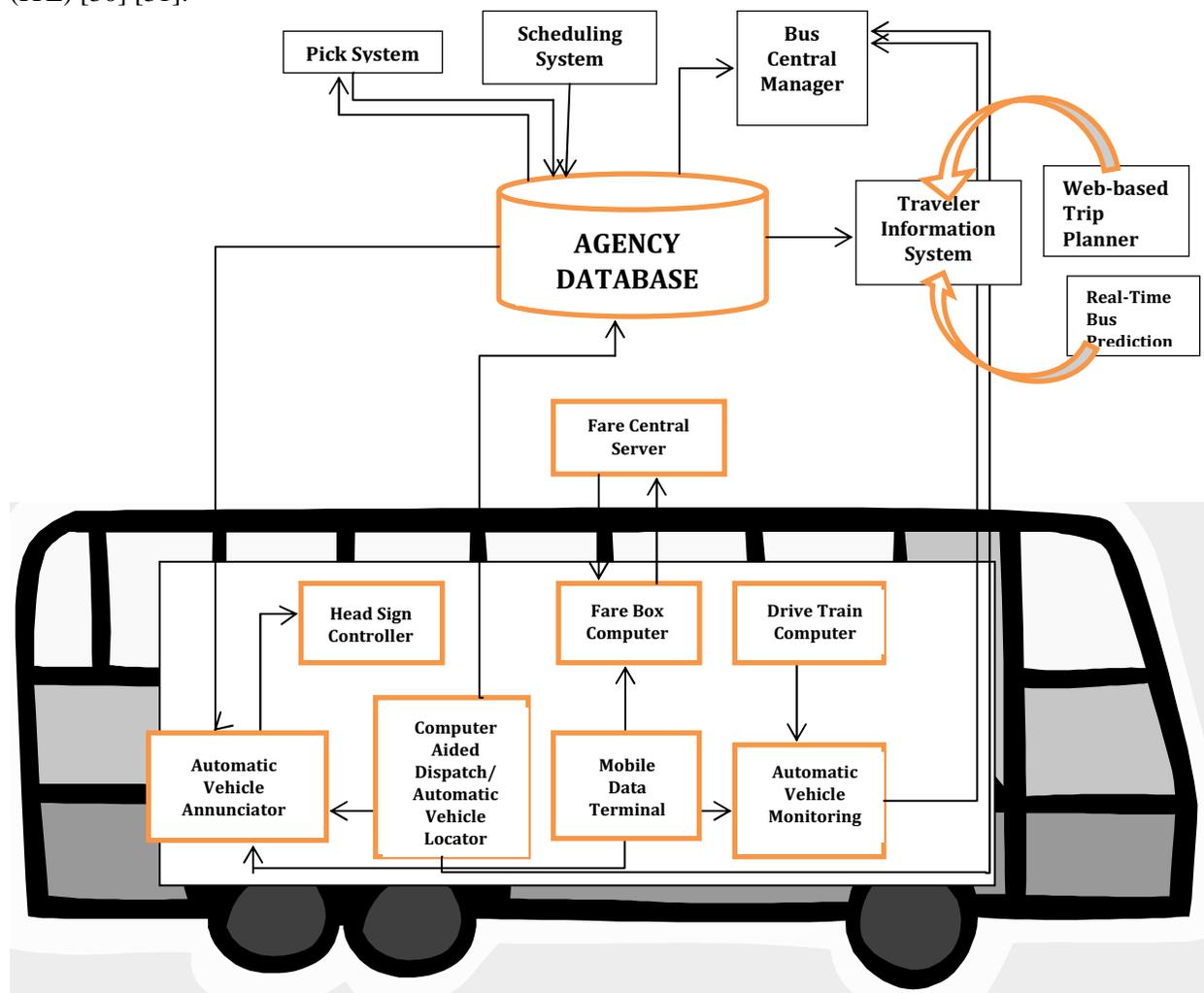


FIGURE 6: ITS architecture of a typical large US transit agency. The complexity and interdependency of this system demonstrates the need for trip planner standards to be compatible with standards of other systems within the agency.

As comprehensive and well-planned as the TCIP standard is, it has not been adopted widely within the transit industry. Correspondence with industry insiders reveal that there is no single transit agency that primarily uses the standard. The General Transit Feed Specification (GTFS), a standard promoted by Google for use in its Google Transit project, has a lot more transit agencies participating – over 447, with a significant amount of those transit agencies based in the US [32]. The popularity of the GTFS standard could be explained partly by the free trip planner service Google offers to transit agencies who submit their data in the GTFS format. This would be extremely attractive to smaller agencies with insufficient resources to dedicate to a trip planner.

The TCIP standard has not gained momentum largely due to the initial difficulty in applying the standards. A Federal Transit Authority (FTA) project [33] to create a multimodal trip planner in the Chicago Metropolitan area examined the TCIP standard for potential use but discovered many problems with implementation. In the first few years after introduction to the public, documentation for the standard had not been provided in the easiest format to handle. Past TCIP standard documents had been presented in formats that did not facilitate ease of understanding; the standards attempt to apply to all aspects of ITS relevant to transit. A lot of the systems represented may also not have been relevant to all agencies. As a result, the standard created confusion for those trying to implement it. Moreover, most legacy systems used by transit agencies are proprietary and don't follow the TCIP standards. It is generally the policies of vendors supplying ITS technologies to try to create products for all transit systems and push for transit agencies to adopt all their products in order to prevent compatibility issues, instead of designing the products for interoperability. If transit agencies do not require TCIP compatibility, vendors will not push for it. As a result, the simpler GTFS is more widely used although it is bare in that it lacks support for a lot of features, such as real-time information or accessibility features. However, it is important to note that the GTFS is an open source standard and although created initially by Google, it is now maintained by the GTFS developer community and has the potential to evolve to become more robust.

While the transit community seems to be making headways in creating a common standard, the airline industry, as a part of the general travel industry has also been pursuing one of its own. Founded in 1999, the OpenTravel Alliance is a member-sponsored organization comprising the major players in the travel industry including the GDS owners and major airlines. The goal of the organization was to create an open standard for the dissemination of distribution data for travel companies. The most recent standard uses extended markup language (XML) to detail specifications for data exchanges and formats. The format is in wide use and the OpenTravel Alliance claims that “tens of millions” of messages are carried every day in its format [34], proof that the airline industry has arrived at its common standard. On the other hand, Amtrak is the only company serving intercity passenger rail market and already has its data available in its own format and in GTFS. This situation leaves the intercity bus industry as the only major mode within the transportation industry that hasn't produced a standard for its member companies. The relatively huge number of operators that exist within the industry and the private nature of the companies are all factors contributing to this lack of a common industry standard. There hasn't been any major effort to arrive at a common standard either.

There are positive signs within most modes that a commonly accepted standard for data transfers are being created and developed. However, it is quite apparent that significant problems will arise in trying to converge to a suitable single standard for all modes within the industry. The ultimate goal should be to create a standard with the user-friendliness of the GTFS<sup>8</sup> that can also accommodate complexities

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<sup>8</sup> One of the chief complaints against the GTFS is its extreme simplicity which results in a lack of capability to handle certain features that transit agencies want represented, one of which is accessibility features.

and features of the various transportation modes while also allowing interoperability with other information systems used by operators. Special care should be taken to ensure that the standard is easy to understand or at least that there are enough documents to facilitate implementation so as to avoid the mishaps of the TCIP. In the process to arrive at this common standard, many problems will arise due to different conventions used in each mode. Even terminologies for similar concepts vary across modes and operators. However, the process, which should be collaborative, is not infeasible.

## ASSOCIATED LEGAL ISSUES

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Within the literature, integration of trip planning systems does not seem to produce any new legal issues except within the transit arena. The issue mainly relates to sharing and ownership of transit data. The issue is fairly new and many transit agencies have resisted sharing initially because they wanted to retain the information for possible financial gains. However, transit agencies themselves contend that they do not want to be liable for misinterpretation or misrepresentation of information by 3<sup>rd</sup> parties. This tends to be of greater concern to larger agencies while smaller agencies see more benefit in participating in systems such as Google Transit.

Two large transit agencies that were notable in abstaining from providing their data to Google Transit are the Washington Metropolitan Area Transit Authority (WMATA) and the Los Angeles County Metropolitan Transportation Authority (LA Metro). News reports [35] [36] suggested that LA Metro delayed in putting their information on Google Transit because the agency forecasted a decreased traffic to its own trip planner and wanted Google to pay for the data. For WMATA, the problem was not only with potential revenues that Google could get from its data but also a fear of being held liable for any wrong information or misrepresentation of information [37]. This was the case even though Google's standard agreement [38] and terms of service on its site [39] indemnifies Google and the participating agency from problems caused by any use. WMATA had made its data available under a license which included terms stating that WMATA could decide to charge for the data at any time [40]. Additionally, if there were any problems caused by poor quality of data or misrepresentation of data, the 3<sup>rd</sup> party was obliged to pay all court and settlement costs. Eventually, both transit agencies did agree to share their information with very slight modifications to the standard Google agreement. For WMATA, this came after many angry letters from the public urging the agency to agree to Google's terms [41].

The aforementioned cases demonstrate the dire situation associated with transit agencies and data sharing. Moreover, it is important to note that major transit agencies (WMATA and LA Metro included) are entering these agreements with Google while having a separate license available for other developers who also want to make use of the data. Transport industry analyst Tim Howgego [42] notes that the practice of having two different licensing models for the same data sets a bad precedence and does not promote fair competition. Howgego's posits that Google's offering of free service does not make it a charity or a non-profit organization. Google could choose to advertise in the future to users based on their destination and time combination. In light of all these concerns, an FTA-sponsored study [43] suggests that federal assistance is needed in clarifying rules and issues relating to culpability in order to encourage coordination on data sharing and standards.

## RESEARCH OBJECTIVES

With the previous sections framing the issue of the lack of a nationwide web-based trip planner by highlighting the lack of available information systems and providing a background on the state of trip planners, this research effort posits that the creation of an efficient and extensive web-based nationwide door-to-door intermodal trip planner is needed to solve many of these associated problems. The aim is to reduce uncertainty in route selection and the inconvenience that accompanies lack of information.

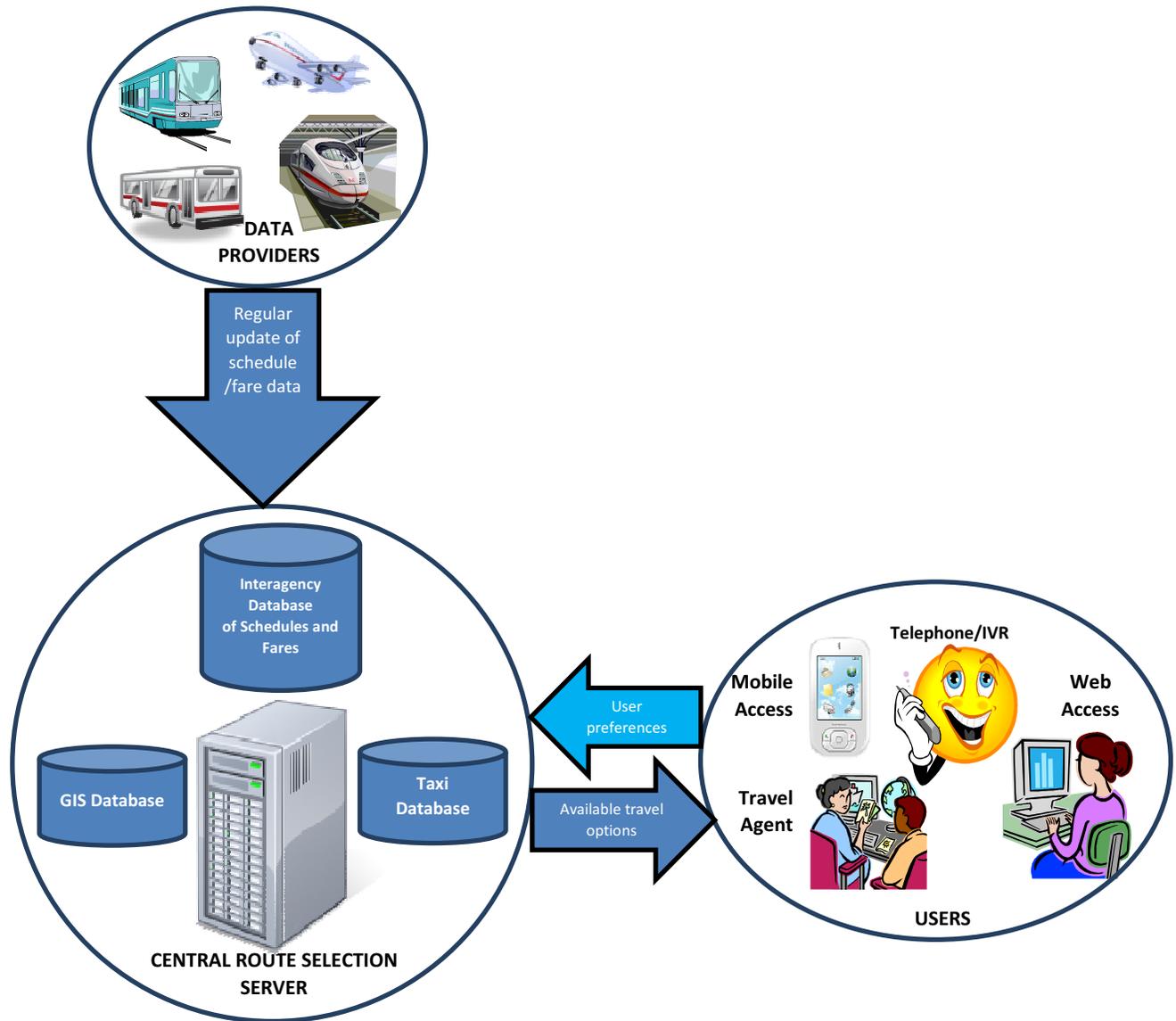


FIGURE 7: Diagram of the proposed traveler information system. Transportation operators provide a regular update of schedules and fares to the interagency database on the route selection server which generates available travel options to users based on their input.

Whereas the current method of trip planning involves multiple portals, even within modes, the proposed system will present travelers with a single portal to meet all their planning needs. Upon selecting a specific trip provided by an operator, travelers can decide to be directed to the websites of operators that comprise the trip in order to make a purchase, if online purchase is offered by the operator. The system

will include operators from the major modal groups including intercity buses, intercity rail, commuter rail, transit, and airlines but it will also include taxis. Taxis are included within the system because of the recognition of the disjointed nature of the US public transportation system. They will serve as means of connecting users who live too far from stations. In the future, additional modes can be included in order to enhance the reach and flexibility of the system. For the modes with fixed routes (all modes except taxis), information will exist on the schedule of trips, the associated costs, and any critical information about the trip. Along that line, since the rates of taxis are based on geographical areas, travelers seeking to plan trips will be able to see rates for taxis based on the specific distance of the leg of the trip that will be serviced by taxi. Also provided will be a list of a few taxi companies for that area along with their phone numbers and websites. The information on taxi rates for various localities can be assembled manually, as most localities have that information available online or by phone. Additionally, a few third parties provide estimates of taxi rides, such as TaxiFareFinder.com, and can serve as a source of data. Figure 7 presents a simple sketch of the proposed system.

The purpose of this research effort is to examine the requirements to creating the described system. This paper will explore several issues pertaining to the creation of this system including the support system needed, potential legal issues, and suitable entities for administration and management of the trip planner. Several questions related to these issues which will be addressed are listed below:

- *Is there need for any support system to be put in place to facilitate the creation of this system?*
- *Will any policy implementation by federal agencies (e.g. US Department of Transportation) facilitate this move and if so, what specific policies?*
- *What potential legal issues could erupt from the creation of this system?*
- *How could this system best be initiated and managed? Where could funding for the system come from?*

The research aims to produce a list of the needs of users and transportation operators in the current system and the benefits that the proposed system will bring to them. Additionally, the research will identify obstacles to achieving this system. In the end a roadmap will be provided to serve as a guide to achieving the proposed system.

## MOTIVATION

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A simple case of a traveler planning a trip from Blacksburg, VA to Boston, MA is presented in order to truly gauge the difficulty of intercity trip planning within the US and to demonstrate why the proposed system is needed. Differences in planning with the current system (Figure 8) and the proposed system (Figure 9) are highlighted for this case as presented for a traveler without possession of a personal vehicle. With the current system, the traveler will have to use many portals to ensure that a suitable route has been selected. Even then, there might be some uncertainty as to whether the best option is selected based on the traveler's criteria. Our traveler decides to travel by airline and eliminates all other means of traveling either because she might not be aware of them, or because she assumes that they might not meet her requirements. The traveler ventures to three web portals – Southwest.com, Priceline.com, and Bing.com – to select the right ticket. Initially, only the airline ticket is bought and our traveler waits until a week or two prior to the departure date to plan for means to and from Roanoke Regional Airport and Boston Logan Airport, respectively. This time, the traveler uses personal knowledge, her social network,

and other websites to find her available options.

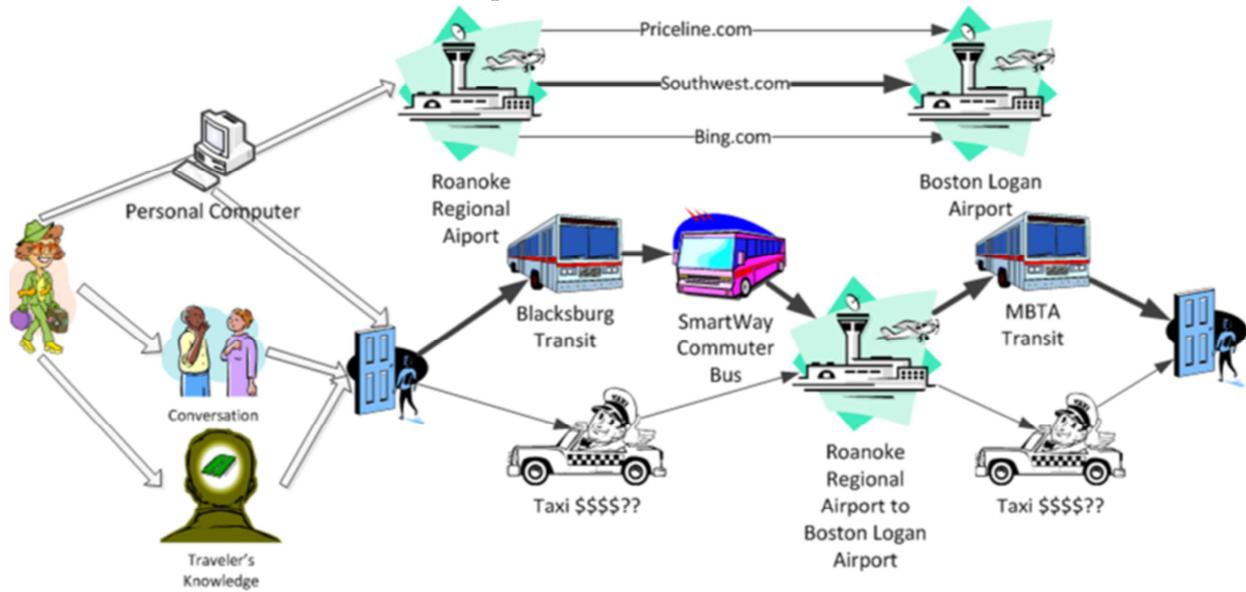


FIGURE 8: Diagram showing a typical trip planned under the current system. A traveler plans a trip from Blacksburg, VA to Boston, MA. The bold arrows show the options selected. Note that the trip is broken apart into segments, which are searched for separately through different portals.

Through these means, she finds out that on the departure side, she can either take the SmartWay commuter bus to Roanoke Regional Airport by means of the Blacksburg Transit bus or she can take a taxi. At the arrival end, she finds out through a web search for the term “Boston public transportation” or through Google Transit that she can take the MBTA’s Silver Line from Boston Logan Airport. Aiming to reduce her travel costs, and because contacts within her social network told her about the complimentary Wi-Fi network available on the SmartWay bus, she decides to take transit to and from the airport.

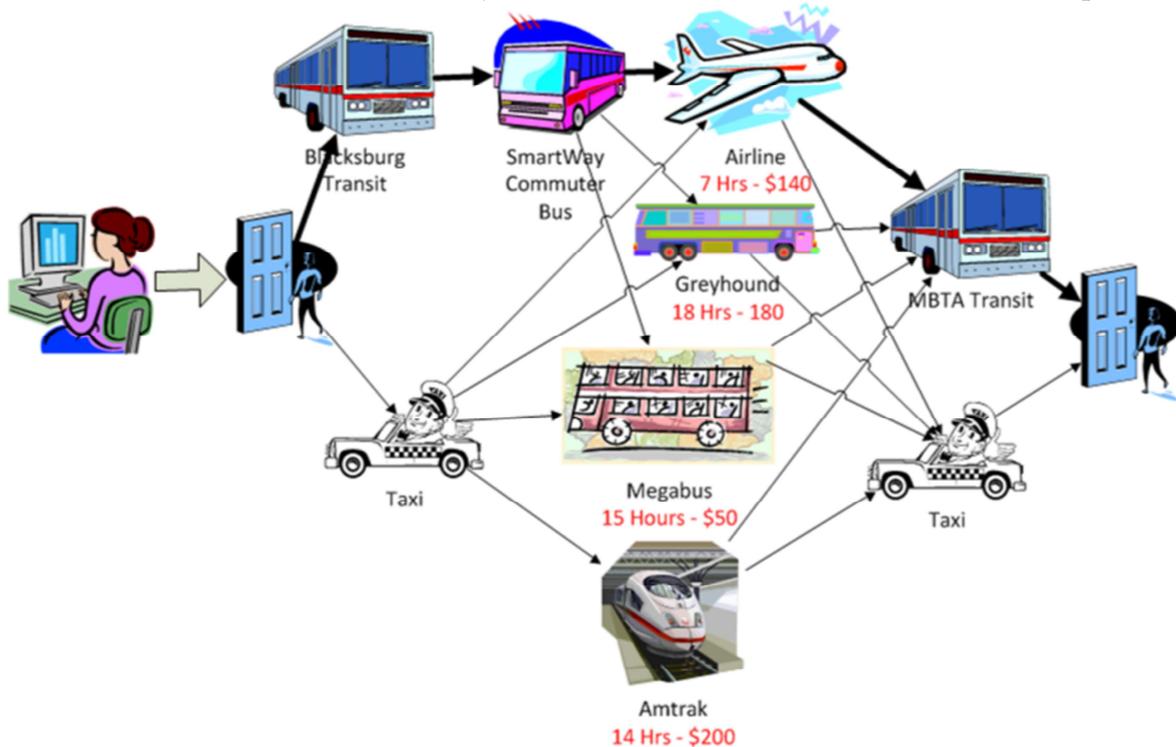


FIGURE 9: Diagram showing a typical trip planned under the current system. A traveler plans a trip from Blacksburg, VA to Boston, MA. Note that only one portal is used and the user can get a sense of the costs (financial and temporal) of the entire journey.

Such is the typical way in which travelers plan their trips under the current disjointed system. Segments of trips are often planned separately from each other and at different times. Additionally, travelers make travel decisions without being fully aware of all of the available options or significant details. For our traveler, contacts within her social network might have omitted crucial information regarding the requirement of exact cash fare of \$4.00 to ride the SmartWay commuter bus. Such missing information could cause inconvenience to our traveler and could result in a missed flight. Additionally, the nature of planning segments of trips separately can also cause inconvenience to travelers. Our traveler might have decided that she would take the SmartWay bus to the airport but because she planned the trips separately, yet she might not be aware that if her departure date was on a holiday such as Memorial Day, the SmartWay bus would not be operational. Moreover, the current system involves much uncertainty and creates the possibility for travelers to select trips that is not the optimum route based on the traveler's preferences. Perhaps our traveler is a student who is going away for vacation and is not so much concerned about travel time as she is with financial cost. She was not aware of the recent establishment of a stop for intercity operator Megabus 20 minutes' drive away from Blacksburg. With such a low cost, that option would have been optimal for our traveler.

Under the proposed system, travelers would be aware of a majority of available options and will be able to plan trips in a door-to-door format and will avoid the troubles associated with planning different segments of a trip separately. Once suitable travel options are presented, the user can elect to visit the websites of operators in order to purchase tickets. The proposed system will allow users to utilize only one portal to discover travel options and make trip planning less time consuming and confusing. It will also reduce the need to have personal knowledge of the area.

## JUSTIFICATION OF THE SYSTEM

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### BENEFITS TO USERS AND SOCIETY

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Although the proposed trip planner will mainly benefit users of the transportation system, there will also be benefits to transportation operators and society in general. As a whole, the system will provide a substantial improvement in the nation's overall transportation system in that it will make it more efficient and easier to use. Subsequently, it will achieve many of the goals established by the ISTEA legislation and current national and local transportation objectives. One notable benefit of establishing this national intermodal trip planner would be the drastic improvement in information availability and the ability of passengers to identify intermodal connections. This will help to promote modes that are not over-constrained or in high demand. A result of this will be reduced congestion on the major modes of transportation. As congestion is a critical issue of the nation's transportation system, this is an important byproduct of the system. These benefits are evident in the causal diagram in Figure 10.

Establishing this system will also make it easier to spot the gaps in the nation's intermodal transportation system. While the BTS's Intermodal Passenger Connectivity Database allows policy makers and experts to gauge the connectivity of the nation's intermodal transportation system, this information is largely hidden from the public because the format is not appealing to the general public. The trip planner will make those gaps more visible to ordinary citizens, whose complaints are usually the driving force behind policy changes and infrastructure adjustments.

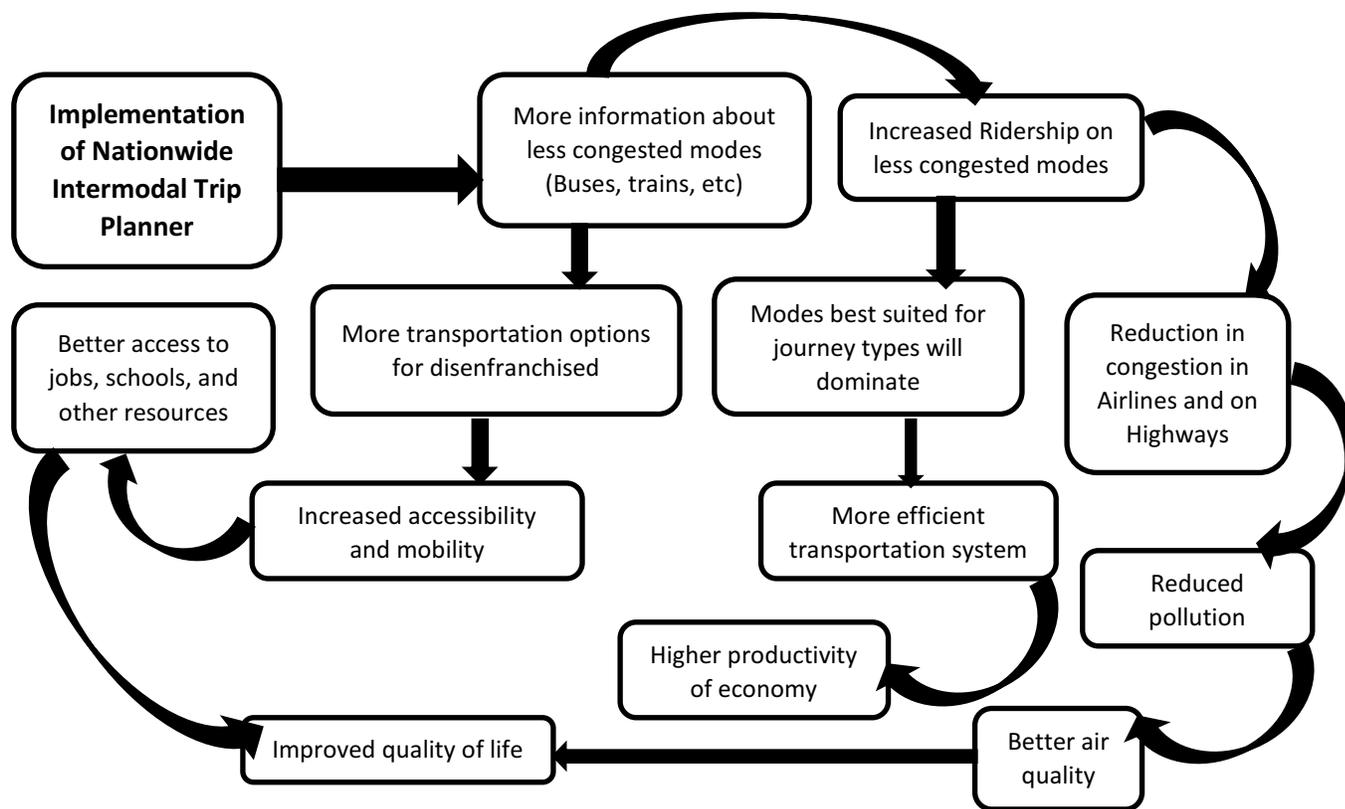


FIGURE 10: Causal diagram of the various benefits of the proposed system.

Overall, the system will improve the nation’s transportation system by making it more efficient, increasing productivity, and making it easier for passengers to navigate. Additionally, the visibility of many different means of transportation will improve mobility for disenfranchised populations who will now have more options for travel. Additionally, as less popular modes tend to consume less energy than the ever popular automobile, there would be an overall reduction in energy consumption and subsequently, the environmental impact of transportation. The tourism industry will also benefit because tourists will be able to navigate through the country more easily.

#### BENEFITS TO OPERATORS

For operators, participation in this system will ensure that one format is selected as a standard for scheduling data. As a result of a single standard for the entire transportation industry, operators will find an even greater amount of vendors will be available to service their internal scheduling systems. Not only will they be able to cut their costs because of the greater level of competition, but they will also find that migrating from one scheduling system to another will take a lot less time and resources than before. With a single standard, it will take less time preparing data for the transfer to a different system.

Additionally, because there will be only one portal for travelers to plan all their trips, operators will also be able to see all the options available to travelers and this will present a better way to assess the market and decide upon new markets to pursue. Gaps in the transportation system will be easier to spot and filled by operators looking for new ventures. In this way, costs attributed to market research will be reduced. On the other hand, as competition is increased between operators because customers can better evaluate and compare options, some operators might find that another operator is providing a better option for travelers and can decide to shift resources from unprofitable areas. An example of this could be

the case where intercity buses capture a significant market share of trips of less than 300 miles from Amtrak. If that happens, Amtrak can decide to eliminate certain stops along its lines. The elimination of these stops could help Amtrak not only become more efficient in operations but also make it a viable competitor to the airlines for trips between 300-500 miles. Of course, this could lead some airlines to cut unprofitable routes and allow for more efficiency. This process has the potential to increase the productivity of the nation's transportation industry. A summary of the various benefits is presented in Table 1, partitioned by the main recipient of the benefit.

Users	Society	Operators
Better access to resources	Increased productivity of transportation system	Cheaper costs to maintain internal scheduling system
Better ease of navigation of transportation system	Reduction in overall fuel consumption	Shorter time and lower costs in migrating to new scheduling systems
Improved mobility for disenfranchised populations	Improved air quality	Lower cost and easier means of identifying underserved and surplus markets in conducting market research
	Reduced congestion on roads and at airports	

TABLE 1: Benefits of the proposed system to users, society, and transportation operators.

Subsequent sections of this paper will assess the current and past legislation on the national level regarding the creation of a seamless transportation system, with a focus on traveler information systems. They will also assess national and local transportation agenda to determine whether the goals of the proposed system complement those transportation objectives. An analysis of the costs and benefits of implementing the proposed system which will be drawn from interviews with key personnel within the transportation industry, surveys with transportation system users, and a review of nationwide trip planners in other countries. Finally, a roadmap will be offered on how best to implement the system. The roadmap will include a mention of the necessary players needed to participate to allow the system to function properly, what actions they need to take to ensure the system works, and how the system can be sustained.

## CHAPTER 2 - LITERATURE REVIEW

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### REVIEW OF LOCAL AND NATIONAL TRANSPORTATION OBJECTIVES

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There would be no logic in proposing a system or tool to be incorporated within the nation's public transportation system if such a tool would not satisfy national and local transportation objectives. To determine what the national and local transportation objectives are and how they relate to multimodal passenger transportation, it is important to examine the objectives set forth by the various organizations that govern transportation planning activities in their respective geographical areas. In addition to that, it is also essential to examine current and past legislative acts regarding transportation and concrete actions taken as a result of those laws and an evaluation of whether or not the original objectives were achieved. A review of these objectives and laws should yield the official position of federal and local governments on the issue of intermodal passenger transportation. As noted before, special attention is paid to the relationship between these objectives and traveler information systems that facilitate intermodal passenger transportation.

#### US DEPARTMENT OF TRANSPORTATION (DOT)

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The main agency in charge of formulating transportation policies for the nation aims to create a "safer, more efficient and cost-effective" transportation system for moving passengers through intermodal supply chains. It is worth noting that the mission of the agency is to

*"...serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future [44]."*

In order to continue to fulfill that mission, the agency set numerous goals as part of its strategic plan, a few of which create a direct overlap with the goals of the proposed nationwide intermodal trip planner. The DOT's goal of seeing an overall reduction in urban congestion through "increased transportation capacity resulting from public private transportation partnerships" can be met through a nationwide trip planner which incorporates various modes of transportation and includes a mixture of public and private operators. By juxtaposing underutilized modes such as intercity buses and rail with over capacitated modes such as airlines, a nationwide trip planner will help increase capacity by facilitating a more efficient use of available resources. The availability of more connections also has the potential to draw more travelers towards using public transportation and reducing the number of personal vehicles on the streets, thereby reducing urban congestion.

In addition to this goal, the DOT also aims to see an "increased use of integrated Intelligent Transportation System (ITS) networks", a close reference to a trip planner. The final DOT goal which coincides with the goals of a nationwide intermodal trip planner aims for an "increased access for all Americans", which can be achieved by the trip planner because increased connections to many modes and carriers will undoubtedly improve the access Americans have. Whether they live in rural areas or in cities, they will have easy access to the nation's entire public transportation network.

There are also many mentions of the intention to reduce pollution or any other adverse environmental effects, all of which are byproducts of an integrated public transportation system created by a nationwide trip planner. The goal is to promote a truly intelligent system, not just mode-based intelligence systems.

While government agencies can have goals and objectives set with regards to a certain issue, if there is no follow-up in terms of legislative action or provision of funding, the issue will not progress. In examining the legislative actions taken by government agencies that intended to foster the creation of a seamless nationwide transportation system, it was discovered that while there has been a significant amount of effort by federal agencies and legislative bodies the governance structure in the country limits how much can be accomplished by the federal government. Additionally, federal transportation policy has historically, focused almost exclusively on individual modes rather than intermodal connections [4]. So while ISTEA viewed different transportation modes as part of a larger transportation network, it maintained separate funding for the individual modes. It did manage to establish guidelines for metropolitan areas to prioritize highway and transit needs of the entire region and an overall approach for decision making regarding surface transportation which local and state governments could follow in promoting an integrated transportation system. ISTEA also established the Office of Intermodalism within the DOT however the office dealt mainly with intermodal freight issues and as a result the term “intermodal” within the DOT refers almost exclusively to freight intermodality. In addition to being mostly focused on freight, the office also had a strong focus on research as it existed within DOT’s Research and Innovative Technology Administration (RITA). The office existed until a GAO report in 2007 [45] recommended locating the office outside of RITA. Since then, the office has been disbanded and integrated within the office of the Secretary of Transportation in order to coordinate intermodal efforts at the federal level. Whether that shift was beneficial, has not yet been determined.

The next major transportation bill, the Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21) [46] continued many of the basic policies and programs earlier established by ISTEA. However, it provided states and local governments with the ability to use highway funds for transit projects, a move that seems to prioritize the achievement of general transportation goals rather than goals for a specific mode. Airlines, which are treated separately with regards to federal transportation legislations, under the Vision 100 – Century of Aviation Reauthorization Act [47], received little focus on intermodal transportation. While the legislature encourages intermodal connections, it focused mainly on runway and terminal infrastructure.

Overall, while Congress has aimed to improve intermodal transportation, an effort that is clearly reflected through the various legislations, efforts have not been coordinated. The fragmented nature of governance structures in the nation makes it difficult for a coordinated effort to be taken. Additionally, since the DOT still operates along modal lines, what happens more frequently is that modal goals are pursued instead of system-wide goals. In addition to recommending a relocation of the Office of Intermodalism, the GAO report also cites three main issues that inhibit intermodal transportation development in the nation:

- *Limited federal funding for intermodal projects because of legal requirements*
- *Limited collaboration between stakeholder organizations*
- *Limited ability to evaluate the benefits of such projects*

The GAO report explains that the continuing practice of funding along modal lines gives less viability to intermodal projects as they don’t completely satisfy the requirements of either one of the modes included. Additionally, the fragmentation of agencies and organizations that deal with various facets of transportation ensures that intermodal transportation development continues to be inhibited. On a final

note, the limited ability that stakeholders have to evaluate the benefits of intermodal projects prevents progress because stakeholders cannot get a true quantitative sense of the value of said projects. It is often difficult to assess the impact of connecting to a nationwide system when the benefits are spread across the nation and becomes diluted for the stakeholders in the immediate area of interest.

#### METROPOLITAN PLANNING ORGANIZATIONS (MPOS)

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While it is quite clear that DOT goals and mission support implementing a nationwide trip planner, the nation has a federal government system. While the federal government might make certain policies, it may be difficult to implement those if they conflict with the policies of individual states or localities. For that reason, it is also worthwhile to investigate the goals of MPOs throughout the nation to determine whether their objectives coincide with that of a nationwide trip planner. MPOs came into existence as a result of federal legislations that realized that effective planning for regions could only be carried out if it were a continuing and comprehensive process, and involved the cooperation of all municipalities involved. As part of their functions in creating continuous plans for their respective areas, MPOs are required by law to produce a transportation plan and a transportation improvement plan which is updated yearly. Since MPOs work with and are comprised of leaders from local areas under their control, they present a great opportunity to access the transportation objectives of those local areas. Transportation plans for a total of 5 MPOs, representing about 48 million people, 15% of the entire US population, were reviewed and shows that their objectives overwhelmingly support the proposed trip planner. While all of these MPOs do express explicit support for the goals of the trip planner, their various focuses reveals the different character of each region.

The Chicago Metropolitan Agency for Planning (CMAP) focuses on performance and expresses a goal of developing a transportation system that maximizes the performance of existing facilities [48]. Along with this, it aims to support proposals that not only had this goal of improving capacity of existing facilities but also ones that aim at improving connections between existing transportation facilities and providing better accessibility to surrounding land uses. In terms of congestion relief, CMAP's objectives are to develop a transportation system that improves information available to travelers and reduces recurring delay through incentives encouraging alternate modes of travel. Along a similar line, the Southern California Association of Governments (SCAG) aims for "a seamless public transportation system" and to provide a transportation system "where most of the gaps have been addressed", an almost word-for-word description of what the proposed trip planner aims to achieve. Additionally, SCAG intends to support more travel choices and improve the air quality and energy efficiency [49].

Given that Boston is known as "America's walking city" and has one of the most extensive public transportation networks in the nation, it is only fitting that the policy of the Boston Region Metropolitan Planning Organization not only proposes to reduce reliance on automobiles and increase public transportation mode share but also to encourage "transportation choices that promote a healthy lifestyle such as walking and bicycling" [50]. It is easy to see how a tool such as the proposed trip planner, in providing incentives for travelers to abandon private vehicles, encourages walking as it is often the most common means of accessing transit stops. In addition to promoting a healthy lifestyle, the Boston area MPO goals regarding mobility and equity also complements the proposed trip planner. The vision for increasing mobility in the area is to "maximize the implementation of multi-modal transportation approaches in both urban and suburban settings, including roadway, transit, bicycling, and pedestrian." In terms of equity, the MPO aims to provide better access for all including disenfranchised members of society (the youth, elderly and disabled users, and members of zero-vehicle households). One of the barriers to equity in accessibility of transportation options for disenfranchised populations, especially members of zero-vehicle households, the elderly and the youth is the lack of knowledge of available options. If a member of that population is not aware that an option is available to travel somewhere, that

person will most likely not make the trip because the option of a private vehicle may not exist. However, if all information exists at a single location, it is easy to find out any available transportation options. Likewise, the New York Metropolitan Transportation Council (NYMTC) also recognizes the need to maintain convenient and flexible transportation choices and set the goal of providing that in addition to “expanded connections, particularly between modes and between communities” [51].

The dissection of the transportation goals of all the aforementioned MPOs point to their implicit support of the creation of an integrated and intermodal trip planner since it achieves the many goals of having an efficient transportation system, that is both equitable and provides many options, while also reducing the air pollution and increasing energy efficiency. However, some may still argue that these objectives are mainly for application within their respective regions. This assessment is inadequate because if residents in a region can easily access facilities within the region, but then find themselves disenfranchised when it relates to traveling outside the region; they will still find that the transportation system does not meet their needs. Along the same note, it is difficult to reduce air pollution due to transportation in a region without considering intercity transportation originating or ending in that region.

When it comes to MPO goals that are complementary to those of the proposed trip planner, the Washington Metropolitan Council of Governments’ (WMCOG) goals coincide with the proposed system the most of all the examined MPOs. In order to provide reasonable access at reasonable cost, Washington's MPO aims to have "a comprehensive range of choices for users of the region's transportation system", "accurate, up-to-date and understandable transportation system information which is available to everyone in real time, and is user-friendly for first-time visitor and residents, regardless of mode of travel." There is also much emphasis on creating an integrated and multi-modal transportation in the region. Included among WMCOG’s objectives is

*"a web of multi-modal transportation connections which provide convenient access (including improved mobility with reduced reliance on the automobile) between the regional core and regional activity centers, reinforcing existing transportation connections and creating new connections where appropriate."*

Additionally, WMCOG aims to "use the best available technology to maximize system effectiveness" while also providing a "user-friendly, seamless system with on-demand, timely travel information to users, and a simplified method of payment." Like the other MPOs, there is also the environmental component to WMCOG’s goals which aims to reduce VMT and increase mode share of non-auto modes. Unlike the other MPOs however, and most likely due to the existence of Washington, DC as a national capital, there is much focus on making it easy for first-time visitors to use the region’s transportation system in addition to supporting "efficient, fast, cost-effective operation of inter-regional passenger services" [52].

## STATE DEPARTMENTS OF TRANSPORTATION

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This paper proceeded with an MPO-focused approach to discerning the transportation policies of regions and localities within the US because of the legal obligation of these organizations to produce transportation plans for their respective regions. However, in most cases, MPOs do not receive funding designated for areas within states. State DOTs tend to be responsible for the bulk of transportation funds to be disseminated within their jurisdictions and funding is usually expected to go in hand with the policies set by the MPOs. As evidenced by the lack of consistency between the policies of MPOs and the lack of seamless transportation systems, this happens less often than it should. Despite this disconnect, many state DOTs have established a 511 traveler information system to provide residents with

information about traveling within the respective states. Unfortunately, most of these sites do not have trip planners for users to plan trips across the state; rather, many directed users to the websites of separate transit agencies within the state (Illinois [53], California[54], Maryland [55]) or offered a trip planner that didn't cover the entire state (New York [56]). Even well-connected states such as Massachusetts [57] relied only on the trip planner of the Massachusetts Bay Transit Authority (MBTA) which does not provide information for the transit agencies at the western ends of the state. New Jersey [58] was the only state to include a complete trip planner within traveler information system, although it is worth noting that the website functions through the use of the Google Transit trip planner and crucial information is missing from the trip planner including fare information.

Although more can be done, New Jersey's action shows that providing a statewide trip planner is a relatively simple task. However, either because of a lack of vision or awareness, most states have not pursued this route, although they generally serve as the financial arm to the policies of MPOs. On a national level, despite the presence of numerous legislations advocating for the creation of a seamless transportation system both in terms of information and infrastructure systems, no progress has been made to arrive at a nationwide intermodal trip planner. In fact, this issue is not even on the agenda of the DOT. It is also important to note that there is no specific legislative action that aims to create a nationwide intermodal trip planner. The lack of actions to create a nationwide trip planner even though policies tout the necessity of such a system emphasizes the need for more research and advocacy around the issue.

## CHAPTER 3 - APPROACH AND METHODOLOGY

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With the purpose of exploring the requirements to implementing the proposed system, this research sought to determine the costs and benefits of the system, in addition to the current needs of users and transportation operators. This was necessary in order to provide a guide on how best to implement the system. The main method of analysis employed was interviews with representatives of stakeholders within the transportation industry. These stakeholders were from transportation service providers, the U.S. Department of Transportation, and private sector organizations involved or seemingly involved in the development of such a trip planner. Additionally, transportation system users were also surveyed to determine whether this tool being proposed to facilitate planning intercity trips will be seen as useful or necessary by travelers.

### INTERVIEWS

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The general goal of the interviewing phase was to build a collective attitude from the perspective of each of the respective groups regarding their individual opinions of the system proposed by this research effort. The research sought to determine what these stakeholders perceive as specific support systems that would be needed to encourage their participation in such a system. The number of transportation service operators contacted was 11, including 7 airlines, 3 intercity bus companies, and 1 intercity rail provider. Because of the organization's unique role in the development of a nationwide trip planner, Google was also contacted although its representatives refused to comment. With regards to the DOT, there were a total of conversations with 4 representatives and each person came as a referral from a previous. An interview was also conducted with the president of the American Bus Association (ABA). As expected, it was much more difficult to talk to individuals with ties to the private sector. When reasons were cited for a refusal to answer questions or give interview, the most common reason given was the fear of divulging proprietary information. However, except for the set of questions directed at Google, the other companies received questions that were merely opinion questions. Telephone interviews were identified as the preferable medium for the interview but email was allowed if responders did not have the time or were unwilling to participate by phone. Interviews were intended to be conversations that were free flowing and interviewees were encouraged to speak as freely as possible.

## DOT REPRESENTATIVES

Representatives of the DOT were interviewed to find out the extent to which any semblance of a nationwide trip planner was on the agenda of the DOT. Additionally, they were asked to provide several obstacles to this issue being fully pursued by the agency. In addition to these obstacles, they were also asked to provide clues as to what the DOT could do to push the agenda forward and to persuade transportation service providers to participate, in terms of incentives. Representatives interviewed tended to be more heavily involved with transit and participated in Federal Transit Administration (FTA) projects. Two were from the DOT's Research and Innovative Technology Administration's (RITA) Volpe Center, the main interviewee was a program manager with RITA's ITS Joint Programs Office (Mr. Yehuda Gross), while the remaining individual did not specify which branch of the DOT she worked within. Specific interview questions are provided in Table 2. If representatives were not able to answer certain questions, they were asked to provide a reference within the DOT who would be better suited for that question.

DOT Interview Questions
Is the issue of a nationwide multimodal traveler information system currently on the agenda of DOT? If so, to what extent?
Based on analysis from the transportation objectives of major MPOs, recent Transportation Bills, and current DOT objectives, a seamless passenger transportation system seems to be something that planning organizations are verbally touting but there is not much being done to promote this. Is this something that DOT could possibly be interested in pursuing in the future?
One of the noted obstacles issues presented is that standards are needed. If there exists TCIP standards that could properly accommodate traveler information systems that incorporate multiple modes, both intercity and intracity, would the DOT support mandating all agencies benefiting from federal funds to make their information available in such a format within a certain amount of time? Would the DOT be willing to assist smaller transit agencies in terms of providing funds to make their information available in that format or to hire personnel to handle that?
Are there any specific concerns that DOT might have over the pursuit of a web-based door-to-door trip planner?
What types of current government assistance are provided to the various modes of transportation especially Intercity Bus and Airlines (excluding security)?
What possible incentives does the DOT have in its arsenal that could be offered to lure in private companies to participate in such program?
I would like to know where I can find information on the types of current government assistance are provided to intercity bus companies (e.g., Greyhound, Coach USA) and the Airlines (excluding security).
What possible incentives does the DOT have in its arsenal that could be offered to lure in private companies to participate in a nationwide multi-modal trip planner?
Are there any other issues that are being overlooked?

TABLE 2: List of interview questions addressed to DOT representatives.

## REPRESENTATIVES OF TRANSPORTATION SERVICE PROVIDERS

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Transportation operators were contacted to address questions that mostly dealt with the perceived disadvantages and advantages of participating in a nationwide trip planner of any kind. They were asked to give examples of incentives that would entice their participation. A list of all questions addressed to transportation service providers are provided in Table 3. While several large intercity bus operators were contacted individually, they either declined to discuss their business systems or did not reply to requests for interviews. Operators that were contacted, such as Greyhound, noted the preference of dedicating resources to business practices instead of participating in a student-led research. Instead, an interview with Mr. Peter Pantuso, the CEO of the American Bus Association (ABA), served to provide the industry’s point of view. The trade group, based in Washington DC, represents over 1,000 motorcoach and tour bus companies in the US and Canada. Of all the operators contacted, only Amtrak and the president of the ABA provided interviews.

Transportation Service Providers Interview Questions
What do you perceive as some of the possible disadvantages and/or benefits of participating in a web-based intermodal trip planner WITHOUT fare information provided?
What do you perceive as some of the possible disadvantages and/or benefits of participating in a web-based intermodal trip planner WITH your company’s scheduling AND ticketing (fare) information available next to other competitors (within the same transportation mode and including other modes)?
From your organization’s standpoint, what are some of the pros and cons associated with having either a public or private operator manage this system (with scheduling AND fare information)?
Do you think that your organization would be willing to have its information included in such trip planner? If not, why and would the position change even if it were guaranteed that no surcharges would be added to the ticket price and that they would get full revenue for tickets sold through the trip planner?
What are possible incentives or provisions that would be needed to make it more attractive for your organization to include its information in this trip planner [the proposed system]?
What do you perceive as the single major obstacle that must be overcome to have such a system that is being discussed?
Are there any other concerns or issues that have possibly been overlooked or do you have any other comments?

TABLE 3: List of interview questions addressed to transportation service providers.

## GOOGLE

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As the initiator of the most widely used standard for scheduling data among transit agencies and the owner of the most complete intermodal trip planner in the US, Google plays a significant role in the quest to achieve a trip planner that has extensive reach throughout the nation. Due to the secretive and competitive nature of the private industry, Google responded that most of the questions required confidential information. Understandably, its representatives could not address the questions. The questions are presented in Table 4.

Google Interview Questions
What were the original goals of Google Transit? Why was it started?
What are plans for the future of the Google Transit project? Any incorporation of real-time information possible? What considerations are there within the GTSF to accommodate the changing technological landscape (real-time information, need for accessibility information)?
The General Transit Specific Feed has an interesting format that has some limits (limit on the maximum allowable transfer, some service information cannot be handled). Are there any plans to address or modify these in the future?
Are there any plans to include other modes of transportation (intercity buses, airlines) to have a truly intermodal trip planner?
How willing is Google in spearhead such an initiative to establish a nationwide intermodal trip planner [similar to the proposed system]?
What are some of the barriers and perceived disadvantages that would need to be overcome before such initiative can take place?
Are there any possible government incentives that could make it more attractive to Google to pursue this initiative?
From Google's perspective, why have some transit agencies not made their data available to be incorporated in Google Transit?
Are there any possible incentives to companies and agencies as a whole to participate in such a system? If so, what are they?
Are there any other concerns or issues which have not been addressed?

TABLE 4: List of interview questions addressed to Google about Google Transit and the GTFS.

## SURVEYS

The creation of an efficient and extensive web-based intermodal trip planner could be instrumental in solving some of the problems intercity travelers encounter when traveling by public transportation, especially for trips that require transfers between various modes. The majority of these problems stem from the lack of adequate information in one location which makes the trip planning process unnecessarily complicated. The purpose of the survey, presented in Table 5, was to verify that these aforementioned problems do exist for intercity travelers traveling by public transportation. These problems include the lack of information regarding connections to certain parts of the country, a lack of a central source of information for travelers, and the resulting restriction it places on travelers. This research maintains that vulnerable travelers with no knowledge of services to certain areas may forego their plans because of the perceived lack of services to their destination. The survey aims to either support or refute the idea that travelers will benefit much from a web-based nationwide door-to-door trip planner that allows them to plan across major transportation modes.

Survey Questions	Response Allowed
How often do you travel between locations _____ miles apart?	Multiple Choice Options: 4 times a <i>month</i> or more frequent, 1-3 times a <i>month</i> , 4-7 times a <i>year</i> , 3 times a <i>year</i> or less frequent
When you do travel that distance, which form of transportation are you most likely to use: public (air, train, regional rail transit, bus, or any combination) or personal vehicle:	Multiple Choice Options: Public and Personal
For these trips of that distance, what is generally the most problematic aspect of travel for you? In other words, if there was one thing you could change about these trips from the time you leave one door to the point when you enter the doorways of your destination, what would it be?	Free Response
How do you usually plan these types of trips? What resources do you use? These could be specific tools on the internet, using your knowledge alone, travel agents, etc. Please be as detailed as possible.	Free Response
Is there any tool(s), improvement to the nationwide transportation system, or any idea you can think of that would make it easier or simpler to plan your long distance trips?	Free Response
<i>[The proposed tool is revealed and detailed to the participant]</i> With this description in mind, how important do you think it is to have such a nationwide door-to-door trip planner that allows you to plan across different modes including intercity bus (Greyhound, Megabus, etc); trains (Amtrak); airlines; and public transit (subways, buses) to find the cheapest or shortest route?	Multiple Choice Options: Very Important, Somewhat Important, Neutral, Somewhat Unimportant, and Not Important

TABLE 5: Survey questions addressed to public transportation system users.

Information will be gathered from travelers on the major problems they experience when traveling from one city to another by means other than their private vehicles. Participants were asked several questions in relation to their intercity travel behavior and asked to assess the level of importance of such a trip planner. The end goal is to determine whether this tool being proposed to facilitate planning intercity trips will be thought of as useful or as needed by travelers.

The survey was administered to travelers of legal age who tend to conduct intercity travel by means of public transportation. Subjects were approached at various locations in the Washington, DC metropolitan area including Union Station at Amtrak and BoltBus terminals, and also at the Megabus terminal. Additionally, a few others were surveyed by phone. Surveys were conducted during a wide range of times, ranging from weekend mornings to weekday evenings. Participants were directly asked questions and did not complete the survey independently. This method was used because the survey took about 15 minutes each of the participants' time with some sessions reaching 20 minutes. It was determined based on a trial that participants would not want to complete the survey in its entirety unless the participants felt that the process engaged them in a conversation. Because of the relatively long time of surveys and a research staff of only one, only 39 participated in the survey.

Participants were asked four questions for various distance classifications (50-150 miles, 150-300 miles, 300-500 miles, and over 500 miles) about their frequency of travel, mode most frequently used, problems encountered while traveling, means of planning, any suggestions to improve the trip planning process. After these preliminary questions, participants were provided details about the purpose of the research and the proposed trip planner. They were then asked to judge the importance of the trip planner. Special care was taken to ensure that participants did not know the specific purpose of the survey in order to avoid influencing their responses.

## CHAPTER 4 - ANALYSIS OF NEEDS AND BENEFITS

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The results of the interviews and the surveys are used to analyze the current needs of users and operators and the benefits that implementation of the system will bring. These results suggest that the proposed trip planner is a much needed tool not only for users of the transportation system but also for operators. While it is clear that the issue is not on the agenda of the DOT, representatives from the DOT reveal a general perception that a comprehensive nationwide trip planner is a much needed tool for the US. Operators also see a way to derive benefit from the systems. Users surveyed about the importance of the system likewise overwhelmingly support its implementation.

### USERS

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Of all the potential beneficiaries of the system, users might gain from the system the most. All but 1 of the 39 participants found the proposed trip planner to be at least somewhat important while 28 deemed the planner very important. Because the survey was conducted in-person, it allowed for more conversation than just simply providing answers to questions. Often, conversations continued with participants long after the survey. One conversation revealed the potential for current information systems to isolate the elderly. Since most elderly travelers may not be familiar with the use of computers and the internet, they often get travel information by phone, in person, or through a relative. Nowadays, there is certainly not nearly as much information easily available by phone as there is on the internet. The elderly participant noted how he, like other seniors, had so much time to travel but they are being priced out of the market from the very start. He didn't think it was fair and believed that the government needed to offer better ways for less wealthy folks to travel. As his answers to the survey questions revealed, he always called specific airlines (United and Continental) to check on their prices and even when his trip is being scheduled at least a month ahead of time, the price always ranges between \$500 and \$600 round-trip, a far cry from the BTS reported average of about \$374 [59] from the Cleveland airport or the national average of \$337. He considered his Amtrak ticket of a little under \$300 for the same origin-destination pair a relative bargain. While this traveler represents a single data point, he highlights the need of disenfranchised populations to be provided better options for transportation. Since transportation options were dispersed through so many portals, it was difficult for the participant to easily seek out and identify travel options that fit his financial requirements.

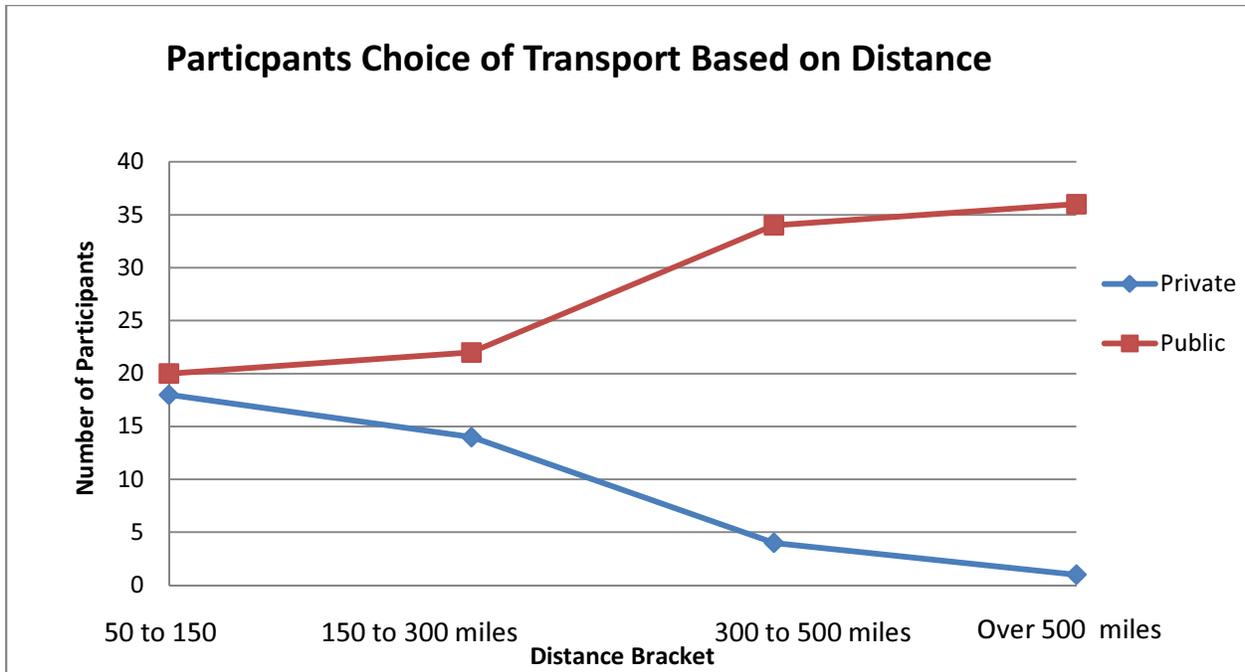


FIGURE 11: Graph showing participants' choice of transport based on intended travel distance. Private refers to driving in a personally owned vehicle and public refers to all means of public transportation including airlines, intercity bus, commuter and intercity rail, and transit.

Another issue highlighted by participants was the importance of location, trip purpose, and number of people in the traveling party. These participants noted that they were more likely to drive if they were traveling somewhere with friends or family even if the distance was far. Additionally, if the location being traveled to was thought of as isolated in terms of access to public transportation options, they would not even consider taking public transportation to get there. Instead they would automatically use their private vehicle if they had one. However, it seemed clear from their responses that above 300 miles however, distance mattered most, as shown in Figure 11. The graph shows the importance of providing better information for long distance travel as most travelers in the survey seem to shun driving distances over 300 miles. Additionally, one could guess that an attractive public transportation system might entice more travelers to also travel short distances by public means.

In Table 6, results show a plethora of channels used by participants to plan their travels. With just 39 participants, 34 distinct means of planning were listed. Although there were a good number of means used to plan, most of these means are fragmented along modal lines. No web-based planner was mentioned for intercity bus travel that contained more than one carrier<sup>9</sup>. Web-based methods used for intermodal planning were Hopstop.com, which contains mainly transit and Amtrak information, like Google Transit. Additionally, participants mentioned conducting a general query on a search engine as another means to obtain information, with Google being the preferred engine. Participants were also asked to name a problem they wish they could eliminate for each distance bracket for the entire journey, from door-to-door. In the Table 7, participants' related responses are grouped into categories. For the problems encountered while traveling, four categories (finding connections to stations and airports,

<sup>9</sup> Most likely due to its non-existence

Automobile	Airline	Intercity Bus	Intercity Rail	Rental Car	Intermodal
Carpool	Hotwire.com	Megabus.com	Amtrak.com	Priceline	Hopstop.com
Personal Vehicle	Expedia.com	Boltbus.com	By phone		Travel Agent
	Kayak.com	Greyhound.com	In person		Google search
	Individual airlines (United, Continental, Jetblue, Delta, US Airways, Southwest, Airtran)	Washington Deluxe			Having a family member make reservation
	Sidestep.com (now merged with Kayak.com)	Chinatown buses			
	Buddy Pass	Transbridgelines.com			
	Priceline.com	In person			
	Groupon.com				
	Orbitz.com				
	Travelocity.com				
	Bookingbuddy.com				
	AdventureTravel.com				
	Bing Travel				

TABLE 6: Trip planning portals listed by survey participants, classified by mode.

layovers, and lack of knowledge on where to start the search) can be solved by a basic nationwide trip planner, including the second most popular issue.

When asked about possible improvements to make it easier to plan for intercity travel, 21 responded with suggestions of which, 15 advocated for a nationwide intermodal trip planner. In their collective words, the participants wanted a simple system that served as a central hub of information to provide cheaper options, better transfers, and intermodal connections with the option to plan travel from door-to-door.

The survey shows that not only can the current problems that travelers view as important be solved by a nationwide intermodal planner but the collective view of the participants on improving trip planning amounted to a description of such system. As a result, participants showed overwhelming support for the implementation of this system. The results reveal that there are too many traveler information systems which do not provide enough information to travelers and that the lack of sufficient information on public transportation options is driving travelers to private vehicles for shorter distances even when they would like to journey by public means.

List of Problems Encountered While Traveling	Number of Participants listing this as a problem
Delays and Unreliability of service	19
Finding connections to station or airport to and from home	12
Going through airport security	5
Personal Comfort and Preferences - (crowdedness, cleanliness, hunger and noisiness from other passengers)	5
Layovers (Too long, and too short, where travelers must rush in order to transfer)	4
Physical comfort (inadequate space, no rest stops)	3
Being on standby status	3
Carrying luggage throughout journey	1
Lack of knowledge on where to start search	1
Cost	1
Deciding best time to purchase tickets	1

TABLE 7: List of problems that survey participants listed they encountered while traveling

## OPERATORS

As for operators, benefits to participating in the proposed system are generally perceived as being the increased distribution of their services. Not only will visitors be able to find out more easily about connections to the operators' services if they must travel to the operator's service area, but the system might draw new users who might become attracted to that operator's services to become perpetual users. In the end, if the system works to make public transportation easier to use and draws a greater amount of users to the nation's public transportation system, all operators will benefit although the benefits might be so dispersed that individual operators might not detect a significant change. The ABA's Pantuso noted the benefit that participation in such a system could potentially offer in terms of providing more opportunities to travelers who would now see a variety of options in where they can travel. In his view, the significantly lower cost of operating intercity buses compared to airlines and rail, provides the intercity bus industry a more widely extended network and has a potential to serve as a means to connect travelers from smaller areas far from airports and rail stations or vice versa.

For the airline industry, the benefits from participating in the system would come from reduced costs that would come as a result of increased leverage over the GDSs. Even though all attempts to obtain interviews from individuals within the airlines rank failed, one can see how the availability of an additional viable distribution option can pressure GDSs to reduce their rates. However, most airlines would probably continue to list their services on the GDSs until the proposed system is proven to have a wide enough reach.

Because the intercity bus industry has made very little headway in aggregating its scheduling and/or ticketing information, as have other industries (e.g., airlines and transit), the system would benefit the industry a lot more than other industries. Pantuso had a positive initial reaction to the described system as he cited the frustrations of many intercity bus operators that the only way to get comprehensive information about traveling across the nation has been through Greyhound although there are approximately 60 to 80 other carriers. Because of this deficiency within the industry, Pantuso noted that the ABA has already been examining various options to move in a direction that can provide travelers with comprehensive access to the entire industry, although many of these options are not directly

addressing the problem. He noted that the Kayak.com model<sup>10</sup> is an especially attractive model to the trade group because it circumvents the complicated nature of collaborating with ticketing and pricing information. The projects aimed at fostering more collaboration are BusReservations.com,<sup>11</sup> and a product called GroupConnect.com<sup>12</sup> in collaboration with the Ontario Motor Coach Association. These are designed to allow for easier collaboration between companies however, as mentioned earlier, they do not allow travelers to plan their trips but serve more as tools for operators. Overall, the proposed trip planner would generate a lot of interest from intercity bus operators and there is a general acceptance among members that this is needed within the industry. From the viewpoint of most operators in the transportation industry, it would serve as a great way to increase distribution of their products.

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<sup>10</sup> Note: Kayak.com is an aggregator site. It only requires consent from travel site owners that their sites are “mined” and doesn’t require much collaboration. However, many bus operators don’t offer a means for passengers to buy their tickets online.

<sup>11</sup> Currently, the site is mirror of another site charterbusconnect.com which is only for booking with charter bus companies

<sup>12</sup> GroupConnect is strictly for business-to-business interaction and is aimed at the tourism industry, with a focus on charter and tour buses. One of the practical goals of the website is to facilitate packaging of deals through multiple companies.

## CHAPTER 5 - ANALYSIS OF OBSTACLES AND COSTS

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While all parties agree on the need for the proposed system and the benefits the system will provide to the nation's transportation system, there is not a clear consensus on how to approach the implementation of the system. One reason for this is the existence of many obstacles and costs to achieving this system.

### FUNDS

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Funding appears in this section not as an obstacle because such a system has not been previously proposed and failed because of a financial roadblock. Rather, the financial cost of the system is seen as a price the industry or society has to pay to initiate this system. If public funds are used to initiate this system, the cost is likely to be marginal compared to the nation's total transportation expenditures. If initiated by the operators, the costs are likely to be shared among operators and then passed unto users in the form of slight fare increases. With the participation of many operators, this is unlikely to have much effect on users. Besides the general cost of the system, some smaller operators within the intercity bus and transit industries that may not have schedule available in a digital format could encounter financial difficulties in converting data to the proper format. They would need to obtain the funds to cover the additional operating costs associated with maintaining skilled information technology personnel. Included in a Necessary Steps which provides recommendations on steps for implementation, solutions are presented for creating a means of reducing the burden on these operators.

### LACK OF WILL

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While funding has not been an obstacle, the lack of will and vision is seen as a major obstacle to achieving the proposed system. Even though many survey participants and interviewees saw the implementation of this system as a DOT duty, no operator interviewed or even representatives from the DOT expects the creation of the system to come at the hand of the DOT. In fact, DOT representatives admitted that the issue was not on the agenda of the department or a research project within the department's research arm. Although European national transport ministries were quick in recognizing the need for such systems and making moves to establish it within their respective countries, the DOT has failed to specifically identify such issue. Program Manager at the ITS JPO Yehuda Gross noted in the interview that this trip planner would be hard-pressed to find traction to be initiated by any DOT branch in part because of the heavy influence of the auto industry on the US economy; the industry will view the move as antagonistic. Accordingly, active moves from the administration to promote public transportation would be strongly resisted by lobbyists from the auto industry and other benefiting industries.

DOT is not the only entity at fault either. Huge private operators have made little effort to improve information coordination for their customers short of taking over other operators. Whether or not it is due to the relative weak presence of the public sector within the transportation industry or the apathetic attitude of operators towards their customers, if this obstacle is not overcome, no progress towards a nationwide intermodal trip planner will be made.

### POTENTIAL REDUCTION IN REVENUES FROM WEB TRAFFIC

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One of the minor but critical obstacles to participating in this system that affects only operators has to do with the reduced traffic to their website as a result of participation in such a system. Some

operators bundle vacation packages and offer other amenities and advertising that appeal to travelers using the sites. If web traffic on an operator's site decreases, the value of advertising and the chances of more travelers purchasing bundles diminish. Operators without a website or one that has low traffic are likely to be unaffected by this issue or at least care. These operators are most likely to be clustered within the intercity bus industry. The issue is labeled as minor because in actuality, very few operators actually generate a lot of advertising on their sites. Even large transit agencies such as Washington, DC's WMATA have difficulty getting a steady stream of willing advertisers. The airline industry has the most to lose in this sense because of the prevalence of bundles within the industry.

## LACK OF TRANSPORTATION INDUSTRY DATA STANDARD

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A more significant technical issue involves the lack of an acceptable standard for the transportation industry. This very obstacle was cited by a few transit agencies in a recent report sponsored by the FTA's Office of Mobility Innovation [43] as some of the reasons for which they are not partaking in Google Transit in addition to other problems including a citation that the GTFS format limits the maximum number of transfers and doesn't include some service information (e.g., accessibility to the handicapped, etc.). Gross however suggests that while these reasons are sound, they are only serving as excuses. He further noted that the mostly large transit agencies that held out on their information being added to Google Transit did so mainly because the information is being provided freely to Google. The transit agencies believe that they should receive payment for their data and it is unfair for others to profit from their information.

While Gross does not believe the issue of a standard for transportation scheduling data is responsible for keeping some transit agencies from sharing their data with the public for incorporation in aggregate trip planners such as Google Transit, this issue does exist and issue of will become significant with the push for an intermodal trip planner. At the moment, Google Transit contains mostly transit agencies however an intermodal system should carry information in a format that is usable to all modes of transportation.

## POTENTIAL LOSS OF CUSTOMERS

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Another noted obstacle or cost facing operators participating in a trip planner is the potential to lose riders to other transportation options that might become visible to users. The idea is that when riders see more attractive options presented next to the option they regularly choose, they might opt to take the more attractive offer. However, while acknowledging the existence of this obstacle, the ABA's Pantuso noted that the situation could also go both ways. He observed that the improvement in intercity buses, especially along the east coast corridor where buses are equipped with Wi-Fi connections and electrical outlets, has not really taken riders away from other companies but actually cause a bit of a mode shift towards intercity buses. Accordingly, a DePaul University report [60] that studied the rise of popularity of curbside buses in 2010 confirms that during the same time period, ridership figures for traditional bus lines such as Greyhound benefitted from a spillover effect which saw travelers viewing intercity bus travel in a more positive light. Extending this concept, an improved public transportation system has the potential to increase the share of Americans using public transportation.

## CHAPTER 6 - IMPLEMENTATION OF THE SYSTEM

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Much work needs to be done in the move towards a seamless and efficient intermodal transportation system for passenger transport. The following sections provide lessons that can be learned from other intermodal systems such as the US freight industry and systems in Europe. In combination with the lessons learned from these systems, the following sections will also utilize insights from the interviews and surveys to provide a sketch of a roadmap that the public transportation industry must take to achieve a completely intermodal trip planner as part of the overall goal of achieving a seamless transportation system.

### LESSONS FROM THE FREIGHT INDUSTRY

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Unlike the passenger transport industry, the nation's freight industry has evolved into a highly intermodal industry. The industry has progressed to a point where it exploits the strength of each mode and integrates it to work in the entire system in a seamless manner. Shipping is now largely used for bulk cargo and imported international goods while rail is used for long distance haul for heavy goods. On the other hand, trucking functions as a flexible mode for local pickup and delivery and also short distance haul. Air transportation is mainly reserved for long distance haul for more valuable goods. The advent of seamless intermodality in freight transportation came as a result of several factors. Changing public policies, the need for more efficient operations, and the advent of technological breakthroughs all worked together to create a push for an intermodal freight industry. Freight companies knew that to become more efficient, they needed to implement a seamless system to ensure that goods were transferred from ships to their various destinations as quickly as possible. A driving force for this was the containerization of the industry and standardization of the sizes of containers and latch systems used [61].

In addition to this, government deregulation in the 1980s also allowed companies to deal across various modes and opened up the market [62]. This allowed freight companies to offer customers the opportunity to deal with only one bill of lading, simplifying the financial process. Additionally, technology also allowed for automation of the loading and unloading process, management systems, and other complex systems involved in operations. As a result of a combination of all these factors, modes within the freight industry generally operate within the markets in which they're most efficient. Only 5% of rail traffic deals with distances of less than 750 miles in the US because trucking is far more efficient for that range [61].

There are some differences in decision patterns between the freight industry and passenger transport. Being more focused on profit maximization, the industry is naturally forced to become very efficient in order to expedite the shipping process. A customer of the freight industry often has a goal of getting goods from one point to another as quickly and safely as possible. Because businesses are the major customers of freight companies, natural business practices will dictate that the most economical means that satisfy the shipping specifications (time and safety factors) are met, without regards for the specific means. Naturally, the process allowed freight companies to compete to provide more efficient services. As each leg of the shipping process became optimized, transfer points emerged as major bottlenecks and freight companies sought to create standards, arrangements and deals to allow more

efficient transfers. While for physical integration and improvement of efficiencies in transfers<sup>13</sup>, these differences would matter, they factor in less for the case of information integration.

The passenger transport industry can examine the case of how the freight industry came to achieve the high levels of efficiency it currently experiences. The industry took advantage of new and advanced technology, collaborated to create standards to enable interoperability, and lobbied on behalf of and benefitted from changing government policies. A similar approach must be taken with the information system in passenger transport. Members of the industry must collaborate and use advanced information technology to achieve a seamless system. They must also lobby on behalf of government policies to help foster the right environment. Although the government has a higher responsibility to encourage change for the better, operators should not expect the government to initiate the process of creating an integrated information system. That expectation is unrealistic because of the general slow pace of government. There needs to be coordinated efforts taken through many means and from all sides – airlines, rail, intercity bus, transit, and the federal government.

## LESSONS FROM EUROPEAN SYSTEMS

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Despite some fundamental differences in the governance and structure of these respective public transportation systems and the characteristics of these nations, European trip planners can offer some lessons for the US. It might be tempting to attribute the lack of a nationwide trip planner in the US to the size of the country; however it is important to note that even in US states much smaller than some European countries, policy makers have failed to implement a statewide trip planner. As mentioned before, only New Jersey offers a statewide trip planner on its 511 website and even that system does not provide travelers with enough information for traveling. Observers might also be tempted to classify the process towards integrating information systems as much simpler within European countries due to the fewer number of transport authorities present in most European countries if a country-to-country comparison is made. However, adjusting for size and comparing to US states, it is clear that most European countries have many more agencies to deal with. Even the overwhelming presence of public involvement in the public transportation industry does not do well enough to explain why the disparity exists. The dynamic created by having a relatively dominant public sector might make it easier to create systems that focus on benefitting the public but the main reason for the lack of existence of a nationwide trip planner in the US is the lack of vision and willpower. At the time of this research, such a system was not even on the agenda of the DOT, according to DOT personnel interviewed.

The US transportation industry can take key lessons from European countries in focusing on enhancing the traveler's experience and the quality of using the nationwide public transportation system. This comes out of a realization of the innate disadvantage that public transportation has to driving. The need to enhance the quality of the traveler experience should however, not be satisfied at the expense of the competitive advantage of businesses involved. The Swedish case serves as a good example, where a sleek, attractive, and relatively cheap trip planner was marketed to transport providers. All participants voluntarily joined the system because they could understand how it would make them more competitive against private ownership. While having transport providers voluntarily joining a collaborative trip planner is good, the US should also not be hesitant to spur creation of a trip planner through active and direct legislation as in the case of the Czech Republic where legislation mandated the creation and

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<sup>13</sup> Humans make their own, sometimes irrational, decisions and require a certain level comfort while cargo can be moved without their own will and generally without regard for their comfort.

maintenance of a nationwide timetable database for regional public transport [19]. The Germany case also shows us that when there is a juggernaut in the industry moving in a particular direction, it can be easier to move smaller companies towards that same direction. Even though Germany does not have a specific website for a nationwide trip planner, the huge presence of Deutsche Bahn made other providers want to join with them to provide better connection to their passengers. As a result, the Deutsche Bahn website is the de-facto door-to-door trip planning site for Germany.<sup>14</sup> Of course, the large operator should have the willpower to want to provide its customers better connections. The last lesson learned is that a well-designed trip planner by itself will still serve as a huge resource to travelers even if a universal ticketing or fare system has not yet been worked out. And even when the ticketing system is not directly connected to the trip planner, as in Sweden's ResRobot case, it still serves as an important tool to travelers because they can still be directed to websites of transportation operators.

## NECESSARY STEPS

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The following steps have been identified as necessary to arrive at a nationwide intermodal trip planner within the US. Following these specific actions are guidelines and recommendations on how to achieve with impetus from both the public and private sector.

- *A cooperative of transportation stakeholders must be formed*
- *An industry-wide standard for scheduling data must be arrived upon*
- *A national interagency database for intermodal transportation must be created that can allow high frequency of updates*
- *As many transportation service providers within the major groups (airlines, intercity bus, intercity rail, transit) should make their information available in the interagency database*
- *Taxi data should compiled and submitted to the database on the central server*
- *Design of a simple yet comprehensive routing system with various interfaces that can serve as a central hub of information to provide cheaper options, better transfers, and intermodal connections with the option to plan travel from door-to-door*

## COOPERATIVE OF PUBLIC TRANSPORTATION STAKEHOLDERS

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In order to take the first steps to establish a nationwide trip planner, the major obstacle that must be overcome is the lack of will. All that is needed to surmount this obstacle is for a group of small to medium operators that together play a significant role in the transportation market, at least one major transportation operator, or the DOT to decide to take action to create this system. It is suggested that the collaborative approach be employed for the trip planner because it will allow for a single portal and the participation of many. That initiator can then formulate the plans to market the system to other operators in order to recruit more members. Should the DOT decide to

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<sup>14</sup> Of course, it also helps that the transport market was heavily regulated and publically owned prior to the creation of this system.

become the initiator; the department wields the funding arm and power to offer enough incentives to lure private operators. The private industry initiators can, on the other hand, form a cooperative that includes the major players of the respective industries. With the major operators participating, smaller operators are likely to participate in order to gain entry into the nationwide public transportation system.

However, any initiative, especially by private stakeholders, should be accompanied by a thorough study to identify the financial costs and benefits to participating operators. After the obstacle of lack of will is overcome, the main factor in obtaining greater number of operators participating will be the marketing campaign used. Some assurances and incentives should be provided to make participation more enticing. Among those is the assurance that smaller operators will get fair treatment. ABA CEO Peter Pantuso notes that an incentive for the intercity bus industry members to participate will be the provision of equal opportunity to all participants so that no advantage is given to one company over another, whether large or small. With regards to the airline industry participating in the system, literature review has shown the dissatisfaction of airlines with the GDSs. This dissatisfaction can be exploited to demonstrate to airlines the availability of additional lower costing options through which they can distribute their products. Assuming a private initiation, publically affiliated operators, such as transit agencies and Amtrak, would sooner follow suit and participate in the system just as they have in the case with Google Transit if there is enough public outcry or if the private sector can lobby for government action on the issue.

Realistically, the DOT will not initiate this system but can provide support to the cooperative that is formed mainly by private operators. DOT can work with local authorities in concerted efforts to allow operators to provide services from the same facilities as other modes, including transit, airline, and rail. This specific issue is apparently a very critical one within the intercity bus circle and the benefits of operating alongside and being connected to other modes would be significant. An example of this issue is the existence of the Washington, DC Greyhound terminal a far walk from Union Station or any of the local transit stations for that matter. With Union Station being the largest intermodal station in the metropolitan area (serving Amtrak, the local transit system, car rental companies, bike rentals, select intercity buses, commuter rail lines from West Virginia, Virginia, and Maryland, there is a huge potential to provide connections to Greyhound and its customers. Since such terminals are publically influenced<sup>15</sup>, this is an area within the control of government officials and can be leveraged in getting intercity bus operators to participate in the system.<sup>16</sup> In doing this, DOT would move closer to both an integration of infrastructure and information systems.

## INDUSTRY-WIDE STANDARD

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Regardless of the initiator of the system, an industry-wide standard is needed to allow different data from different transportation modes to coexist in the same database. The standard should not only deal with the format of data but also with the terminologies which industry insiders use, a lot of which

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<sup>15</sup> While the Union Station Redevelopment Corporation is a non-profit federally chartered corporation and it has subleased the station to a private owner, the corporation has on its board of directors, the Secretary of Transportation, mayor of DC, and other officials from the public sector.

<sup>16</sup> When asked whether the main reason why the Greyhound terminal is far from Union Station pertains to space issues, he refutes that and suggests that the reason has more to do with the type of passengers that are attracted by operators such as Greyhound. They tend to be of lower socio-economic status than those traveling by trains.

vary by mode and sometimes by operator. Perhaps the industry with the most complex data requirements is the transit industry since it serves as the intersection of many different ITS technologies. The standard must allow many facets of information from not only transit agencies but all other modes to be captured. Additionally, the new standard should either have or allow for future incorporation of real-time data simply because that is the definite trajectory of the future.

This goal can be accomplished by either the DOT or the private industry. However, given that the DOT has tried its hand at developing a standard and failed to a certain degree, officials might be reluctant to attempt a similar feat again. On the other hand, the private sector can arrive at this standard on its own. After all, the GTFS was developed within the private sector. Since GTFS is an open source standard and is widely used by many operators, one way to approach this is for the community of GTFS developers to work with developers within other industries to make the standard robust enough to accommodate other industries. Special care should be taken to avoid the situation of the TCIP where funds were wasted creating an extremely robust standard that never achieved widespread use because of the complexity in modifying data to fit the proper format.

## NATIONAL INTERAGENCY DATABASE

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A national interagency database should be created that can allow frequent updates of schedules and prices as required by airlines. The airline industry is likely to be the mode that requires the most frequent modification of scheduling and pricing data. Care should also be taken to ensure that as many operators as possible participate in the database because the utility of the system increases with the amount of agencies participating. The most efficient way to achieve this is through a public-private partnership. DOT would find it quite difficult to adopt measures to mandate private companies to participate in the system, especially in a country where citizens are fond of emphasizing the rights of private enterprise. Rather, DOT does have the power to require transit agencies obtaining federal funds to make their data open to the public and to participate in the system, an action that can be taken very swiftly by advocating for a presidential order. Special grants can also provide funding to small transit agencies and intercity bus operators without IT departments or with insufficient funds to convert their data into the accepted format.

## TAXI INFORMATION

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The information on taxi companies throughout the US is the simplest item to tackle. Both the DOT and the cooperative can pursue this in a similar manner, with a slight addition. It requires either the dedication of man-hours to compile information about taxicabs in various regions and the structure used to calculate the rates or the purchase of a data from a website that has such information. Of course, the extra step the DOT can take is to require all commissions that set taxi rates to submit their information and any subsequent changes to the database. While this issue is the simplest to tackle, it is very important because it ensures that many citizens can access the public transportation system.

## ROUTE SELECTION SERVER AND INTERFACE

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Once the database has been setup up, the services of a capable contractor can be sought to provide the route selection service and the interagency database can be stored on the contractor's server. Another option is to use an open source service such as OpenTripPlanner and after some modifications to accommodate for the special case of the proposed system; it can be maintained and managed in-house by the DOT or the cooperative. Sweden's ResRobot follows a similar pattern as the latter option and it was

still available at an affordable price. The interfaces (interactive voice response system (IVR), website, and mobile website) should be of simple yet comprehensive system designs.

## CONCLUSION

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While many obstacles exist that prevent the implementation of an intermodal nationwide trip planner, there are many benefits to all stakeholders to spur the creation of this system. Moreover, through interviews with the DOT and transportation operators, this paper provides steps which can be taken by either the private or public sector to achieve the proposed system, although a combination of both efforts is suggested.

## CHAPTER 7 - FURTHER RESEARCH AND LIMITATIONS

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Further research should aim to achieve the goal points set out in the recommendations. Additionally, special effort should be made to acquire opinions from representatives within the airline industry and the necessary changes to the recommendations should be made based on those opinions. In addition to determining the financial costs and technical requirements of initiating and maintaining the proposed system, further research is also needed to determine a suitable cost-sharing structure for transportation service providers to operate within.

It is worth noting the small sample size of the survey of travelers which does not represent and is not meant to represent the whole spectrum of intercity travelers in the US. Rather, this survey is aimed at providing a glimpse of the lack of seamless information system within the transportation industry. Also to be noted is the high importance that almost all participants gave to the proposed system. On a final note, since most of the participants were intercepted while already in the process of traveling, there is a possibility that they were biased towards the transportation problems they had most recently encountered. For example, three participants encountered at a Megabus stop while on standby list noted that the worst part of traveling for them was being on standby. These were the only participants to mention standby and coincidentally were the only participants who were on a standby list for travel.

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