Northwest Denver Coordination Project

Developing the Trip Exchange Software Platform

Enabling Demand-responsive Transportation Providers to Automatically Exchange Trip Data

Final Report

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Prepared through a Mobility Services for All Americans Grant

Administered by the U.S. Department of Transportation's Federal Transit Administration and the Intelligent Transportation System Joint Program Office

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Abstract

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Executive Summary

Project Overview

Four transportation providers in Northwest Denver in Colorado collaborated to develop a means to share trip data for demand-responsive transportation to improve service coordination. This project was funded under a Mobility Services for All Americans (MSAA) grant. MSAA is a program jointly developed and funded by the U.S. Department of Transportation's (USDOT) Federal Transit Administration (FTA) and the Intelligent Transportation System Joint Program Office (ITS JPO)

There were two distinct purposes to this project. The first was to use technology to provide more rides for more people. The specialized transportation providers in Northwest Denver are in a situation that is common for many regions:

- Human services transportation resources are limited while needs are great.
- Many trips need to travel across jurisdictional boundaries.
- There are a variety of service providers, some of which may have overlapping boundaries or serve clients who are eligible for services under multiple programs. For example, a rider could be a senior, a veteran, and have a disability that makes him or her eligible for ADA Complementary Paratransit, Veteran's Transportation services, and the local services provided by the Senior Center.

This results in a complex situation that can be difficult for riders, family members, or human service agency staff to navigate as they try to figure out what agency to call to get needed transportation. Similarly, a transportation provider would not know if there might be another provider who could carry a trip that is difficult to serve or that it does not have the resources to serve. A provider would also not know if there is another provider traveling in the same general corridor at the same time who could provide a trip more efficiently. It is a situation where existing technology can provide a means to quickly enable data about trip availability to be exchanged, allowing agencies to quickly get the information needed to make decisions that provide the most trips and use resources effectively.

The second purpose was to create a software platform to exchange the needed trip data and to do so in a way that can be replicated. Once fully tested and piloted in NW Denver it may be used in other parts of the Denver metropolitan area. It also has the potential to be used in other geographic areas.

This was a software planning and deployment project based on solid collaboration between providers and software vendors. It was grounded in systems engineering to assure that the requirements for an effective system were clearly defined and resulted in open-source software for exchanging data about demand responsive transportation trips. The software platform primarily uses Application Programming Interfaces (APIs) to allow the provider's different software scheduling systems to exchange data with one another. At present it is set up with the basic functionality to exchange trip information and can be enhanced in the future. Two scheduling systems (DemandTrans Solutions Mobility DR and RouteMatch) are adapted to send and receive data streams that include the basic trip information.

Project Background

A short history of how the project came about helps in understanding the pragmatic and focused approach that defines the project. The mission of Via Mobility Services (Via) is to provide specialized transportation services to older adults and individuals with disabilities. Via has successfully bid for contracts to provide general public Call-n-Ride (CNR) service in Longmont and other areas for Denver's Regional Transportation District (RTD). Via also became a provider of RTD's paratransit service in the area. As a result, the agency found itself dispatching different vehicles to the same locations at the same time for riders eligible to use different services.

With all services provided by the same agency, Via and RTD began to sort out the institutional and technical issues of allowing different riders to ride on a single vehicle. Via's mission service uses RouteMatch software to schedule and dispatch trips that go through their reservation center. The CNR service uses Mobility DR for scheduling trips. Riders can schedule online or call drivers, but they do not go through a reservation center. To combine riders between these services meant that Via and RTD had to figure out how to enable an exchange of information between the different scheduling systems.

The resulting system worked but was only partially automated; a staff person spent a good deal of time each day making sure the trips were shared and trip performance went smoothly. It was time consuming and clunky, not suitable for replication. At the same time, it improved productivity on both the RTD Call-n-Ride service and Via's mission service, a paratransit service. The result of providing more rides with the same level of resources showed the potential for further development and replication in other areas.

The logical next step was to create a functional platform that would result in a fully-automated system (significantly reducing staff time required) and remedy issues such as drivers needing to have two tablets (one for each scheduling system) in their vehicles. This necessitated developing a new structure for how and what information would be exchanged. Simply automating the process already in use would not resolve basic limitations in the existing system that relied too heavily on the structures of the existing scheduling systems. A new structural design was needed using a data exchange hub for the system to be:

- Fully automated so staff time would be minimal; and
- Able to accommodate a wide range of scheduling systems.

Project Stakeholders

The stakeholders included four transportation providers: Via Mobility Services, RTD, City and County of Broomfield, and Seniors' Resource Center, along with the two software vendors: DemandTrans Solutions and RouteMatch. The two software vendors were responsible for adapting their software to work with the new system. In addition, DemandTrans was responsible for developing the Trip Exchange software. The transportation providers were responsible for defining what the system needed to do, providing feedback to the developers as the project progressed, and for actively working together to identify and resolve institutional issues.

The riders and the residents of our communities that support these human service transportation programs are also considered stakeholders. Because of the value mobility

services bring to a community, they are supported by donations from individuals, businesses, and governmental entities as well as tax-pay funded programs. Working hard to meet the mobility needs of the riders and respecting the generosity of the funders, each of the participating agencies works hard to make the best use of their limited financial resources and provide riders with the mobility they need to live and work in our communities. This project illustrates those values as it enables the participating agencies to provide more rides with the same resources.

Figure ES-1: Rider Profile Steve D., age 55

I'm a blind, middle-aged white guy who likes to play African drums. And be employed.
PHOTOGRAPHER: RACHEL GOMEZ

On the morning of July 19, 1977, young Steve was a healthy, inquisitive 16-year-old, ready to explore the adventures of his day. Six hours later, a rare and unexplainable build-up of spinal fluid in his brain crushed the optic nerve, leaving him with limited light perception and an inability to see detail or color.
After many years of under-employment, Steve was hired by Longmont's family-owned Welzig Heating & Air. The company decided to give Steve the opportunity to show what he could do rather than focus on what he couldn't do. They took a chance on him. His severe vision impairment carries a number of challenges at work. He was offered the full-time job on a Friday and told to report to work the following Monday. That was seven years ago.

Now Steve's voice is the first a customer hears at Welzig Heating & Air. There has been a lot of disappointment in Steve's life before getting this job. He relies on Via to get him to work each day. We are there every morning. We will not disappoint him.

I am contributing because of Via. I am enjoying my community. I am living a full life.

Development Process

Developing a software platform that would enable providers to share trips required:

- Building a common language and common understanding of project challenges
- Agreeing upon what was needed to meet the functional needs of providers
- Refining to clearly define and build a system that would achieve the objectives
- Working through institutional and technical issues
- Testing and adjusting the final application so that it works as envisioned

This was a deployment planning and development project more so than simply a planning process. The tenants of good planning and systems engineering were used throughout

in an iterative process to develop a functional software system to exchange trip data.

The stakeholders recognized that a narrow focus would increase the chances of success. They opted to narrowly define the project, identifying the minimum necessary to enable partners to automatically exchange trip information, thus improving the existing system. The stakeholders felt it was important to have a functional (although limited) system developed as a result of this project. It can be augmented and enhanced over time as it is implemented in Northwest Denver and other areas. The framework concepts were broad, well tested, and widely used even as the project itself was narrowly focused. The result is a system for exchanging data that is flexible and adaptable.

Lessons Learned

This project was quite successful; key reasons for the success were:

- The stakeholders were trusted partners, each committed to making this work and each willing to go the extra distance if needed. Most of the primary stakeholders were deeply involved and spent considerable time on the project.
- It was grounded in reality and built upon prior successes.
- The group was pragmatic and disciplined enough to establish and hold to a narrow focus.

A variety of lessons were learned, including:

- **Iterative Development Process**. An iterative process for developing the software was used. This was especially valuable as stakeholders were building an understanding of what was needed and how design options would function in practice. It strengthened their involvement in the process and their feedback resulted in a stronger product.
- **Developing a Shared Vision.** While the concepts employed have been well tested and widely used in many industries, they were new to the project stakeholders and to this application. Project stakeholders first needed to understand the basic concepts and relate these concepts to their own experiences as a provider or software developer. The next step was for each stakeholder to understand what the concepts meant for the other participants. Over the course of the project, their understanding of the concepts deepened, and their ability to see the potential and options available broadened. Fully developing a shared vision depended on all the primary stakeholders gaining a common level of understanding. *It took eighteen months for a shared vision to completely come together.*

  Even as the project has come to completion, this shared understanding is still changing as stakeholders continue to deepen their understanding of the importance of the work that has been done and how it can be developed in the future.
- **Exploring New Ground**. The project explored new ground as stakeholders did not have a model to follow. Although there were a variety of tools, it was necessary to make sense of how each related to the project objectives.
- **Communication: A Common Vocabulary**. A common and sometimes new vocabulary needed to be developed. Often, participants used the same words or

phrases to mean different things, and the transportation providers needed to develop a technology vocabulary.

- **Sharing the Vision with Others**. The development of a shared vision occurred among the six primary stakeholders (four providers and two software companies) who spent long hours together, working through the many project issues. Secondary stakeholders (including our Federal, State, and regional partners) are still, as individuals, building their understanding of the how the project fits into a larger framework as well as understanding the potential and the limitations of the final product. There are many individuals at the secondary stakeholder level who, appropriately, participated in an oversight role only rather than attending long hours of meetings. While the level of understanding varies with the individuals, this points to the difficulty of the project and the challenge of building an understanding in an area that requires both deep technical and deep operational understanding.

  It makes one realize how hard-won the shared understanding is among the primary stakeholders and how much work will be needed to communicate it to others. Primary stakeholders forged this understanding through many hours of working together on various aspects of the project. Finding an effective way to communicate the value to specialized transportation providers across the nation will require concerted effort.

Applying the Lessons Learned

As the primary stakeholders now have a solid understanding of how useful the Trip Exchange software is, they hope that others will learn about it and continue to build on the tools that have been developed. However, the lessons learned tell us that it will be important to communicate to a wider audience in a gradual fashion. It is important to introduce the project in stages, allowing individuals to gain a deeper understanding as they are interested in doing so. As a result, the final report presents a basic description but references are provided for those who wish to explore the project in more detail and potentially use the software in their region.

Trip Exchange

The MSAA project resulted in the Trip Exchange, a “data exchange hub” for demand responsive transportation trips. This is available as open-source software with a user’s manual. In addition, two scheduling programs, Mobility DR and RouteMatch, were adapted to be able to send data streams to the Trip Exchange and to act on data received from the Trip Exchange.

Features

The Trip Exchange is designed to work with any electronic scheduling system through API connections. It enables transportation agencies to post trips that other agencies might have the potential to serve and to claim trips that can be fit into their vehicles.

The Trip Exchange transfers information through structured messages that include only the minimum amount of information needed for an agency to decide if they can accept and complete the trip. The messages are designed to include information specialized

transportation providers would need, such as pick-up and drop-off addresses and whether the passenger is traveling with a mobility aid.

The structure of the Trip Exchange and its guidelines address key operating issues encountered by agencies, such as:

- When does control over a trip transfer from the agency posting the trip to the one claiming the trip?
- What qualifications does an entity need to participate and accept given trips?
- How is the shift in providers communicated to the rider?
- What happens if the rider needs to cancel or change the trip, especially on short notice?

At present, the Trip Exchange is set up with the basic functionality to exchange trip information. A variety of reports can be run such as a monthly report of trips delivered by provider. It will be able to address billing and financial issues but this component is not yet built out.

Decentralized System

An important characteristic of this system is that it does not require a brokerage or centralized reservation system to determine if trips can be shared. Control over whether or not trips are posted and claimed resides with individual participating agencies. As such, it is designed for a decentralized system where individual providers have their own means of scheduling.[1]

Human service transportation providers generally have limited financial, vehicle, and driver resources that determine how much service they can provide. For the participating agencies, it is important to retain control over whether or not they accept trips. The Trip Exchange allows them to see trip requests and determine (using their scheduling system) if they can add a trip to an existing vehicle run. In theory, the payment for that trip would need to cover at least the marginal cost of picking up the extra rider and perhaps something more. This supports “providing more rides to more people” using existing resources, and the existing semi-automatic system shows that it can work effectively.

Next Steps

The system has been tested and is almost ready for use. The next step is for the partners to enter into agreements that define how they will work with each other. This includes sharing costs for hosting and for addressing payments for providing trips on behalf of others. Then the system can be used among the partners to exchange trips.

Three key follow-on development activities have been identified:

- Build out the payment and billing portion, enabling agencies to post what they are able to pay for a trip and to provide an invoicing system.

[1] It could also be used as part of a brokerage that is only partially centralized. A partially centralized brokerage would be one in which many providers are under a single scheduling system but other providers do some or all of their own scheduling. For example, trips could be posted for taxis or other independent drivers to consider picking up.

- Work with other scheduling systems to connect to the Trip Exchange. This requires that the scheduling system use APIs to send information to the Trip Exchange and to read and respond to messages received from the Trip Exchange.
- Adapt the system so it can also answer key questions for providing efficient regional trips services:
    - Are there enough trips in a corridor to make it financially feasible to establish a vehicle run?
    - Can an existing vehicle run be extended to provide an additional trip? If extended, would the provider remain the same?

As an open-source system, it will be necessary to build a community of users who can support the use and continued development of the program.

Future Potential

The questions identified above under the Next Steps heading provide a guide as to the potential of the Trip Exchange. Building out the ability to transmit the financial information associated with each trip and to allow the providers to see what they can get paid for the trips they provide is a critical next step. If most the major scheduling systems could connect to the Trip Exchange, agencies could purchase and use the scheduling system that is right for them, rather than what the big players in the region use. Finally, adapting the Trip Exchange to assist providers in building effective regional trips would solve a common problem and enhance the usability of the system for trips that need to travel across jurisdictional boundaries.

While the Trip Exchange is presently somewhat limited in functions, with the above modifications its functionality will greatly increase. As importantly, the Trip Exchange represents a key programming structure that will be needed for trip planners or One-Click software to allow customers to not only identify available services but also to reserve a spot or purchase a ticket on demand response transit services.

1. Introduction

Purpose

The Northwest Denver Metropolitan Area Coordination Project was built on prior coordination efforts. The project sought to enhance the systems already developed so they would function more automatically, a key for scalability and replication. It also sought to expand these systems to additional areas and new operators. To do so necessitated addressing technical and institutional issues.

This project enhances the current coordination model used in Longmont, CO, using technology to scale the concept up to more locations and more providers, with a goal of having a product that can be replicated by other systems. The enhancements require some significant steps forward in technology. It is necessary to move from a system that works around the existing technology challenges to one that is designed for the required functionality and enhances the capability of software systems already in place.

The Northwest Denver Coordination Project was fortunate in being awarded a USDOT Mobility Services for All Americans (MSAA) grant. This grant provided the opportunity to develop a software platform that allows providers with different scheduling systems to share trips. Providers put trip information into a data exchange hub called the Trip Exchange so other providers can view the trip. If one of the other providers can carry the passenger, the trip can be accepted and delivered by the other provider.

Longmont Coordination Model

The vision of this coordination project was to "create more rides for more people". Specific objectives were to:

- Coordinate independent paratransit services to improve ridership and productivity and reduce duplication.
- Employ a Mobility Coordinator to coordinate customer trips.
- Employ technology to support coordination.
- Develop a replicable model.

In Longmont, Via operates Call-and-Ride (CNR) service for RTD, is available to operate Access-A-Ride (AAR) paratransit service, and operates specialized transportation in Longmont. Moving a passenger from AAR to CNR (or vice versa) is an operation that happens internally within Via. Via and RTD modified the scheduling systems for each program and addressed institutional barriers so that Via could share slack time on vehicles operating under different contracts. The result was a semi-automatic means to provide trips efficiently.

Productivity and ridership increased but the current system requires more manual intervention than sustainable for a replicable model.

Vision

The MSAA project will enable the providers in Northwest Denver Metro Area to extend the Longmont Coordination Model to other Call-and-Ride service areas so providers can use resources more effectively and provide more rides to more people. It will demonstrate scalability and will serve as a model for additional coordination in the Denver Metro area as well as for systems in other parts of the country.

Project Goals and Objectives

Goal 1 – Coordinate independent paratransit services to improve ridership and productivity and reduce duplication.

1.1 Identify those items that can remain independent among partners and those items where consistency is required to enable agencies to exchange trips.

Goal 2 – Identify how to extend the Longmont model to other Call-n-Ride areas and additional transportation providers.

2.1 Extend the Longmont coordination model to Louisville, Brighton, Northglenn, Federal Heights, Broomfield, Thornton, Superior, and Interlocken Call-n-Ride (CNR) areas, with Seniors' Resource Center and City and County of Broomfield EasyRide services as additional providers.

Goal 3 – Through technology, provide a high level of automated exchange of data and reduce the amount of manual intervention required.

3.1 Develop a means to automate the exchange of trip data so it is feasible to scale the project up to other areas.

3.2 Develop a means to import trip data from more than one scheduling system to a data exchange hub for all providers to post and claim trip tickets. This includes the necessary adaptations for each software system.

3.4 Develop a means to automatically have data show on a single mobile data terminal (the RouteMatch tablet) so drivers work from a unified manifest.

3.5 Address the functional requirements of all stages of the provision of service, including trip data, confirmation and tracking, reporting, and billing.

Goal 4 – Work with partner agencies to address institutional and operational barriers so the project can be successfully expanded.

4.1 Work through the operational and back-office issues related to shared trips.

Goal 5 – To develop a system that is scalable, replicable, and cost effective.

5.1 Use open-source software.

5.2 Thoroughly document the system so it can be readily understood and adapted by others.

Figure 1-1: Rider Profile: Vita Marker

Two years ago, at age 86 I quit driving. Hanging up the car keys was similar to losing a member of the family -- except I didn't have to bury the Honda. The impact on my independence was huge. I contemplated selling my house and moving to a senior facility. Then I discovered Easy Ride. I can request rides to doctor appointments, grocery shopping, exercise class and even the beauty parlour when their schedule permits. An extra bonus are the new friends I've met who also ride the bus -- one of whom is 101 years old! Today Easy Ride picked me up at home for this appointment and will take me back when I call. Much of my independence has been restored.
Aging in place is a desirable option for seniors; I would amend it to Aging in Broomfield.

Decision-making Process

The project followed along two basic tracks. One was that of developing a technological platform to allow providers to exchange relevant trip information. The other followed process and procedures: the agreements needed for the system to function effectively, the processes that needed to be in place, and the items where common definitions needed to be used. These two tracks were worked side-by-side as it was important for the software developers to understand what the providers needed for the Trip Exchange to effectively support their operations and for the providers to understand the strengths and the limitations of the software options.

Project Rationale

To realize the project vision, it was necessary to create a functional platform that would result in a fully-automated system (significantly reducing staff time required) and remedy issues such as drivers needing to have two tablets (one for each scheduling system) in their vehicles. This necessitated developing a new structure for how and what information would be exchanged. Simply automating the process already in use would not resolve basic limitations in the existing system that relied too heavily on the structures of the existing scheduling systems. A new structural design was needed using a data exchange hub for the system to be:

- Fully automated so staff time would be minimal; and
- Able to accommodate a wide range of scheduling systems.

The project understanding evolved over the course of the project, as stakeholders individually and as a group began to understand what would need to be done to achieve the project goals. They started the project with a conceptual understanding. Providers knew how their individual software scheduling systems worked and had a conceptual understanding that these systems should be able to share information. They had seen it accomplished in Longmont, within the Via system, and more broadly in other types of systems. For example, they knew that when they traveled by air, if there was a problem at the airport, it was possible for airlines to share information about their flights. A flight reserved on Delta could easily get rescheduled to United.

It took some time to translate this conceptual understanding to a working model that their systems could use to share trips. Over time they began to understand how the concept broke down into various parts, how the parts fit together, and what the options were for each part. They discussed the trade-offs of different approaches and developed a consensus around a system that would have the required functionality.

Stakeholders and Project Boundaries

Stakeholders

The primary partners in this project included four specialized transportation providers, the Denver Regional Transportation District (RTD), and two software vendors. RouteMatch is the scheduling system used by Via, SRC, and Broomfield Easy Ride. Mobility DR by DemandTrans Solutions is the scheduling system used in the RTD Call-n-Ride services. DemandTrans Solutions developed software for the Trip Exchange.

In addition, other participants in the project were the USDOT's FTA and ITS JPO and Colorado Department of Transportation (CDOT). The Denver Mobility and Access Council, a regional coordinating group also participated. TransitPlus provided project management.

Table 1-1: Partner Agencies

Partner	Role
Via Mobility Services	Mission is providing specialized transportation in Boulder County. Also operates other RTD contract services.
Denver RTD	Regional transit operator with several CNRs in area.
Broomfield – Easy Rides	Mission is providing demand response service to the elderly & disabled in City & County of Broomfield
Seniors Resource Center (SRC)	Mission service is specialized transportation in Jefferson County & NW Metro area
DemandTrans Solutions	Adapt Mobility DR; develop Trip Exchange

The riders and the residents of our communities that support these human service transportation programs are also considered stakeholders. Because of the value mobility services bring to a community, they are supported by donations from individuals, businesses, and governmental entities as well as tax-pay funded programs. Working hard to meet the mobility needs of the riders and respecting the generosity of the funders, each of the participating agencies works hard to make the best use of their limited financial resources and provide riders with the mobility they need to live and work in our communities. This project illustrates those values as it enables the participating agencies to provide more rides with the same resources.

Figure 1-2: Rider Profile: Elizabeth M., age 102

I was talking to a woman on the phone the other day and when I told her how old I was, the woman exclaimed, Good Lord!

PHOTOGRAPHER: SOPHIE KLAFTER

If centenarian Elizabeth's life is an example, the recipe for healthy longevity consists of lifelong learning and teaching, curiosity about the natural world (especially birds), and taking every opportunity to walk, walk, walk.
Elizabeth was born the year World War 1 began (1914), and has early childhood memories of traveling 22 miles in a horse-drawn buggy to visit her grandparents.

Elizabeth became a teacher and taught all of her life, until retiring at age 67. Elizabeth audited classes at CU-Boulder until she turned 100.
Elizabeth's advice to today's youth is *to maybe slow down a little bit, maybe enjoy life a little bit more. Live every day. And enjoy it. A day at a time, I think is good. And think positively that things will get better if they aren't so good now. And exercise as much as you can.*

Project Boundaries

Figure 1-1 illustrates the project boundaries. This project has a relatively narrow focus on the RTD CNRs in the Northwest Denver Metro Area. The boundaries of the Longmont Coordination model are noted, as are the areas proposed for expansion.

Note that some CNRs are in Via's service area, some in the service area of SRC, and one in Broomfield. This project will extend the coordination project to SRC and City and County of Broomfield.

The technology solution can adapt to any scheduling software system through a neutral hub. It also can stretch beyond the CNR boundaries and to include other providers. However, at present, the services and participating providers are purposefully narrow to promote a successful project.

In the Longmont area, Via operates the CNR service, under contract to RTD. Via also operates their mission paratransit service and is one of the RTD Access-a-Ride (AAR) providers. Thus, moving a passenger from their mission service to CNR (or vice versa) is an operation that happens internally within Via. When other operators are included in the expanded coordination system, more institutional issues will need to be addressed in addition to the technical challenges.

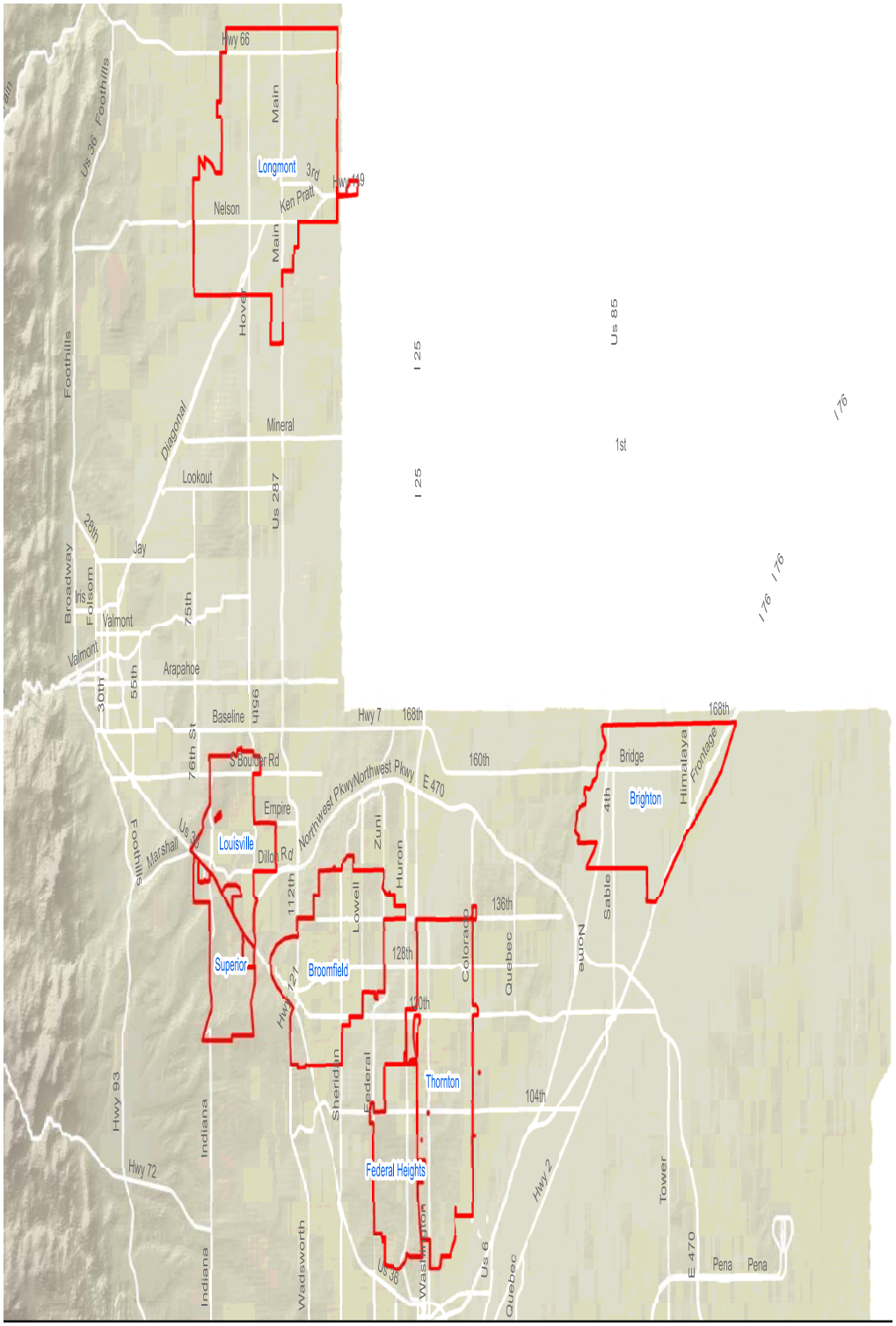
An institutional issue that still needs resolution is that of getting paid for trips provided. With Via holding contracts for both CNR and AAR vehicles they can get paid under one contract or the other. When the trip provided falls under Via's trademark service, there is no need for outside payment as it is an agency-funded trip. When another provider, such as SRC, provides a trip for an RTD service, payment for the trip will need to take place. In keeping with the plan of having a focused project approach, the stakeholders agreed not to address payment until the system was in operation for nine months.

This Report

This report is written for individuals with some knowledge of the specialized transportation industry but who may not have a background in information technology. It introduces the basic concepts forming the foundation of the Trip Exchange. The appendices and reference material allows interested individuals to gain a deeper understanding, exploring the project in more detail, and potentially using the software in their region.

The report begins with a description of the Trip Exchange with a focus on what it does. This provides the reader with an overall picture of the results of the project and how it works. Chapter 2 focuses on how the Trip Exchange functions while chapter 3 describes how the partners adapted their processes to support coordination through the Trip Exchange. Chapter 4 describes the planned implementation of the project. Chapter 5, the last chapter provides information on the final products of the project, references for those interested in learning more, a review of lessons learned, and suggested next steps.

Figure 1-3 - MSAA Project Boundaries



2. Trip Exchange Description

Background

Two documents clarify how the project was defined and approached. One is *"Concept of Operations for the Northwest Denver Metropolitan Area MSAA Project",*[2] a document that presents the information on how the existing Longmont Coordination Project functions. It guides the reader through the process followed in determining how the Trip Exchange would work. The second document is *"Systems Requirements for the Northwest Denver Metropolitan Area MSAA Project"*[3], a comprehensive description of what the system needs to do. Some of the basic information from each document is summarized in this final report and the reader is referred to the full documents for more in-depth information. This chapter presents information on what the Trip Exchange does and how it functions. This is a high-level presentation; more detail is available for interested readers.

Understanding a Data Exchange Hub

The rail yards, switching tracks, and turntables that are part of transportation history are a good way to begin understanding our modern data exchange hubs. Beginning in the mid-1800's, many rail lines coming into urban centers needed a way to exchange cars and engines to provide for the efficient movement of trains. The yards provided a waiting area for trains and a place where trains and their engines could be switched along different tracks so the cars and engines could be connected as needed to move freight and people to their ultimate destinations. There were different types of switching mechanisms and even turntables (most commonly seen in roundhouses) that allowed engines and cars to be sorted and sent out on the correct track. These functions started out as manual, and over time became mechanized ones and now are computerized.

A data exchange hub is similar, exchanging data about trips or trip requests instead of rail cars. Data exchanges are ubiquitous and can be found in all types of data systems: from financial trading to air traffic control; from health care applications to management of power grids. You use a data exchange when using services such as Expedia, Travelocity, Expedia, or Google Flights to find out airline travel options.

Data exchange hubs have filtering mechanisms to sort information. So, for example, one can find available flights between two specific airports and further refine a search for flights on a specific day.

Data exchanges are essential for effective coordination of various systems and the efficient utilization of resources. Within the transportation industry there are many systems, so data exchanges can be a useful tool. Within any region there are:

- Multiple transportation providers – public, specialized, private (taxi, car networking

[2] "Concept of Operations for the Northwest Denver Metropolitan Area MSAA Project", 2016, O'Neill, Suzanne, et al. Available at: https://www.its.dot.gov/research_archives/msaa/msaa_project_overview.htm.

[3] "Systems Requirements for the Northwest Denver Metropolitan Area MSAA Project", 2017, O'Neill, Suzanne, et al. Available at same address as in footnote 2.

companies, medical transport, etc.), and agency-provided services for only their clientele.

- Various systems, each paid for using either a unique fare structure or multiple public and private funding sources.
- Public systems where anyone can ride and various human service or client-oriented services with eligibility systems in place.

Data exchanges mediate the information available from different software systems allowing information to be shared. Think back to the railroad analogy for a moment. Trains may arrive in the Chicago train yard via Burlington Northern Santa Fe Railway (BNSF), CSX Transportation, or Union Pacific Railroad. Each railway has its own operating systems, each sending necessary information to the rail yard. In turn, the rail yard sends information back to the individual railway about which tracks to use. While the track management system at the rail yard is different from the scheduling systems used by each railroad, there is a need for them to communicate with each other.

Today, different transportation providers in a region may have scheduling software produced by different vendors or even different versions of programs produced by the same vendor. Taxis are served by another type of software, reflective of the services they provide, and transportation network companies use a completely different type. In every case there are multiple vendors or programs. A data exchange hub can enable different providers to share information about trips despite differences in their scheduling software.

When customers use a travel website, the data exchange enables them to first *identify* available flights that match their needs. It also allows customers to *schedule* a trip and *pay for* the ticket. This is another use of data exchanges as the exchange enables a variety of information to be shared about trips. Within the public transportation environment, programs that enable one to find services <u>and</u> schedule trips <u>and</u> purchase tickets do not yet exist to serve multiple modes or providers. One can find services on Amtrak and purchase a ticket for a trip. But if a link to other public transportation is needed at either end of the trip, it is necessary to go to other sites for information.

About the Northwest Denver Trip Exchange

Four transportation providers in Northwest Denver collaborated to develop a means to share trip data for demand-responsive transportation to improve service coordination.

The project had two distinct purposes. The first purpose was to use technology to provide more rides for more people. The specialized transportation providers in Northwest Denver are in a situation that is common for many regions:

- Human service transportation resources are limited while needs are great.
- Many trips need to travel across jurisdictional boundaries or could be served through multiple programs or fund sources.
- There are a variety of service providers some of which may have overlapping boundaries or serve clients who are eligible for services under multiple programs. For example, a rider could be a senior, a veteran, and have a disability that makes him or her eligible for ADA Complementary Paratransit service, Veteran's transportation services, and the local services provided by the Senior Center.

This results in a complex situation that can be difficult for riders, family members, or human

service agency staff to navigate as they try to figure out what agency to call to get needed transportation. Similarly, a transportation provider would not know if there might be another provider who could carry a trip that is difficult to serve or that they do not have the resources to serve. A provider would also not know if there is another provider traveling in the same general corridor at the same time who could provide a trip more efficiently. It is a situation where existing technology can provide a means to quickly exchange data about trip availability, allowing agencies to quickly get the information needed to make decisions about how to provide the most trips and use resources effectively.

The second distinct purpose was to create a software platform to exchange the needed trip data and to do so in a way that can be replicated. Once fully tested and piloted in NW Denver it may be used in other parts of the Denver metropolitan area (e.g., expanding to all the Denver Regional Transportation District Call-n-Ride (CNR) service areas) and has the potential to be used in other geographic areas.

This was a software development project that resulted in open-source software for exchanging data about demand responsive transportation trips. It primarily uses Application Programming Interfaces (APIs) to allow different software scheduling systems to exchange data with other providers. At present, it is set up with the basic functionality to exchange trip information; it can be enhanced in the future. Two scheduling systems (DemandTrans Solutions Mobility DR and RouteMatch) have been adapted to send and receive data streams that include basic trip information.

Project Background

A short history of how the project came about helps one to understand the pragmatic and focused approach that defines the project. The mission of Via Mobility Services (Via) is to provide specialized transportation services to older adults and individuals with disabilities. Via has successfully bid for contracts to provide public CNR service in Longmont and other areas for Denver's RTD. Via also became a provider of RTD's paratransit service in the area. As a result, the agency found itself dispatching different vehicles to the same locations at the same time, for riders eligible to use different services.

With all services provided by the same agency, Via and RTD began to sort out the institutional and technical issues of allowing different riders to ride on a single vehicle. Via's traditional service uses RouteMatch software to schedule and dispatch trips that go through their reservation center. The CNR service uses Mobility DR for scheduling trips. Riders can schedule online or call drivers, but they do not go through a reservation center. To combine riders between these services meant that Via and RTD had to figure out how to enable an exchange of information between the different scheduling systems.

The resulting system worked but was only partially automated; a staff person spent a good deal of time each day making sure the trips were shared and trip performance went smoothly. It was time consuming and clunky, not suitable for replication. At the same time, it improved productivity on both the RTD CNR service and Via's traditional service. The result of providing more rides with the same level of resources showed the potential for further development and replication in other areas.

The logical next step was to create a functional platform that would result in a fully-automated system (significantly reducing staff time required) and remedy issues such as drivers needing to have two tablets (one for each scheduling system) in their vehicles. This necessitated developing a new structure for how and what information would be

exchanged. Simply automating the process already in use would not resolve basic limitations in the existing system that relied too heavily on the structures of the existing scheduling systems. A new structural design was needed using a data exchange hub for the system to be:

- Fully automated so staff time would be minimal; and
- Able to accommodate a wide range of scheduling systems.

The framework concept of a data exchange hub is broad, well tested, and widely used across many industries. Using this model can result in a system that is flexible, adaptable, and can serve as a foundation for other coordination activities.

Overview

The Trip Exchange enables demand response transportation providers operating in the same or overlapping service areas to share trips with other providers, ultimately providing more trips to more riders and increasing productivity. If a provider is unable to schedule a trip for a rider, the provider can post the trip to other providers who may have capacity in a vehicle to see if someone else can schedule the trip. To verify if capacity exists, providers will have their scheduling system check to see if the trip can be scheduled.

Each provider maintains its own scheduling system, rider eligibility based on fund sources or agency policy, and fare structure. The agreements between providers remain largely behind the scenes except in the following ways:

- A customer whose ride cannot be scheduled is asked, “Would you like me to see if another provider has room to carry you on this trip?”
- A customer who is scheduled with another provider is informed as to what vehicle will come to pick him/her up.
- A customer riding on another provider’s vehicle will pay the fare for that provider or be asked to donate if there is not a fare system in place.

As the true costs of the trip are different from the fares, the provider agencies determine how much the “requesting” agency pays the agency for carrying the passenger.

There are three primary benefits of the Trip Exchange. The first is that it enables agencies to determine if another provider can carry hard-to-serve trips. This results in more rides for passengers and better utilization of existing transportation resources. The second is that, while participating agencies must agree to some common standards, it allows agencies to continue to maintain their individual policies and practices in most areas. *This is a decentralized system that allows participating agencies to retain control over the trips they operate*. Finally, it allows for agencies to use the scheduling system best suited for their operations. The choice of scheduling systems may be based on many factors such as type of operation, size of system, and other agency activities. The Trip Exchange is simply a mechanism to exchange trip information and report on the same while each agency continues to use its internal software for scheduling, billing, allocating payments, and tracking performance metrics.

Development Process

Developing a software platform that would enable providers to share trips required:

- Building a common language and common understanding of project challenges

- Agreeing upon what was needed to meet the functional needs of providers
- Refining to clearly define and build a system that would achieve the objectives
- Working through institutional and technical issues.
- Testing and adjusting the final application so that it works as envisioned

This was a deployment planning and development project more so than simply a planning process. The tenants of good planning and systems engineering were used throughout in an iterative process to develop a functional software system to exchange trip data. Originally, the project was scheduled to be complete in 18 months; it took nearly that long for all parties to clearly understand the technical requirements of creating a data exchange hub that would work with all software vendors. As a result it took just over two years to complete the project.

How the Trip Exchange Works

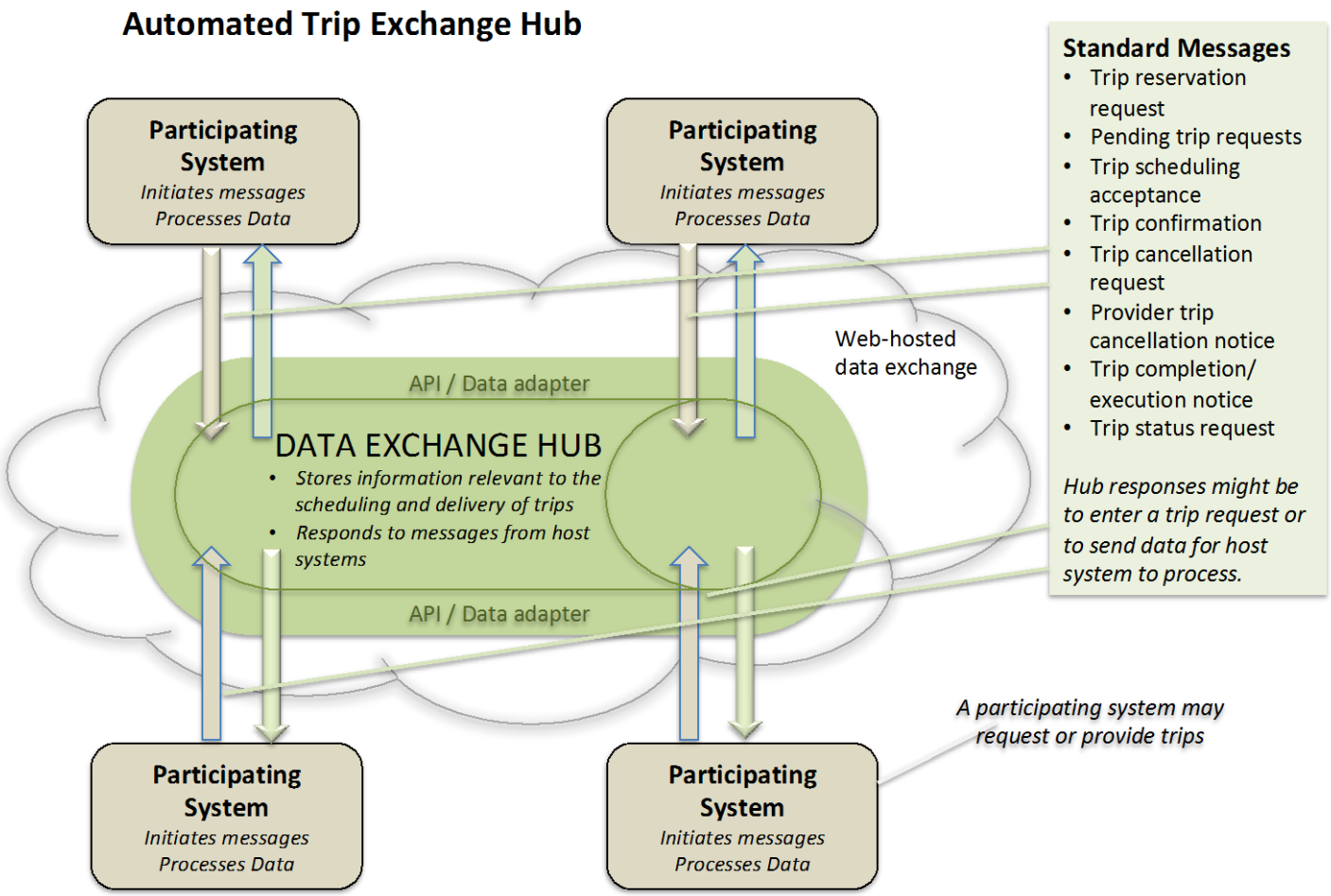
The purpose of the Northwest Denver Coordination Project is simply to exchange the trip data necessary to allow partners to determine if they can schedule a needed trip on their service. The Trip Exchange allows information to flow between providers and can share all trip information and connecting to various scheduling systems for demand response transportation.

The project components, also referred to as subsystems, are:

1. The Trip Exchange, through which relevant trip information is automatically sent between providers.
2. The application program interfaces (APIs) that enable scheduling software systems to connect to the Trip Exchange, providing for data flows to and from the Trip Exchange. RouteMatch, one of the scheduling systems participating in the project opted to use a software adapter (Adapter) that was developed by Ride Connections in Portland OR as part of an early version of a data exchange hub, known as the Clearinghouse. All future connections are anticipated to be through APIs.
3. The adaptations to the provider's scheduling software system to enable each to read information coming from the Trip Exchange and to send data in a structure that can be read by the Trip Exchange.
4. Institutional and non-technical processes and agreements necessary for functionality.

The actual Trip Exchange is internet based. Figure 2-2 illustrates the Trip Exchange in a cloud, with participating systems sending and receiving information via API connections. The participating systems (four host systems are shown but any number can be involved)

Figure 2-1 - Schematic of the Trip Exchange



send information through the Trip Exchange using a set of defined messages. Typical messages that are needed to communicate information about a trip are listed on the right side.

This was a narrowly defined project as the stakeholders recognized that a narrow focus would increase the chances of success. They opted to identify the minimum amount of information necessary to enable partners to automatically exchange trip information. Thus, they improved the existing system but did not include all aspects they might eventually want to see. The stakeholders felt it was important to have a functional (although limited) system developed as a result of this project. It can be augmented and enhanced over time as it is implemented in Northwest Denver and other areas. For example, it has been structured so that pricing information can be included, but that part has not yet been built out.

This narrow focus enabled the Northwest Denver stakeholders to work closely with the developer. This assured that the product would meet their needs and develop common protocols and definitions so they could work effectively together. The narrow focus also resulted in a successful working product.

Key Characteristics and Terms

It is useful to explain some key characteristics and terms so the reader understands how they are used.

Trip Lifecycle: The Trip Exchange must support the trip from inception to completion—the "trip lifecycle''—and enable the different organizations involved in its planning and execution to share and view all relevant data about the trip during this process. The lifecycle has the following phases: (1) trip reservation request; (2) trip scheduling; (3) trip cancellation—in some cases; (4) trip execution; (5) trip reporting.

Automated Message Exchange: The Trip Exchange provides a set of messages that are used to exchange data relevant to the scheduling and delivery of passenger trips. Every message type is constructed such that the interchange of data is automated and requires no manual intervention. This reduces the amount of time that schedulers need to spend on each trip request. There are numerous references throughout the documentation that contribute to the automated functionality. These include interfaces between scheduling programs and the Trip Exchange, adaptations needed to scheduling programs, and the use of consistent terms and definitions in agency agreements.

Message Types and Data Elements: The messages each represent a discrete action and contains the information needed to complete the action. The essential types of messages that must be exchanged by the collaborating systems include:

1. Trip reservation request
2. Pending trip request
3. Trip scheduling acceptance
4. Trip confirmation
5. Trip cancellation request
6. Provider trip cancellation request
7. Trip completion/execution notice
8. Trip status request

User Interfaces: A set of user interfaces have been developed so participating agencies can determine the "state of the system" including the status of individual trips. These interfaces are visible on the screens of the computers used by reservationists or trip schedulers. Some are illustrated in the User Manual included in Appendix A.

Useful Definitions: Some terms used in this report are defined as follows:

- "Requestor" is the requesting agency that does the initial intake and puts the trip on the Exchange (and is responsible for funding the trip, when applicable); "Provider" is the agency that accepts the trip and will provide transportation. In some documents, the "Requestor" has been referred to as the Owner, and these terms have the same meaning. In Figure 2-2 the participating systems can be either a Requestor or a Provider, depending on whether they are posting a trip for another agency to operate or if they are "claiming" or accepted a trip and will provide it.
- "Booking" is requesting and confirming a customer's trip (also called reservations); "Scheduling" is placing a trip on a vehicle manifest (provider operations); "Dispatching" is real-time scheduling (such as canceling).
- A "trip" is a one-way trip; a round trip is booked as two trips.

Adapting Scheduling Software to Exchange Data

The third component of the project is adaptations to the provider's scheduling software system to enable each to read information coming from the Trip Exchange and to send data in a structure that can be read by the Trip Exchange. This is a critical concept and worth some discussion. This section will start by describing how most scheduling systems presently function. Then the functionality needed for exchanging information through the Trip Exchange will be described.

Existing Functionality

Consider your existing scheduling software. A typical program contains:

- A **client database** as well as information on the fleet, vehicle runs, funders, and other key information.
- A **scheduling algorithm** that schedules trips for the fleet and calculates if (a) additional trips can be added to the schedule and (b) how the scheduled trips can be optimized. There are a variety of settings that can be used to fine-tune the schedules based on system and rider characteristics.
- A variety of software **routines** for connecting the various data tables, system functions, and providing user interfaces for staff using the program.

A general flow for booking, delivering, and reporting on trips is illustrated in Figure 2-3 showing the data flows that may need to be considered for adaptation for the Trip Exchange. It illustrates what staff does and what the scheduling program does behind the scene.

- The process begins when reservationists enter information on trips that riders want to schedule. They do this through a text box on the computer screen (a user interface) that has space to enter all the necessary information about the client who wants the trip and about specific trip request. Some systems allow trip requests to be entered other ways such as through an online portal.

- The scheduling algorithm determines if the trip can be scheduled. If it can be placed on a schedule, then the trip is booked. If not, the passenger is either told "no" for that day and time or placed on a wait list of unscheduled trips to see if something might open up before the trip is needed.
- Trips for any given day are distributed to drivers at the beginning of their shifts – often via tablets that the drivers use. Alternately, the drivers' manifests may be in a print format.
- Once the trip has been provided, the driver enters information such as fare paid and, for pickup and drop-off, the odometer reading and time. If passenger is a "no show", this is noted. If a tablet is used, this information goes directly into the scheduling system. If a manual system is used, the data are written down and then entered by another staff person. In either case, putting the data on trips delivered or canceled back into the scheduling system allows the day's records to be verified, reported, and billed.

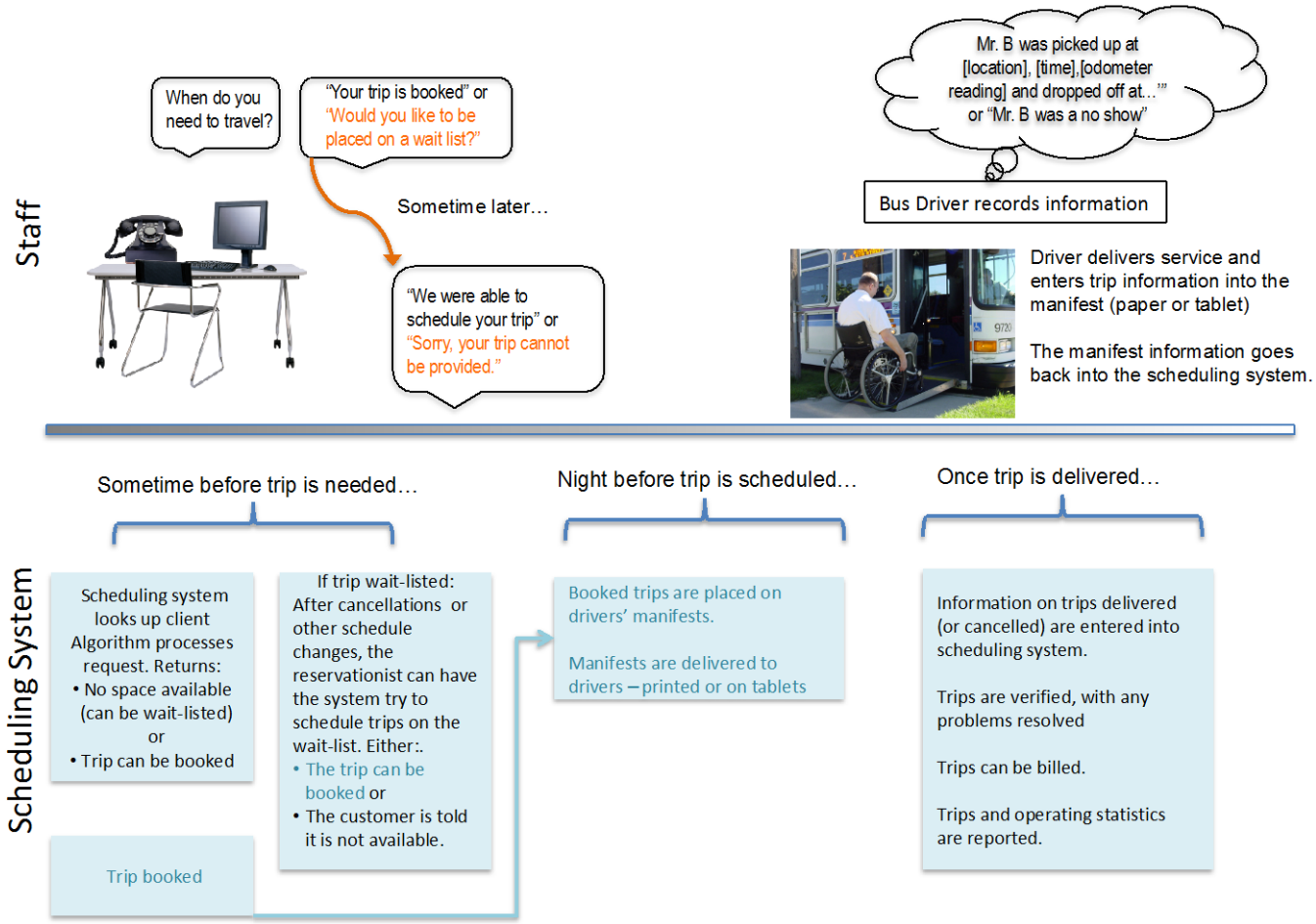
Functionality Needed to Use Trip Exchange

Scheduling software will continue to function the same for all trips that are scheduled in the traditional way. The adaptations will allow the scheduling system to *also:*

- Read information coming through the Trip Exchange;
- Act upon this information (e.g., book a trip or report a change in trip status); and
- Send information to other providers.

The adaptations needed to use the Trip Exchange revolve around the structure of the messages. As noted earlier, the messages each contain the information needed to complete an action such as posting an available trip, claiming a trip, or reporting that a trip has been provided.

Figure 2-2 - Role of Staff and Scheduling System in Trip Scheduling and Delivery



The information in each message is sent in a stream with data elements lined up in a particular order. The scheduling software needs to be adapted to read the message using the data elements to carry out the specific action. For example, if the reservationist wants the scheduling software to see if an available trip can be scheduled, the scheduling program needs to be able to use the data in the "Trip Reservation Request" message to determine if the trip can fit into the day's schedule. Instead of getting the information from the reservationist, it simply comes from a different source.

In addition to being able to read information from a data stream, the scheduling software must be able to send information to partners in a message through a data stream. When an agency sends a trip to the Trip Exchange for another partner to consider operating, it needs to send information on the specific trip as well as pertinent client information (Is a mobility aid used? If so, what type? Does the rider travel with a care attendant? Etc.) This means the scheduling software needs to be able to create and send each type of message.

The software program needs to be able to act on messages automatically. Once a reservationist clicks to accept or "claim" a trip, the scheduling program needs to automatically book the trip. In this project, the stakeholders plan to use the Trip Exchange for trips that are placed on a wait-list. Once a trip is "claimed" by a partner, the trip would automatically come off the wait-list and be shown as booked.

After the trip has been provided, the Provider's scheduling program needs to be able to form and send a message to the Requestor's scheduling program stating that the trip was completed. Much of this information will come from the driver's manifest. It may be entered into the scheduling system by the driver via a tablet or by other staff after the driver turns in a paper manifest.

Summary of How the Trip Exchange Works

The purpose of the Trip Exchange is to enable demand response transportation providers operating in the same or overlapping service areas to share trips with other providers. A key concept is that each provider maintains its own scheduling system and retains control over the trips they operate. The reservation agent (or scheduler) makes the decision on whether to claim and schedule a trip available through the Trip Exchange, just as that reservation agent makes decisions on trip requests made by customers who call in for rides.

The agency's software system continues as the single source of all scheduling, dispatch, and reporting for services provided. All trips are scheduled through the agency's scheduling software. The trips booked through the individual system appear on the drivers' manifests and are reported as services provided under contract.

To create this functionality, two software structures are needed. One is the Trip Exchange, a cloud-based program that allows information to flow between agencies and which has the capacity to hold relevant records for a period of time so the information can be verified and reported. The other is the software adaptation needed for each of the connecting scheduling systems. Each scheduling system connecting to the Trip Exchange needs to be adapted to send and receive information in a series of messages through API connections.

Potential and Limitations

Conceptually, the Trip Exchange is the foundation for better coordinating transportation services and resources in regions where there are multiple transportation providers. It enables different software systems to communicate with each other. This is a concept widely used in a variety of industries. It is well suited to specialized transportation, a complex industry that pulls upon a variety of data sets with agencies that balance competing needs for resources including funding from many sources (each with different eligibility and reporting requirements) and the availability of drivers and vehicles.

The Trip Exchange developed through this Mobility Services for All Americans (MSAA) grant is limited in scope but provides an essential foundation for the stakeholders in Northwest Denver as well as for other regions. While the initial focus and functionality is purposely somewhat narrow, it will significantly improve existing coordination efforts and allow them to be replicated with two other agencies.

Two other MSAA projects in progress at the same time, one in San Luis Obispo, CA, and one in Atlanta, GA, each took a comprehensive approach to defining a system that meets the needs of agencies and customers in discovering what trip options are available and in enabling the booking, trip delivery, and billing necessary for coordination and sharing of trips among providers. The Trip Exchange is particularly well suited to the transactional activities (booking, trip delivery, and billing) and is quite necessary to enable individual customers to book trips once they sort out the availability.

The problems being addressed for specialized transportation providers and their users are quite complex, consisting of several related issues.

- For riders who want to access demand response services, how do they find out what is available, the cost, and how to schedule their trip? This might be as part of a fixed route trip or it might be entirely a demand response trip.
- For funding agencies that want clients to access transportation services, how do they verify eligibility and payment rates as well as assure that trips are scheduled with qualified providers and provided at a competitive rate?
- For providers, how do they match driver and vehicle availability with needed rides, fill the most seats possible, and maintain financial controls?

The overall problem covers a broad range, from trip discovery to trip transaction, including the related reporting and back office functions. In most transportation systems, trip transactions, reporting, and back office functions may require data located in several different databases or the use of different software systems. Different geographic areas have different data and software systems in place, and each area has different historical patterns of service provider development. These factors mean that the framework for accomplishing the tasks must be flexible, adaptable, and able to operate in real-time. The Trip Exchange is well suited to the task at hand.

The task of addressing this complex problem is still in its formative stages. The Trip Exchange constructed through the NW Denver MSAA project is an important foundational step but is only a first step. It needs additional work and testing in a real-world environment to realize it's narrowly defined function for dealing with the transactional side of exchanging data. It also has the potential to expand into the "trip discovery" side of the equation as well as to address other key issues faced by providers.

At present, the Trip Exchange is limited to exchanging trip information between systems needed to allow them to provide trips for each other. It connects two demand-response scheduling systems (Mobility DR and RouteMatch) and is set up so that any electronic scheduling system can be connected through APIs. Three key follow-on development activities have been identified for the near-term:

- Build out the payment and billing portion, enabling agencies to post what they can pay for a posted trip and to provide an invoicing system.
- Work with other scheduling systems to connect to the Trip Exchange. This requires that the scheduling system can use APIs to send information to the Trip Exchange and to read and respond to messages received from the Trip Exchange.
- Adapt the system so it can also answer key questions for providing efficient regional trip services:
    - Are there enough trips in a corridor to make it financially feasible to establish a vehicle run?
    - Can an existing vehicle run be extended to provide an additional trip? If extended, would the provider remain the same?

A longer-term consideration is to expand the Trip Exchange so that it can address the trip discovery needs. This would enable riders (or staff trying to arrange appointments for medical or various program activities) to determine if demand-response transportation service is available for regional trips. For trips within the service area of a single provider, only that provider needs to be contacted. Quite often, trips cross the political or service area boundaries of more than one provider.

Another important item for the long-term is that as an open-source system, it will be necessary to build a community of users who can support the use and continued development of the program. There is not, at present, an established structure or organization that can serve this function. If it were a proprietary system, the company owning the rights would be responsible for continued development. As an open-source system, it will be necessary to provide for this if the system is to reach its potential. Other related open-source products in this arena (One-Click, RidePilot) face the same issue. It may be that together a large enough forum can be created to provide the ongoing support and development.

3: Shared Functional Standards

Introduction

While the previous chapter focused on a description of the functional aspects of the Trip Exchange, this chapter discusses how the partner agencies had to adapt to continue to provide good quality service to their customers when working in partnership through the Trip Exchange.

There are a variety of challenges for agencies wishing to coordinate services. They include differences in service characteristics or rider needs, different operating practices, differences in agency missions, and the need to be able to control resources and service quality. The latter two items are a key to sustainability for non-profits. Many of these items are related. For example, different operating practices may be due to differences in service characteristics or riders as well as funding requirements.

The variety of service characteristics, rider needs, operating practices, funding requirements, and reporting needs must be reflected in how the Trip Exchange operates, the data are transmitted, and the message construction.

The stakeholders strove for a balance between what was simplest to agree to do the same and where differentiation was important to allow them to meet mission needs and funder requirements. The structure of the Trip Exchange supports variety – it is quite adaptable and flexible.

The agencies participating in this project deliver services and have funding sources that are like many agencies throughout the nation. There are two large private non-profit agencies (one transportation only and one a multi-purpose agency), a city and county provider of senior services (of which transportation is one), and a public transit district. They use common funding sources including local general funds, donations, Title III funding from the Older Americans Act, Federal Transit Administration funding, and Medicaid non-emergency medical transportation. In many regards, they are similar to several other agencies and the decisions made may well provide a good foundation for others. Three agencies use the same scheduling software (RouteMatch) but each has tailored it differently.

Process of Reaching Agreement

For these agencies, the process of agreeing on the rules they would follow, creating uniformity in terms, definitions, and processes, was relatively easy – easier than in many situations. The stakeholder agencies have characteristics that align in supporting an effective partnership. While these characteristics are not always present, other agencies can practice and learn to replicate them. The characteristics are ones that can be learned and are accessible to those committed to practicing them.

- ✓ The leaders had developed trust over years of working together, were respectful of the needs of other agencies, and were committed to working out solutions.
- ✓ The right person was at the table. They each had significant authority in being able to modify rules, knew what could not be changed, and were able to develop a work-around if needed. (Perhaps they would decide to re-configure an internal

agency report or run an extra report to get information they would need in a joint system.)

- ✓ Throughout the project, the stakeholders focused on how to work successfully together and were not going to let minor things get in the way of success.
- ✓ Each stakeholder committed time to the project and engaged in the detail of how each piece would work. This was approximately 40 hours of detailed work, outside monthly meetings, for each stakeholder. Their work produced the standards, definitions, processes, and business rules that are reflected in the *"System Requirements"* document and its appendices.

Importantly, the work of the stakeholders is also reflected in how the Trip Exchange operates. There was an iterative process as the stakeholders and developers worked back-and-forth to make sure that the Trip Exchange provided the functionality the individual partners needed. The scheduling software developers were also active in this process, identifying how their software could support the project goals.

Two other strategies were important in the process and they reflected the stakeholders' commitment developing a successful product. First, they set aside the challenging issue of figuring out how to pay one another for carrying passengers for each other, deciding that they would get this up and running first. They decided they would operate for nine months before sorting through those issues. Second, they were all comfortable operating with some grey areas, leaving some things unresolved until acceptable solutions could be found. Not all issues have been resolved; there are not necessarily clear or easily implemented solutions in some areas. Examples are in the use of seat belts and car seats on different types of services, or minor differences in service area boundaries. The agencies will maintain their existing policies (which are generally based on their rider characteristics and needs) but recognize that the same rules may not be appropriate for other rider groups. Until acceptable solutions can be identified, they give either drivers or dispatchers some latitude in applying the rules.

Issue Areas

There were several areas that received significant attention in the design of the Trip Exchange, its message set, and the data elements transferred. These have been grouped into the following major categories.

Service Quality. This includes driver training, vehicles and equipment (accessibility, safety equipment required), and service standards (curb-to-curb vs. door-to-door is one example). Some items are agency specific and reflect either a commitment to how passengers are treated or risk management. Other items are mandated by funders (Medicaid, Older Americans Act) and include required training or safety equipment.

The stakeholders all considered each other to be "trusted" providers with similar standard of training. All met the same general funding requirements. In the design of the Trip Exchange, they recognized that other providers, about which less is known, might participate at some point. As a result, the Trip Exchange includes a process for approving a provider who claims a trip. This allows the Requestor agency to verify that the Provider agency is capable of carrying the trip and meet expected standards.

When RTD and Via initially began their coordination project in Longmont, CO, there was some resistance to mixing clients on different services. After a while the mobility coordinator told reluctant customers: "If you want a ride, you'll have to go on the assigned vehicle." This barrier went away a few weeks afterwards as most people tried it and found no real problems. In developing procedures for implementing the Trip Exchange, the providers discussed effective phrasing to let riders know that a differently marked vehicle would be picking them up and to address any concerns about this.

Operating Characteristics. This includes a variety of practices individual agencies have in place to make sure they have a way to track trip requests and service delivery through the entire process, from initial request to either an "unable to serve" response or delivery of the trip. This category also addresses:

- ✓ Issues of the amount of lead-time needed for agencies to respond to requests posted for someone else to consider providing and when passengers need to be notified of the availability of service (or lack thereof).
- ✓ Vehicle capacity is included here: how much space (or what vehicle type) is needed to carry the passenger, mobility devices, and aides or family members?
- ✓ When does the control of a trip transfer from the Requesting agency to the Providing agency?
- ✓ What notifications are needed between agencies to make sure that trips are tracked appropriately?
- ✓ Differences in loading times need to be accounted for in scheduling. General public riders on average require a two-minute load time while passengers who use mobility aids or are frail and require extra assistance on average require seven-minute loading time. This needs to be accounted for in the scheduling algorithms of different services.
- ✓ The scheduling software must assure that original client files are not overwritten by incoming data. It is common for riders to be registered with more than one provider.

While agencies are similar in how they operate services, the issues revolved around what and when information needs to be exchanged, and what communication is needed between agencies. The discussion of these details is shown in the data table (reflecting all the elements that may need to be communicated), the message structure, and a list of notifications that agencies send as needed to communicate pertinent information. This information can be found in the *"System Requirements"* document.

Resource Control. All partners identified this as an issue and agreed they needed control over the trips they agree to carry. Individual agencies balance between the availability of funding, drivers, and vehicles. In order for them to do so and maintain both a sustainable service model and quality service, they need to have the option to accept (or claim) a trip or pass it by. This is a key manual piece of the program: the reservationist needs to click on the screen to accept a trip as is done with any trip request. An agency cannot assume another provider will carry a trip: each trip must be claimed.

It is worth noting that this discussion took place in the absence of details about what they ultimately will get paid for an individual trip. They all know the realities: many funding sources do not pay for the full cost of a trip and it is only cost effective to carry it if it can be grouped with other passengers traveling in the same corridor. Once the payment

element is included in the Trip Exchange and a provider can see that they will get paid (for example, $5.50 for picking up a passenger), it will affect the decision process. It may make it easier to say, “Let’s claim the trip as it will only require five extra minutes of time to add one more passenger” or “We can’t afford to do that as it would cost us $30 to carry the rider and the revenues fall far short of that”.

This emphasis on agency control is a defining characteristic of the Trip Exchange. It allows for coordinating trips in a decentralized setting. A master brokerage is not required or even considered in this model. However, participating in the Trip Exchange does not mean that the agency may not also broker out some trips to a taxi company or alternately make some of their capacity (e.g., a set number of vehicles) available to another broker.

Conclusion

The stakeholders worked to make sure that how the Trip Exchange operates reflects their operating realities and the policy decisions upon which they agreed. In the process of agreeing to a variety of shared definitions and procedures, they also agreed to make some changes in how they operate within their agencies. For example, each may make minor changes to their guidelines for entering clients into the scheduling software and adjust definitions for items like mobility definitions, service needs, trip purpose, and medical problem identifications.

As these agencies are reflective of many agencies across the nation, it is believed that the system as set up here will generally work well for others. There remains latitude in how a given region would choose to define fields or terms. It will be necessary to make some changes as each state has different ways of setting up key human service programs and funders have different reporting requirements. The key is that there is consistency in definitions and business rules within an area so that trip information is accurately understood.

4: Implementation Plan

This chapter addresses the steps the stakeholders plan to go through in implementing the Trip Exchange. On the one hand, it will be a straightforward process as it builds upon the development of software rather than simply a planning process. The key software has been developed and gone through basic testing. The main activities that are outstanding are to:

- ✓ Agree to how the Trip Exchange will be hosted and arrange for hosting. Agreement is also needed on how the costs of hosting will be shared.
- ✓ Enter into agreements that define how stakeholders will work together.
- ✓ Implement the system for each provider and within each CNR service area.
- ✓ Continue to work to address outstanding issues.
- ✓ Provide for ongoing support and development of the Trip Exchange.

On the other hand, a variety of issues do remain to be resolved and these will need to be worked through over time. The key issue is how agencies will identify what they can pay each other for specific trips and how that will be accomplished. As such, initial agreements are likely to be flexible and subject to change as various decisions are made.

This chapter describes the implementation plans at a high level, summarizing the roll-out while maintaining a focus on the activities listed above.

Overview and Deployment

The implementation and ongoing development of the Trip Exchange provides for implementing the Trip Exchange within the service areas of three specialized transportation providers (Via, Broomfield EasyRide, and Seniors' Resource Center) and the nine RTD Call-n-Ride (CNR) services in Northwest Denver.

Once the Trip Exchange is fully tested it will enable providers to offer trips to other systems and claim trips that have been posted as needing an available provider. It will be a highly automated process and the expectation is that it will result in:

- ✓ Reduced staff time for the existing coordination efforts in Longmont, Colorado, due to the increased automation.
- ✓ More rides provided and increased productivity for public CNR and specialized transportation services in the project area.

It is also expected that it will take some time to fully implement the coordinated services as the schedulers and reservationists figure out how to use it most effectively and riders get comfortable with their options. As a result, the impact will be minimal the first few months but will grow after that.

The initial deployment is simply getting the Trip Exchange operational in all systems. This requires that the agencies will agree to how it will be hosted and how the costs will be shared. The verbal agreement among agencies is that they will operate it for nine months before actual trip costs are shared. This requires that the providers continue to hold regular meetings to:

- ✓ Work towards developing a comprehensive agreement for long-term operation.
- ✓ Continue to address outstanding issues from how to charge for and reimburse each other for services to operational issues such as boundaries or the use of seat belts or car seats.
- ✓ Respond to issues that arise during the initial deployment.

The long-term deployment activities can be divided into those the stakeholders can directly pursue, given current resources and the state of development and those that will require additional resources. The stakeholders can expand the implementation into other areas within the service areas of existing providers. An important opportunity for this is for Seniors' Resource Center, which serves all of Jefferson County, and RTD to expand the program to additional areas where RTD has other CNR services.

Three key follow-on development activities have been identified, each of which will require resources:

- Build out the financial and billing portion, enabling agencies to post what they are able to pay for a posted trip and provide an invoicing system.
- Work with other scheduling systems to connect to the Trip Exchange. This requires that the scheduling system can use APIs to send information to the Trip Exchange and to read and respond to messages received from the Trip Exchange. This activity includes RouteMatch switching from using the "adapter" designed to send spreadsheet files to API connections so the full functionality of the system will be accessible.
- Adapt the system so it can also answer key questions for providing efficient regional trips services:
    - Are there enough trips in a corridor to make it financially feasible to establish a vehicle run?
    - Can an existing vehicle run be extended to provide an additional trip? If extended, would the provider remain the same?

Another important item is that, as an open-source system, it will be necessary to build a community of users who can support the use and continued development of the program. This is an issue common to other similar open-source programs serving this industry. One-Click software, for example, provides trip discovery information for people needing transportation services (with installations in Atlanta, GA, Jacksonville, FL, and San Bernardino-Riverside, CA). RidePilot, a management and scheduling software for small transportation operations, is widely used in the Salt Lake City region and the Portland region.

Costs and Potential Benefits

The costs of implementation are minimal. The cost areas and amounts include training of scheduling or reservationist staff (less than $1,000 one-time), hosting the system through a web-hosting service (estimated at less than $6,000/year), and ongoing technical support. On-going technical support for the existing system is expected to be low (under $6,000 per year) but over time as the system develops that could increase so it is reasonable to budget for a total of $20,000 per year for all costs.

The potential benefits are in two categories. One is that less of the Mobility Manager's time will be used for Longmont as the process will be more automated and result in fewer bounce-backs that need to be addressed manually. Two, the true value of the system will be in rides that are provided that otherwise agencies would be unable to serve.

With an estimated ongoing cost of about $20,000 annually and an average trip cost of $25, it will require 800 annual trips (3 coordinated trips a day) to break even – where the cost of the ongoing system maintenance will be less than the cost of additional trips. In the Longmont project, over several years ridership increased significantly, but it is most fair to look at the productivity of the service. Prior to coordination, the service carried a combined 2.2 riders per hour (CNR = 3.5 and Via = 1.6). Several years later, when the coordination project was well established, the average productivity was 2.8 riders per hour (CNR = 4.6 and Via = 2.3).

While this provides a sense of the order of magnitude for valuing the resulting coordination, there are some important things to remember. The existing costs will not go away as the Mobility Manager will continue and support the increased rides in several additional CNR service areas, as well as initially supporting implementation in each of the areas. Therefore, the existing $75,000 annual cost will remain. Similarly, the increase in productivity in Longmont will remain the same but is not expected to increase. Via will have some reduction in annual maintenance costs of the existing system ($2,000 - $3,000 annually).

The costs of maintaining the Trip Exchange are essentially new costs. While productivity will increase (with no additional service hours planned), there is a hard cost associated with hosting and maintaining the Trip Exchange. Like funding the provision of additional service, the providers will need to fund these costs. There are nine CNR service areas, with the Longmont CNR as by far the largest. If costs were spread out equally among the CNR service areas, it would amount to $2,000 - $3,000 per CNR per year.

To measure the costs and benefits, the participating agencies will track the costs of operating the Trip Exchange, the increase in trips carried, and productivity of each service as measured by riders per hour.

Management Overview

The major tasks in implementing the Trip Exchange are to:

- ✓ Agree to how the Trip Exchange will be hosted and arrange for hosting. (Amazon hosted the test phase of the Trip Exchange.) Agreement is needed on how the related costs will be shared.
- ✓ Enter into agreements that define how stakeholders will work together.
- ✓ Implement the system for each provider and within each CNR service area.
- ✓ Continue to work to address outstanding issues.

The stakeholders agree that it is important to build out the financial and billing side of the Trip Exchange but that is not part of the initial implementation as it will require additional resources.

Table 4-1 - Implementation Schedule

Activity	Resources	Schedule	Completion
Hosting: - Agree on payment - Establish hosting	Staff time Funds for paying hosting fees	March – May 2018	Hosting agreement in place
Enter into an agreement defining how partners will work together.	Staff time; legal counsel as needed.	May 2018	Partner agreement in place
Implement sequentially, training staff as needed. - Via, beginning with Longmont CNR and then adding others. - Broomfield - SRC	Staff time	May – June 2018	Implementation has occurred within all CNR areas for all providers.
Resolve issues - How payments will be calculated and billed - Outstanding operating issues - Other issues as they arise	Staff time	Ongoing. Meetings every other month are anticipated. Address payment issue by March 2019.	Resolution of individual issues

Agreements for Hosting and Other Cost-Sharing

An agreement is needed on how the partners will work together to share trips through the Trip Exchange. This includes a variety of issues including:

- ✓ Responsibility for web-hosting contract and cost sharing for same. (In test mode, DemandTrans Solutions has provided for hosting via Amazon.)
- ✓ Clarification of service standards
- ✓ Clarification of how partners will work together
  - o Billing and payment for trips (initially this will only state that partners will amend the agreement in nine months after decisions are made).
  - o Other cost sharing – how will costs for technical assistance be shared? What other costs need to be considered?
  - o For what items do partners need to be notified of changes? (E.g., changes in service, training, or equipment.)
  - o Is an operating procedures document needed (outside the contract) that addresses things such as the emergency communication protocol or to provide more detail on expected service standards?
- ✓ What is the process for adding a provider and initial Provider requirements? This could be important in the near term depending on what third party contractors are operating various CNRs.

- Consider descriptions of the features of their services relative to customers' needs and funder requirements.
- Consider standards covering:
  - Driver background checks (including years of the check),
  - Insurance coverage,
  - ADA and Title VI compliance, drug testing,
  - On-time performance, and
  - Good customer service.
  - Provider transport restrictions, such as booking time window, accessibility, trip purpose, use of seatbelts, rider's age, etc.

✓ Use and licensing of the program files. This is an open-source program so the partners will need to agree upon:

- How will refinements or updates to the program be managed?
- Where will the files reside and which of the partners will be responsible for managing the files used by the partners?

Some items will take a bit of sorting out. The stakeholders will need to decide when an agreement needs to be in place and if an interim agreement (with perhaps a one-year term) can cover basic items until a final agreement can be negotiated.

Implementation by Agency and Site

The system has been tested and operates properly in the partner operations: Via Mobility Services, Broomfield Easy Ride, Seniors' Resource Center, and Denver RTD's Call-n-Ride services.

Implementation of the program at each site will require training of the reservation and scheduling staff. Information will need to be provided to drivers as well. At Via, the training will be minimal for drivers as they already have a similar system in place in Longmont and training for that is part of their routine service training. Via staff will need to understand how this system differs from that presently used:

✓ For drivers, the primary difference is that they will be using a single tablet rather than needing a tablet for both systems in their vehicles.

✓ For reservation staff, training will be needed in how the user interface works under the new system.

For Broomfield Easy Ride and SRC, policies and procedures will be needed for drivers and reservation staff on any differences on how CNR passengers are handled. Similarly, CNR drivers in the new service area will need training like that already provided in Longmont. This material is available for the Longmont service but will need to be tailored for the other operations, provided via in-service training for existing staff, and integrated into their routine training.

Resolution of Issues

Just as the partners in the Longmont coordination effort continued to meet as needed, the partners will need to continue working as a group to resolve outstanding issues or issues that arise in the operation of the system.

Conclusion

The implementation activities identified here are the final steps to making the Trip Exchange operational. They switch from the development phase to the beginning of the service phase.

It is likely that in the first year of operation the providers will identify parts that work well and some they would like to improve. They have already identified some areas for continued work and development.

This software is ready for use in the project area and for systems that use the two scheduling programs for which connections have been developed. However, it is still very much in a formative stage with significant room for development and expanded use.

5: Results and Lessons Learned

The result of this project is the Trip Exchange for specialized transportation providers. It enables providers to post trips, which they cannot readily serve, to other available partners. The Trip Exchange allows participating agencies to automatically exchange trip data, regardless of the type of scheduling software they use.

It is designed for a specific situation in Northwest Denver where there are public Call-n-Ride (CNR) services as well as specialized transportation providers. However, its application is much broader as described in this chapter. The Trip Exchange is an effective device for many of the tasks that are a part of a Travel Management Coordination Center.

The Trip Exchange is fully functional for exchanging trip information and will be implemented in Northwest Denver in 2018. Experienced specialized transportation providers and public transit system staff guided this project. The result is a practical and efficient means of coordinating transportation resources among varied providers.

The Trip Exchange is an open-source program and it is hoped that its use will be expanded within the Denver Metropolitan Area as well as in other locations.

This chapter provides additional detailed information on the Trip Exchange for readers interested in learning more about it. It also summarizes some key lessons learned in carrying out the project and identifies potential future direction.

Trip Exchange Resources

This final report is written to provide a broad audience with an understanding of the Trip Exchange that was developed and how it works. There is a significant body of resources that augment this high-level description and will be useful to regions interested in further exploration. Some information is provided in appendices to this report, some in the *"NW Denver Coordination Project System Requirements"* document, and some is available on websites as noted. While this report documents the project as of February of 2018, additional activity will be carried out. The website information will be the best way to obtain up-to-date information on the project as it develops.

Appendix A of this report is the User Manual. This provides a view of how the system works for the users, illustrating the interfaces that are provided.

Appendices B – E contain useful lists and files (also found in the *"System Requirements"* document) that provide detail on what is covered in the Trip Exchange.

- ✓ Message Set – provides detailed information on the messages sent through the Trip Exchange between scheduling systems used by partner agencies.
- ✓ Data Table – contains the various elements included in the exchange
- ✓ Notification Message List – a list of notifications sent to providers identifying available trips and the change in status of particular trips.
- ✓ API list – a description of the various APIs that are used in the program.

Readers wishing additional information are encouraged to refer to the *"NW Denver Coordination Project System Requirements"* document as it provides a thorough explanation of the components of the program and how they work together. This document is available on the following websites:

USDOT Site: https://www.its.dot.gov/research_archives/msaa/msaa_project_overview.htm

Via Site: www.viamobility.org

TransitPlus: www.transitplus.biz/projects

Readers seeking additional information may also contact the above agencies. There are plans to post the software on GitHub. Once available, information on how to access the files will be posted on the websites above.

Relationship to Other Initiatives

The development of software solutions to support coordination of transportation resources has been a slow process. There has not been an agency with responsibility for undertaking this activity. The Federal government recognizes the importance of and advocates for coordination. They also have provided key funding for projects such as this. But it has remained the responsibility of local entities to figure out a logical "next step" to move the process along. A variety of local agencies, states, and private entities have taken important steps forward. However, these steps have not been coordinated but rather have been based on a combination of the knowledge of key individuals, local needs, the willingness of agencies and individuals to support a project in the interest of mobility, and happenstance. To understand how the Trip Exchange is useful going forward it is helpful to have a picture of how the various endeavors fit together.

Some of the basic areas information technology is used are in:

- Scheduling and system management software. Most is proprietary and complex with scheduling algorithms and a means to tie trips to funding sources. At least one program is open-source.
- General Transit Feed Specifications (GTFS) are specifications used to send data about fixed route services to be used in a variety of mapping software and third-party applications that use the data to help riders understand what transit services are available. GTFS-Flex will provide similar information for demand-responsive transit services.
- Trip planners assist riders in providing directions via transit, driving, or walking. Trip planners found on transit websites may be limited to the transit mode although most are broader now. They are a combination of proprietary and open-source programs.
- One-Click is open-source software used to help consumers discover what services are available in an area. It provides information on services that are available to the public, to a sub-set of the public (such as all elderly or all veterans), and for human service agency clients. One-Click identifies what service is available, enabling one to go to a specific website for registration or to request a trip.
- The Trip Exchange provides demand response transportation providers with the ability to share trips, exchanging the data needed for a transaction to occur.

While the Trip Exchange is presently somewhat limited in functions, it represents the basic programming structure that will be needed for trip planners or One-Click software to allow customers to not only identify available services but also to reserve a spot or purchase a ticket on demand response transit services.

Lessons Learned

This project was quite successful; key reasons for the success were:

- The stakeholders were trusted partners, each committed to making this work and each willing to go the extra distance if needed. Most of the primary stakeholders were deeply involved and spent considerable time on the project
- It was grounded in reality and was built upon prior successes.
- The group was pragmatic and disciplined enough to establish and hold to a narrow focus.

A variety of lessons were learned, including:

- **Iterative Development Process**. An iterative process for developing the software was used. This was especially valuable as stakeholders were building an understanding of what was needed and how design options would function in practice. It strengthened their involvement in the process and their feedback resulted in a stronger product.
- **Developing a Shared Vision.** While the concepts employed are well tested and widely used in many industries, they were new to the project stakeholders and to this particular application. Project stakeholders first needed to understand the basic concepts and relate these concepts to their own experiences as a provider or software developer. The next step was for each stakeholder to understand what the concepts meant for the other participants. Over the course of the project, their understanding of the concepts deepened and their ability to see the potential and options available broadened. Fully developing a shared vision depended on all the primary stakeholders gaining a common level of understanding. *It took eighteen months for a shared vision to completely come together.*

  Even as the project has come to completion, this shared understanding is still changing as stakeholders continue to deepen their understanding of the importance of the work that has been done and how it can be developed in the future.
- **Exploring New Ground**. The project explored new ground so stakeholders did not have a model to follow. Although there were a variety of tools available, it was necessary to make sense of how each related to the project objectives.
- **Communication: A Common Vocabulary**. A common, and sometimes new vocabulary needed to be developed. Often, participants used the same words or phrases to mean different things, and the transportation providers needed to develop a technology vocabulary.
- **Current Technologies are Needed**. The Application Programming Interface (API) connections are critical for full functionality. A decision was made to allow RouteMatch to use “Adaptor” software that had previously been in development instead of an API, out of respect for the business constraints they faced. (The

RouteMatch APIs were not going to be ready within the project timeframe.) This was a decision that all came to rue as all parties put too much time into making an old technology passable and pulled resources away from the important task of developing solid API connections.

- **Sharing the Vision with Others**. The development of a shared vision occurred among the six primary stakeholders (four providers and two software companies) who spent long hours together, working through the many project issues. Secondary stakeholders (including our Federal, State, and regional partners) are still, as individuals, building their understanding of the how the project fits into a larger framework as well as building their understanding the potential and the limitations of the final product. There are many individuals at the secondary stakeholder level who, appropriately, participated in an oversight role only rather than attending long hours of meetings. While the level of understanding varies with the individuals, this points to the complexity of the project and the challenge of building an understanding in an area that requires both deep technical and deep operational understanding.

  It makes one realize how hard-won the shared understanding is among the primary stakeholders and how much work will be needed to communicate it to others. Primary stakeholders forged this understanding through many hours of working together on various aspects of the project. Finding an effective way to communicate the value of this project to specialized transportation providers across the nation will require concerted effort.

Use of the Trip Exchange in Other Regions

As the primary stakeholders now have a solid understanding of how useful the Trip Exchange software is, they hope that others will learn about it and continue to build on the tools that have been developed. Areas that are interested in pursuing the use of the Trip Exchange should expect:

- *The Trip Exchange will need to be tailored to local services*. On the scheduling software side, this means that the software vendor will need to adapt the software to use APIs to communicate through the Trip Exchange. On the provider side, this means that providers will need to work through the details to tailor the program to meet their needs.
- *Allow plenty of time* to build an understanding of the basic concepts and how to effectively use them in your region. Remember that participants will need time to develop a shared understanding and common vocabulary.
- *This will be a team effort*. Support will be needed to accomplish the task at hand. You may have some of the needed skills in your organization. If not, they can be hired to support your internal project team. The critical skills that were needed in the NW Denver Coordination Project were individuals with programming skills (both for the scheduling system adaptations and the Trip Exchange) and project management skills.
  - Various scheduling programs will need to be adapted, as described in Chapter 2. This will need to be done by the staff of each proprietary system so they will need to be part of the project.

    - The Trip Exchange is an open-source program written in Java. While the basic program is available, someone with the ability to access and install the files needs to be on your team. You will also need to arrange for hosting of the program.
    - A project manager is needed to facilitate communication between people with very different knowledge sets and maintain a project focus that balances competing needs and interests.
- *The Trip Exchange will continue to evolve*. Building out the financial component is a logical next step but other improvements are likely as well. The use of the Trip Exchange may initially be somewhat limited, assisting only a few providers to better use existing resources. Over time, it may also be a foundation for broader coordination efforts.

Next Steps

The system is ready for implementation, as described in the previous chapter, and implementation activities will be carried out in 2018. Specific follow-on activities have been identified for the partners in Northwest Denver as well as to support the continued development of the Trip Exchange as a foundation for strengthening coordination of transportation resources and enabling a wide range of users (providers, agency staff, and individuals) to access a broad range of mobility options.

Three key follow-on development activities have been identified:

- Build out the payment and billing portion, enabling agencies to post what they are able to pay for a posted trip and provide an invoicing system.
- Work with other scheduling systems to connect to the Trip Exchange. This requires that the scheduling system be able to use APIs to send information to the Trip Exchange and to read and respond to messages received from the Trip Exchange.
- Adapt the system so it can also answer key questions for providing efficient regional trip services:
    - Are there enough trips in a corridor to make it financially feasible to establish a vehicle run?
    - Can an existing vehicle run be extended to provide an additional trip? If extended, would the provider remain the same?

Another important item is that, as an open-source system, it will be necessary to build a community of users who can support the use and continued development of the program.

Appendices

The appendices reflect the data definitions and data tables in the test version of the software platform. These are presented to provide an understanding of the range and scope of the system. The final software and technical documentation will be posted on GitHub, along with any updated versions and forks that may be developed.

A. User Manual

B. Message Set – provides detailed information on the messages sent through the Trip Exchange between scheduling systems used by partner agencies.

C. Data Table – contains various elements included in the exchange.

D. Notification Message List – a list of notifications sent to providers identifying them of available trips and the change in status of trips.

E. API list – a description of the various APIs that are used in the program.

Appendix A: Users Manual

Northwest Denver Region DRT Trip Exchange

User Manual for Site Administrator and Providers

March 15, 2018

System Scope:

The **Trip Exchange** is a web-based system developed by DemandTrans Solutions for use by demand responsive transportation (DRT) providers in the northern Denver region who are primarily involved in transportation for human services purposes, but also includes the regional public transit agency. The Trip Exchange enables multiple transportation providers (Providers), each with its own scheduling and dispatch software, to share information with other Providers and to enable transactions amongst them. Providers can submit customer requests in the form of “trip tickets” for available capacity or offer their services for unmet customer needs of other Providers. The Trip Exchange identifies potential matches between capacity and need based on date/time of trips, location of providers and customers, mobility requirements, and service eligibility. When a provider is capable of fulfilling a trip ticket submitted by another provider, the Trip Exchange provides the functionality to claim the ticket and then later send the trip execution results back to the submitting provider.

Providers can interact with the Trip Exchange in either of two ways.

1. Providers’ staff can log on to the Trip Exchange and via its user interface—accessible by a web browser—perform a variety of actions using the application, including claiming trips.
2. Providers can set up machine-to-machine communication between the software systems used by the Trip Exchange's members and allow the software systems to post trip tickets and claim trip tickets based on business relationships and functional needs/desires of the participating agencies.

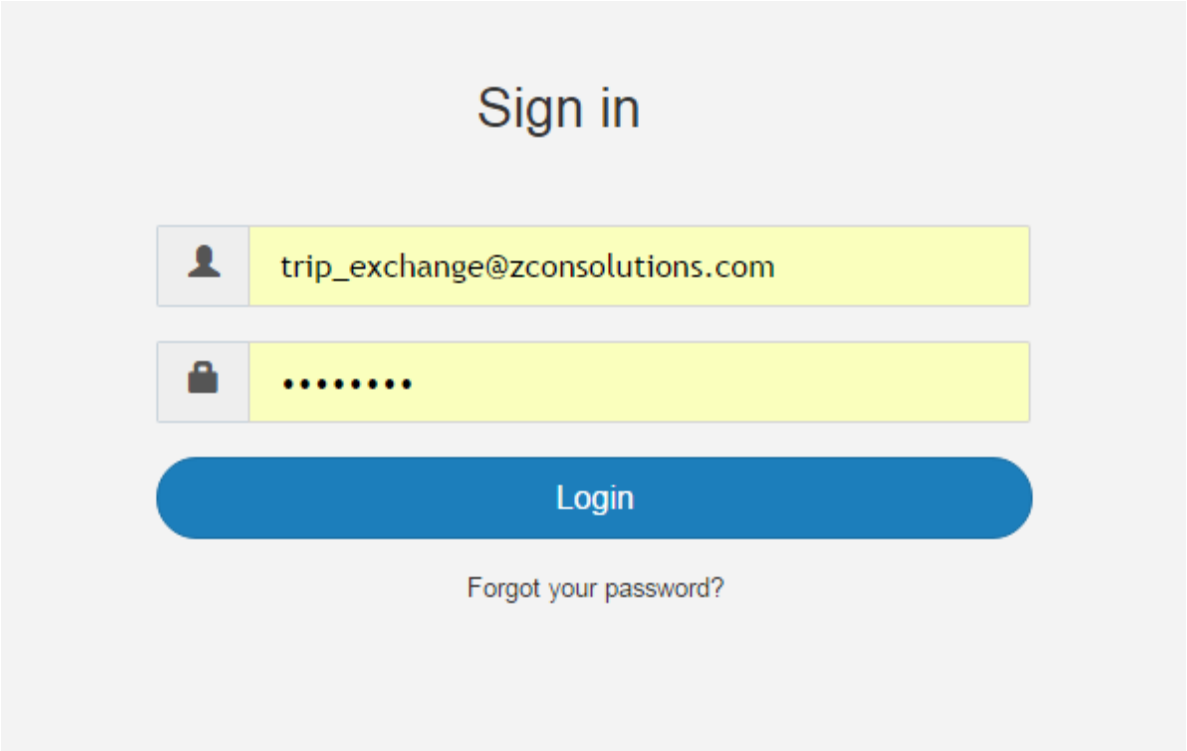
There are 3 types of Users of the Application – (1) Site Admin; (2) Provider Admin; (3) Provider User.

1. Site Admin – This is a Super User of the application who can create providers and has all authorities over providers and their users.
2. Provider Admin – This is the Admin of a Provider. Provider Admin’s can create Users for the Provider, can setup Service Areas, can Create/Rescind Claims as Claimant Provider and Approve/Decline Claims as Originating Provider.
3. Provider User—This is a User of the system. All Users belong to a Provider and act on behalf of that Provider. Users can Create/Rescind Claims on behalf of their Provider and can Approve/Decline Claims on behalf of their Provider.

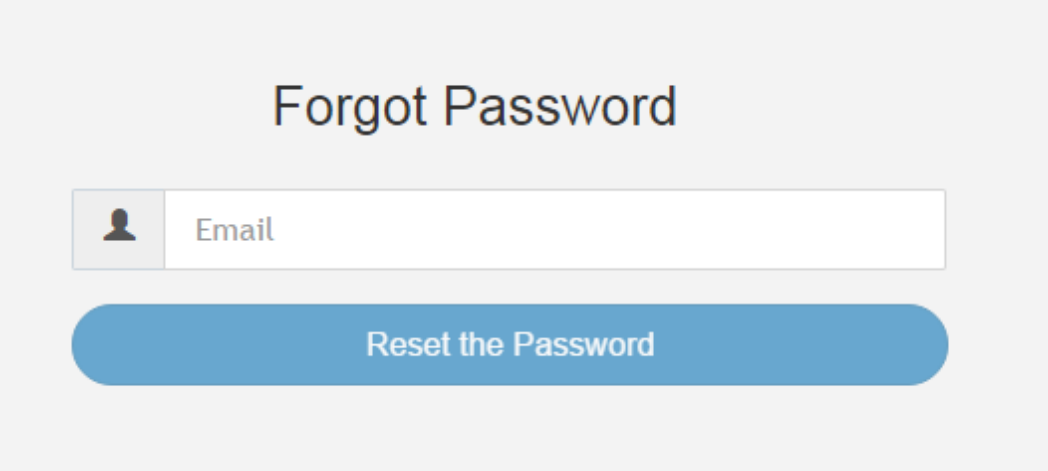
The remainder of this User Manual describes the functional capabilities available to these 3 types of Users and how they can use the system to achieve their purposes.

Roles and Responsibilities of Site Admin

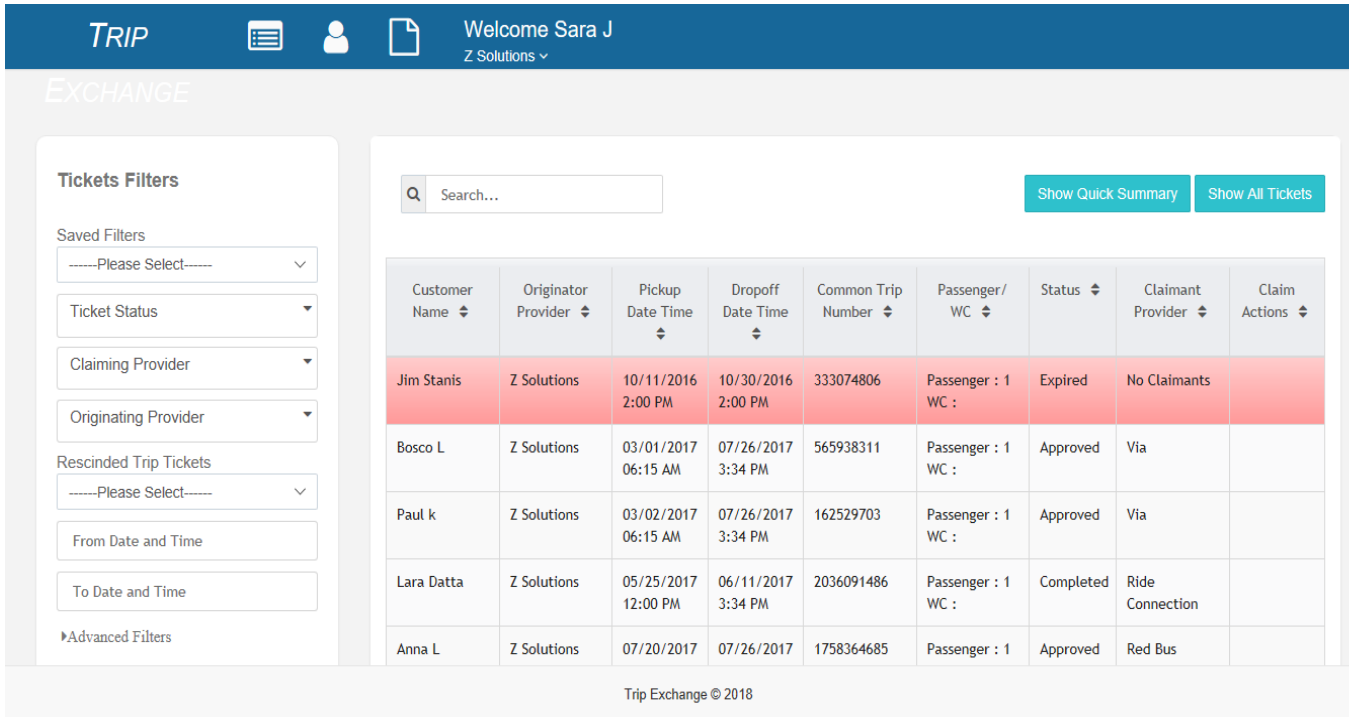
1. Login – Enter email address as Username and the password provided by Provider Admin to login to the application.



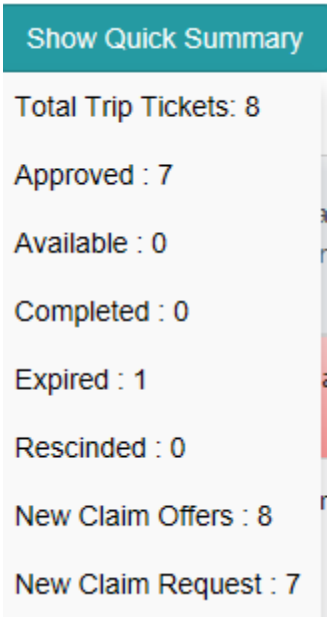
2. Forgot your password? - Click on link to enter email id. User will get an email with temporary password and Reset Password. Use the temporary password to reset/change the password.



3. Application Menus – After Login as Site Admin, the Trip Tickets page will be displayed as a Landing page. On the top header, you will see icons for Trip Tickets, Admin and Reports displayed left to right. In the middle of the screen at the top of the page, the user name for the logged in user is displayed. On the upper right-hand side of the screen there are two buttons: Show Quick Summary and Show All/My Tickets.

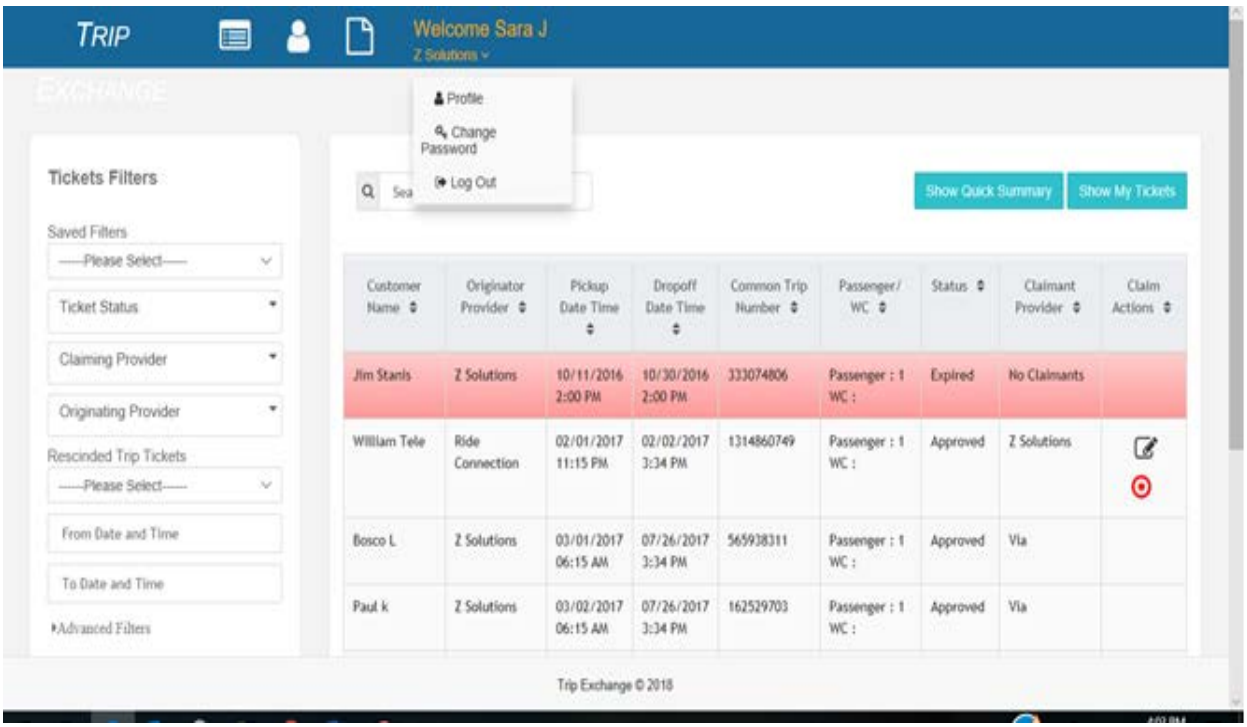


Clicking the Show Quick Summary button opens a pop-up display that shows a summary of the status of all the Provider's trip tickets in the Trip Exchange, as shown below.

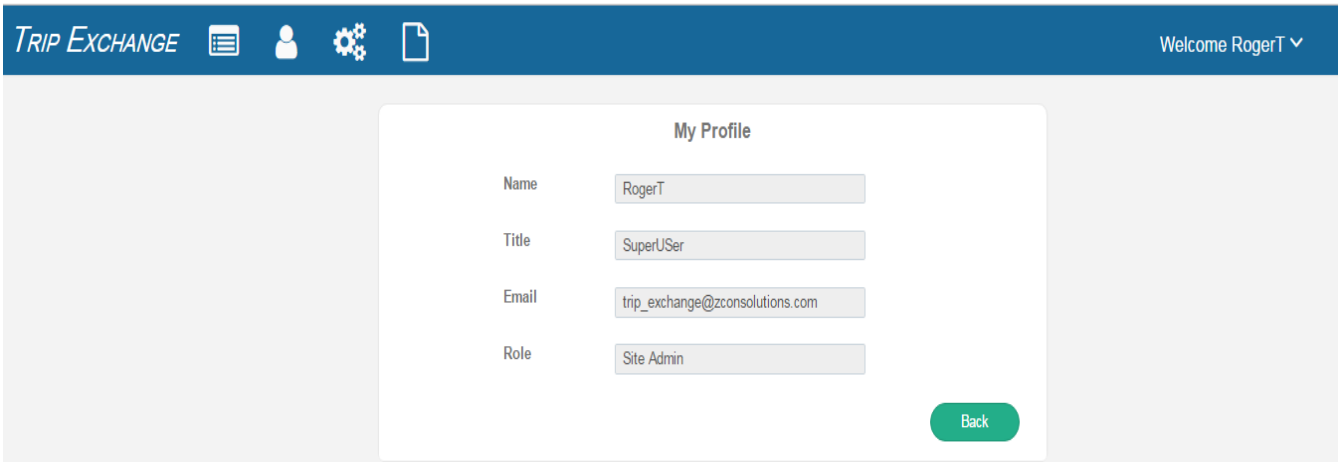


When the main Trip Exchange screen is entered, the default setting for the Show All/My Tickets button is to show all the trip tickets in the Trip Exchange. Clicking the Show My Tickets button restricts the visibility to only the trip tickets of this specific Provider.

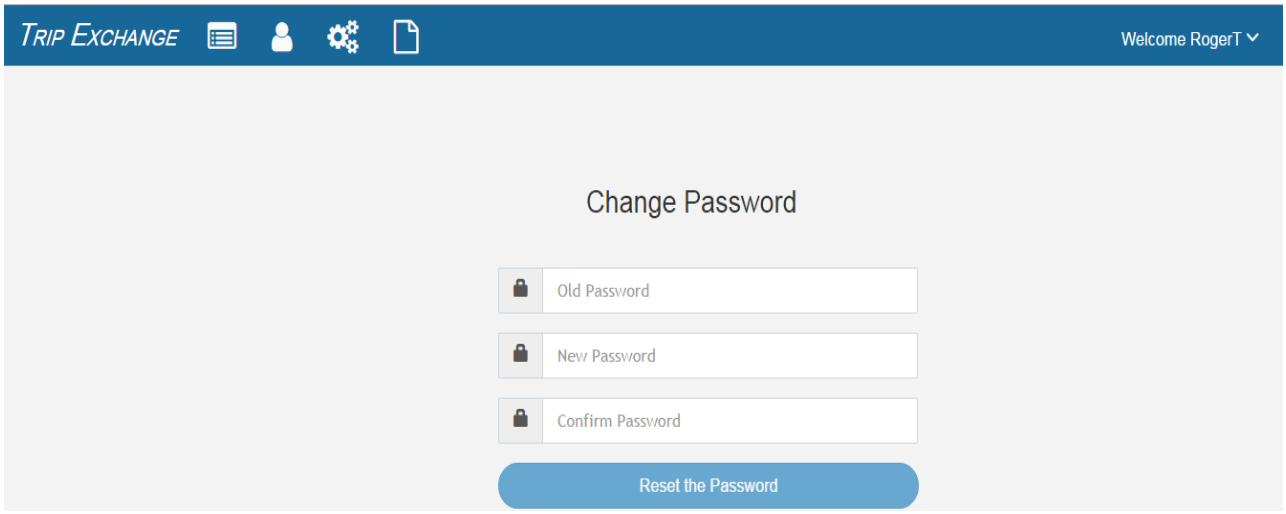
Hovering over the User's name on top menu bar reveals the sub-menu for Profile, Change Password, and Log Out buttons. Click on any button will redirect you to that function.



4. Profile – On the Profile screen, the user will see details of Name, Title, Email and Role. Profile is only for display purpose.

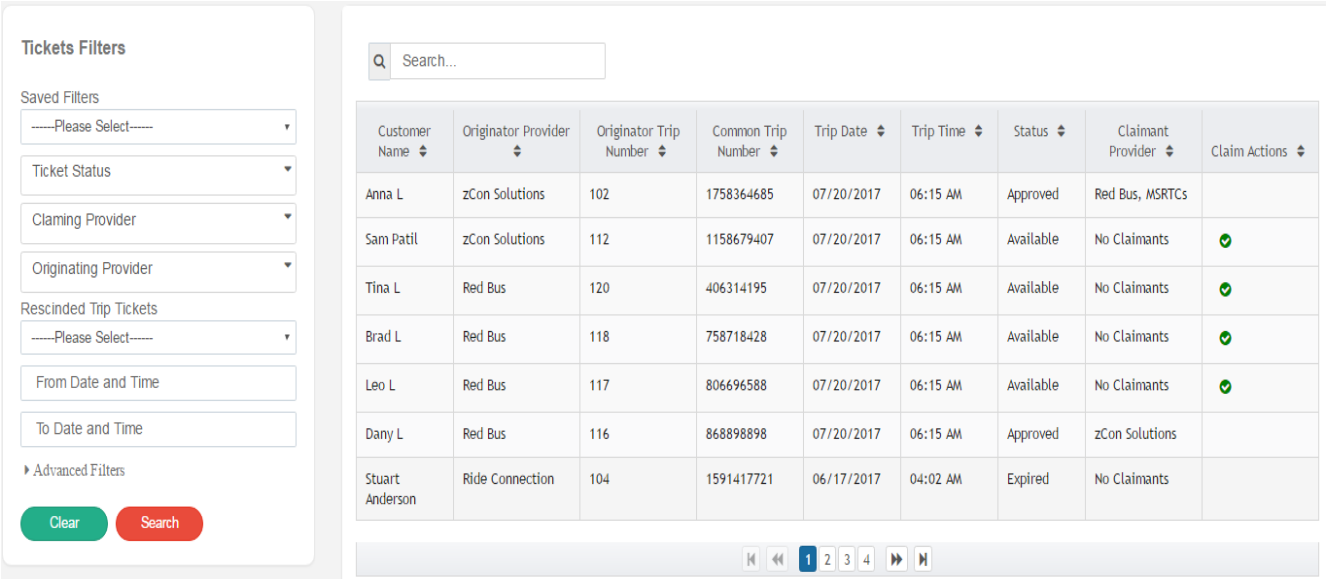


5. Change Password – To change application password enter old password and new password and click on button.



6. Trip Ticket Details and Filters – Site Admin can see all Tickets of all Providers. Site Admin can filter Trip Tickets data using any parameters in the filters. Filters can be saved for future use. Saved filters can be updated.

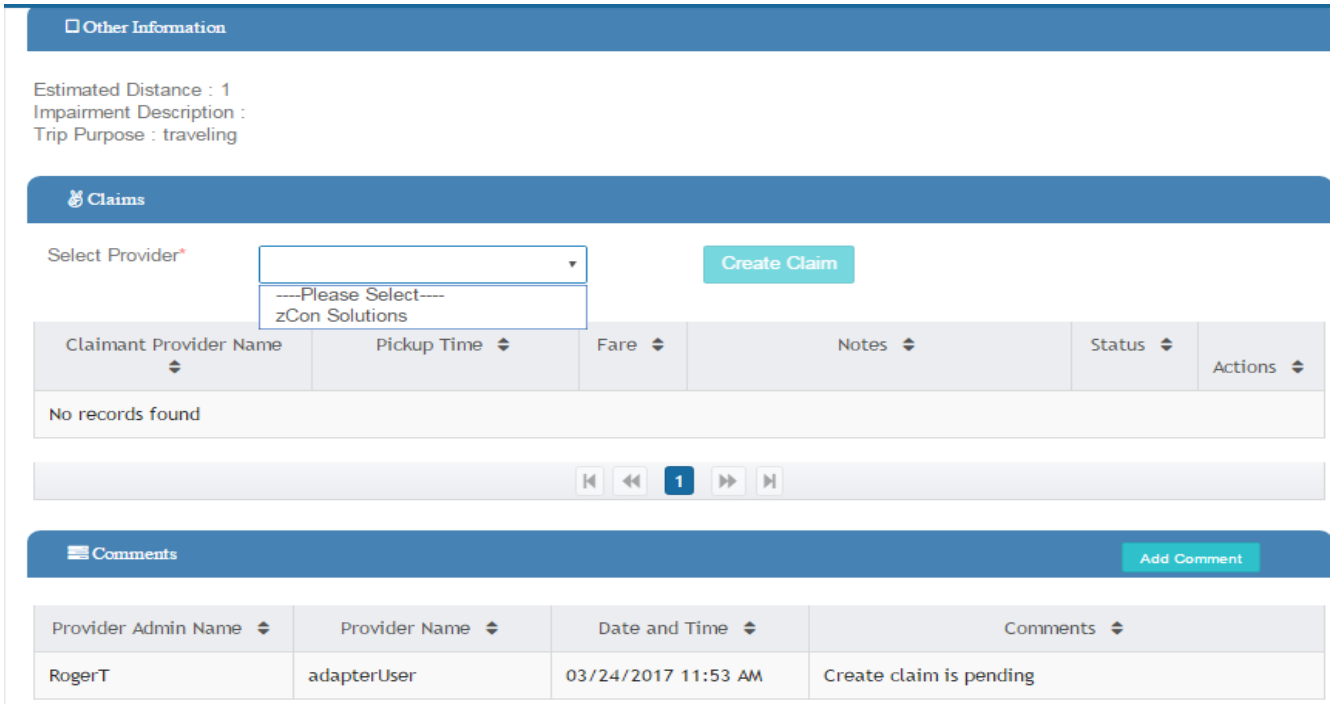
- Trip Tickets records are sorted on Trip Pick Up date and time.
- Click on Customer Name to see details of a Trip Ticket.



- Trip Ticket Details View has information related to claims, Customer Information, Trip Details, Claim Details, Comments, etc.
- Click on Activity button to see Trip Ticket's History. Activity contains Trip creation date, Claim creation and approval date, Trip Ticket Status, Comments Details with respect to Providers.

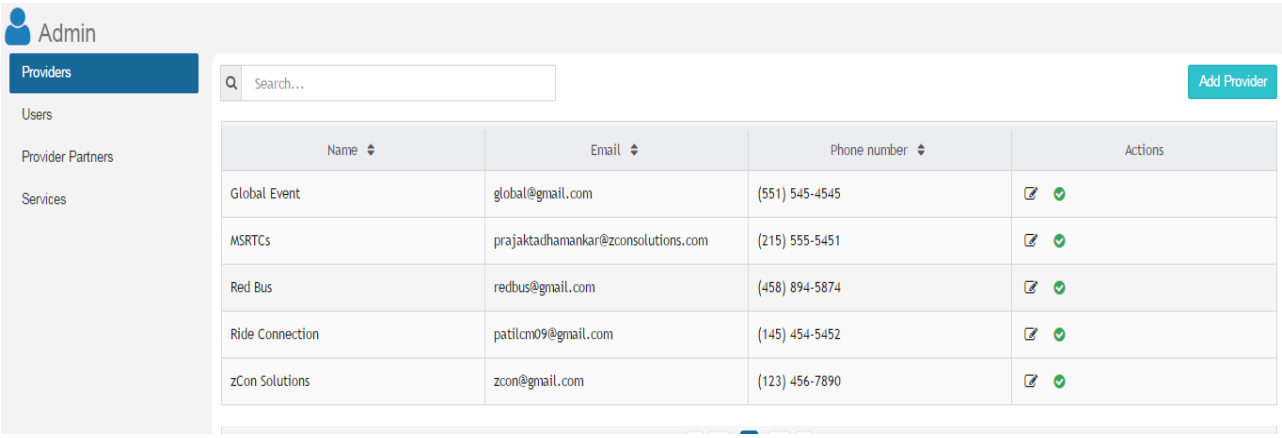
- Site Admin can also Create Claim on behalf of any Provider. A list of Providers is shown to select the Originating Provider and Claimant Provider.

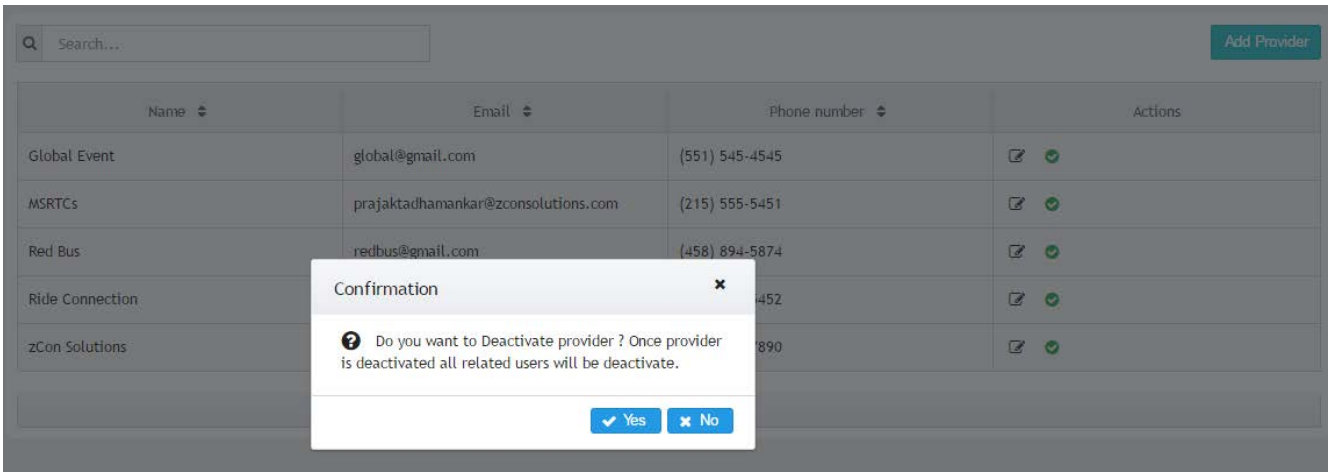
- Based on Provider's Service Area if Trip Ticket's Pick Up and Drop Off address is within the Service Area then only the Provider in that Service Area can claim that Ticket.



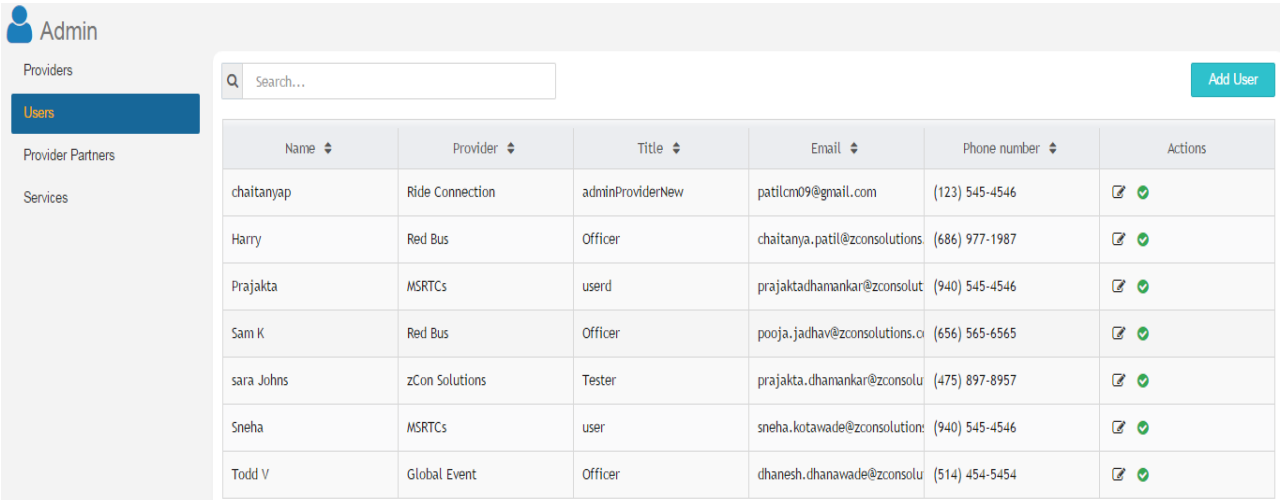
Admin Menu

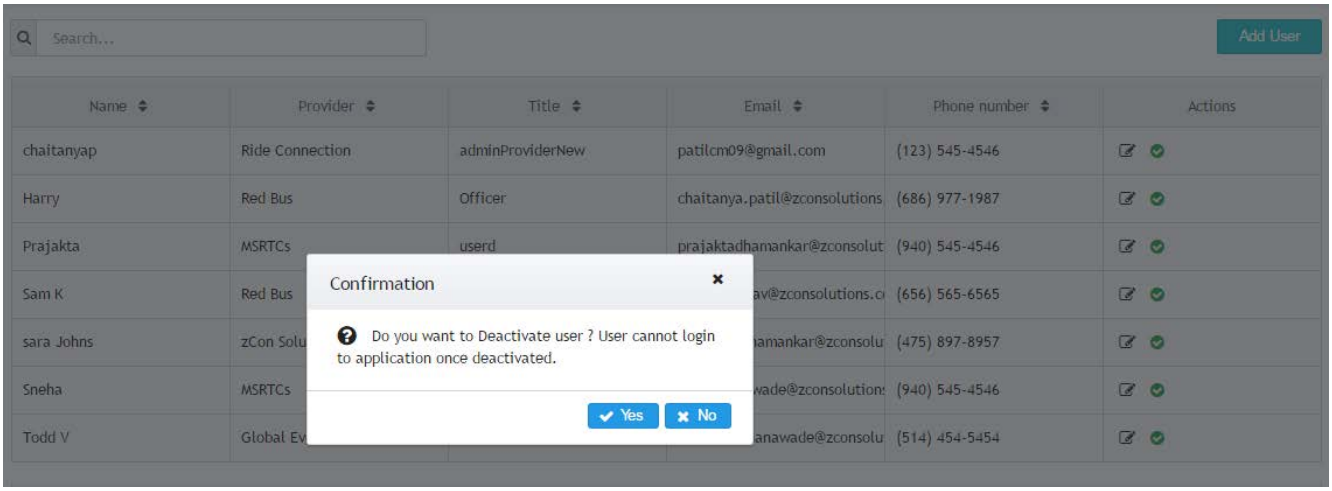
7. Provider – Site Admin will see list of all Providers. Site Admin can add or update a Provider in the application. Site Admin can Deactivate/Activate Provider. Once a Provider is deactivated, all users of that Provider will be deactivated. After Activation of Provider, users will be activated and they can login to the application.





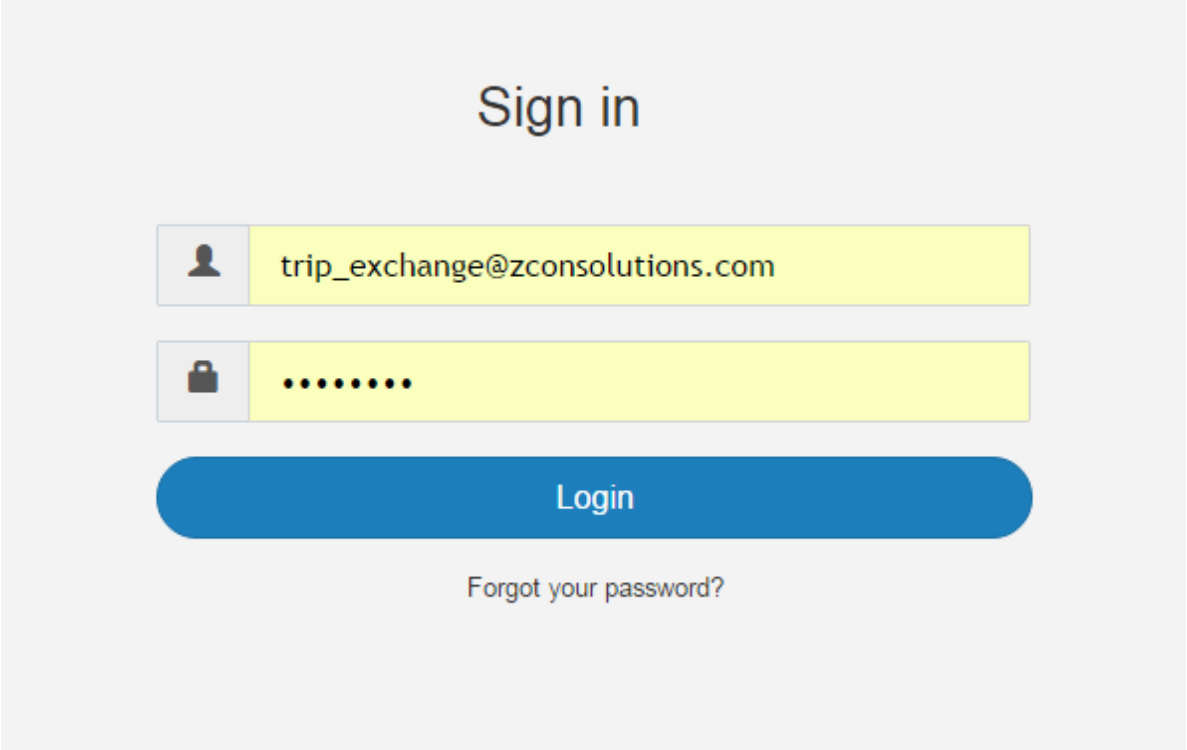
8. User – Site admin can add/update Users for a provider. Site Admin can activate/deactivate users.


Admin
Providers
Users
Provider Partners
Services
Search...
Add User
Name
Provider
Title
Email
Phone number
Actions
chaitanyap
Ride Connection
adminProviderNew
patilcm09@gmail.com
(123) 545-4546
Harry
Red Bus
Officer
chaitanya.patil@zconsolutions.
(686) 977-1987
Prajakta
MSRTCs
userd
prajaktadhamankar@zconsolut
(940) 545-4546
Sam K
Red Bus
Officer
pooja.jadhav@zconsolutions.c
(656) 565-6565
sara Johns
zCon Solutions
Tester
prajakta.dhamankar@zconsolu
(475) 897-8957
Sneha
MSRTCs
user
sneha.kotawade@zconsolution
(940) 545-4546
Todd V
Global Event
Officer
dhanesh.dhanawade@zconsolu
(514) 454-5454

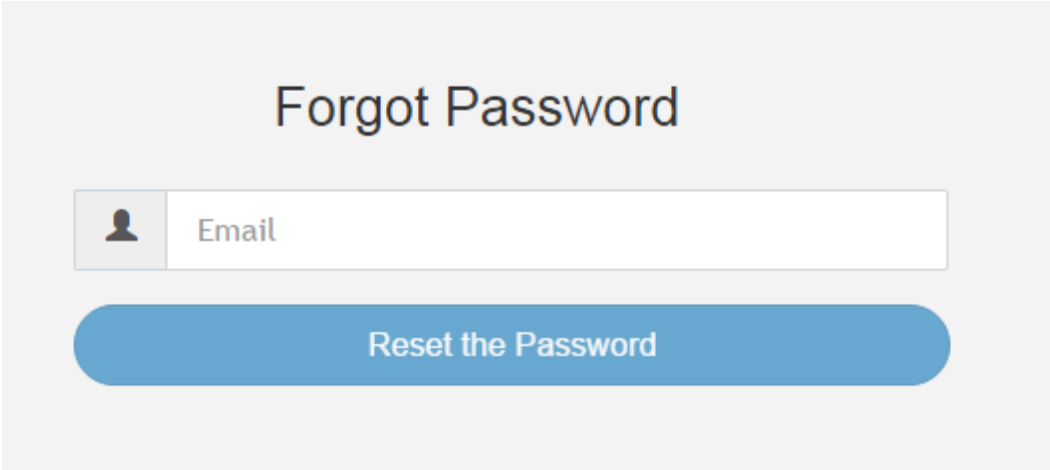

Search...
Add User
Name
Provider
Title
Email
Phone number
Actions
chaitanyap
Ride Connection
adminProviderNew
patilcm09@gmail.com
(123) 545-4546
Harry
Red Bus
Officer
chaitanya.patil@zconsolutions
(686) 977-1987
Prajakta
MSRTCs
userd
prajaktadhamankar@zconsolut
(940) 545-4546
Sam K
Red Bus
(656) 565-6565
sara Johns
(475) 897-8957
Sneha
MSRTCs
(940) 545-4546
Todd V
(514) 454-5454
Confirmation
Do you want to Deactivate user ? User cannot login to application once deactivated.
Yes
No

Roles and Responsibilities of Provider Admin

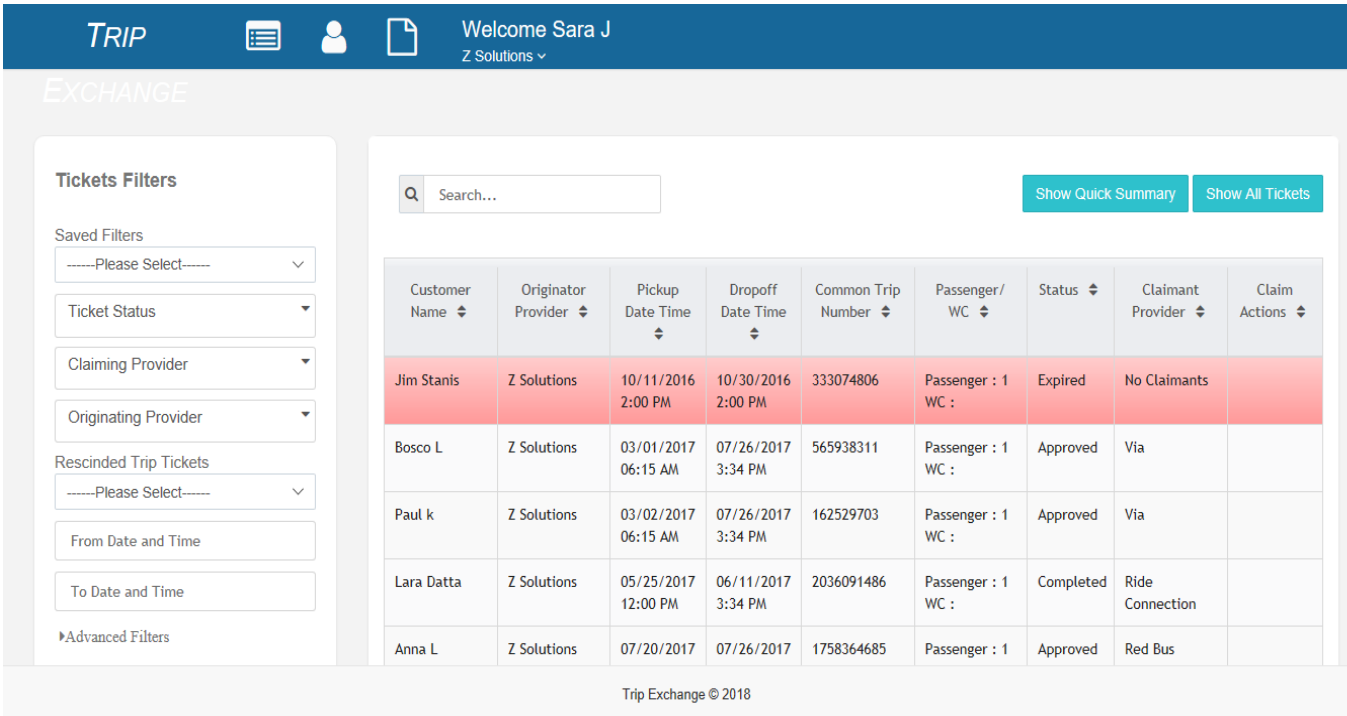
1. Login – Enter email id as Username and password to Login to the application. If users fails to login in 4 attempts, then respective User's account will be deactivated for that day. It will be re-activated on the next day.



2. Forgot your password? - Click on link to enter email id. User will get email with temporary password and Reset Password. Use these temporary passwords to reset/change the password.

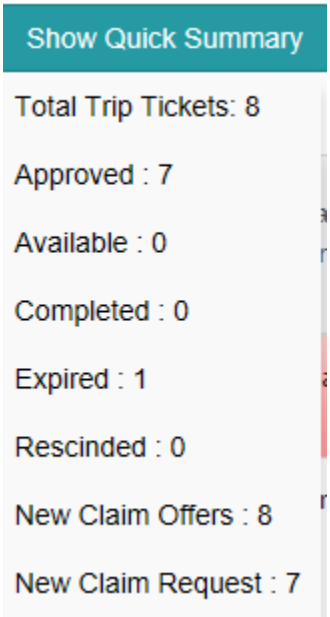


3. Application Menus – After Login as Site Admin, the Trip Tickets page will be displayed as a Landing page. On the top header you will see icons for Trip Tickets, Admin and Reports displayed left to right. In the middle of the screen at the top of the page, the user name for the logged in user is displayed. On the upper right-hand side of the screen there are two buttons: Show Quick Summary and Show All/My Tickets.

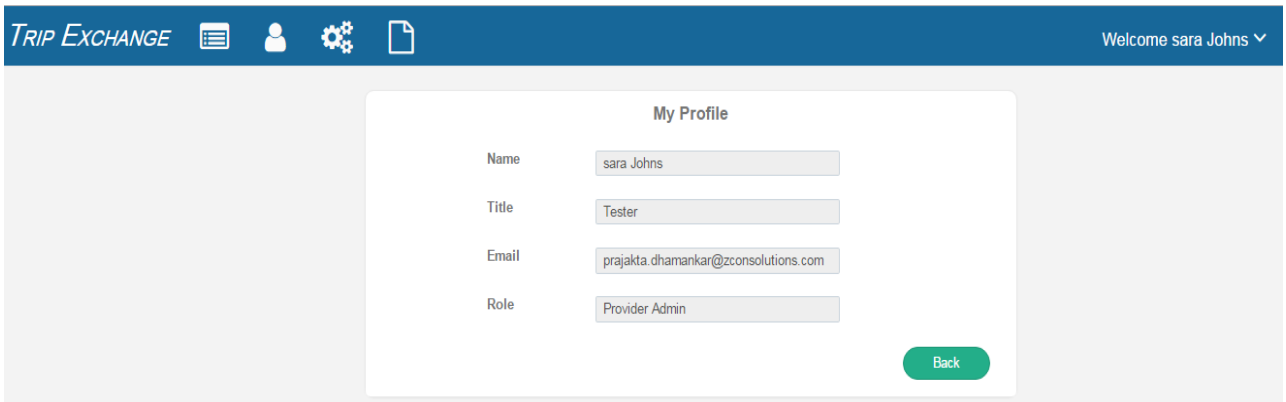


Clicking the Show Quick Summary button opens a pop-up display that shows a summary of the status of all the Provider's trip tickets in the Trip Exchange, as shown

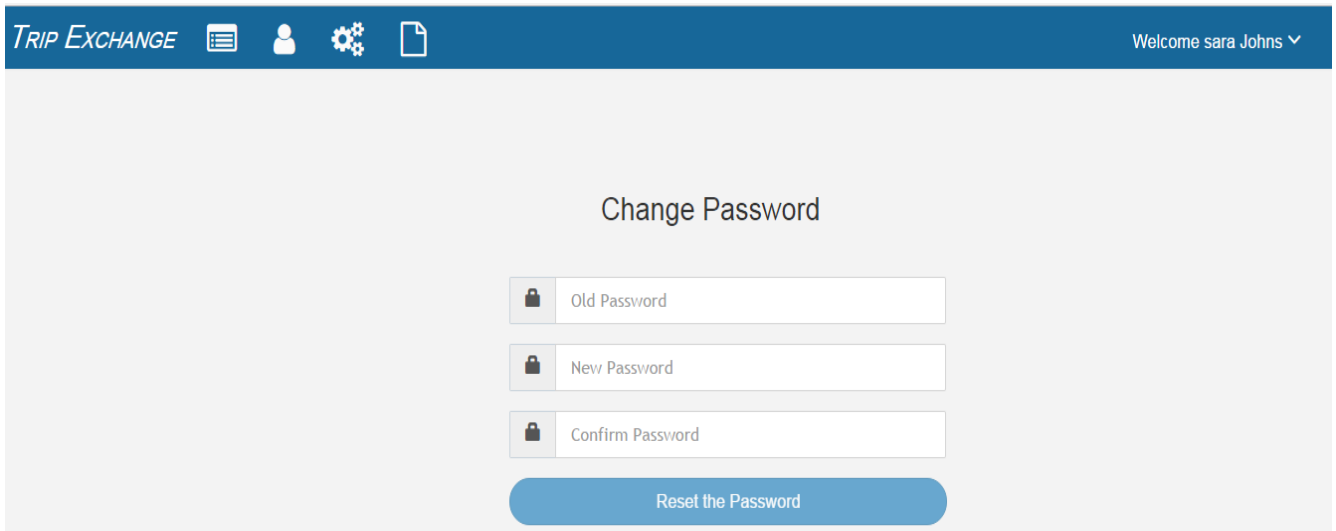
below.



4. Profile – On Profile page user will see details of Name, Title, Email and Role. Profile is only for display purpose.

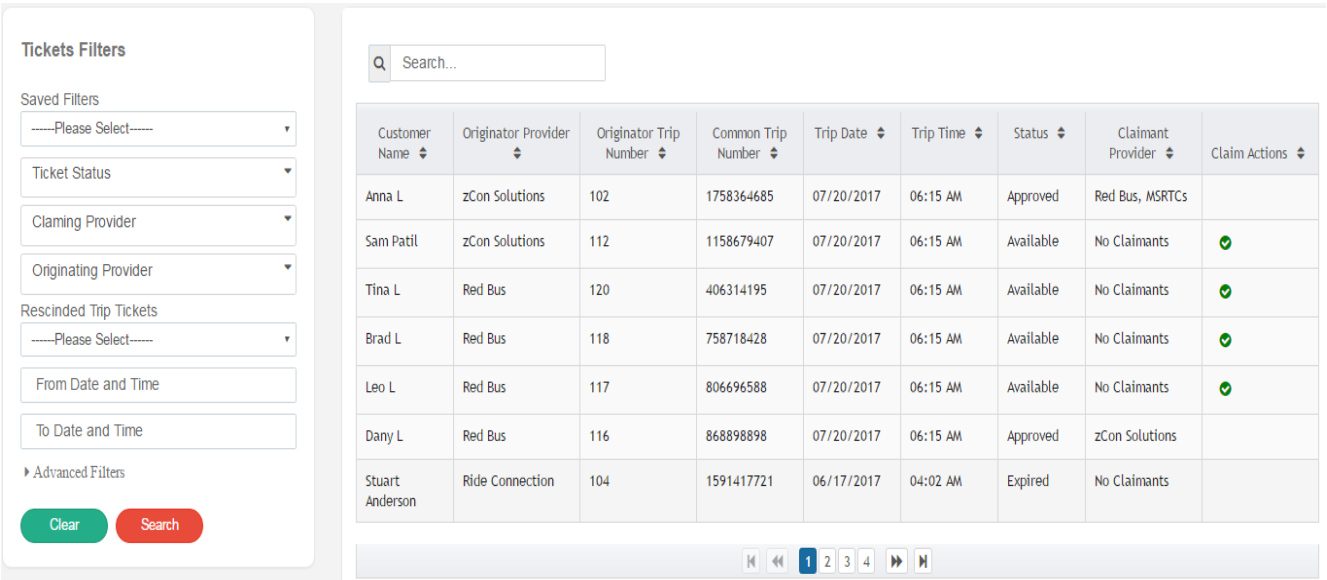


5. Change Password – To change application password enter old password and new password and click on button.



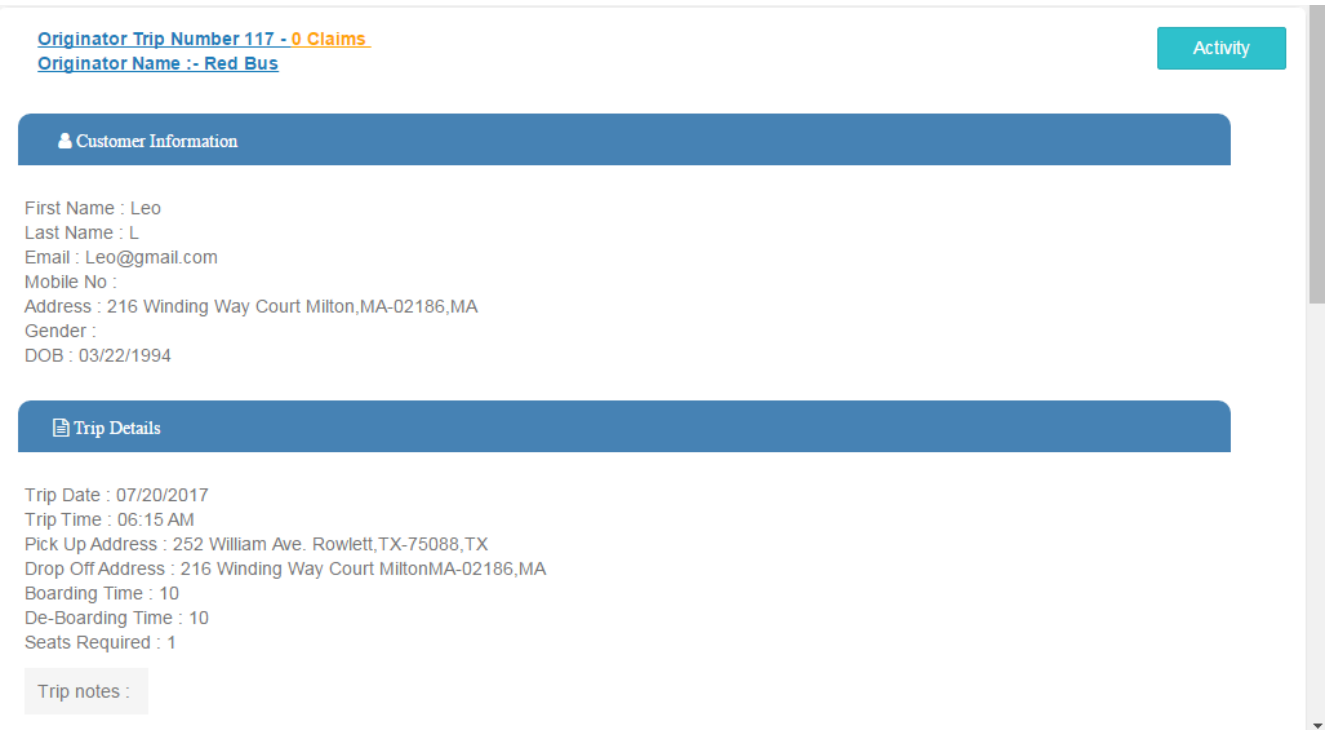
6. Trip Ticket Details and Filters – Provider Admin can see Tickets of Partner Provider filtered on own Service Areas. Provider Admin can filter Trip Tickets data using any parameters in the filters. Filters can be saved for future use. Saved filters can be updated.

- Trip Tickets records are sorted on Trip Pick Up date and time.
- Click on Customer Name to see details of Trip Ticket.



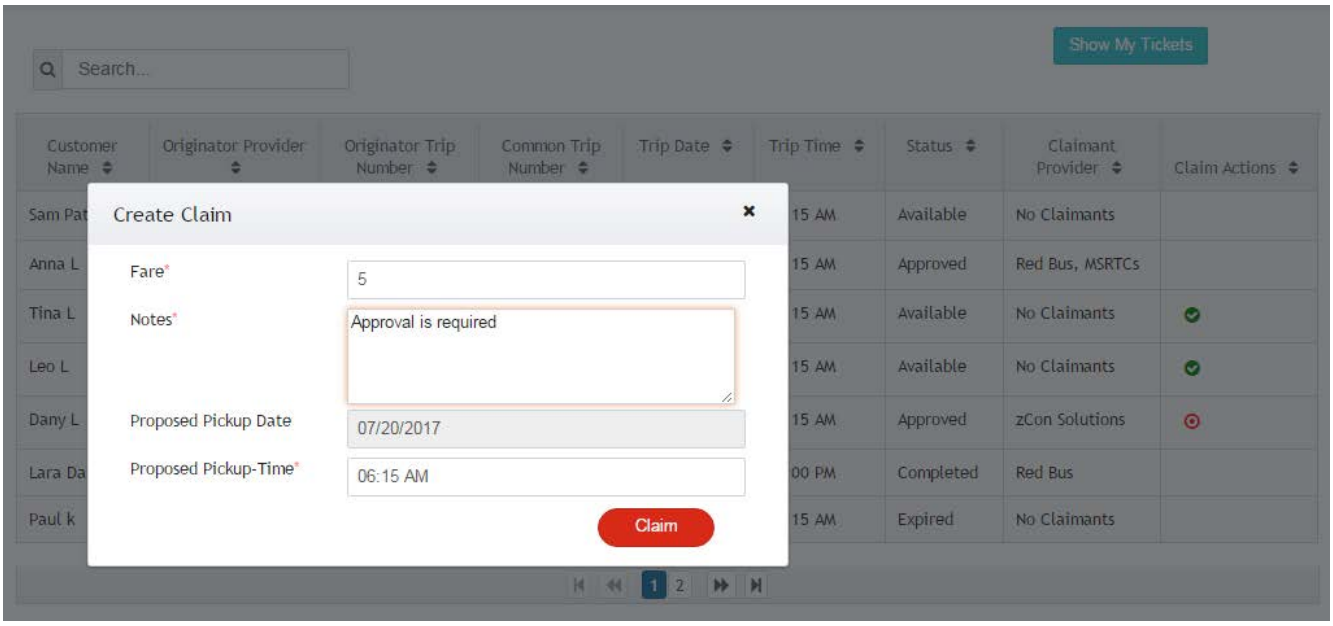
- Trip Ticket Details View has information related to claims, Customer Information, Trip Details, Claim Details, Comments, etc.
- Click on Activity button to see Trip Ticket's History. Activity contains – Trip creation

date, Claim creation and approval date, Trip Ticket Status, Comments, Details with respect to Providers.



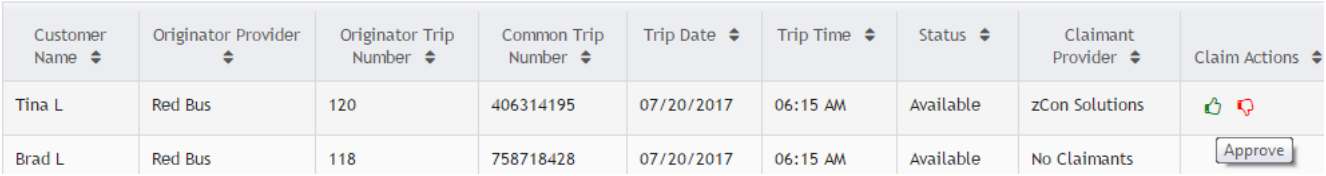
7. Create Claim

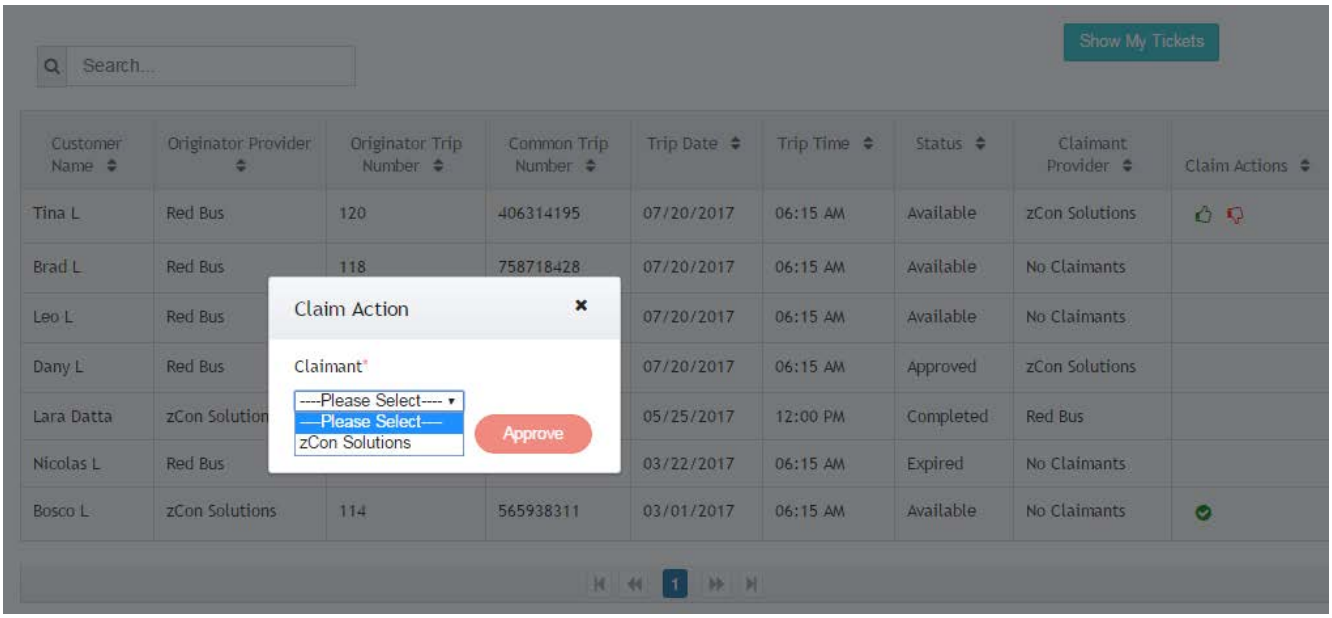
- Provider Admin can Create Claim for Trip Tickets of Partner Provider. Facility is given Trip Tickets grid in 'Claim Action' Column.
- Click on Create Claim button. Enter details and click on Claim button.

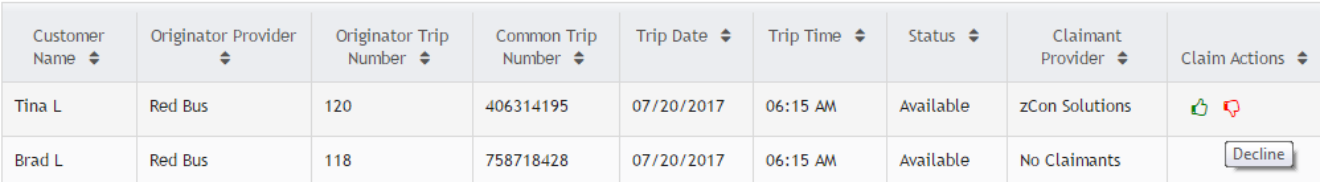


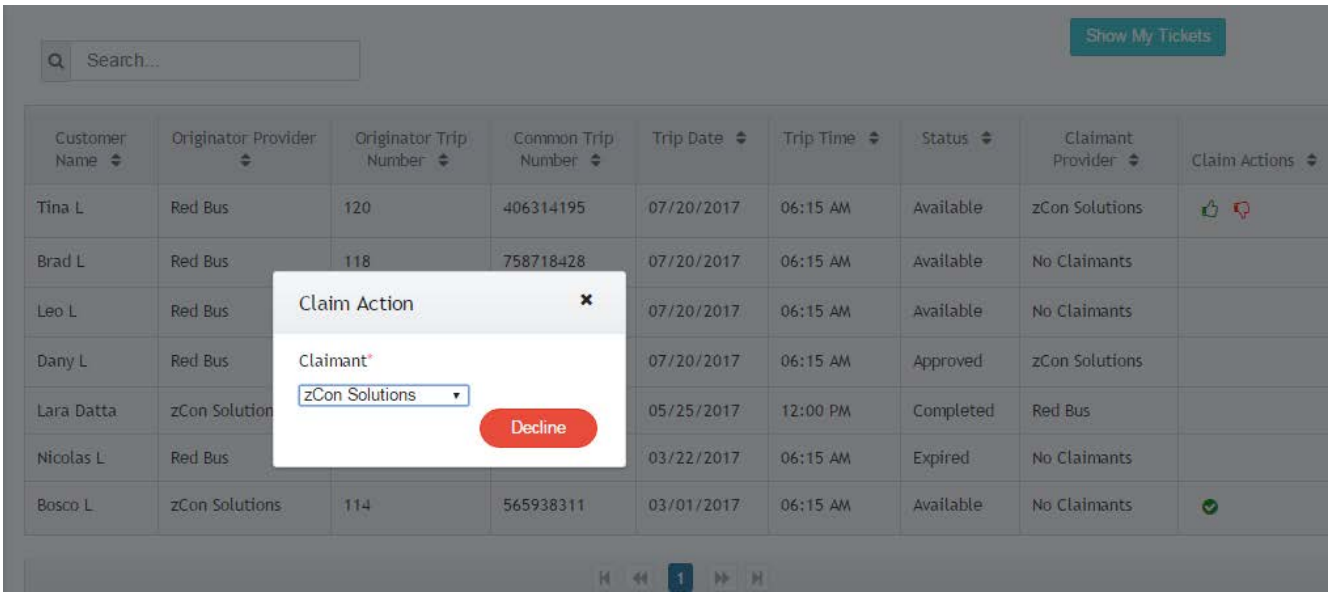
- After creating Claim, Provider can Rescind the claim before or After Approval.
- Trip Ticket Status will be displayed in Status column.
- Claimant Providers name is displayed in Claimant Provider Column.

- If the Claim is by a Trusted Partner, it is automatically approved by the Trip Exchange after it is made.
- If the Claim is by an organization that is not a Trusted Partner of the Originating Provider, the latter can Approve or Decline the claim.
- If more than one Claim is made by Providers who are not Trusted Partners of the Originating Provider, the latter can select the Provider to approve from the drop down.









- Provider Admin can see the Provider's own Tickets by clicking on 'Show My Tickets' button.

Search...

Show My Tickets

Customer Name	Originator Provider	Originator Trip Number	Common Trip Number	Trip Date	Trip Time	Status	Claimant Provider	Claim Actions
Sam Patil	zCon Solutions	112	1158679407	07/20/2017	06:15 AM	Available	No Claimants	
Anna L	zCon Solutions	102	1758364685	07/20/2017	06:15 AM	Approved	MSRTCs, Red Bus	
Tina L	Red Bus	120	406314195	07/20/2017	06:15 AM	Available	zCon Solutions	
Leo L	Red Bus	117	806696588	07/20/2017	06:15 AM	Available	No Claimants	
Dany L	Red Bus	116	868898898	07/20/2017	06:15 AM	Approved	zCon Solutions	
Lara Datta	zCon Solutions	100	2036091486	05/25/2017	12:00 PM	Complete d	Red Bus	
Paul k	zCon Solutions	113	162529703	03/22/2017	06:15 AM	Expired	No Claimants	

Admin Menu

8. Provider – Provider Admin can only update their own details and cannot add a new Provider.

Admin

Providers

Users

Provider Partners

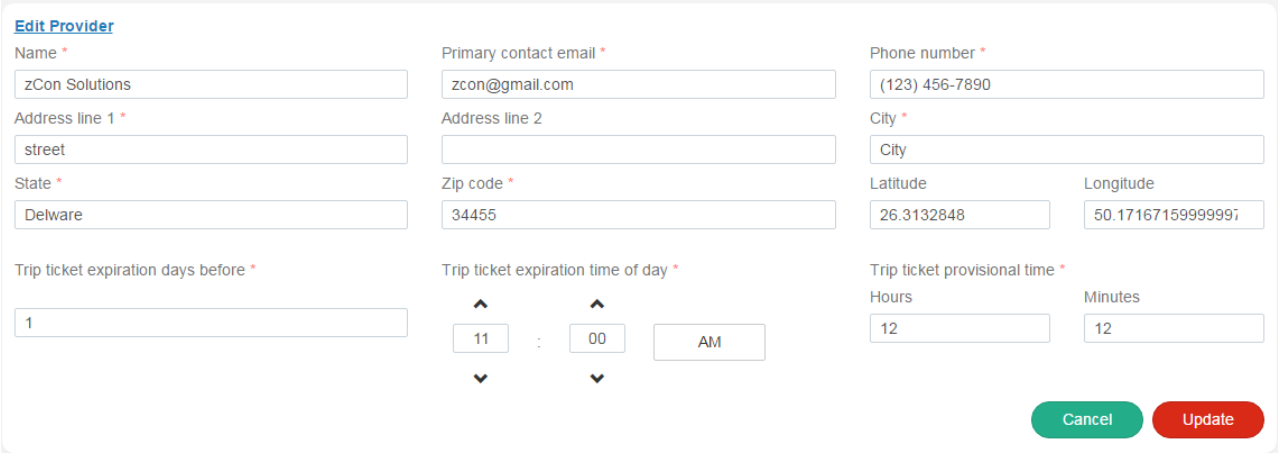
Services

Search...

Name	Email	Phone number	Actions
zCon Solutions	zcon@gmail.com	(123) 456-7890	

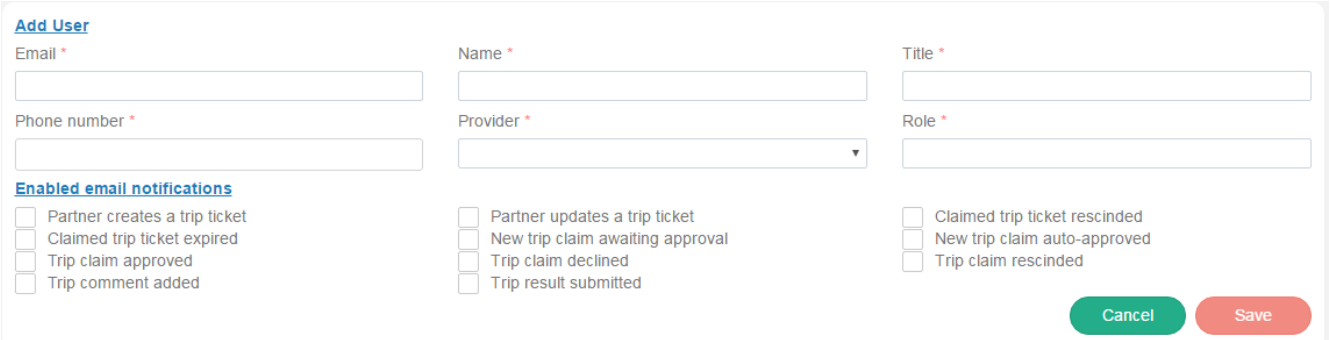
1

- Trip ticket expiration days before and Trip ticket expiration time of day – Expiration Date of Trip Ticket is calculated based on Pick Up Date/Time of Trip Ticket. Trip Ticket gets expired if No Claim is created.
- Latitude and Longitude auto populated based on entered valid zip code.



9. Users – Provider Admin can add/updates users of own organization. It can also activate/deactivate users of the Provider.

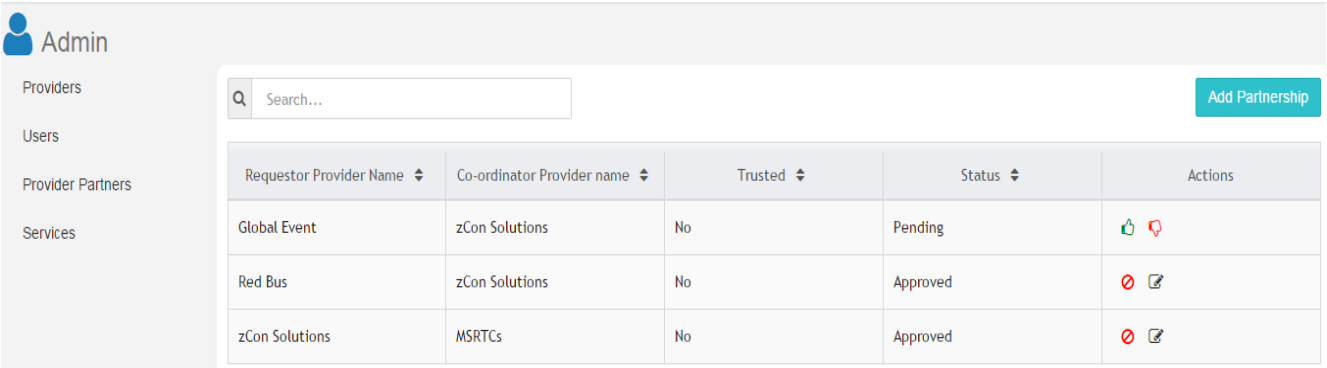
- Email Notification indicates that for which action users should receive emails through application.

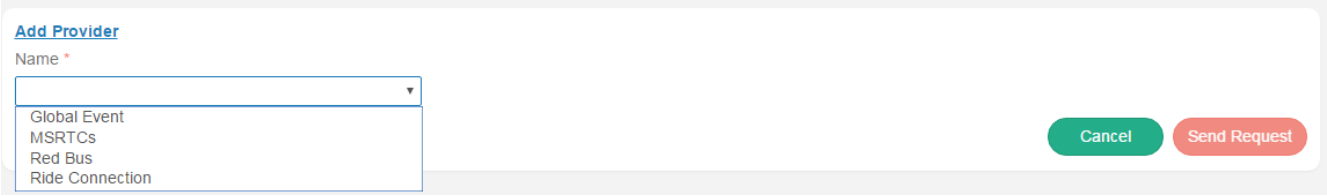


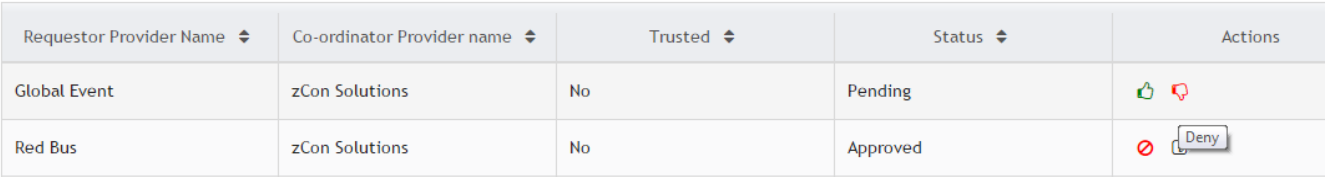
10. Provider Partners – Provider Admin will see a list of their current Partners.

- Can request a New Partnership.
- To request a new Partnership be added—Select Provider and click on Send Request button.
- Can Approve or Deny Partnership request from another Provider.

- Can Terminate a Partnership.
- Can Update a Partnership.
- To update a Partnership, Provider Admin can only change the Trusted flag.
- Can add Trusted Partnership by changing the status of the Trusted flag.
- The status of a Partnership is displayed in the Status column.



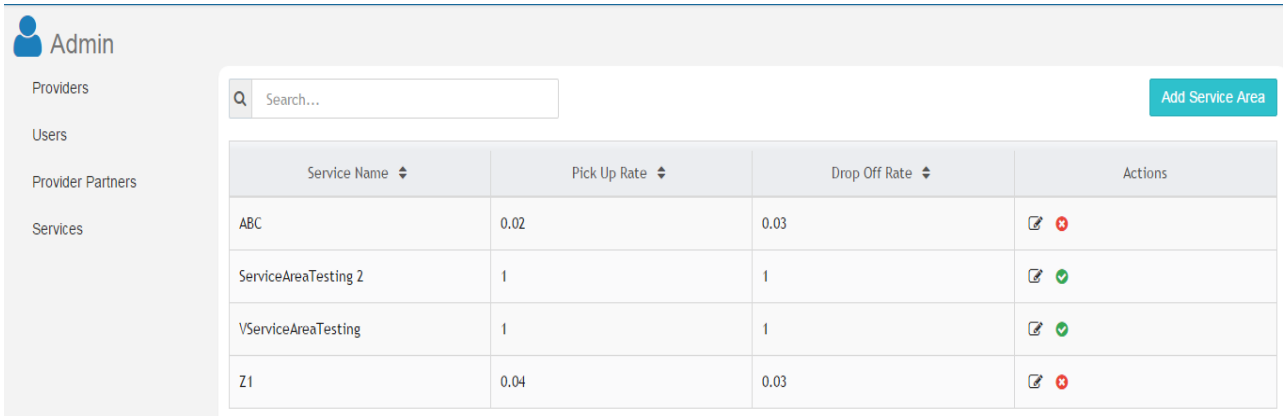


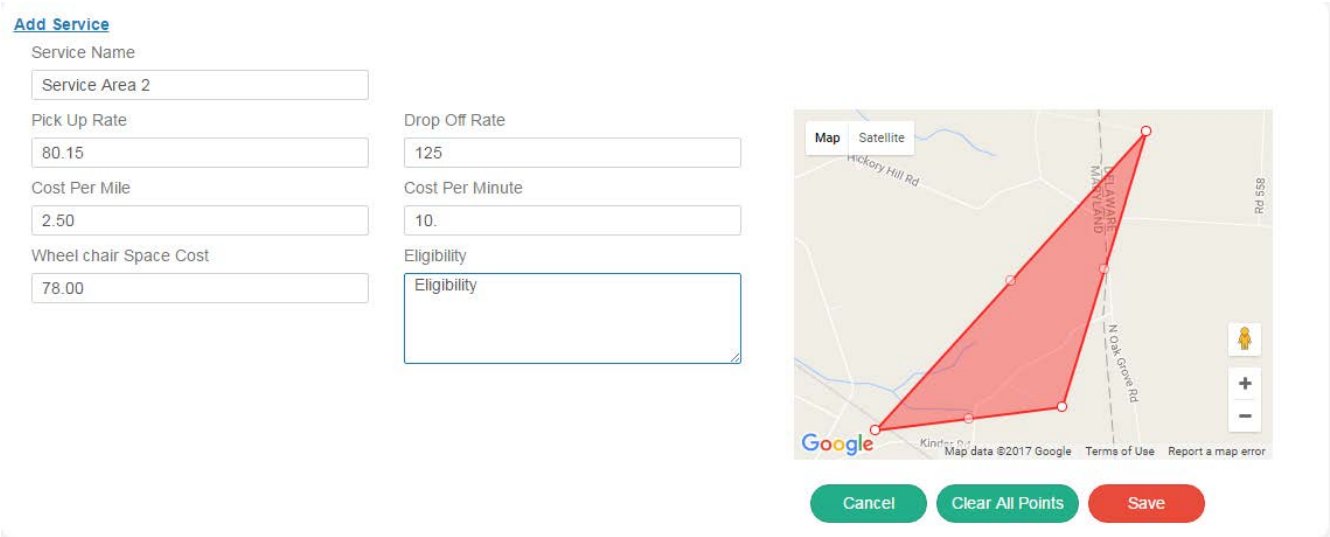


11. Service Area – Provider Admin will see list of Service Areas.

- Can add new Service Area
- Can update new Service Area
- Can activate/deactivate Service Area

- Trip Tickets get filtered out based on Service Area





12. Reports - Provider Admin can see 2 reports
    1. Provider Summary Report
    2. Current Tickets Report

<u>Report 1 - Provider Summary Report</u>

- This report shows Total count of each Trip Ticket Status for 3 categories like Currently Active Trip Tickets, New Claim Offers Received and New Claim Requests Submitted for Logged in Provider.
- 'From Date' is calculated based on the oldest non-completed ticket.
- 'To Date' is required to filter out tickets record.

Provider Summary Report

From Date * 01/16/2017 06:11 PM

To Date * 03/24/2017 12:00 PM

Filter Report

Currently Active Trip Tickets

Total New Trips	4
Approved(Awaiting result)	1
Available	2
Completed	0
Expired	1
Rescinded	0

New Claim Offers Received

Total new offers	3
Approved(Awaiting result)	2
Declined	1
Rescinded	0

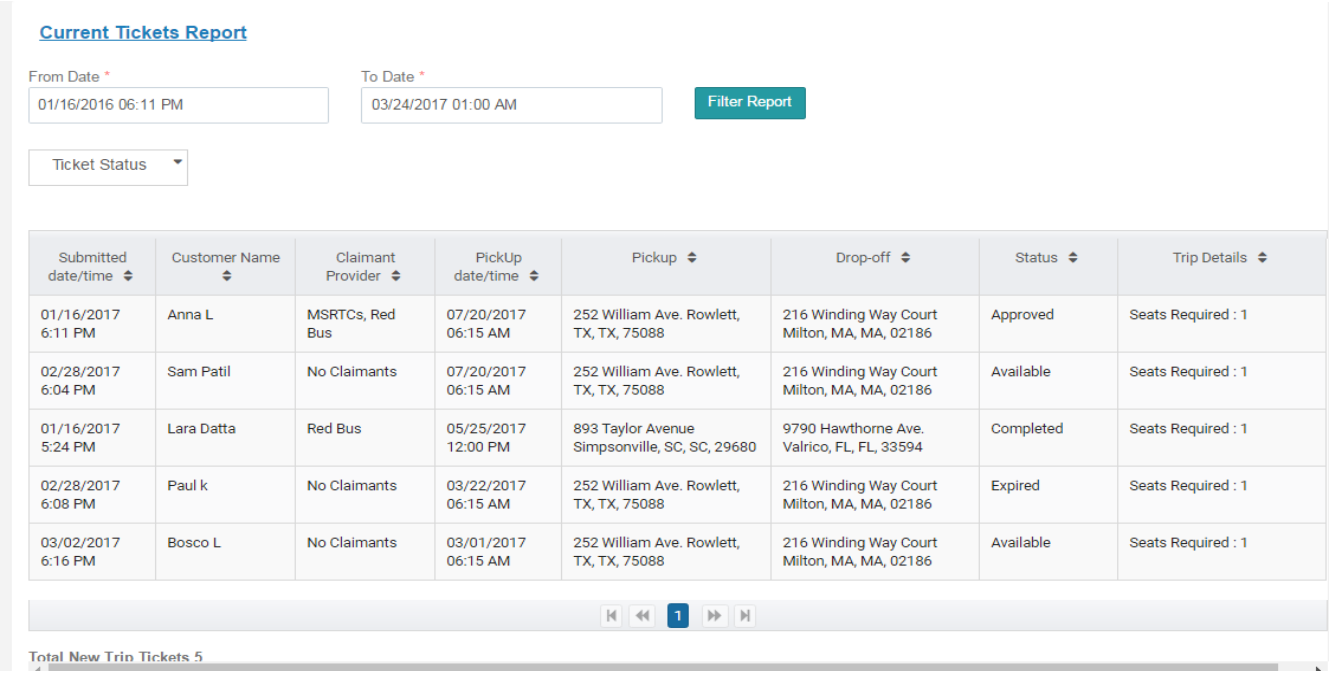
New Claim Requests Submitted

Total new requests	1
Approved(Awaiting result)	1
Declined	0
Rescinded	0

Report 2 - Current Tickets Report

- This report is generated based on the oldest non-completed ticket. With no filter, it will show all tickets for this provider, all tickets claimed by this provider, and all unclaimed tickets in the system. It will show completed tickets if the start of the date range is prior to a completed ticket's date. Completed tickets can only be shown if the user moves the date range to a date prior to the first non-completed ticket, it shows completed tickets if applicable.

- 'To Date' is required to filter out tickets record.



Current Tickets Report

From Date * 01/16/2016 06:11 PM

To Date * 03/24/2017 01:00 AM

Filter Report

Ticket Status

Submitted date/time	Customer Name	Claimant Provider	PickUp date/time	Pickup	Drop-off	Status	Trip Details
01/16/2017 6:11 PM	Anna L	MSRTCs, Red Bus	07/20/2017 06:15 AM	252 William Ave. Rowlett, TX, TX, 75088	216 Winding Way Court Milton, MA, MA, 02186	Approved	Seats Required : 1
02/28/2017 6:04 PM	Sam Patil	No Claimants	07/20/2017 06:15 AM	252 William Ave. Rowlett, TX, TX, 75088	216 Winding Way Court Milton, MA, MA, 02186	Available	Seats Required : 1
01/16/2017 5:24 PM	Lara Datta	Red Bus	05/25/2017 12:00 PM	893 Taylor Avenue Simpsonville, SC, SC, 29680	9790 Hawthorne Ave. Valrico, FL, FL, 33594	Completed	Seats Required : 1
02/28/2017 6:08 PM	Paul k	No Claimants	03/22/2017 06:15 AM	252 William Ave. Rowlett, TX, TX, 75088	216 Winding Way Court Milton, MA, MA, 02186	Expired	Seats Required : 1
03/02/2017 6:16 PM	Bosco L	No Claimants	03/01/2017 06:15 AM	252 William Ave. Rowlett, TX, TX, 75088	216 Winding Way Court Milton, MA, MA, 02186	Available	Seats Required : 1

1

Total New Trip Tickets 5

Appendix B: Message Set

Detailed information on the messages sent through the Trip Exchange between scheduling systems used by partner agencies.

This appears as Appendix A in the System Requirements Document.

Details on Messages: Functional and Data Requirements

General

The trip reservation request message is generated by a Requesting software system, which is requesting a collaborating system to take responsibility for scheduling and execution of a trip reservation request that the Requesting system cannot accommodate. The message from the requesting system must provide all data elements relevant to the external, collaborating system—referred to as the "scheduling system"—that the latter needs to be able to schedule the trip onto the vehicle resources that it controls. The primary data elements include the following:

- Trip ID (from originating system)
- Passenger identifier (name, etc.)
- Requested pickup or delivery date/time
- Pick-up location (address, geocode)
- Drop-off location (address, geocode)
- Wheelchair indicator
- Other device indicator (walker, etc.)
- Service animal indicator
- Attendant indicator
- Special needs notes
- Time window before—if the passenger can be picked up prior to the requested pickup time, this field will be populated with the value of how many minutes in advance of the requested time it will be feasible to pick-up the passenger.
- Time window after—the time window in the host system for the number of minutes after the requested PU time that the passenger is willing to be picked up, likely to be a system-defined parameter
- Maximum fee—the maximum fee that the originating organization is willing to pay to have this trip delivered. If this value is null, it means that the agency responsible for delivering the trip will use its pre-defined fee formula (e.g., $5 flag drop, $1.50 per mile) to generate the fee for the trip.
- Trip confirmation time—if this field is null, there is no requestor-specified time limit on when the trip needs to be scheduled and confirmed, although as a practical matter there will be a default system-specified value such as 1 hour prior to requested pickup time by which a provider must "claim" the trip. If there is a value in this field it means the trip must be confirmed by the provider organization to the requesting organization

prior to the trip confirmation time. After the trip confirmation time is reached, the host system can no longer change anything about the trip.

- Hub trip ID—the hub system will generate a unique identifier for each trip request, which will enable it to be tracked in both the originating system and the scheduling system which has assumed responsibility for the trip—provided by data hub.
- Date/time that the trip-scheduling request is being made—provided by data hub.

1. There are other data elements that are desirable but not essential to the functionality of the data exchange hub.
2. **Primary Messages**
3. Below is a description of the primary messages.
4. Pending trip requests
5. The pending trip requests message instructs the data hub to provide to the requesting software application a list of all trip reservation requests that remain open, i.e., have not been "claimed" by a service provider, subject to certain qualifying criteria as specified below. If no criteria are provided by the requesting application, all current open requests are provided. The data returned to the invoking application include all data elements specified in the trip reservation request message. There will be as many "records" in the message as there are pending trip requests.
6. The requesting system can filter the list of pending trip reservation requests returned to it by using one or more of the following criteria:

- Trip requestor (agency) ID
- Host system Trip ID
- Date range of trip reservation requests—this could be a single day
- Date range of when trip reservation requests were issued
- Hub Trip ID

7. Trip scheduling acceptance
8. The trip scheduling acceptance message is sent by an external software application to the data hub, and informs it that the trip scheduling request for the specified trip ID has been accepted by a specified transportation provider. This will change the trip status for the specified trip ID in the data hub's database. Note that with the one-way data communication paradigm, the host system, which "owns" the trip is responsible for sending a trip status message to the data hub to determine if a trip has been scheduled by a provider. The data elements contained in the trip scheduling acceptance message are the following:

- Hub Trip ID
- Host system Trip ID
- Trip Provider ID (organization that is providing the transportation)
- Trip Provider name
- Promised pickup date/time
- Pickup time window (number of minutes after promised pickup time that passenger may have to wait until actual pickup)
- Trip Provider Vehicle ID—optional, not required initially, provided prior to actual

pickup

- Trip fee—nullable, if value is null the trip fee will be based on fee formula for provider (which can be obtained via user interface in data hub)
- Trip confirmation flag—set to Null if no confirmation by trip requestor required, initially set to False if trip confirmation required as trip requestor will not have confirmed acceptance of trip by provider yet
- Notes

9. Trip confirmation
10. The trip confirmation message is sent by the trip requestor to the data hub confirming that they agree—or not—to a transportation provider assuming responsibility for delivery of one of their specific trips. If the response is positive, then the provider "owns" the trip from that point forward except in the case of a trip cancellation. If the response is negative, then the status of the requested trip is changed back to being available for another provider. Note that with the one-way data communication paradigm, the provider must use the trip status message to determine if a host system has confirmed the provider's "claim" on a trip. It is possible to configure the trip exchange so that trip confirmations are automatic, that is, there is no requirement that the trip "owner" approve a trip claim. It is also possible to create "trusted" relations among participants in the trip exchange and to restrict automated trip confirmations to such trusted partners, with other trip claims needing to be explicitly confirmed by the organization that "owns" the trip. The following data elements must be present in a trip confirmation message:

- Hub Trip ID
- Host system Trip ID
- Provider ID
- Trip confirmation flag—set to True if trip requestor accepts delivery of trip by provider ID associated with record, set to False if trip requestor does not wish to have trip delivered by provider ID claiming the trip
- Comments—any special messages from the trip requestor to the trip provider which are pertinent to the confirmation or denial of the latter's trip claim

11. Trip cancellation request
12. A message sent by the trip requestor to the data hub specifying that the trip identified is no longer to be performed, and any resources associated with performing the trip by the provider can be released. Trip cancellation requests are specific to individual trips; if all trips on a day are being cancelled, a message must be sent from the requestor to the data hub for every trip for that day. Note that with the one-way data communication paradigm, trip providers must use the trip status message to determine if a host system has cancelled any of the trips that they "own". The following data elements must be present in a trip cancellation message:

- Hub Trip ID
- Host system Trip ID
- Cancellation date/time
- Cancellation reason (a list of standard reasons for cancellations will be developed).
- Comments—any special comments about why the cancellation occurred.

13. Provider trip cancellation notice
14. There may be situations in which the trip provider is forced to cancel a trip request that they had previously agreed to serve. For example, if insufficient vehicles or drivers are available, or adverse weather limits the amount of service that can be provided on a day, then fewer trips can be served and some may need to be cancelled. In such a case, the trip provider can send a message to the data hub, where it will be available for the trip requestor, to inform the latter of the cancellation situation. All trip cancellation messages must reference the specific trip ID whose trip with this provider is being cancelled. Note that with the one-way data communication paradigm, trip requestors must use the trip status message to determine if a provider has cancelled any of the trips that they have previously claimed, or to otherwise determine the status of those trips. The following data elements are required in the message:

- Hub Trip ID
- Host System Trip ID
- Provider ID
- Cancellation date/time (the date/time when the provider generated the cancellation)
- Cancellation reason (a list of standard reasons for cancellations will be developed).
- Comments—any special comments about why the cancellation occurred

15. Trip completion/execution message
16. After trips have been executed, the trip provider must communicate back to the hub database the information about the actual trip logistics, which will then enable the trip requestor (originator) to have access to this data. A single message can contain many trip records, each of which must have the following required data elements:

- Hub Trip ID
- Host System Trip ID
- Provider ID
- Actual Pick-up location (address, geocode)
- Actual Drop-off location (address, geocode)
- Actual Pickup Time
- Actual Drop-off Time
- On-board distance
- On-board travel time
- Total number of passengers
- Wheelchair flag
- Other device flag
- Attendant flag
- Service animal flag
- Actual trip cost

- Notes

17. Trip status request

18. This is a message sent by any organization participating in the trip exchange to the data hub which requests the status of either a specific trip or a set of trips. The options for identifying trips include the following; one or multiple parameters can be specified in the message. The most restrictive subset will be generated if there are multiple parameters. For example, if both provider ID and a date range are provided in the message request, then the data returned will include only the trips for the specified provider for the days included within the date range. *This message type has not yet been implemented.*

- Hub Trip ID
- Host System Trip ID
- Provider ID—provides all scheduled, cancelled and completed trips for specified provider
- Date range—will provide a list of all trips for the specified date range and the status of each
- All Future—provides the status of all trips not yet performed (including current day trips)
- All Past—provides the status of all trips that have been performed (including current day trips)
- All—will provide the status of all trips in the system, both past trips and future trips

For each trip that is included in the set of trips returned by the data hub, the following data elements are present:

- Hub Trip ID
- Host System Trip ID
- Provider ID (may be null if trip not claimed for scheduling)
- Current trip status (pending, scheduled, confirmed, cancelled, completed, reported)
- Passenger identifier (name, etc.)
- Requested pickup or delivery date/time
- Pickup or delivery request type
- Actual pickup date/time (nullable)
- Actual drop off date/time (nullable)
- Pick-up location (address, geocode)
- Drop-off location (address, geocode)
- Wheelchair indicator
- Other device (walker, etc.) indicator
- Service animal indicator
- Attendant indicator
- Special needs notes

- Trip confirmation comments
- Trip cancellation comments
- Trip completion notes
- Trip reservation request date/time
- Trip scheduling date/time (nullable)
- Trip confirmation date/time (nullable)
- Trip cancellation date/time (nullable)
- Trip cancellation organization ID (requestor ID or provider ID, nullable)
- Trip cancellation organization role (requestor/provider, nullable)
- Trip completion date/time (nullable)
- Trip reported date/time (nullable)

Appendix C: Data Table

Contains various elements included in the exchange.

Table Name	Field Name	Data Type	Is NULL	Reference To	API field Name	CSV field Name	Comments		
tripticket	TripTicketID	int(11)	NO	Primary key	tripTicketId	No need in Adaptor	Auto generated column		
tripticket	RequesterProviderID	int(11)	NO	Provider table	requesterProviderId	provider	It will be filled based on login UserID OR If adaptor is returnig this field then we should have Provider table in sync for all providers		
tripticket	RequesterCustomerID	int(11)	NO	Third Party System I	requesterCustomerId	customer_id	Input from CSV		
tripticket	RequesterTripID	int(11)	NO	Third Party System I	requesterTripId	trip_id			
tripticket	CommonTripID	varchar(64)	YES	Unique Value	commonTripId	KM	Datatable will generate this unique ID. and pass it back to the requester as acknoledgement or auto sync.		
tripticket	ApprovedTripClaimID	int(11)	NO	Trip Claim table	approvedTripClaimId	No need in Adaptor	This filed will contain TripClaimID of Approved claimant provider by Orginating(Requester) provider		
tripticket	CustomerAddressID	int(11)	NO	Address table	customerAddress	customer_home_address_id			
address	AddressID	int(11)	NO	Primary key	addressId		Derived table		
address	ServiceArealD	int(11)	YES	Service Table	serviceAreaId		Added as per discussion in call		
address	HomeEdgeID	int(11)	YES		homeEdgeId	customer_home_edge_id	Input from CSV		
address	Street1	varchar(1000)	YES		street1	customer_home_address_1	Input from CSV		
address	Street2	varchar(255)	YES		street2	customer_home_address_2	Input from CSV		
address	City	varchar(100)	YES		city	customer_home_city	Input from CSV		
address	County	varchar(100)	YES		county	customer_home_county	Input from CSV		
address	State	varchar(100)	YES		state	customer_home_state	Input from CSV		
address	ZipCode	varchar(10)	YES		zipcode	customer_home_zip	Input from CSV		
address	GeometricPoint	point	YES			(customer_home_latitude, custome	Input from CSV		
address	CommonName	varchar(255)	YES		commonName	customer_home_common_name	Input from CSV		
address	PhoneNumber	varchar(20)	YES		phoneNumber	customer_home_telephone	Input from CSV		
address	PhoneExtension	varchar(10)	YES		phoneExtension	customer_home_telephone_extens	Input from CSV		
address	AddressType	varchar(20)	YES		addressType	customer_home_address_type	Input from CSV		
tripticket	CustomerInternalID	int(11)	YES		customerInternalId	customer_internal_id	Input from CSV		

Appendix D: Notification List

A list of notifications sent to providers identifying them of available trips and the change in status of trips.

From Table 3.3(a) in System Requirements Report. Version: 7-13-2017

1. **Partner creates a trip ticket** "A new trip ticket from [member name] for [date/time of trip] has been received by the Clearinghouse"	Hub sends to Requestor; this verifies receipt of trip request.	Near real time (less than five minutes)
2. **Partner updates a trip ticket** "[member name] has updated trip ticket [trip ticket number] for [date/time of trip]"	Requestor sends to Provider	Two-hour cut-off time prior to passenger pick-up.
3. **Claimed trip ticket rescinded** "Your claimed trip ticket [ticket number] for [date/time of trip] has been rescinded by [member name]"	Requestor sends to Provider	Through hub, the day before; day of requires a phone call. Consider provider procedures for day of changes.
4. **A trip your agency previously claimed but which was rescinded is again available.** "Trip ticket [original trip ticket number] that you previously claimed but was rescinded by [member name] due to trip logistic changes has been re-submitted as trip ticket [new trip ticket number] and is available exclusively to you to claim again until [date/time of expiration of exclusive claiming period]"	Requestor sends to Provider	Through hub, at least the day before. Any day of changes requires a phone call.
5. **Claimed trip ticket expired** "Your trip ticket [trip ticket number] submitted on [date/time of ticket submission] for a trip by [passenger name] on [date/time of trip] has expired without being claimed and is no longer active in the Clearinghouse"	Hub to Requester	The default will be 4 PM the business day before the trip. Each agency can decide when messages expire.
6. **New trip claim awaiting approval** "Trip ticket [trip ticket number] has been claimed by [member name] and requires your approval no later than [expiration date/time of approval period]"	Future. Hub to Requester	
7. **New trip claim auto-approved** "Trip ticket [trip ticket number] for trip by [passenger name] on [date/time of trip] has been claimed by [member name] and is automatically approved"	Hub to Provider	Automatic upon claim.
8. **Trip claim approved** "Your claim on trip ticket [trip ticket number] for [date/time of trip] has been approved by [member name]"	Future. Requester to Provider	

Appendix E: API list

A basic description of the various APIs that are used in the program.

Model Name	Request Type	RequestURL	Description
User	get	http://localhost:8081/clearinghouse/users	after hiting that API we can get the data from table for all the users
	getByID	FORMAT: http://{ipaddress}:{portno}/clearinghouse/users/{user id} http://localhost:8081/clearinghouse/users/25	
	Put	FORMAT http://{ipaddress}:{portno}/clearinghouse/users/{user id} http://localhost:8081/clearinghouse/users/25	when we need to update the data we can use .
	post	http://localhost:8081/clearinghouse/users	to add new user
	delete	FORMAT http://{ipaddress}:{portno}/clearinghouse/users/{user id} http://localhost:8081/clearinghouse/users/30	to deactivate the user
Provider	get	http://localhost:8081/clearinghouse/provider	to get all the providers from datbase
	getById	FORMAT http://{ipaddress}:{portno}/clearinghouse/provider/{provider id} http://localhost:8081/clearinghouse/provider/2	to get the specific provider information
	Put	FORMAT : http://{ipaddress}:{portno}/clearinghouse/provider/{provider id} http://localhost:8081/clearinghouse/provider/2	to to do particular changes in particular provider details
	post	http://localhost:8081/clearinghouse/provider/	to add new provider
	delete	FORMAT : http://{ipaddress}:{portno}/clearinghouse/provider/{provider id} http://localhost:8081/clearinghouse/provider/2	to deacticate the provider
Provider Partner	get	http://localhost:8081/clearinghouse/providerPartners	to get the all providerPartners