Dynamic Ridesharing Technologies

Opportunities for the MBTA's The RIDE Paratransit Services

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Acknowledgements

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Executive Summary

It is well documented that many Americans, particularly seniors and persons with disabilities, have difficulty accessing some of their basic needs because they must rely on fragmented, unreliable and inefficiently operated transportation services and systems. As Massachusetts' population continues to age, the mobility needs of seniors, represented by the baby boomers that are now just passing or approaching sixty, and approaching retirement age, will continue to emerge. Demand response transit will need to expand to meet Massachusetts' mobility needs.

The goal of this project is to explore new models and approaches that can be used to coordinate transportation systems in ways that successfully make those systems responsive to the needs of specialized populations. This report explores the opportunity for paratransit services in the Boston Metropolitan area, particularly the MBTA, to better utilize ridesharing technologies to achieve higher vehicle utilization. A key finding is that the single biggest obstacle to deploying a ridesharing system, oriented towards the needs of disabled and older Massachusetts residents, is not technological in nature. Coordination and collaborative efforts are needed to better maximize the resources available to the populations served by these specialty-transportation programs and to expand transportation *choice* for Massachusetts' neediest residents.

The potential benefits from a coordinated and collaborative ridesharing system are substantial, and impact a wide range of stakeholders. The MBTA's The RIDE ADA-Complementary Paratransit Service would benefit from an increase in the number of eligible accessible vehicles and qualified drivers. Passengers would recognize increased mobility choice with the potential to increase same-day service request options. Cost savings would be achieved for all parties as a result of this collaboration. Further, through ridesharing and coordination, a more efficient use of vehicle resources would be achieved leading to a reduction in congestion due to increased vehicle utilizations and greenhouse gas (GHG) emissions, and increased social equity.

An assessment of the MBTA's existing paratransit services, including the technologies used to administer those services highlights opportunities to leverage technology to change the current service delivery model. While the average trip cost of the MBTA's The RIDE ADA-Complementary Paratransit Service is consistent with comparable peer agencies, there is opportunity to increase vehicle utilization.

Further, a review of ridesharing literature reveals a number of innovations which have the potential to augment the paratransit service delivery model nationally. The proliferation of ride hailing and ridesharing applications, made possible through nearly ubiquitous smartphone technology, may have significant implications on how paratransit services are administered nationally. Three US Department of Transportation initiatives: Mobility Services for All Americans (MSAA); the Dynamic Ridesharing (D-RIDE) application from the Integrated Dynamic Transit Operations (IDTO); and Mobility on Demand (MoD), provide a framework and a vision for real-time ridesharing applications in transit service delivery.

Creating a Mobility Clearinghouse in Massachusetts

This paper challenges Boston-area transportation providers to work together to develop a structure that increases vehicle utilization and better coordinates transportation services for residents with the greatest mobility needs. It proposes the creation of the "Mobility Clearinghouse,"

a central trip repository where area transportation providers may bid and compete for demand-response trips. The Mobility Clearinghouse concept expands upon the MBTA's successful Non-ADA Paratransit Taxi Subsidy Pilot Program and is designed to provide a wider range of providers to program members. Also, in order to promote increased vehicle utilization, members are incentivized to choose more cost-effective trips.

The Mobility Clearinghouse would allow prequalified area transportation providers to compete for demand-response business. It is envisioned that through the mobility clearinghouse, demand-response travelers would be able to select service from a wider array of providers, including: taxis; transportation network companies (TNCs) such as Uber, Lyft, or Bandwagon; local non-profits organizations (e.g. SCM Community Transportation or the Independent Transportation Network [ITN]); councils on aging; municipal services (e.g. City of Boston Senior Shuttle); and Veterans Affairs transit services, among others.

The solution is presented as a way of increasing on-demand choice for individuals with specialized mobility needs by establishing a marketplace for service. The intent is to use technology to reduce barriers to transportation and to increase coordination and resource allocation among Boston-area demand-response services.

Further Recommendations

The report concludes with recommendations for additional research that could be conducted by MassDOT or in collaboration with other organizations. This research would include:
- Developing a greater understanding on what effect the Non-ADA Paratransit Taxi Subsidy Pilot Program has had on demand for The RIDE services, access to transportation services for those in the pilot, and what impact, if any, on the taxi providers.
- Evaluating what effect consolidation will have on vehicle utilization as the MBTA moves towards a Centralized Call and Control Center (CCCC) for The RIDE.

As well it will be necessary to address a number of potential obstacles facing the Mobility Clearinghouse concept not covered by this report, including:
- Institutional and jurisdictional challenges
- Geographic constraints
- Fare structure
- Insurance requirements
- Driver certification standards
- Technology and vehicle accessibility

Lastly it is recommended that, MassDOT, the MBTA, partner agencies, and stakeholders will need to establish measurable, area-wide performance measures in order to gauge program success and ensure customer needs are being met.

Introduction

Many Americans, particularly seniors and persons with disabilities, have difficulty accessing some of their basic needs because they must rely on fragmented, unreliable and inefficiently operated transportation services and systems. Further, the needs of these individuals often necessitate specialized transportation services, tailored to their unique mobility challenges. Despite policies aimed at facilitating and encouraging the coordination of related transportation programs at the Federal, state and local levels, mobility remains a significant concern to seniors and persons with disabilities. Coordination and collaborative efforts would maximize the resources available to address specific needs of the populations served by these specialty-transportation programs.

The goal of this project is to explore new models and approaches that can be used to coordinate transportation systems in ways that successfully make those systems responsive to the needs of these populations. This report explores the opportunity for paratransit services in the Boston Metropolitan area to better utilize new ridesharing technologies to achieve higher vehicle utilization.

For the purposes of this discussion, the term dynamic ridesharing is used to describe *an automated system that facilitates drivers and riders to share one-time trips close to their desired departure times*. The hallmarks of a dynamic service are flexibility and convenience. A key component of the concept is the ability to connect passengers with similar geographic origins and destinations to a single vehicle. In this report, no distinction is made between dynamic ridesharing and ridesharing for paratransit operations. The intent is to utilize the ridesharing concept to achieve sustained enhancements to the traditional paratransit service delivery model. The report will explore what aspect(s) of ridesharing may be employed to reduce service delivery costs and increase the mobility of paratransit-dependent populations.

The report uses the MBTA's The RIDE paratransit service as a potential model of how ridesharing may be integrated with current paratransit service delivery models.

The remainder of this chapter is dedicated to introducing the methodology used to devise and validate the concept presented in this study. The remainder of the report is structured as follows:

- **Chapter 3** provides an overview assessment of the MBTA's existing operations, the technologies employed by the MBTA to plan, schedule, and deliver paratransit services, and an overview of the Non-ADA Paratransit Taxi Subsidy Pilot Program.
- **Chapter 4** introduces the literature reviewed as part of the study. Because the body of literature on the subject is thin and evolving rapidly, the review provides a high-level assessment of Dynamic Ridesharing, the form ridesharing programs take, a discussion of modern disruptions affecting the transit/paratransit and taxi markets, and a discussion of how modern technologies are enabling ridesharing applications to evolve.
- **Chapter 5** introduces the Mobility Clearinghouse concept – a proposed, one-stop solution to collect and disseminate paratransit mobility information and a portal for eligible riders to be connected with appropriate, timely paratransit services.
- **Chapter 6** poses a number of questions that stemmed from the study which warrant further investigation.
- **Chapter 7** is the works cited.

Methodology

The methodology employed to complete this study recognizes the value in promulgating recommendations that reflect the input of those who provide and use the services. As such, the study drew upon the guidance from a study committee comprised of representatives from A Better City, MBTA, MassDOT, the Executive Office of Health and Human Services (EOHHS), and the consultant, TranSystems. The study committee was tasked with ensuring mutual understanding and consensus regarding the study goals/objectives. Information gathering was comprised of the following four distinct activities:

1. Input from the study committee.
2. A literature review which focused on innovative technologies/concepts currently affecting the paratransit service delivery market. A quick scan revealed a thin body of literature coupled with a rapidly evolving technological landscape.
3. Interviews and discussions with relevant third-party vendors and transportation network companies (TNCs).
4. A presentation as part of the ITS Massachusetts Lunchtime Speaker Series, delivered to a diverse audience of over 50 transportation professionals, consultants, and users of paratransit services. The presentation sought feedback on the two alternative concepts developed as the key recommendations of this study effort.

Study Committee

A study kickoff meeting was held on September 19, 2014 to discuss a coordinated approach for the summary assessment of the MBTA's existing paratransit services. The meeting included representatives from the MBTA, MassDOT Rail and Transit Division, EOHHS, and TranSystems. The intent of this meeting was to gain consensus among the stakeholders regarding the goals, objectives, and priority of activities for the data collection effort.

A key outcome from the kickoff meeting was the direction to review The RIDE's current dispatch technology: StrataGen's ADEPT software, and a review of the MBTA's fixed route scheduling system, HASTUS. These technology reviews were suggested to identify: a) opportunities for increased regional/agency coordination by leveraging the MBTA's existing technologies; and b) identifying what limitations, if any, these technologies posed.

A subsequent outcome that stemmed from the study committee was the identification of the MBTA's Non-ADA Paratransit Taxi Subsidy Pilot Program as a potential platform with which to disseminate and evaluate future ridesharing ideas. **The intent behind this recommendation is that any ridesharing program should be first instituted on a voluntary basis.** Because the Non-ADA Paratransit Taxi Subsidy Pilot Program was developed by MassDOT/MBTA to meet additional mobility needs on a 24/7 basis, it could serve as a worthy test bed for future programs which aim to increase the pool of available accessible vehicles. In addition to reducing response time, the program offers customers individualized service while reducing strain on existing ADA services – key aspects of the ridesharing concept explored in this study.

Literature Review

The literature review examines the state-of-the-practice in the integration of ridesharing services and technologies with paratransit services and providers. It includes a review of current ridesharing technologies, their constraints and potential opportunities they provide to the paratransit community. Because the body of paratransit-specific literature is thin – *and* the intent

of the research is to move towards an integrated service delivery model where transportation is less siloed – this study draws upon more generic ridesharing examples. For example, the review places particular emphasis on the integration of taxi and related applications with paratransit, demand-response services.

## Interviews with Third-Party Providers/Vendors

Subsequent to the kickoff meeting, a survey was administered to the MBTA technology vendors, DDS Wireless and Giro. The survey was structured to better understand the existing configuration and limitations of the MBTA's software and the potential (through the development of additional modules or interfaces to Stratagen and/or Hastus) to increase vehicle capacity utilization by employing ridesharing tools.

Following these interviews, informal discussions were held with a handful of TNC companies and other related service providers including, Bandwagon, RideCell, Lyft, The City of Boston Senior Shuttle, and SCM Community transportation. The intent of these discussions was to gain insight regarding the technological capabilities of the TNCs and the interest of third-party service providers to participate in a potential paratransit ridesharing demonstration.

ITS Massachusetts Lunchtime Speaker Series

To obtain feedback regarding the initial recommendations, TranSystems prepared and delivered a presentation to the *ITS Massachusetts 2014/2015 Lunchtime Speaker Series* on April 1, 2015. The presentation, titled *Ridesharing, A New Model For Paratransit Service Delivery?,* was delivered to an audience of approximately 50 spectators which included staff from ABC, MBTA, MassDOT, as well as consultants, and registered users of The RIDE.   The event was open to the public. The following abstract was distributed in advance of the presentation:

> "The growing presence of Transportation Network Companies (TNCs) poses a great opportunity for transit agencies to explore the development of new service delivery models for paratransit. TranSystems is leading a discussion of how the MBTA might utilize TNC and ridesharing services to complement The RIDE. We present a trip clearinghouse model whereby the MBTA could offload demand in real-time to service partners. The desired outcomes of this model include a more seamless and convenient experience for riders and potential for reduced operating expenses for the agency."
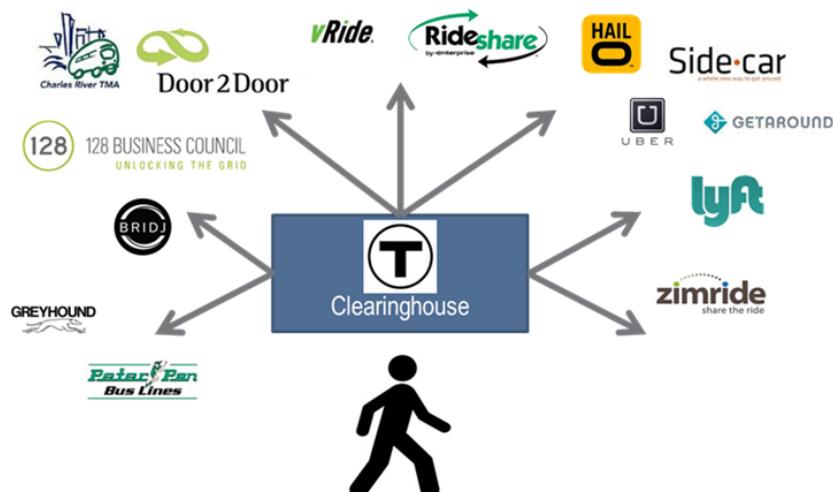
An Assessment of the MBTA's Existing Paratransit Services

System Overview

The MBTA's The RIDE provides door-to-door transit service to persons with disabilities who are unable to access or use the MBTA's fixed route transit system. Since it began operation in 1977, the service has grown from a relatively small operation serving a 12 square mile area in Brookline, Cambridge and parts of Boston, to one of the largest paratransit operations in the nation serving a 712 square mile area including 60 cities and towns with a combined population of 2.5 million. In FY14, The RIDE provided approximately 1.8 million trips to registered customers and 2.1 million total trips (including PCAs and companions). **The average cost to the MBTA per trip is $49.53 and the average utilization of each paratransit vehicle is 1.49 passengers.** A common misrepresentative comparison of costs juxtaposes ADA service delivery against fixed-route services. This comparison unjustly portrays The RIDE as a costly service. Instead, as depicted in Figure 1, we offer a comparison to agencies considered peers of the MBTA. Readers should note that The RIDE's operating expense per unlinked passenger trip is in fact the median.

Figure 1. Operating expenses per unlinked passenger trip for ADA paratransit service
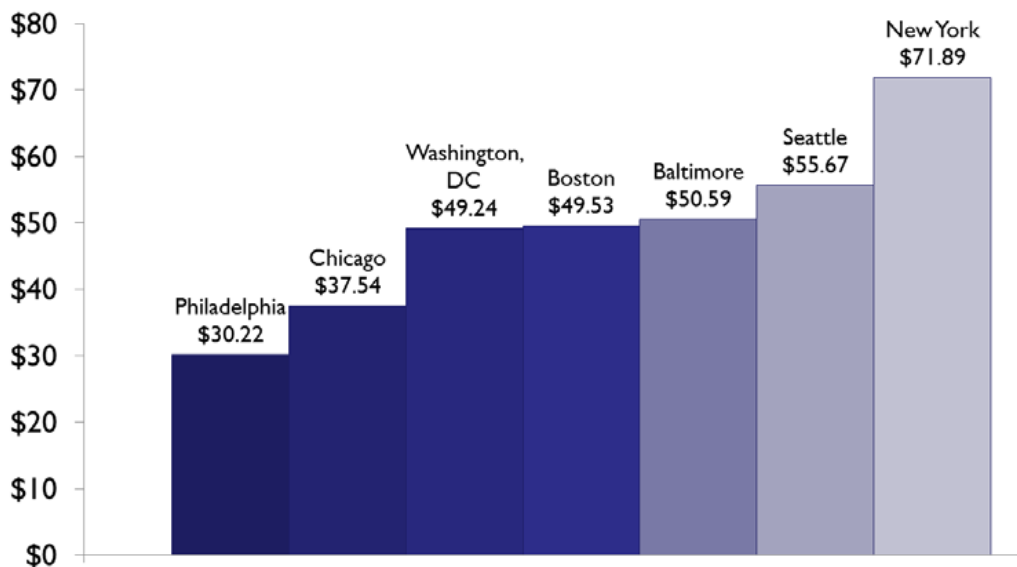
While the MBTA manages The RIDE, it contracts with three transportation providers to conduct service. Each of the three providers is responsible for service within a distinct geographic region: North, West, or South. The three service areas overlap in the Core Area and as such all Service Providers serve the Core Area. The Core Area roughly includes central Boston, Brookline, Cambridge, and Somerville. The MBTA selected the current vendors in January 2014; each service provider is operating on a 5 year base contract with optional two-year extensions that can be exercised at the sole discretion of the MBTA. The service providers are currently turnkey operations—responsible for collecting reservations and scheduling service; dispatching and handling same-day customer issues; adherence to the fare system; information technology administration; service operation, vehicle inspection; vehicle maintenance, repair and storage;

hiring and training of all employees needed to deliver services; statistical reporting; and other related tasks.

The RIDE's three service providers utilize a fleet of lift-equipped vans and sedans. Most of the vehicles in the fleet are provided by the MBTA and are therefore dedicated exclusively to The RIDE service. Service providers are required to acquire additional vehicles, as needed. The MBTA is the license holder of StrataGen's ADEPT software, which is used to manage The RIDE operations. The MBTA is responsible for providing each of the service providers access to ADEPT. The MBTA also uses a fixed route scheduling system, HASTUS. Recently, the MBTA launched a non- ADA paratransit taxi subsidy pilot program.

The MBTA is exploring the feasibility of integrating the current decentralized call center to a Centralized Call and Control Center (CCCC) for The RIDE. As part of this assessment, the MBTA is evaluating the feasibility of contracting a CCCC Manager to oversee reservations, scheduling, dispatching and other same-day functions of The RIDE.   As part of a CCCC service model, service zones may cease to exist as the providers migrate from a per-trip cost-allocation model to hourly rates. As such, it will be up to the CCCC Manager to schedule The RIDE fleet (of all three service providers) as efficiently as possible. At the time of publishing, it is unknown if the MBTA seeks to migrate to a real-time scheduling system that would allow for dynamic trip scheduling or scheduling among non-contracted service providers.

Technologies

The following technology summaries provide a detailed understanding of these three systems and are intended to serve as a baseline in understanding the capabilities, limitations, and opportunities for ridesharing in the commonwealth.

DDS Wireless – StrataGen

The MBTA has extensively used StrataGen's ADEPT software since December 2004 to manage the scheduling and dispatch of The RIDE paratransit services.   ADEPT offers the MBTA a comprehensive management platform to accomplish the tasks of taking client reservations, creating optimized schedules, conducting efficient dispatch operations, and creating meaningful reports. The ADEPT platform manages communication between The RIDE vehicles and dispatchers. On-board computers and Mobile Data Terminals (MDTs) facilitate this by tracking vehicle location and current trip information, sending and receiving canned messages, and displaying real-time passenger manifests. The specific software modules of ADEPT in place at the MBTA are listed in Table 1.

Table 1: Adept Software Modules

Module Name	Business Purpose
AVL Viewer	Map displaying real-time location of The RIDE vehicles in revenue service
Archives	Database storing historical operational data for business intelligence analysis
Client Operations	Database interface to add or update information about The RIDE clients
Complaints	Database interface to log or view complaints received from clients aboard The RIDE services
Dispatch	Decision-support tool giving dispatchers and supervisors up-to-the-minute operational details about The RIDE vehicles in service
ReOptimizer	Routing and scheduling algorithm which optimizes daily operations given the set of reservations received from clients

Adept Reports	Data reporting tool to generate business intelligence reports from Archives database
Manifest	Integration with on-board computer to deliver passenger manifests to drivers

When new reservations are accepted, ADEPT first schedules those trips onto the currently established schedules. Scheduling for a given service day is performed the day prior via a batch schedule after the reservations period is over. When the following day's schedules and manifests are created, the ReOptimizer algorithm regenerates these schedules given the new trips to make operations as efficient as possible. **In its present configuration, the systems does not allow for dynamic trip planning of paratransit services.** This optimization process accounts for several configurable constraints including maximum ride time. In this way, ADEPT can support both real-time reservations and trips arranged in advance. Client data is either entered into ADEPT directly or imported thru third-party data sources. Data is imported and shared with the three transportation providers thru the use of regularly scheduled SQL routines. When a customer requests a trip, the fare for that trip is "reserved." Thus, a customer cannot request a trip if there are insufficient funds in his/her account. If the trip is not made (e.g., if the trip request is cancelled), the reserved funds are put back into the fare account.

ADEPT is primarily used internally at the MBTA to manage and optimize paratransit operations and is generally not visible to The RIDE's passengers. The option to book trips via telephone is available to all passengers. Additionally, some passengers may choose to schedule trips through ADEPT's web interface. The web interface utilizes ADEPT's Manage My Trips module, while the telephone interface is built on ADEPT's interactive voice response (IVR) API. **ADEPT does not feature any customer-facing applications which may be used to provide information to passengers or to schedule trips.**

Further, StrataGen reported that one of the three MBTA paratransit providers uses a third-party software product to manage taxi dispatching during times of excess demand. Data is communicated between this system and ADEPT using ADEPT's socket-based API. Additionally, ADEPT can be configured to communicate trip and schedule data to third-party dispatch systems. This function is not implemented at the MBTA.

Giro – HASTUS
The MBTA has used HASTUS for almost thirty years to schedule fixed-route bus and rail services. GIRO reported that in the first quarter of 2015, the MBTA will begin using HASTUS to manage some aspects of its bus operations.

GIRO/ACCES, GIRO's paratransit management platform, is not used at the MBTA to manage any aspect of The RIDE. GIRO/ACCES is a competing product with ADEPT. Therefore, a transition to this software at the MBTA would likely only occur during the procurement and deployment of replacement paratransit software system. As of April, 2015, this is not a process currently being pursued at the MBTA.

According to information provided by GIRO, GIRO/ACCES does provide the functionality to manage real-time trip booking, scheduling, and dispatching. Additionally, GIRO/ACCES can interface with ridesharing and vehicle-hailing platforms thru the use of web services.

Non-ADA Paratransit Taxi Subsidy Pilot Program

The MBTA began the Non-ADA Paratransit Taxi Subsidy Pilot Program in November 2014. The program is designed to complement The RIDE service and provide additional mobility options for clients. Unlike The RIDE services, taxi services under this program are offered 24 hours per day and 365 days per year. In addition to reducing response time, the Non-ADA Paratransit Taxi Subsidy Pilot Program offers customers an individualized service and reduces strain on existing The RIDE services. As stated in the program's Request for Information (RFI) distributed in May 2014, the program's benefits include the following:

- Reduced response times
- A new, less expensive service option for customers
- Service hours that are consistent and at a minimum equal to fixed-route transit, including holidays
- Improved mobility management
- An on-demand, individualized service
- Reduced strain on the existing ADA service

The operating model for the Non-ADA Paratransit Taxi Subsidy Pilot Program requires passengers to arrange rides directly with approved taxi companies and pay for trips using an MBTA-provided debit card. Use of the debit card automatically processes the passenger's $2 fare and provides the taxi company with a $13 per ride subsidy.

The Non-ADA Paratransit Taxi Subsidy Pilot Program offers existing clients of The RIDE numerous benefits over standard The RIDE services including more convenient, on-demand trip scheduling, an individualized trip in a private vehicle, and a more reliable, shorter response time. Additionally, by reducing demand for The RIDE service, the program offers the MBTA reduced costs and streamlined management of its paratransit operations. This may result in more proactive and cost effective management. The MBTA's three transportation contractors may further be relieved of the need to schedule taxi trips during times of excess demand.

Information regarding the number of clients engaged in the Non-ADA Paratransit Taxi Subsidy Pilot Program, feedback from the taxi vendors, or data regarding trip type, purpose, or time, was not available at the time of publishing.

Assessment Key Findings

The assessment of existing conditions affirmed several hypotheses regarding the deployment of ridesharing within the MBTA's The RIDE paratransit service. These findings are summarized as follows:

- The current service delivery – from a policy and technology perspective – does not allow for the dynamic trip planning of paratransit services. The RIDE's current service policy requires one-day advance notice for all eligible reservations. Trips are "batch scheduled" by the ADEPT ReOptimizer algorithm following the closure of the reservation period (at 5:00 PM daily). These manifests are then distributed to the three service operators and their drivers for completion on the following service day. As the MBTA transitions towards a

Centralized Call and Control Center (CCCC) there may be additional incentive for the CCCC Manager to allow for dynamic trip planning and scheduling – the change from a per trip to hourly rate among the service providers will provide a greater incentive to the CCCC Manager to make the best use of all vehicle resources available.

The ADEPT system, in its present configuration, does not allow for dynamic trip planning of paratransit services. It is unclear whether the MBTA will procure a new paratransit dispatching software following the migration towards the CCCC or if the ADEPT system will be upgraded to allow for the additional functionality. Alternatively, the MBTA may request CCCC Manager to furnish a new paratransit scheduling system capable of meeting the required trip planning and scheduling requirements of the new CCCC system.

- While the MBTA's Non-ADA Paratransit Taxi Subsidy Pilot Program began broadening the pool of driver resources, these drivers' ability to conduct non-MBTA trips in the absence of The RIDE demand is crucial to the program's success. Similarly, if the MBTA implements a true ridesharing model to supplement The RIDE service, those drivers would likewise require additional, non-MBTA work to stay fully utilized and justify operational expenses. Further research is warranted to better understand what effect the program has had on demand for The RIDE services (among pilot program participants), access to transportation services for those in the pilot, and what impact, if any, on the taxi providers.

- The integration of ridesharing with the MBTA's fixed-route services offers the potential to increase The RIDE's coverage area with fewer dedicated resources. However, consistently seamless and efficient mode transfers will only be possible with effective optimization technology.

- Further investigation regarding the opportunity to couple trips and increase the utilization of The RIDE vehicles is warranted. Without a sufficient number of participants in an MBTA ridesharing program (Note: both drivers and riders), the chance of finding a ride, especially one close to the desired departure time, may be very small, and thus the inconvenience may outweigh the benefits. Should the CCCC allow the MBTA to move towards dynamic trip planning, a review of vehicle utilization before and after would be warranted.

Ridesharing Technologies Literature Review

In this section an assessment of prior and ongoing ridesharing programs is provided to understand the relevant research in the area of dynamic ridesharing that might affect the development and eventual deployment of a ridesharing program that is oriented towards the specific needs of MBTA The RIDE passengers. **The intent is to identify *potential* operational scenarios which may be employed to provide greater mobility choice to elderly and persons with disabilities by increasing mobility alternatives for these populations while increasing competition, in an effort to lower the overall operating costs associated with this very specialized service delivery.**

Dynamic Ridesharing

The term dynamic ridesharing is used to describe an automated system that facilitates drivers and riders to share one-time trips close to their desired departure times. **The hallmarks of a dynamic service are flexibility and convenience.** Agatz et al. (2010) list the following features of the concept:

- **Dynamic –** The rideshare can be established on short-notice, which can range from a few minutes to a few hours before departure time.

- **Independent –** The drivers who provide the rides are independent private entities.

- **Cost-sharing** – The variable trip-related costs are reallocated among the rideshare participants in a way that makes it beneficial for them to participate from the perspective of cost reduction.

- **Non-recurring trips** – Most trips served are single trips, as opposed to the recurring trips typically served by traditional carpooling or vanpooling.

- **Prearranged** –Trip participants agree to share a ride in advance, typically before they are at the same location.

- **Automated matching** – To find convenient sharing partners in a way that requires minimal effort from the participants, ride matching must be automated.

No distinction is made between dynamic ridesharing and ridesharing for paratransit operations in this study. The intent is to use the ridesharing concept to enhance the traditional paratransit service delivery model both to reduce service delivery costs and increase the mobility of paratransit-dependent populations.

Dynamic ridesharing evolved from *carpooling*, which became popular again in the 1970s in response to high gasoline prices. Later, states began implementing high-occupancy vehicle lanes to encourage carpools. This form of ridesharing saved users time and money, but it was static and could not be arranged on a need-basis (Swisher, 2011). In the carpool model, drivers and riders are bound to a specific and recurring meeting time and location, which is not amendable to changes in schedule or destination. In the dynamic ridesharing model, drivers and passengers arrange one-way transportation between an origin and a destination at a mutually convenient time.

The development of casual carpooling reflects travelers' desire to participate in ridesharing on a flexible, nonrecurring basis. In the mid-1990s, Federal and State transportation agencies began investing in research projects to develop formal technologies and systems that could help users access and employ informal ridesharing. Ridesharing projects from that era employed a range of technologies, from cell phones and pagers, to information kiosks, to the internet and smart phones.

Ridesharing Program Structure

In the United States, ridesharing's roots have largely stemmed from a response to Federal policies and national crises (Chan & Shaheen, 2012). Historically, ridesharing policies have been used to prohibit or prioritize the practice. While ridesharing's origins can be traced back to the "jitney craze" in the early 1900's (Hodges, 2006), programs were not formalized until World War II, when the Federal Government, seeking to conserve resources for the war effort, initiated an ad campaign to encourage drivers to take passengers along. Since the 1940's policies have long been oriented towards commuters, due to ridesharing's recognized ability to reduce congestion, emissions, and fossil fuel dependency. The end of the war brought forth a significant decrease in ridesharing until the energy crises of the late 1960's and early 1970's.

Despite increased congestion and the creation of high-occupancy vehicle (HOV) lanes in many cities, interest in ridesharing had long remained flat until the advent of smartphones. In recent years, several new websites and smartphone applications have sought to leverage mobile technology and social networking to bring together passengers and drivers with common origins and destinations. Today, these organizations are commonly referred to as Transportation Network Companies (TNCs).

TNCs, like the ridesharing concept itself, have proven to be disruptive – seeking to augment the way transportation services are delivered through the use of common smartphone technologies. These disruptions aren't unique to commuters, as TNCs now pose the opportunity to affect paratransit service delivery. However, as with the jitney craze 100 years ago, local policy is seeking to regulate the role TNCs will have on mobility, especially with regards to paratransit services.

Government Sponsored Programs
Government funding and regulation have both played an important role in the development of ridesharing programs, demand-responsive transit service, and paratransit services for the elderly and handicapped. The earliest ridesharing programs in the United States, and many still in operation today, have been sponsored by government agencies. This originated with governmental responses to national emergencies and the need to conserve resources for wartime efforts. Today, governments sponsors ridesharing programs via "511" travel information lines and sometimes as part of public transit agencies. When sponsored by governmental agencies, ridesharing may be managed by a dedicated ridesharing staff person or contractor. Efforts to organize and facilitate ridesharing and paratransit are best qualified in three distinguishable efforts (Jones, 1992):

1. To promote carpooling and vanpooling to serve commute trips
2. To field transit-like services with the routing and scheduling flexibility necessary to serve small towns and outlying suburbs
3. To provide specialized transportation services for the elderly and handicapped

Contemporary examples of Government-sponsored programs are discussed in greater detail in Section 0.

Employer/Institution Sponsored Programs

Numerous employers offer pre-tax commuter benefits to employees to subsidize the cost of public transit fares and vanpool expenses. Casual carpools are not eligible for the same federal tax benefits, but they are facilitated in part by local and regional traveler information centers. Transportation Management Associations (TMAs) typically provide carpool or vanpool programs to neighborhoods, communities, and large employers or institutions within their service area. These services may be offered as part of a Transportation Demand Management (TDM) program implemented to reduce the number of trips to or from a particular neighborhood or commercial site. Depending on the organization or neighborhood's size, the TMA or employer sponsoring the ridesharing program may manage the program with its existing staff resources, or it may hire a specially designated Ridesharing Coordinator.

Transportation Network Companies

TNC is the term used by the California Public Utilities Commission (CPUC) to refer to technology companies that allow users of location-enabled devices to summon drivers for hire. Unlike taxi and limousine companies, TNC drivers typically use their personal vehicles. TNCs are generally structured with a large staff at a central headquarters facility and designated on-site Community Managers in each market area where services are offered. Major TNCs in business today include but are not limited to Bandwagon, Lyft, UberX, and SideCar. In general, the core service offering of each company is the ability to summon a private car and driver for a point-to-point trip. This differs from true *ridesharing* as described above in that there are no other passengers besides the original app user and his or her guests. However, the TNCs also offer a limited number of services, which can be considered ridesharing, that group passengers together with others traveling in the same direction. **These services illustrate the high level of innovation that location-enabled smartphones are bringing to the ridesharing market.**

TNCs have added innovation to the ridesharing market by developing geospatial algorithms which match users with the closest available driver to complete a trip. Users typically have the option to ride in a driver's personal vehicle (for example, standard Lyft or UberX) or may elect to pay a higher fare for a luxury vehicle (for example, Lyft Plus or Uber Black Car). Payment is integrated into the application, with users' credit or debit cards being automatically charged when the trip is completed. Finally, an anonymous rating system allows drivers and passengers to provide the TNC with feedback about each other and share positive or negative experiences from a particular trip.

The TNC legal category that the CPUC developed in 2013 does **not** include carpooling services such as UberPOOL, LyftLine, and SideCar Shared Rides. Accordingly, in September, 2014, the CPUC ruled that these carpooling services are in violation of the law that passengers may not be charged individual fares when traveling together in a vehicle for hire (Kerr, 2014). While SideCar has since been granted authority to operate SharedRides in California (Soper, 2014), the CPUC ruling against carpooling services represents another regulatory hurdle that may slow the deployment of this technology. Taxi services are generally exempt from these regulatory hurdles and thus have had greater success in supporting the delivery of paratransit services.

Lyft and Uber

Lyft and Uber have received the majority of the media coverage about TNCs as they have worked to introduce their services in new cities. Both TNCs offer private vehicle services and both have recently offered shared-ride services in select areas. New shared mobility services such as UberPOOL and Lyft Line allow users to share a ride – and split the cost – with others who have requested a ride along a similar route. These services facilitate ridesharing using the on-demand convenience and reliability that have become the hallmark of TNC operations.

Lyft has stated that it is looking for ways to expand access for disabled riders and make fleets of on-demand paratransit vehicles available for new and existing passengers.

Uber Wheelchair-accessible vehicles (WAV) – available in limited markets – connects riders with licensed paratransit drivers and curb-to-curb service in vehicles that are equipped with ramps or lifts. UberWAV provides disabled riders with access to the same on-demand transportation technology employed by millions of Uber riders in over 200 cities and 45 countries worldwide. **UberASSIST is designed to provide additional assistance for members of the senior and disability communities.** The service uses drivers specifically trained to assist riders into vehicles, which can accommodate folding wheelchairs, walkers and scooters (but do not have wheelchair ramps or lifts). In Portland, OR, Uber has partnered with First Transit, a national para-transit company, to provide accessible rides as part of its UberWAV platform.

Bandwagon
Rather than providing on-demand transportation, Bandwagon instead helps match passengers with similar itineraries and destinations. As reported in the Washington Post, the Bandwagon business model targets the following parties (Depillis, 2015):

- **Passengers –** Bandwagon facilitates the splitting of taxi fares meaning that passengers pay lower individual amounts.

- **Taxi drivers and dispatch companies –** Bandwagon proposes that taxi drivers collect a surcharge when passengers use its services—this increases the total fare the taxi driver collects.

- **Large transportation hubs –** Bandwagon markets itself to large airports and conference centers for its ability to streamline the cab-hailing process. It does this by automating the process of identifying potential candidates and reducing the total number of cabs needed at the airport to satisfy demand.

While Bandwagon does not specifically account for paratransit riders, the organization has noted an interest in exploring opportunities to provide paratransit services. Further, the organization has been included in this discussion to illustrate the opportunity to match passengers with similar itineraries and destinations.

Carma (Formerly Avego)
Carma is a real-time ride-matching system that utilizes the internet and offers an iPhone application. Up to 30 minutes in advance of travel time, drivers with GPS-enabled iPhones enter their destination to offer rides; riders enter their desired location to find drivers on the same route. Carma allows drivers and riders to automatically exchange money based on the length of the trip, and provides a user-rating system. It also establishes a convenient pick-up point along the driver's route and within easy walking distance for the rider. Participants must register before using Carma, and, as a security measure, users receive PINs when matched for a ride, which they must share with

the driver/rider they are paired with.[1] While Carma does not specifically account for paratransit riders, it shows some alternative models that paratransit operators can consider.

Non-TNC Ridesharing Companies

ZimRide
ZimRide provides ridesharing and carpooling services to large enterprises and university campuses. The company offers a fully-hosted online platform to manage traditional ridesharing in which users post upcoming trips and potential passengers are matched using geospatial search algorithms. Social media integration for current and potential users is also available. (Zimride).

Independent Transportation Network (ITN)
Independent Transportation Network (ITN) is a nationwide organization with an affiliate operation in Boston[2] that provides transportation to seniors through a non-profit business model which relies on volunteers to serve as vehicle drivers. Individuals who join ITN become dues-paying members of a non-profit organization committed to their independence and mobility. In exchange for volunteering their personal vehicle and time, drivers are awarded credits with the agency which can be redeemed for transportation services at any ITN affiliated operation around the country. Members can receive additional credits for transportation by trading in an unused vehicle. Table 2 depicts metrics regarding ITNAmerica's nationwide service.

Table 2: ITN Quick Facts (2010)

Total Rides provided	275,000
Average age of rider	83
Average length of ride	4.7 miles
Average duration of ride	19 minutes
Average ride fare	$9.54

Source: (ITN America, 2010)

ITN members may book trips at any time, but the agency provides discounts if trips are booked in advanced or shared with others. During each trip, ITN members are charged a pick-up fee of $4 plus a per-mile cost of $1.75 (ITNGreaterBoston). Some of the service characteristics include:

- Available 24 hours a day, 7 days a week
- Available for any type of ride within the service area, with no limitations on ride purpose
- Available for health and wellness trips 5 miles outside of the perimeter of our service area
- Rides are provided in private automobiles by trained drivers
- Rides may be booked at any time; **20% discounts are applied to shared rides and those that are booked with advance notice**

The organization developed a proprietary enterprise software, ITNRides!™, which allows for centralized database management. It connects every ITN affiliate community into one effective centralized national network that manages the logistics of the senior transportation service, including member and volunteer management and ride scheduling (Microsoft Corporation, 2009).

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[1] Heinrich, Susan. "Implementing Real-time Ridesharing in the San Francisco Bay Area." (June 2010). http://ridesharechoices.scripts.mit.edu/home/wp-content/papers/Implementing_Real-Time_Ridesharing_Heinrich.pdf

[2] More information is needed to account for the number of ITN members and trips provided in Boston.

ITNAmerica recently launched ITNEverywhere the organization's newest community transportation initiative. **The vision is to establish a non-profit marketplace, supported by technology, where people can share private transportation.** Much like ITN membership, participants will join ITNEverywhere in their rural or small community, become a dues-paying member, open a Personal Transportation Account, and pay for rides through innovative payment options. ITNEverywhere users would earn credit by sharing a ride with others, volunteering to drive anyone in need of a ride, or by trading a car they no longer drive in exchange for rides. Individuals, businesses, and non-profit organizations may join.

Lift Hero

Lift Hero connects seniors with reliable drivers who use their own cars in the San Francisco Bay area of California. The organization recruits health professionals and students to provide service – drivers receive specialized training regarding the needs of an aging population. All cars are the personal vehicles of drivers allowing the organization to pass cost savings to consumers, and "…to focus on what matters most: trustworthy, reliable and caring transportation." Lift hero leverages technology to make it easy for passengers or caregivers to schedule rides. The mobile phone based system allows for customizable ride reminders and alerts and to view trips in real-time.

RideCell

RideCell provides fleet automation software (Dispatch, GPS, Routing, Scheduling, Notifications, Real time carpooling) to transit agencies. RideCell differentiates itself from other technology vendors by offering a TNC-like service through its "Summon" platform. As of 2013, Summon includes a network of 2500 drivers nationally. The service is designed to provide a communication platform to connect and match users of the service who are looking for a ride with third party or organizational drivers.

RideCell Demand-Response software automates requests, dispatch, scheduling, routing, notification and pairs rider and driver apps with analytics so that agencies may routinely evaluate operational performance. Trip requests can be made via smartphone apps, web, or a phone call, giving users multiple choices to make a request. Requests are entered into the system automatically and are assigned to the most suitable agent based on location, current heading, capacity, and a customizable, best-match logic. RideCell's demand response software has numerous applications, including the management of fleets oriented towards persons with disabilities. It is currently used by public, non-profit, and institutional transportation providers.

US Department of Transportation Research Initiatives

Mobility Services for All Americans (MSAA)

Mobility Services for All Americans (MSAA) was built upon several past and current USDOT-led activities, including the USDOT's United We Ride Program, to increase mobility and accessibility for individuals with greater mobility need. The initiative was aimed at achieving more efficient use of Federal transportation funding resources through better coordination of services. The goal of the MSAA initiative was to improve transportation services and simplify access to employment, healthcare, education and other community activities by means of ITS technology (USDOT, 2015).

As part of MSAA, the key to effective and efficient coordination involves the integration of ITS technologies into a physical or virtual Travel Management Coordination Center (TMCC) that

networks all parties together. The technologies included in the demonstration are tested and proven and have demonstrated significant benefits and return on investment, including:

- Fleet scheduling, dispatching, and routing systems.
- Integrated fare payment and management (payment, collection, and processing) systems
- Traveler information and trip planning systems, with an emphasis on systems that address the unique needs of customers with accessibility challenges.
- Advanced GIS and demand-response systems to provide door-to-door service.

A successful TMCC provides benefits to:

- Customers with simplified, one-stop access to unified travel support services-one call via any technology to arrange for transportation services.
- Human service agencies with the ability to coordinate transportation needs across service providers and modes, considering fare structures extending customer service across wider geographic areas.
- Transportation Providers with a method for matching schedules and capacity with requests; an ability to efficiently process financial transactions; an opportunity to eliminate redundancies; and tools to ensure security and customer eligibility to use the system.

Figure 2 illustrates the TMCC concept and demonstrates the MSAA programs goal of improving access to transportation services for seniors and persons with disabilities through a single portal.

Figure 2: TMCC Concept
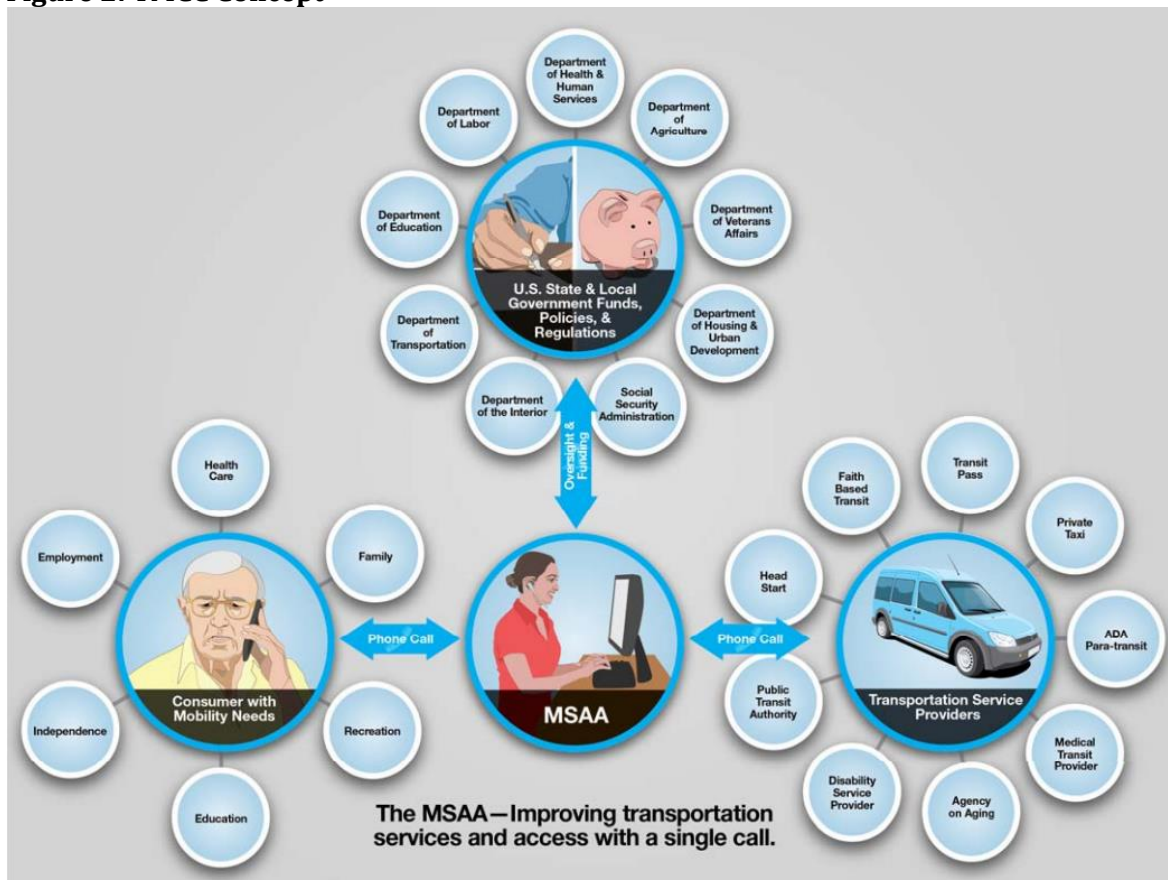
Connected Vehicle Program

The USDOT Connected Vehicle Program seeks to enable safe, interoperable networked wireless communications among vehicles, infrastructure, and passengers' personal communications devices. Within the initiative, the Dynamic Mobility Application (DMA) program seeks to create applications that fully leverage frequently collected and rapidly disseminated multi-source data gathered from connected travelers, vehicles and infrastructure. These applications will increase the efficiency of transportation systems and improve individual mobility while reducing negative environmental impacts and safety risks. Accordingly, the USDOT has identified a portfolio of high-priority mobility applications, including a common bundle collectively identified as Integrated Dynamic Transit Operations (IDTO), as part of the DMA program. The three applications under the IDTO bundle (Connection Protection, Dynamic Transit Operations and Dynamic Ridesharing) will ultimately enable transit systems to provide better information to travelers and increase the quality of service that they are able to provide.

The Dynamic Ridesharing (D-RIDE) application is an approach to carpooling in which drivers and riders arrange trips within a relatively short time in advance of departure. **The Connected Vehicle Initiative envisions a scenario in which people can use D-RIDE to arrange daily transportation to reach a variety of destinations, including those that are not serviced by public transit.** D-RIDE would serve as a complement application within the IDTO bundle by providing an alternative to transit when it is not a feasible mode of transport or unavailable within a certain geographic area. The D-RIDE system would usually be used on a one-time, trip-by-trip basis, and would provide drivers and riders with the flexibility of making real-time transportation decisions.

The two main goals for the D-RIDE application are to increase the use of non-transit ridesharing options including carpooling and vanpooling, and to improve the accuracy of vehicle capacity detection for occupancy enforcement and revenue collection on managed lanes. By accomplishing these two goals, transit systems could also benefit from D-RIDE by reducing excess demand during peak periods, resulting in improved customer satisfaction and more appropriately and affordably scaled system designs. Transportation Information Center and Advanced Traveler Information Systems Applications.

A key component of the DMA program and the D-RIDE application is the Transportation Information Center (TIC), which collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The TIC could play several different roles in an integrated intelligent transportation system:

- The TIC provides a data collection, fusing, and repackaging function, collecting information from transportation system operators and redistributing this information to other system operators in the region and other TICs. In this information redistribution role, the TIC provides a bridge between the various transportation systems that produce the information and the other TICs and their subscribers that use the information.

- The TIC is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories, traffic and road conditions, transit schedule information, yellow pages information, ridematching information, and parking information. The TIC is commonly implemented as a website or a web-based application service, but it represents any traveler information distribution service including systems that broadcast

digital transportation data (e.g., satellite radio networks) and systems that support distribution through a connected vehicle network.

Mobility on Demand (MoD)

The USDOT is developing a long-term strategic vision for a multimodal, integrated and connected transportation system, colloquially referred to as Mobility on Demand (MoD). MoD is a concept which imagines mobility as a commodity and a service. The research program aims to promote choice in personal mobility, promote the use of advanced technologies for service delivery and coordination, leverage and advance emerging technologies (with an emphasis on connected vehicles and automated [driverless] vehicles), leverage data exchange, and encourage system interoperability.

The MoD program recognizes that aging Americans increasingly require mobility choice: (1) from 2005 to 2020 there will be 30 million additional people age 60 or older; and (2) The growing "aging in place" trend requires unique mobility solutions. MoD also seeks to eliminate silos and streamline human-services transportation funding, acknowledging that an astounding 80 Federal programs fund transportation services for transportation disadvantaged.

Similar to the Connected Vehicle TIC, MoD seeks to fund the development of regional, interoperable systems that adds value to the customer, service provider and human service program. The scalable Travel Management Coordination Centers (TMCC), depicted in Figure 2, would provide one-stop, unified, customer-based travel information and trip planning services while supporting and advancing coordinated human service transportation solutions.

Literature Review Key Findings

Several conclusions and recommendations can be formulated based on ridesharing technology projects conducted in recent decades, including but not exclusive to:

- The barriers to deploying a dynamic ridesharing program at the MBTA are not technological in nature. **The technology necessary to achieve ridesharing (more specifically, the algorithms) exist in the current marketplace and could be readily employed by the MBTA to achieve an alternate service delivery model that allows for greater utilization of vehicles and increased same-day service.** Modules are available from the MBTA's current technology vendors which may provide for increased utilization of paratransit and fixed-route vehicles by The RIDE-eligible participants.   Further, there are a number of third-party applications that allow for real-time trip allocation and vehicle assignment. Some vendors are capable of providing technology and driver resources in given geographic areas.

- An exhaustive review of literature, periodicals, and direct communication with TNCs reviewed that aside from the steps taken by Uber and Lyft to introduce accessible vehicles into their fleet, **no integration of real-time ridesharing with paratransit service has occurred at this time**. A January, 2015 article in the San Francisco Examiner revealed that the City of San Francisco could be exploring such an arrangement with Uber (Rodriguez, 2015). Specifically, while UberWAV is already available in San Francisco, the article reports that Uber has contacted the City of San Francisco to explore the potential about further optimizing paratransit service in San Francisco using Uber's technology platform. However, as of the completion of this study, there are currently no plans to pursue this partnership

further because the TNC does not meet the insurance requirements that would be required. **This study notes insurance requirements as a topic area that warrants additional investigation before ridesharing or use of third-party providers to satisfy trip needs can progress.** Nonetheless, aspects of the model could one day be employed by The RIDE and other paratransit services around the country to reduce costs and improve customer services.

- Findings showed that a fear of strangers was often cited as a reason for not sharing rides, highlighting the need to allow potential riders to target others who are part of their social networks (Heinrich, 2010). Therefore, any integration of paratransit services with a ridesharing program must be mindful of making participants feel more comfortable making travel arrangements with would-be strangers. However, ridesharing programs can provide socially-necessary transportation alternatives to certain groups who may not have easy access to public transportation, such as senior citizens.

- Marketing is necessary to draw an initial crowd to a rideshare system, and incentives (e.g., iPhones offered by Carma or free BART tickets offered by RideNow) can draw more users (Amey, Attanucci, & Mishalani, 2011).

- Dynamic ridesharing systems that incorporate accurate GPS technology mitigate several concerns of potential users. First, GPS enhances ridesharing services utility by providing directions and convenient meeting locations (Heinrich, 2010). Secondly, GPS can save users' time by automatically detecting their starting locations. Lastly, GPS can enhance security for passengers by allowing them to track their route and confirm that the driver is not going off-course (Amey, Attanucci, & Mishalani, 2011).

- Applications that run on smart phones and other mobile devices fulfill users' desires for easily accessible, convenient rideshare services. In several projects (Bellevue Smart Traveler, TransAction Network), participants found rideshare systems overly complicated and the matching process too long. With mobile devices, users can establish rideshare arrangements on-the-go and can take their ride-match contact and trip information with them when they go to meet drivers/riders and throughout the trip (Heinrich, 2010).

- Dynamic Ridesharing is capable of improving network efficiency by allowing transportation infrastructure to be used more effectively by focusing on "person throughput versus vehicle throughput," minimizing the frequency of repair and construction costs to government agencies.

The literature concerning previous ridesharing successes and failures mentions several potential issues that would need to be considered during the integration of ridesharing operators or TNCs with public transit agency paratransit services. These include but are not limited to:

- **Accessibility of vehicles.** No TNC currently in operation has been started with accessible transportation as a primary focus. Before a TNC or rideshare operator is integrated with a public transit authority, its fleet should be analyzed for accessibility to ensure that all customers' mobility needs would be met.

- **Maintaining critical mass.** There are many examples in the literature of ridesharing services that struggle to maintain a critical mass of participants. In order to avoid the same

problem, ridesharing services or TNCs partnered with paratransit providers should be allowed to operate independently in the absence of paratransit demand. As ridesharing partners are identified, a thorough assessment should be made as to whether each potential partner is independently sustainable within the geographic region.

- **Service areas.** For-profit TNCs individually determine service areas where operations are profitable. If integrated with a public transit agency, this would need to be reconciled with the legally mandated service area of paratransit operations.

- **Trip sharing policies.** A set of policies would need to be implemented to govern when trips are offloaded to rideshare providers rather than provided in-house. These policies should account for both the time cost for the passenger and the financial cost for the transit agency.

- **Fare integration.** The fare collection process should be automated to the degree feasible, preferably with the ability to accept and process transit agency fare media. This ensures a seamless experience for the rider and streamlined back-end accounting for the transit agency.

- **Enforcing driver standards.** In addition to the training rideshare drivers receive from their respective service providers, drivers of paratransit vehicles should receive additional training on the safety risks with transporting disabled passengers and the correct operation of wheelchair lift and ramp equipment. The transit agency should reconcile its own driver behavior and professionalism expectations with those enforced by rideshare operators and TNCs.

- **Sharing of Trips.** The trip sharing policies established for an integration of a paratransit operator with a ridesharing operator or TNC may necessitate offloading trips under the following two scenarios:

  o Trips reserved in advance: If it is known in advance that a transit agency will be unable to accommodate all of a day's demand, they may choose to proactively offload some excess trips to a rideshare operator or TNC.

  o Spur-of-the-moment: In the case of an unforeseen event such as a maintenance-related delay, crew shortage, or traffic congestion, it may lower transit agency costs and enhance customer service to offload trips to rideshare operators or TNCs. Additionally, paratransit operators may wish to accept on-the-spot trip requests with pickup windows in as little as fifteen minutes. In some cases, a rideshare operator or TNC may be better equipped to respond to these last-minute requests.

- **Driver Rating / Feedback.** A common feature among TNCs is the ability for passengers to rate driver performance on every trip and provide direct feedback to management. This feedback would be particularly useful for the public agency to assess the performance of drivers performing outsourced demand response transit services. Reviewing driver performance on a trip-by-trip basis is not standard to most transit agency operations; however, most agencies will accept customer complaints/commendations. A method for the TNC to communicate driver feedback to the agency will be useful as will be a method for the agency to prevent drivers with recurring low scores from being assigned trips. A high

degree of coordination will be required to ensure customer satisfaction; however, the TNCs offer the potential to increase the feedback received regarding the level of customer service.

Recommendation: The Mobility Clearinghouse

The intent of this section is to bring together the lessons learned from the existing conditions, the literature review, and the various interviews and discussions with TNCs, vendors, and other stakeholders to define a potential concept of operations for a ridesharing system. The high-level concept of operations outlines steps that Massachusetts may take to incorporate ridesharing in the MBTA's The RIDE paratransit service. The recommendation provides a feasible structure whereby the dynamic ridesharing concepts may be employed by transit agencies.

Mobility Clearinghouse

The proposed concept builds upon and expands the Non-ADA Paratransit Taxi Subsidy Pilot Program by providing a portal for users to be voluntarily matched with demand-response services. Like the Non-ADA Paratransit Taxi Subsidy Pilot Program, this service would be optional for RIDE-eligible travelers and provide a new resource to all travelers who face mobility challenges. **An aspect of the Non-ADA Paratransit Taxi Subsidy Pilot Program which the Mobility Clearinghouse seeks to replicate is the ability for passengers to individually select eligible, pre-qualified vendors to complete trips.**

The Mobility Clearinghouse is envisioned as a standalone system capable of integrating a wide-array of local and regional service providers into a single portal. The Mobility Clearinghouse is a one-stop, automated dispatch tool for a variety of transportation services provided by different operators. Services offered through the Mobility Clearinghouse could include standard paratransit services operated by The RIDE contractors using branded vehicles, licensed taxis, local or community-based transportation providers, veterans transportation vehicles, council on aging vehicles, and ridesharing services provided by transportation network companies (TNCs) such as Uber, Lyft, LiftHero, ITN, and Bandwagon. The Mobility Clearinghouse may also serve as an integrated fare payment system; however, the focus in this high-level operational concept remains on the centralized trip apportionment functionality.

The Non-ADA Paratransit Taxi Subsidy Pilot Program is providing greater mobility choice to RIDE-eligible users, allows for same-day service on a 24/7 basis, and introduces additional capacity to satisfy trip needs, particularly short (less than 5 miles) trip needs of riders. The Mobility Clearinghouse creates an opportunity for other service providers to participate in this program. The benefits may include:

- Increased passenger choice.
- Lower overall operating costs due to increased coordination, competition, and use of existing vehicle capacity.
- Reduced greenhouse gas emissions through increased vehicle utilization and the use of smaller, more fuel-efficient vehicles when possible.
- An established marketplace where a variety of vendors, non-profit and community-based organizations, and independent operators can compete to deliver accessible transportation.

The Mobility Clearinghouse concept builds upon key aspects of Mobility Services for All Americans (MSAA) and the Connected Vehicle's Integrated Dynamic Transit Operations (IDTO). Central to both of these concepts was the creation of a central virtual Travel Management Coordination Center

(TMCC) or Transportation Information Center (TIC), respectively – a central, client-facing data exchange capable of connecting travelers with transportation resources in a given geographic area. Lastly, the Mobility Clearinghouse offers the greatest potential to bring together sufficient users to successfully incentivize ridesharing. There remains a "critical mass" dilemma that must be overcome before ridesharing will be more widely adopted in wide geographic areas (as opposed to geographically constrained models where HOV lane requirements induce car/van-pooling). **Enabling TNCs to couple paratransit riders with non-paratransit riders will reduce the total cost of travel for all users while increasing the efficiency/utilization of resources.** It should also be noted that existing research notes the societal benefits that stem from a transportation system that unifies riders of various classes, abilities, etc. For customers who receive subsidized transportation benefits (e.g., taxicab coupon programs) the Mobility Clearinghouse may offer incentives to encourage more efficient traveler behavior (e.g., for trips that are shared, a percentage of the base fare is returned to the user account for future trips).

Operational Concept

This high-level operational concept focuses on the feasibility of integrated scheduling and booking. The workflow (depicted in Figure 3) is envisioned to manage trip booking with the Mobility Clearinghouse as follows:

1. **Eligibility.** Rider eligibility for the various services would be included in the rider profile and tied to the payment account (e.g. The RIDE-eligible passengers would have access to book trips with the MBTA or use mobility vouchers for other services). The rider profile would also include mobility needs (e.g. vehicle accessibility requirements such as handicapped accessible vehicles). Eligibility may factor the passenger's place of residence (e.g., City of Cambridge Taxicab Coupon Program is also offered free of charge to Cambridge residents with disabilities) and affiliation with a particular institution (e.g., East Boston Neighborhood Health Center member).

2. **Trip Reservation.** Passengers wishing to schedule travel via the Mobility Clearinghouse would create a trip reservation request by using the web, a smartphone application, or by dialing a reservations call center. If the trip is for a day in the future, it would be added to the list of trips for that day and included in the day's optimized schedules. If the trip is for the same day, the algorithm would attempt to include it in the current day's schedules by determining which vehicle would be least costly to reroute.

   During the trip booking process, the data on available trips options could be used in one of two ways. In one version, the Mobility Clearinghouse may be configured to automatically select the option which most closely matches a set of trip selection criteria and only offer that option to the user. This configuration may be used to minimize the subsidies paid by the MBTA, or to maximize use of MBTA resources before allocating trips to third-party providers. Alternatively, the user could be presented with a list of options within a website or smartphone application. This configuration would give the user greater flexibility in that the user could quickly compare price, travel time, pickup time, and other details and choose the option which most closely meets his or her needs.

3. **Vehicle Assignment.** The routing of vehicles and passengers would be optimized using an algorithm which balances the number of requested trips with the number of available drivers and vehicles. For each trip, the system would compute the relative costs of

providing the trip in-house on The RIDE services and outsourcing the trip to ridesharing providers or a taxi company (via the Paratransit Taxi Subsidy Pilot Program). The cost and travel time estimates of outsourced transportation would be provided to this algorithm by a real-time data exchange with the rideshare providers.

Figure 3: Mobility Clearinghouse Systems Diagram
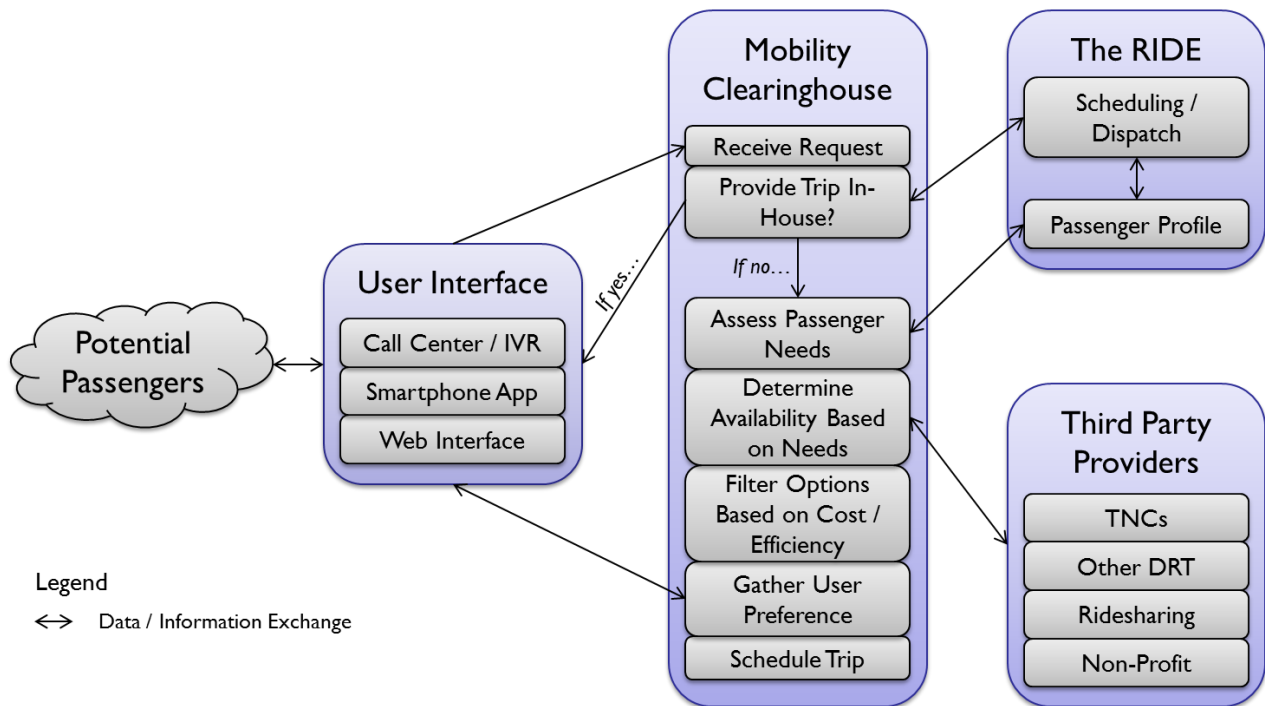
Opportunities

Dynamic ridesharing concepts coupled with the technological capabilities offered by today's location-enabled smartphones, presents a host of opportunities to introduce innovation to the paratransit market.   Many paratransit operators – including the MBTA – do not currently accommodate last-minute requests. Many transit agencies struggle to meet the demand of trips scheduled in advance.   By establishing a seamless communications portal with ridesharing programs by which paratransit operators can share excess demand, transit providers could lower costs and provide more conveniences for passengers with special mobility needs.

Development of a Paratransit-Specific Trip Clearinghouse
The Mobility Clearinghouse would provide numerous customer service advantages over today's operations. By employing one-call-one-click concepts, the Mobility Clearinghouse may provide customers with a one-stop solution to identify the *right* transportation provider for their trip need. In present-day operations, customers are required to call the correct call center (among three MBTA contractors) depending on the origin of the trip. To use the *Non-ADA Paratransit Taxi Subsidy*, customers must schedule taxis from the pre-approved taxi company directly. Presently, neither solution allows clients to create or cancel reservations via web or smartphone. Further, no

solution allows passengers to track their vehicle location in real-time, leaving paratransit riders with a window of when to expect service.

There are a host of other transportation providers operating in the region, including but not limited to: The City of Boston's Senior Shuttle, SCM Community Transportation, East Boston Neighborhood Health Center, and shuttles administered respectively by Partner's Healthcare, Longwood Medical Area, and the Cambridge Health Alliance. The sequestered nature of these transportation providers does not allow customers to easily compare travel times, costs, and service availability.

As its name implies, a one-call-one-click transportation service is designed to connect passengers with the most suitable transportation service via a single telephone call or single web browsing session. **Implementation of a similar system would relieve passengers of the current burden of placing many different calls to sufficiently evaluate available options, or to become aware of better options that they do not realize are available.** The Mobility Clearinghouse seeks to take this concept a step further and provide for greater regional service coordination of trips among various non-emergency medical providers.

Reduction of Burden on Existing Paratransit Fleet and Personnel

By employing a large staff of dedicated drivers to provide paratransit service on vehicles used exclusively by The RIDE, the MBTA cannot adequately respond to variations in supply and demand. During times of high demand, this may result in longer waits and poor service. Alternatively, during periods of lower demand, drivers and vehicles may go underutilized, thereby greatly increasing the cost per trip of providing the service. The Mobility Clearinghouse expands the *Non-ADA Paratransit Taxi Subsidy* without explicitly requiring the agency to develop contractual arrangements with additional third parties. To participate in the system, all vendors (and drivers) would submit to a to-be-defined regulatory process to ensure consumer safety. By allowing customers to self-select vendors depending on their own preferences and needs, the Clearinghouse may allow the MBTA to better ensure that The RIDE's vehicle and personnel resources are more consistently utilized during periods of service variability.

Reduced Operation Cost of Providing Service In-House

The ability to supplement the MBTA's dedicated paratransit service with a variable fleet of taxis, TNCs, and other suppliers will have an effect not only on service delivery and passenger mobility but also the MBTA's own operating costs. By leveraging other existing transportation resources, the MBTA may realize reduced operating costs as it: a) makes greater utility of its own in-house resources; and b) outsources additional demand to third parties, as needed. This model may allow the MBTA to operate a smaller, dedicated fleet.

In Massachusetts, like many parts of the country, transit agencies have few options available when selecting third-party contractors to provide paratransit service. The Mobility Clearinghouse may broaden the potential pool of eligible vendors and drivers capable of competing for paratransit business – ensuring that when service agreement contracts are rebid, a wider array of eligible organizations are exposed to the industry and potentially able to compete for the business. Increased competition will not only lead to a reduction of costs, but also incite new innovations in the industry.

Implementation of a Seamless Experience for Passengers

The implementation of the Mobility Clearinghouse has the potential to greatly enhance the experience and convenience of using paratransit services. Under The RIDE's current policies, trips

must be booked between one and fourteen days in advance. This requires passengers to schedule entire days around routine appointments and errands. Additionally, some changes that passengers may wish to make to a trip can result in a change in fare to the full rate instead of the discounted ADA rate. By using a much larger fleet of vehicles, the Mobility Clearinghouse is better equipped to accommodate-last minute changes or cancellations.

The implementation of a smartphone application to accompany the trip clearinghouse has the potential to provide customers with real-time vehicle location and up-to-the-minute arrival time estimates. The real-time information could also be communicated to passengers via telephone using an interactive voice response (IVR) system. A standardized data format is required in order for the service providers to submit their vehicle location, availability, capacity, etc. to the Mobility Clearinghouse.

Expansion of Real-Time, Dynamically Dispatched Options for Customers

The option for immediate, on-demand paratransit services is greatly limited and cost-prohibitive for many constituents. The concept would greatly expand the number of vehicles (and seats available on rideshare vehicles) to provide better service to passengers in real-time.

Potential Emissions and Vehicle Miles Traveled Reductions

The environmental benefits of demand-response transportation services vary based on the number of passengers per vehicle, type of vehicle, and the type of fuel used. As with all public transit modes, the number of passengers aboard the vehicle greatly impacts the emissions savings: the more passengers that are riding on the vehicle, the lower the emissions per passenger mile. According to the FTA, nationally, demand response transit averages 3.100 lbs. CO_2 per passenger mile. This represents roughly three times the CO_2 being produced by the average drive alone vehicle as many trips are being provided with specialized buses and vans that are not as fuel efficient as smaller sedans. By comparison, the MBTA's bus system achieves 0.732 lbs. CO_2 per passenger mile while the MBTA (including all modes) achieves 0.336 lbs. CO_2 per passenger mile. Nationally, demand response travelers' account for 1.57% of public transit riders and achieve a ridership equivalent to 12% of vehicle capacity. While it will be a challenge for the environmental impacts of demand response trips to equal those of bus and public transit, there is significant room to reduce these impacts by increasing vehicle utilization rates.

The Mobility Clearinghouse concept seeks to increase demand response vehicle utilization by incentivizing passengers to choose more efficient means, when available. As such, it would reduce GHG emissions by reducing demand-response vehicle miles traveled (VMT). In addition, it optimizes reduction of greenhouse gases through efficient operation, dispatch, and navigation of vehicles across numerous providers, many of whom today operate with limited dispatch technologies (e.g. Council on aging shuttles).

Constraints

This section discusses the barriers which may inhibit the success of the Clearinghouse concept.

Implementation of Shared Data/Technology Platform

The Mobility Clearinghouse requires a highly reliable real-time data exchange system between transportation providers. This real-time data exchange would allow the Mobility Clearinghouse to

obtain the up-to-the-minute status of each transportation provider including vehicle and driver availability, vehicle capacity and accessibility, current travel time estimates, and fare estimates.

In spite of the numerous benefits enabled by this real-time data exchange platform, fully implementing it would require substantial coordination between the MBTA, TNCs and ridesharing providers, taxi companies, and software developers. The RIDE currently uses ADEPT StrataGen software to manage scheduling and dispatch operations. ADEPT, like most paratransit operations software, is not suited to handle last-minute requests and real-time dispatching, and would require enhancements to make it capable of real-time operations and open data exchange.

Real-time data management and exchange is a crucial component of TNCs and dynamic ridesharing services. While these companies are well suited to deploy real-time application programming interfaces (APIs), it is unlikely that these APIs would follow a standardized specification. Because of this, the trip clearinghouse may need to be configured and programmed in a custom fashion for each participating TNC. Alternatively, TNCs may be required to provide data in a standardized format if they wish to be a trip clearinghouse transportation provider partner.

Similarly, taxi dispatch systems may require an extensive overhaul to be compatible with this open data exchange. The informal nature of taxi hailing is not conducive to centralized data management and complicates the process of knowing the real-time availability of a taxi fleet. **Taxi companies participating in the Non-ADA Paratransit Taxi Subsidy Pilot Program should be involved in the Mobility Clearinghouse planning process to ensure system and data exchange compatibility as integration is rolled out.**

Insurance/Policy Requirements

A longstanding and well-documented concern regarding TNCs is the level of insurance coverage available to protect drivers and passengers. In 2015, many states (including Massachusetts) moved to more clearly define the insurance coverage minimums for TNCs. In January, the state filed a list of rules and regulations that formally recognize Uber, Lyft and other ridesharing operations as official modes of transportation in Massachusetts with the Department of Public Utilities (DPU) acting as the licensing authority with jurisdiction over ridesharing operations. The Public Utilities Department will have the power to "conduct, or have a third party conduct" criminal background and driving record checks of rideshare drivers. Rideshare companies will not be allowed to partner with drivers who are registered sex offenders or who have been convicted of violent or sexual abuse crimes or driving under the influence – among others – in the past 10 years. Further, $1 million of liability insurance coverage is required by drivers when they are responding to passengers or working through the applications. The legislation was developed through consultation with municipal leaders, company representatives and public safety advocates on behalf of the Commonwealth of Massachusetts.

While the TNCs have been slow to respond to user concerns, insurance companies have started to evolve their product offerings to better provide coverage for drivers – many of which are considered independent contractors to the TNC. These "hybrid" insurance policies allow TNC drivers to maintain enhanced insurance coverage as more states move to require more stringent insurance policies.

MBTA's service providers are currently required to adhere to minimum vehicle insurance coverage. In the case of the Mobility Clearinghouse, vehicles that feature wheelchair lifts and restraints will

likely be subject to greater insurance coverage requirements and as such, may limit the number of providers with fully-wheelchair accessible vehicles who wish to compete for business.

Standardized Driver Training and Performance Feedback Process

The MBTA currently offers a formal commendation and complaint process for The RIDE. Any passenger feedback about service quality will be investigated and answered within 10 business days. The Mobility Clearinghouse will offer a consistent commendation and complaint system to ensure driver quality and to assess whether the partner organizations are delivering an acceptable quality level of service. Implementing a feedback process with the Mobility Clearinghouse would provide MBTA with high- level passenger satisfaction data. However, the agency may not have any authority to reprimand or correct driver behavior. Drivers whose score falls below a minimum acceptable threshold may be required to undergo additional training or face a probationary period until their driver score rises to an acceptable level. Drivers with consistently poor reviews can be banned from competing in the clearinghouse.

In addition to minimum vehicle insurance coverage, MBTA's service providers are also required to adhere to driver training, and driver adherence to drug and alcohol policy requirements – a similar standard is worth investigating further should the Mobility Clearinghouse concept progress. However, there is also a concern with the MBTA's ability to enforce a training standard across third-party operators authorized to provide transportation through the Mobility Clearinghouse. While the MBTA could enforce high-level training guidelines, it may have limited ability to dictate specific driver training standards.

Accessibility Standard for Personal Automobiles

The RIDE serves passengers with a variety of mobility needs. Not all passengers require a fully-accessible, ramp-equipped van, but using these vehicles for all trips ensures that all mobility needs can be met. Enabling third party providers and rideshare operators to compete for paratransit trips must be done in such a way that passenger mobility is not threatened. Specifically, the Mobility Clearinghouse may need to maintain a database of the mobility requirements of each passenger and attributes of third party vehicles. As trips are dispatched through the system, the algorithm used would ensure that passengers are only assigned to vehicles whose on-board equipment meet his or her mobility needs.

The TNCs biggest challenge remains providing access to people with disabilities, particularly wheelchair-accessible vehicles. Table 3 summarizes the plans for meeting the needs of disabled passengers submitted to the CPUC by five TNCs. However, no organization offered a clear-cut plan as of publication (Said, 2014). The news media has not extensively reported on the legality of these services in test markets outside of California.

Table 3. Summary of Forms and Reports Filed by TNCs to CPUC

Company	Wheelchair Access	Application/Website Accessibility standards	Service animals
InstantCab	"We may offer a higher share (of ride revenue) or one-time bonus to drivers who have accessible vehicles ... (or) reimburse drivers for all or a portion of the cost of making their	Will modify app to work with text-to-speech tools within six months (from December).	"Allowed ... barring a medical condition of the driver or some other emergency."

	vehicles accessible."		
Lyft	"Drivers will be able to indicate what, if any, accessibility needs they can accommodate. ... We are working to engage and educate the handicapped community in each of our markets."	"The app and website already comply in part with the accessibility standards." Will fully comply by June 30, 2014.	Will add an app feature to let users set preference for "service animal accessible vehicle."
Sidecar	Meeting with disabled-rights groups to discuss incentives to attract drivers with accessible vehicles. Exploring pilot program to let such drivers "operate on a 'volunteer firefighter' model."	"App and mobile website are accessible to blind users."	"Currently, most Sidecar drivers accept service pets." (sic)
Wingz	"We will start a campaign to find drivers who can offer (accessible) vehicles." Will cut its 15% commission for these drivers.	Within two months from November, will make sure app/website meet accessibility standards.	"Users add information about their animal in their request, and drivers who have vehicles that can accommodate animals accept these requests."
Uber	"Will reach out to transportation companies with accessible vehicles about the possibility of partnering."	iOS app has VoiceOver support.	"No need for a user to indicate ahead of time that he or she is accompanied by a service animal."

Source: Adapted from "As Uber, Lyft, Sidecar grow, so do concerns of disabled." The San Francisco Chronicle

Additionally, both Lyft and Uber have recently been faced with lawsuits alleging that they violate the Americans with Disabilities Act (ADA) by not maintaining a fleet of wheelchair-accessible vehicles (Rosenthal, 2014).

Managing Real-Time Demand with a Limited Set of Vehicles and Drivers

A constraint related to deploying the Mobility Clearinghouse is the reconciliation of real-time demand with a limited set of drivers and vehicles. In order for the trip clearinghouse to achieve its intended purpose, users will need to have a high likelihood of receiving an immediate match when requesting a trip. Likewise, transportation vendors will need to know that a day's operating expenses will be offset by a sufficient number of trips.

TNCs typically adjust trip pricing to reflect surges or other periods of high demand. This policy ensures that drivers have an incentive to meet this demand and that customers are likewise served in a reasonable amount of time. While this policy is a pillar of the TNC business model, public transit does not typically allow for peak pricing, which may be seen as unequitable and may be technically difficult to implement in traditional fare payment systems. **Therefore, the operator of**

the Mobility Clearinghouse may need to be prepared to offer incentives to partner transportation vendors to ensure that periods of high demand are met.

This supply and demand example is less of an issue for trips scheduled in advance than it is for trips requested at the last minute. The use of paratransit scheduling software allows for an optimized schedule given trip demand, available drivers, and available vehicles. If used appropriately, it could avoid the need to responsively adjust trip prices.

Integration with Public Transit

The paratransit sector is often far from profitable, and shrinking government revenues may make incentivizing participation by ridesourcing/sharing companies problematic. Some cities have in fact chosen to use companies such as Uber and Lyft as an additional source of revenue to ensure availability of paratransit vehicles. For instance, Seattle passed an ordinance last summer creating a 10-cent surcharge on every ride originating in Seattle with UberX, Lyft, or Sidecar that will be used to defray the cost of owning and driving a wheelchair-accessible taxi.

The lack of integration between transit and ridesharing services has been mentioned as a weakness of many ridesharing programs. This integration has obvious importance when considering the potential supplementation of paratransit service with ridesharing. Two aspects of the relationship between ridesharing and public transit could be streamlined:

1. The integration of trip information pertaining to both traditional public transit and ridesharing could encourage a higher number of multi-modal travelers. (Amey, Attanucci, & Mishalani, 2011). In this scenario ridesharing is viewed as a complementary service to public transit service – connecting travelers between modes to their destinations to lower overall VMT, GHG, and trip cost. In the Mobility Clearinghouse, travelers could be permitted to request service to the nearest fixed-route rapid transit station for a lesser fee than the full trip to the destination.
2. The ability to "transfer" between ridesharing and public transit similar to transferring between transit lines could further enhance the integration between ridesharing and public transit.

Interagency Coordination

The coordination of demand-response transportation services focuses on bringing together all the key people and organizations that have responsibility for helping people meet their mobility needs in ways that permit decisions about what services are offered and who offers them. Coordination is driven by an understanding of who the customers are, what their needs are, and what kinds of services under which circumstances can be most cost effective and cost-efficient in meeting those needs safely and responsively. Coordinating paratransit services creates economies of scale and operating efficiencies, and can improve efficiency for providers while increasing mobility for users.

Successful implementation of the Mobility Clearinghouse hinges on the Boston-area's ability to coordinate across service providers, jurisdictions, and even business models. In this regard, while technology can facilitate communication between riders and drivers in real-time, significant hurdles must be overcome to address jurisdictional concerns. The Massachusetts Regional Coordinating Councils (RCCs) may pose the greatest opportunity to discuss these coordination challenges.

RCCs have formed across Massachusetts as part of a statewide initiative. Transportation providers, planners, human service providers, advocates and self-advocates, and other stakeholders work together to identify and address transportation needs in their region. Each Regional Coordinating Council is different and reflects local priorities. RCCs stem from the Executive Order 530 report on improving quality and efficiency of paratransit services in Massachusetts. As described by MassDOT, RCCs are voluntary advisory bodies, which provide a forum for open discussion, information exchange, and decision making about regional transportation priorities. RCCs are an opportunity for a wide-range of local stakeholders to come together to:

- Identify unmet needs, articulate regional priorities, and build coalitions around new projects in mobility and transportation.
- Coordinate existing services at the local level to serve more people and increase sustainability of services.
- Communicate local unmet needs and mobility priorities to planning agencies (for their coordinated plan updates), MassDOT, the Executive Office of Health and Human Services (EOHHS), and other state agencies.
- Participate in a statewide campaign to raise awareness of the important role that community transportation services play for seniors, people with disabilities, and all Massachusetts residents.

Regulatory Considerations
The regulatory landscape for all current ADA transportation providers is well defined. The regulatory framework governing TNCs remains in flux and is undergoing active change (as of July 2015). Regardless of the outcome, specific regulatory considerations will be needed to assess whether organizations can participate within the Mobility Clearinghouse structure.

Background Checks
The RIDE requires all drivers to submit to a pre-employment drug test and Criminal Offender Record Information (CORI) background check. The source of criminal history information contained in the iCORI database is the Office of the Commissioner of Probation (OCP), a subdivision of the Administrative Office of the Trial Court (AOTC). Accordingly, OCP is the only state agency that can change information that appears in the iCORI database. The CORI Support Services Unit provides CORI to Board certified, non-criminal justice agencies such as schools, day care centers, home health aides, youth athletic coaches, and municipal government agencies.

TNCs, however, are facing a litany of scrutiny and regulation to bring operations onto "equal footing" with taxis. TNCs typically require drivers to submit to background checks which are administered by private companies. This process differs from taxi drivers which are required to undergo background checks which are performed by the municipal police departments. In Massachusetts, State legislation may soon require TNC drivers to undergo a background check involving fingerprints.

Insurance
Insurance is also a major concern and consideration for TNC-related legislation. Regulations vary widely between jurisdictions. Massachusetts is considering legislation that would require TNC drivers to obtain commercial insurance, which is required of taxi and livery drivers in Boston. Further, TNC drivers would be permitted to keep personal insurance policies for their vehicles, as long as the company provides commercial insurance during any rides with customers. Other states have stipulated that TNCs provide up to $1 million in liability insurance – from the time a driver

accepts a request to the moment the rider leaves the car. More stringent regulations in California require TNCs to provide insurance from the moment a driver turns on the app.

Accessibility

TNCs have also faced criticism and suits regarding the treatment of persons with disabilities. The suits stem from claims that TNC drivers illegally denied service to a number of vision-impaired passengers with guide dogs. TNCs also face litigation for not providing wheelchair-accessible vehicles. In Massachusetts, TNCs are responding to inquiries from the office of the Attorney General. Measures have been proposed that would require TNCs to maintain one wheelchair-accessible vehicle for every 100 in its network, and mandate that drivers pick up riders with service animals.

Next Steps

Ridesharing is in the midst of a renaissance thanks in part to the smartphone technologies which enable drivers to connect with passengers in real-time. The organizations that have sprouted as a result are innovating transportation service delivery; demand-response service is no exception. In this paper we have tried to understand how these technologies can improve mobility for persons with disabilities and Massachusetts frailest constituents. This report evaluated opportunities to leverage innovative technologies and emerging applications to augment the MBTA's demand-response transit service delivery structure. In particular, it sought to establish a framework to incorporate ridesharing benefits, namely increased vehicle utilization, decreased per trip costs, and decreased VMT and GHG for public transportation providers.

The Mobility Clearinghouse is presented as the structure that could incite further competition among area providers for demand-response trips. It proposes a framework to deploy real-time ridesharing technologies to connect travelers with area transportation providers. It is intended to complement the expansion of the Non-ADA Paratransit Taxi Subsidy Pilot Program. The Mobility Clearinghouse is modeled after the USDOT's MSAA Travel Management Coordination Center (TMCC) and the IDTO Transportation Information Center (TIC), both of which would collect, process, store, and disseminate transportation information to system operators and travelers. The Mobility Clearinghouse is intended to increase mobility *choice* for persons with disabilities through increased competition for service.

It is important to note that there is not a single best way to move forward. It will be up to Massachusetts' special transportation needs stakeholders, especially members of the Boston area RCC, among others, to weigh in on how best to advance these efforts. This report shall be used to guide discussions on transformative goals, performance measures, and user needs and ultimately direct the development of a Concept of Operations for the Mobility Clearinghouse. However, there remain a number of rideshare-related topics that are suitable for further research. Many of these future research topics can be explored through properly designed and managed rideshare trial or demonstration projects.

- Research is warranted to better understand what effect the Non-ADA Paratransit Taxi Subsidy Pilot Program has had on demand for The RIDE services (among pilot program participants), access to transportation services for those in the pilot, and what impact, if any, on the taxi providers. From a user perspective, further information regarding willingness to schedule trips independently is needed. Lessons learned from the Non-ADA Paratransit Taxi Subsidy Pilot Program could impact the operational concept and design of a future Mobility Clearinghouse.

- A thorough data analysis of demand-response trips across all providers is justified. Further investigation regarding the opportunity to couple trips and increase the utilization of The RIDE vehicles is needed. As the MBTA moves towards the Centralized Call and Control Center (CCCC) for The RIDE, it will be important to evaluate what effect this consolidation (and the incentive to the CCCC contractor) has on vehicle utilization.

- Significantly addressing a number of obstacles facing the Mobility Clearinghouse concept not covered by this report, namely: institutional and jurisdictional challenges; geographic constraints; fare structure; insurance requirements; driver certification standards; and

technology and vehicle accessibility, among other considerations is warranted. The Concept of Operations shall investigate these considerations further, especially what effect each would have on the various user groups. The concept of operations will describe the characteristics of the system from the viewpoint of an individual who will use that system. It is used to communicate the quantitative and qualitative system characteristics to all stakeholders.

- Establishing measurable, area-wide performance measures is recommended. The MBTA and its partner agencies shall be working to achieve measureable objectives as part of the Mobility Clearinghouse concept. Example metrics may include: number of shared ride trips, number of active Mobility Clearinghouse participants, and the number of trips provided across providers.

While this report was funded by the Barr Foundation and led by A Better City – it is recommended that the Massachusetts Department of Transportation Rail and Transit Division, Mobility Management group lead the next steps in the concept development. At a minimum, advancement of the concept should be coordinated with a diverse set of stakeholders representative of the public, private, non-profit, and institutional sectors most affected by demand-response service delivery.

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Dynamic Ridesharing Technologies

Opportunities for the MBTA's The RIDE Paratransit Services

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