Mobility Services for All Americans

Northwest Denver Coordination Project

Concept of Operations

November 7, 2016

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I. Introduction

Overview

The Northwest Denver Metropolitan Area Coordination Project is built on prior coordination efforts. We seek to enhance the systems already developed so they function more automatically, a key for scalability and replication. We also seek to expand these systems to additional areas and new operators. To do so will necessitate addressing institutional issues as well as some technical ones.

This project is undertaken through a cooperative agreement with the U.S. Department of Transportation, the Federal Transit Administration, and the Federal Highway Administration. Colorado Department of Transportation is a partner in this project.

A key early step in the project is to assure that the stakeholders have a common understanding of project goals, the needs of all stakeholders, and what options are available to address those needs. This Concept of Operations document describes the project, lists the needs of the stakeholders and shortcomings of the current system, and identifies the selected approach to addressing technological issues. It will serve the project and stakeholders by documenting the consensus understanding and direction the project will pursue, documenting the quantitative and qualitative system characteristics to all participants.

Document Contents

This document is arranged as follows:

1. Introduction. Contains a general project description, including the purpose, audience, stakeholders, and boundaries. It also identifies the vision and goals for the project.

II. Current System. This chapter contains a detailed description of how the current services function, and identifies needs, shortcomings, and challenges.

III. Resources. This chapter provides a brief list of references.

IV. Operational Needs. This section provides a more in-depth look at expected outcomes, institutional issues, operating policies, and technology requirements.

V. System Description and Alternatives. Three topics are covered:

(1) A high level description of what the system will need to do to achieve the project goals.

(2) A description of alternative ways of meeting these needs from a technical perspective.

(3) An evaluation of how well each alternative addresses the needs.

VI. Operational Scenarios. This chapter describes functionality and flows of the selected alternative.

VII. Relationship to the National ITS Architecture. A brief description of how the project relates to the regional and national architecture.

Brief Project Description

This project will enhance the current coordination system used in Longmont, CO, using technology to take it to the next level, and expand it to more locations and more providers. The enhancements require some significant steps forward in technology, going from a system that works around the technology challenges to one that is designed for the functionality that is required to make the system scalable and replicable. The expansion to other providers requires that a wide range of institutional issues be addressed.

Audience and Stakeholders

The primary audience consists of providers participating in the project: Via, RTD, Seniors' Resource Center, and Broomfield Easy Ride. Another stakeholder, Denver Regional Access and Mobility Council (DRMAC) is developing a similar system that is focused on improving transportation for Veterans and addressing long-distance trips. DRMAC is an important part of the audience. We will work together as much as possible in developing systems that are compatible and take a uniform approach to business rules. Both the Northwest Metro Denver and DRMAC coordination projects have narrowly tailored and somewhat different approaches:

- The Northwest Denver Coordination Project is focused on coordinating Call-and-Ride trips with specialized transportation providers. These occur in relatively small geographic areas as illustrated in the next section.
- The DRMAC coordination project is focused on trips for Veterans and their families as well as the long distance trips that are a challenge for providers to operate as they can tie up a vehicle for several hours. DRMAC will work with a broader range of providers to meet the needs of the population of Veterans.

Process of Developing the Concept of Operations

After a kick-off meeting in November of 2015, the stakeholder committee began meeting on a monthly basis in January, 2016 build a common understanding of what could be accomplished in the project, to define project objectives, and identify issues and options.

During the planning stage, stakeholders analyzed the needs and shortcomings of their current system and examined the institutional and technological barriers of expanding the system to additional areas and providers.

This document summarizes the project objectives, clarifies the questions and needs the project design must address, and documents the consensus concept of operations.

II. Current System and Project Goals

This chapter describes in some detail the current system in order to build an understanding of what is needed to achieve project goals. It begins with a description of the Longmont Coordination model, its goals, and the boundaries or the Longmont services and proposed project expansion. It continues on to identify the technology and institutional agreements of the current system.

The reader is advised that because a current system is in place, this section goes directly to describing the parameters of the current technology as found in Section III of the outline for preparing a concept of operations plan. This Concept of Operations plan then takes the high-level system parameters and shortcomings of the current system to the next level, analyzing the alternatives available to address the needs and selecting a concept to address them.

Longmont Coordination Model Description and Vision

The vision of the initial coordination model in Longmont, Colorado 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 as appropriate on these services.
- Employ technology to support coordination.
- Develop a replicable model.

Productivity and ridership have increased, using technology and a mobility coordinator successfully. The current system can require a higher degree of manual intervention than is desirable for a replicable model.

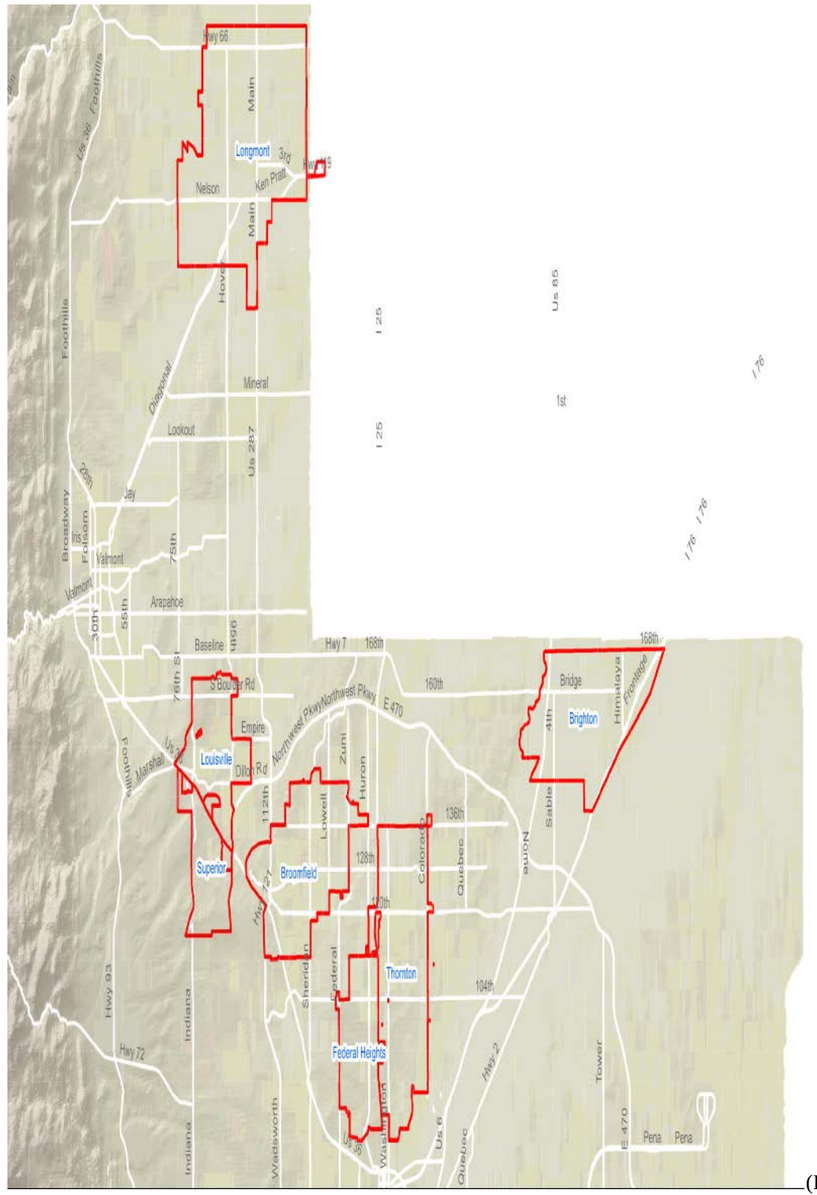
In Longmont, Via operates Call-and-Ride (CNR) service for RTD, and is available to operate Access-A-Ride (AAR) paratransit service. In addition, Via operates specialized transportation in Longmont.

System Boundaries

Figure 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 Seniors' Resource Center, and one in Broomfield. As we move to expand the coordination module, setting up protocols between each CNR and RTD will extend the project to SRC and City and County of Broomfield.

The technology solutions are focused on the CNR service areas. AAR services within the Via service area will also be able to utilize the outcomes, as Via is an AAR contractor. By developing

Figure 1: MSAA Project Boundaries



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a system that can adapt to any scheduling software system through a neutral hub and by adapting the interfaces for the mobile data tablets so the driver's manifests the coordination model has the ability to stretch beyond the CNR boundaries and to include other providers. However, at present the services and participating providers are purposefully narrow in order to promote a successful project. The project is limited to Via, RTD, SRC, and Broomfield Easy Ride as providers and focuses on CNR and the general services operated by each of the providers. Coordination with AAR will be ancillary rather than focused. No other human service providers are included in the project.

In the Longmont area, Via operates the CNR service, under contract to RTD. Via also operates their specialized transportation service and is one of the Access-a-Ride (AAR) providers. Thus, moving a passenger from AAR 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. For example, a key issue is getting paid for trips provided. At present, because Via holds contracts for both CNR and AAR vehicles they can get paid under one contract or the other. When the trip getting provided falls under Via's trademark service, there is no need to get paid: they would be operating the trip anyway. When a provider such as SRC provides a trip for an RTD service, payment for the trip will need to take place.

The Mechanics of the Trip Exchange

Via has two vehicles assigned for Longmont CNR service (Vehicles 6 and 7). Via identifies time blocks where demand was slack or where they are able to move trips to create slack. They use these hours for scheduling non-CNR trips as illustrated. Figure 2 provides an example of how the time blocks might break down. Via allocated time spans are orange and CNR timespans are blue. They vary significantly by vehicle and throughout the day.

Figure 2: Via Shares Slack Time on Two Vehicles – A Sample Day

CNR service is *the same as* Via's specialized transportation in that each operate as demand response services. In Longmont, both now operate in the same geographic area.

The CNR service is *different* from Via's specialized transportation service in that the CNR service transports the general public. No passenger data is required for eligibility: a person calls to arrange a trip and can ride assuming there is room on the vehicle and time to make the trip. On the specialized transportation service, as with the AAR services, a passenger must be deemed eligible prior to reserving a trip.

Via primarily uses RouteMatch (RM) scheduling software to schedule specialized transportation trips. RTD also uses RM scheduling software for AAR trips. For CNR service, RTD uses Mobility DR scheduling software. For the CNR service Via operates under contract for RTD, the MobilityDR system is used.

Customers typically call Via for specialized transportation or the CNR driver for CNR service. A separate number is used for customers arranging AAR service. If Via's specialized transportation service does not have an opening, then CNR schedules are checked as appropriate for the customer[1], service capacity and paying attention to limited resources. CNR customers book trips by calling direct to CNR drivers or via online or mobile self-service. If their trip is denied, they may call Via. Customers are savvy to calling both services.

The two shared Via vehicles have CNR mobile tablets and both RM and Mobility DR trips appear on the single MDR manifest. Via posts trips assigned to CNR to a phantom vehicle so that they can keep track of it in-house on the RouteMatch system. This extra step is an example of something that needs to be addressed to make the system scalable.

Via's Mobility Coordinator has the ability to view both the Via and CNR manifests. On a daily basis the coordinator will rearrange vehicle tours by swapping trips between the two services to more efficiently use capacity—thus avoiding duplication and carrying a customer who may not otherwise have been served. The Mobility Coordinator uses the CNR Agent Booking feature, essentially logging online as the customer to book their trip. The coordinator also books AAR requests on Via RouteMatch, but not yet on CNR. Trips booked this way are flagged for reporting.

Figure 3 illustrates how the existing trip data exchange works for shared vehicles. Here is how the Via RM trips are inserted into CNR tablet. Follow the dark blue arrows in Figure 3:

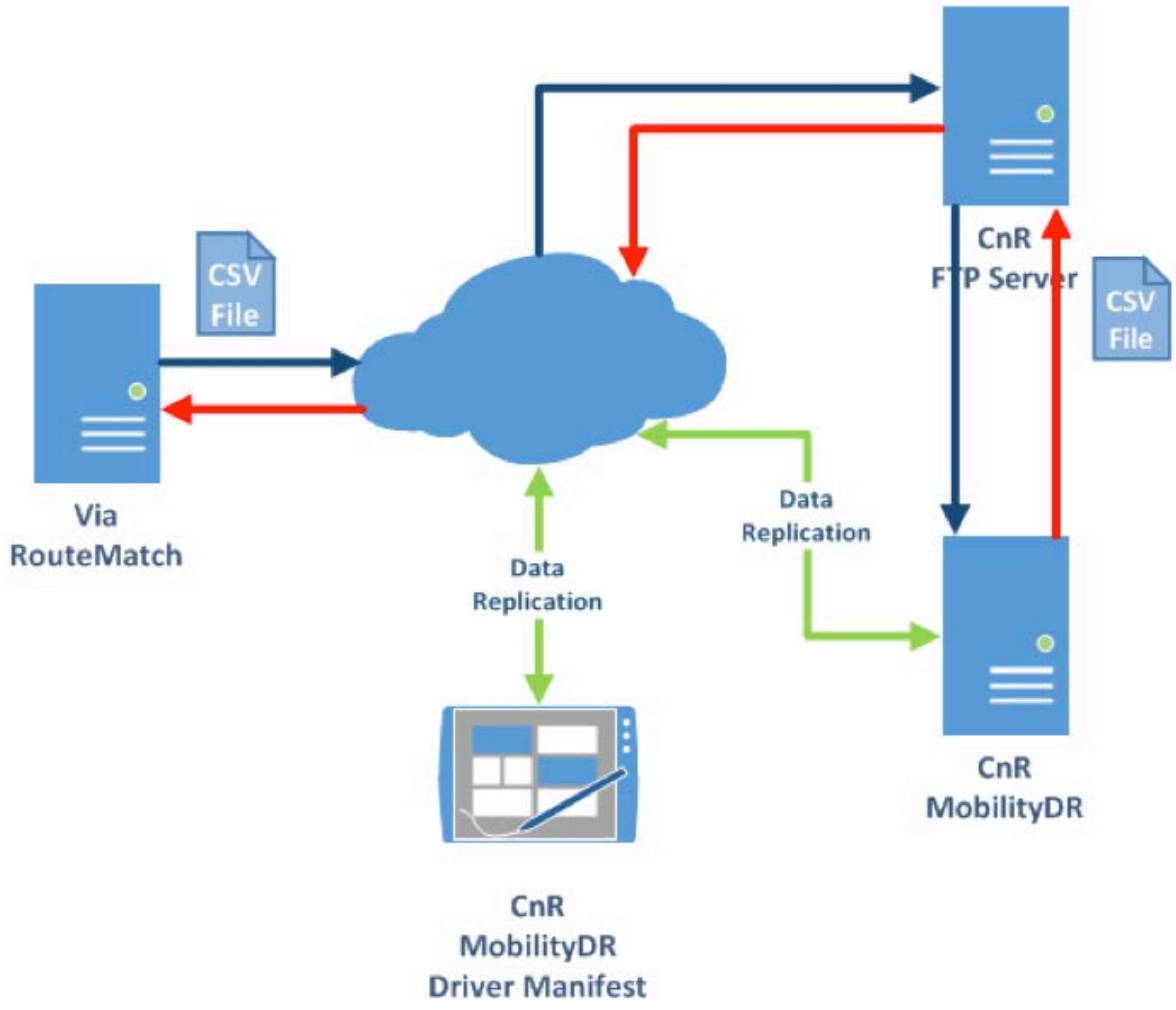
- Route Match posts a file to the RTD FTP site every 5 minutes with the current trips assigned to Via vehicles 6 and 7.
- Every 5 minutes MobilityDR checks the FTP site for the latest file from RouteMatch.
- MobilityDR determines if there are any new or cancelled trips or trip changes in the file.
- If there are changes, vehicles 6 or 7 are notified to perform replication (green arrows) with the database server.
- All trips are replicated on the MobilityDR manifest and displayed to the driver.

[1] A small list of clients that are not appropriate for CNR service is maintained (e.g., due to boarding time) and if Via service is not available for these few riders, then the trip is denied.

Then completed trip data are sent back to Via:

- A driver starts/ends/no-shows a trip using the CNR MobilityDR manifest you see at the bottom of diagram.
- As trips are updated, changes are replicated to the MobilityDR database server, the green arrows.
- At the end of the day MobilityDR creates a CSV file of all coordination trips executed that day, the red arrows.
- RouteMatch picks up that file and updates its database with the completed trips details from MobilityDR.
- RM places about 18 and CNR about 22 of the total 40 boardings per day on the 2 shared vehicles.

Figure 3: Via Shared Vehicles Trip Data Exchange

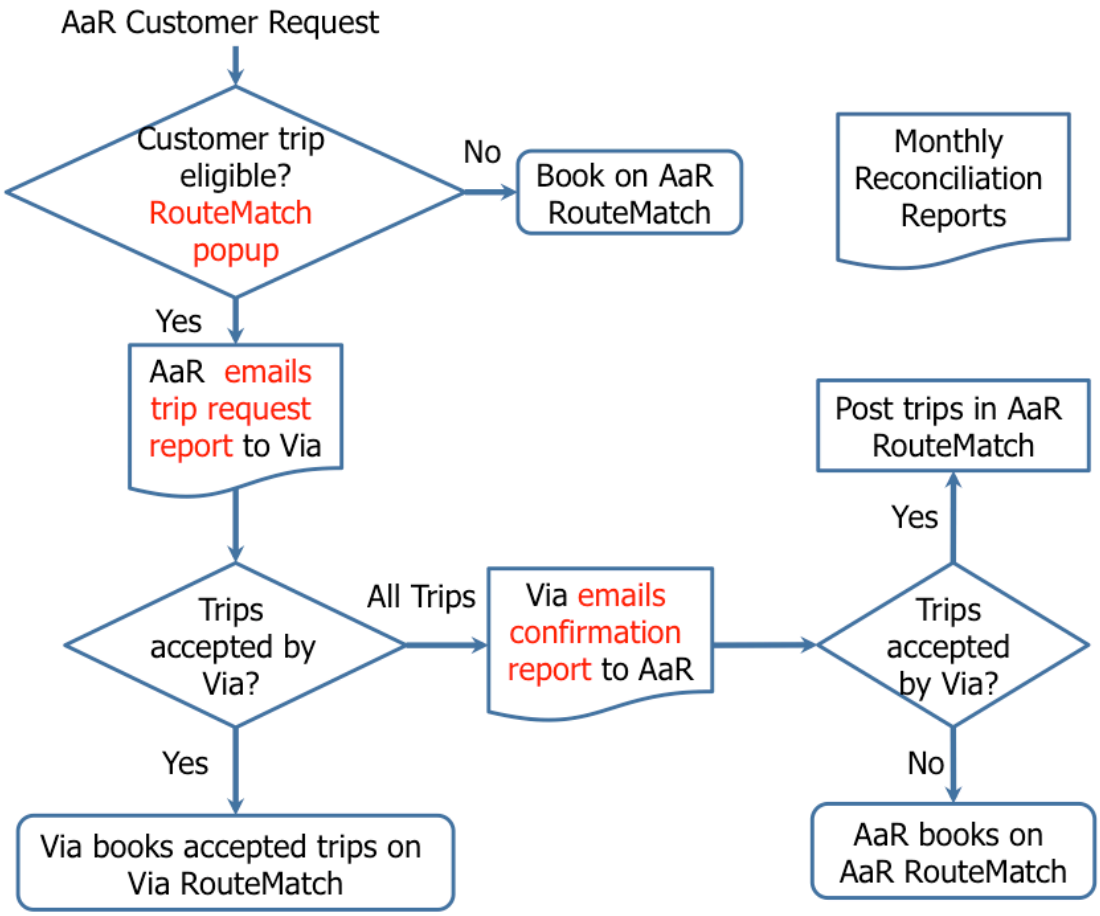


The RTD AAR system also sends trips to Via for trips in Longmont to save money. Figure 4 illustrates the parallel process for the exchange of trips between AAR and Via.

- An RTD Access-a-Ride customer makes a request for service.
- If the AAR trip is within the Longmont area & schedule, RouteMatch automatically pops up a screen for the reservationist to ask if the customer is willing to make the trip on Via.
- If yes, AAR saves the trip to a file and emails all the day's trip requests in a report to Via at 13:00.
- Via books acceptable trips on Via RouteMatch.
- Then Via emails trips they can schedule and those they can't to AAR by 15:00.
- Trips Via does not confirm are then booked on AAR.
- Trips that Via booked are posted to a separate AAR file.
- Trips are reconciled in monthly reports.]

The complexity of these systems, level of manual intervention, and processes required to work around the lack of electronic communication are barriers to scalability and replication.

Figure 4: RTD AAR – Via Trip Exchange



User Needs

Stakeholders identified the user needs in a series of meetings, some of which occurred prior to submitting the original grant application. The group working on the Longmont Coordination Model has continued to meet and identify how to improve and develop the model so it can be replicable and scalable. The following user needs were identified.

INSTITUTIONAL AND FUNCTIONAL NEEDS

In the current system, a variety of institutional and functional barriers were identified which will *need* to be resolved. While most have been addressed for Longmont, they also remain pertinent as the system is expanded to additional areas and providers. The issues and response in Longmont follow:

- Service area boundaries were different so we conferred and made them the same.
- CNR general public versus Via human services clients. 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 after.
- CNR curb to curb versus Via door to/through door, driver assisted. We made all services door to door to serve customers as needed.
- Boarding time: CNR 2 min. versus Via 5-7 min. A customer's extra boarding time is recorded as part of the customer profile, so trip scheduling uses these when necessary instead of defaults.
- Similar, but different vehicles and drivers. Customers simply got used to expecting different color vehicles and drivers.
- Seat belts, child seats: CNR none versus Via mandatory. Seat belts were installed on all vehicles, but child seats are still an issue to be resolved.
- Fares: CNR Local bus versus Via fares or donation. Customers are told the fares for each service and are expected to pay that fare regardless of how they are booked. However, drivers are lenient.
- Funding sources & accountability. Issues about funding sources and accountability have yet to be raised, so not yet a barrier. However, RTD CNR is not paying Via for use of their shared vehicles as yet. RTD AaR has just negotiated a payment of $15 per trip with Via and this saves AaR about $15 per trip. Both services benefit!

TECHNOLOGICAL NEEDS

The current Longmont system is increasing productivity and reducing costs, allowing resources to be used to provide more rides to more people. This MSAA project responds to the limits of the current system and the requirements for the coordination system to be scalable.

- The current system is complex (as described in the previous section and does not lend itself to scaling up or replication. It has been cobbled together as a one-off system, and users

need a system that electronically exchanges trips through a hub, based on a set of pre-determined business rules.

- The level of manual intervention is high. In order to scale the system up to other areas, there is a *need* to electronically exchange trips with only limited manual intervention. By this it is meant that:
    - The provider will still have the opportunity to accept or reject a trip, but only a simple mouse click or automated transaction will accomplish the work of transferring the trip.
    - There will be far fewer exceptions or "bounce-backs" that require the mobility coordinator's time to enter them into the system.
- One goal is to enable Via or any service provider to have a single tablet in their vehicles and have this tablet show the driver's full manifest of all trips.

This project will improve the efficiency of vehicle routing and scheduling, providing full tracking and reporting capabilities. A focus of this project is to extend a proven concept so that it will be both replicable and scalable. To do so requires that both technical hurdles and institutional issues be addressed as described later in this document.

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, enabling providers to use resources more effectively, providing 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.

Goals and Objectives

The primary goal of the Longmont Coordination Model remains pertinent for this project and is listed as the first goal. The remaining goals reflect the focus of this project to expand the project to other areas and other providers.

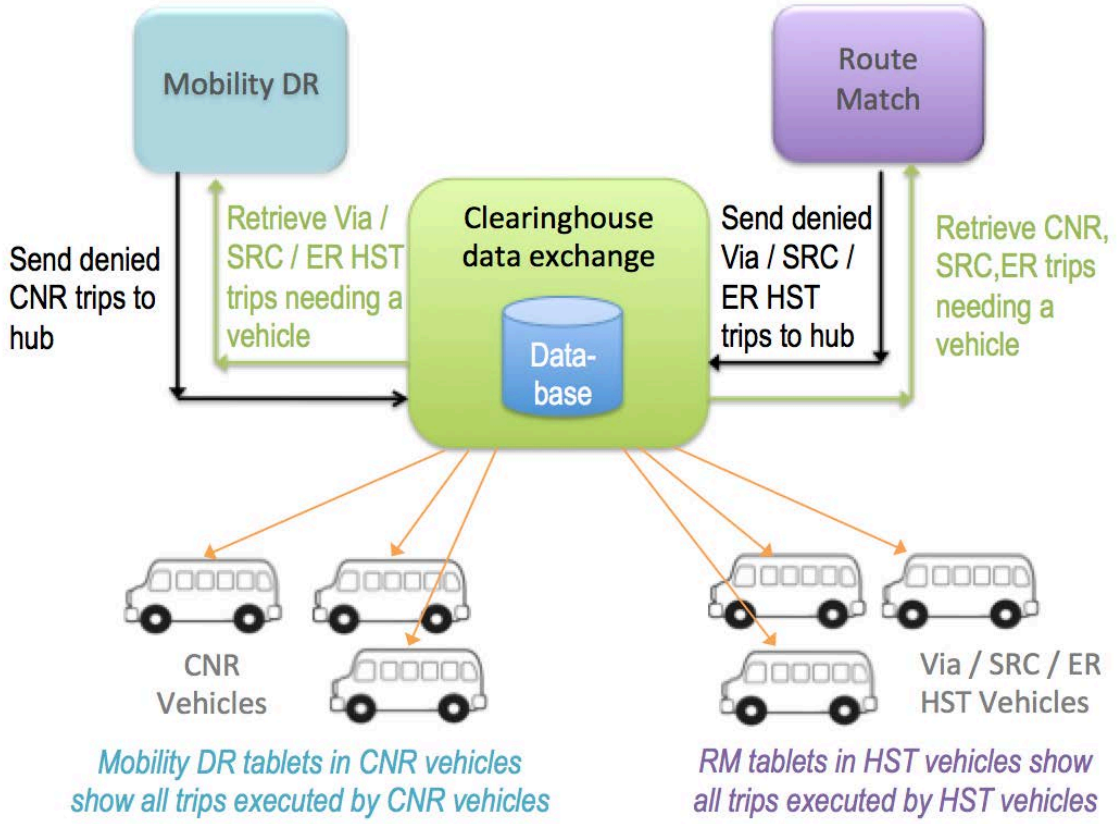
1. Coordinate independent paratransit services to improve ridership and productivity and reduce duplication.
2. Identify how to extend the project to the following CNR areas: Louisville, Brighton, Northglenn, Federal Heights, Broomfield, Thornton, Superior, and Interlocken involving Seniors' Resource Center and City and County of Broomfield as additional transportation providers.
3. Through technology, provide a high level of automated exchange of data and reduce the amount of manual intervention required.
    a. Develop a means to automate the exchange of trip data so it is feasible to scale the project up to other areas.

   b. 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.
   c. Develop a means to automatically have data show on a single mobile data terminal (the RouteMatch tablet), so drivers work from a unified manifest.
   d. Address the functional requirements of all stages of the provision of service, including trip data, confirmation and tracking, reporting, and billing.
4. Work with partner agencies to address the institutional and operational barriers so the project can be successfully expanded.
   a. Work through the operational and back-office issues related to shared trips.

RTD, Via, and SRC have scheduling software in place that contains all the necessary functionalities for reserving trips, scheduling, dispatching, fare payment and management, tracking, and invoicing trips. The City and County of Broomfield Easy Ride service is in the process of acquiring such software. This project is focused on connecting varied software systems, enabling them to work cohesively to efficiently deliver rides.

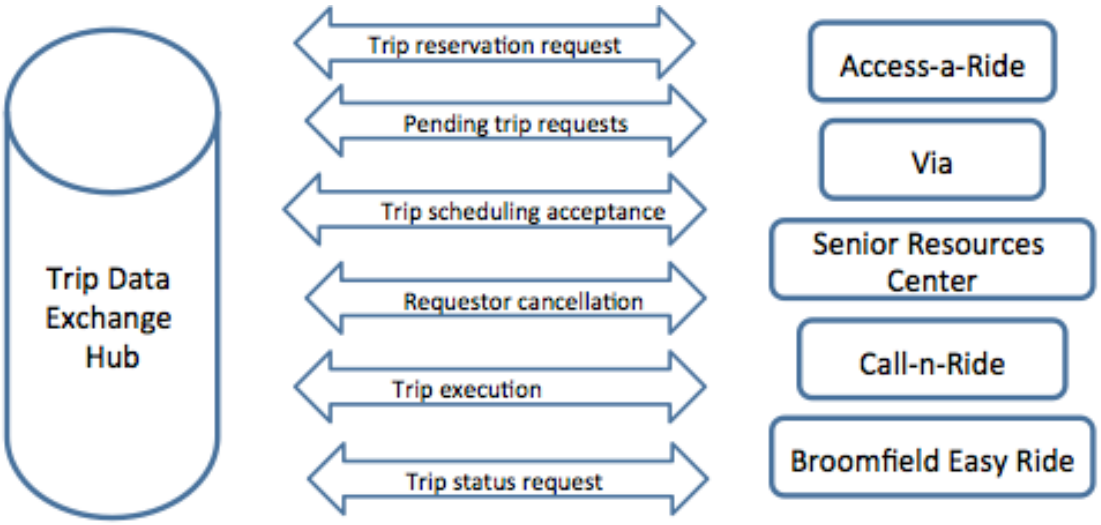
This MSAA project will address institutional, technical, sustainability and scaling problems, establish business rules that will be consistent across all stakeholders, and develop a set of web-based interfaces and messages that can be sent through a web-based data exchange hub as depicted in Figure 5. It will result in a system that is scalable and can be replicated in other systems across the nation.

Figure 5: Schematic of Northwest Denver MSAA Project



A data hub in the envisioned system will store trips that can be exchanged among the five independent service providers (shown on the right in Figure 6). The MSAA project will focus on the six CNR service areas where two or more of these providers overlap. The arrows in the middle represent web interfaces and messages that allow the providers scheduling systems to exchange trips with each other through the data hub.

Figure 6: Data Exchange Hub


Trip Data Exchange Hub
Trip reservation request
Pending trip requests
Trip scheduling acceptance
Requestor cancellation
Trip execution
Trip status request
Access-a-Ride
Via
Senior Resources Center
Call-n-Ride
Broomfield Easy Ride

III. References

The work completed for the Longmont Coordination model is the backbone of this expansion project. This includes the internal documents, meeting notes from working group meetings, and system enhancements made by both RouteMatch and DemandTrans Solutions.

Other resources include:

1. Transit Cooperative Research Program Web Document 62: Data Standards for Mobility Management, 2014. http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_w62.pdf

2. The SUTI Standards, or "Standardisorat Utbyte av Trafikinformation". This is a set of standards developed in Sweden and in use in the Scandinavian countries for the "Dynamic Resource Allocation" of many transport providers. The SUTI Standards are published in English, and the documents "SUTI Messages", "SUTI Message Flow", and "SUTI Case Studies" will all serve as reference material in this project.

3. Documents from Kevin Chambers of Ride Connection in Portland OR that are posted:

- Background documents on the Ride Connection Clearinghouse project, developed in association with Panoptic Development:

  https://drive.google.com/open?id=0B-1RgO-4FC4yOTNVRHR2dTlISDg

- Code for Ride Connections Clearinghouse project:
  https://github.com/rideconnection/clearinghouse

  https://github.com/rideconnection/clearinghouse-adapter

The reader is directed to Appendix B where one of the key background documents is included.

4 Transportation Coordination Systems Advisor Project - Final Report; March, 2013; Prepared by Nelson-Nygaard for Denver Regional Mobility and Access Council.

5. Regional Intelligent Transportation Systems Architecture for the Denver Regional Area, November, 2007; Prepared by URS Corporation for Colorado Department of Transportation, in association with Denver Regional Council of Governments. Note that the plan is currently being updated and a new version will be released in the near future.

IV. Operational Needs

This section defines the outcomes, policies and issues that will be addressed by the project to in extending the coordination model to additional CNR areas. The resulting system will complement and improve the operations of the existing Via, RTD, SRC, and Broomfield Easy Ride transportation services in the project boundaries.

The generic system's operational needs are enumerated in this chapter.

Outcomes

Stakeholder outcomes are listed in the goals and objectives, with the over-arching objective being improved coordination of existing services. Through technology, the stakeholders wish to provide a high level of automated exchange of data and reduce the amount of manual intervention required, enabling the Longmont Coordination Model to be replicated and scaled up to cover other areas.

Key activities in this process are:

- The automatic exchange of passenger trip data to minimize the amount of manual intervention and improve the accuracy of the data streams.
- Addressing institutional issues such as establishing contract agreements that allow for the smooth exchange of both passengers and trip costs.
- Addressing business rules to allow for the smooth and seamless delivery of service to passengers.
- Providing for all data to flow to a single mobile data terminal to improve the operations of services for all providers.

The needs related to these activities are listed below.

Technology Requirements Related to Needs

1. A data exchange hub is needed to allow information to flow between providers, enabling providers to easily shift trips from vehicles assigned to one program to another (e.g. specialized service, CNR, AAR). This is new software that will be web-based, so a web-based service will need to be paid for as part of the project implementation.
2. The data exchange hub will include a database that stores the relevant information about all trips that are submitted to the data exchange.
3. The following functionalities are needed in the data exchange hub, and as described in detail in Appendix A:
    a. **Trip Life Cycle –** Data supports the trip from inception to completion; host systems can share and view all relevant data about the trip
    b. **Automated Message Exchange -** provides for automatic exchange of data through a hub that has the ability to store data for the duration of the trip cycle.

c. **User Interfaces –** for determining status of system and rides, allowing providers to determine the status of all stages of the provision of service, including trip data, confirmation and tracking, reporting, and billing.

d. **Message Types and Data Elements** - supports necessary data exchange among all the host software systems responsible for originating or performing trips.

4. Need 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 requires that RouteMatch and Mobility DR scheduling systems be adapted so they are each able to produce and consume data streams.
5. Automatically having data show on a single mobile data terminal (the RouteMatch tablet), so drivers work from a unified manifest is a desired outcome. This requires that RouteMatch develop a software interface that would provide the functions that Via now completes through its reservations and dispatch procedures. The Mobility DR tablet already has this capability.
6. Item 5 will result on no longer needing to use the CNR tablets for Mobility DR software on the CNRs operated by Via.
7. Participants will each need to have scheduling software in place. At present the City and County of Broomfield does not but they are in the process of purchasing such software.

Institutional Issues

Key institutional issues involve:

1. What contractual agreements are needed between participants to assure quality standards are met, expectations are clearly stated, and processes are in place so the process is smooth and can be sustained.
2. Agreement on costs and fares credits.
3. Billing procedures and arrangements.

Operational Issues

A variety of operational issues have been identified in the planning stage. While these will be explored in more detail as the process unfolds, at this point they do not impact the decision on the primary approach to technology. However, many of them will impact the message sets and data necessary to transfer trips between systems.

1. The MSAA project participants will need to discuss and refine the exchange functions and develop standards and rules to manage expectations for the proper execution of all elements. The following are among the factors that should be considered. This is only a partial list, as others will become manifest as more detailed requirements are generated. What is the latest time (hours) before the scheduled trip pickup that a requesting agency can request the trip's cancellation? System default or by agency? What is the expected fee consequence?
2. What is earliest advance time—days/hours before the scheduled pickup—that a trip can

be entered on the exchange? What is the latest advance time—days from today— that a trip pickup may be entered in the hub? System default or by agency?

3. No trip subscriptions at this time (except as converted to individual trips).
4. Matching trip requestor requirements to trip provider qualifications. Set up a table on the hub data exchange of characteristics that are flagged and which can be matched by the exchange, for example: attendant, boarding time, door-to/through-door, wheelchair/assistive device, etc.
5. Some agencies may only be willing to use specified other agencies as providers of their trips, and these restrictions must be accommodated.
6. Service provider trip fees: Will it be a formula or table? An agreement for payment will be needed.
7. User fares/fees, how are they charged and how are they credited to the agency responsible for the trip?
8. Different fare/fee structures—including full private pay—for different programs and service providers.
9. Can any Medicaid transportation be facilitated via the trip exchange, given the restrictions on sub-contracting applied to qualified providers?
10. What are the exchange system hosting requirements? Can Via host the data exchange hub?
11. What reports and filters are essential to support agency operations and funding requirements?
12. Discuss individual agency expectations and procedures for trip acceptance and confirmation.
13. Discuss individual agency expectations for how their host system will interface with the data exchange hub for exchanging messages. This is largely the responsibility of the host software, but it is important to identify how it will be accomplished.

V. Proposed System Needs

This chapter provides a description of specifically what the system needs to address from a technology and operational perspective in order to achieve the stated goals.

Technology

As part of the development of the concept of operations, the stakeholders developed a list of the ~~functional requirements~~ system needs to enable trip data to be exchanged among the five providers. The working document is included in Appendix A while the needs are summarized in this section so that alternative means of meeting the needs can be evaluated.

Three basic concepts have been identified for consideration:

- A purpose-built data exchange hub
- Work with the Denver Regional Mobility and Access Council (DRMAC) to use the data exchange hub they are developing for long-distance trips.
- Build upon the work developed by Ride Connection, using open source software in a program that enables providers to exchange data.

This section describes the needs that must be met by the data exchange hub. Figure X illustrates the concept of the data exchange hub.

Operations

The provider agencies have identified the following items that the data exchange hub needs to be capable of the following items in order to meet their operating, reporting, quality control, and management needs.

Trip Lifecycle: The data exchange needs to 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. This is critical for maintaining quality control over the passenger trip, assuring that all trips are delivered as promised, within the time window, with the appropriate vehicle, and as efficiently as possible. 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 providers need the system to offer automated exchange of data so that as little staff time as possible is used for each transaction. This means a set of messages will be needed to enable the host systems to exchange data relevant to the scheduling and delivery of passenger trips.

User Interfaces: The system needs to have user interfaces so that individuals in participating agencies—and the organization responsible for operating the data exchange—can determine the "state of the system", including individual trips.

Message Types and Data Elements: The stakeholders have identified the message sets that will be needed to exchange trip information automatically. The essential types of messages that must be exchanged by the collaborating host systems (at a minimum) are listed here.

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

These host paratransit software systems need to have access to all of the relevant data about a given trip, even when the needed data originates in the other system. Standard data definitions or a translator will be needed to assure that data can be read among different provider systems. The agencies participating in this project use the following systems, so communication will be needed among them:

- Via: RouteMatch server based
- RTD Call-n-Ride: Mobility DR
- Seniors' Resource Center: RouteMatch server based
- Broomfield Easy Ride: RouteMatch cloud-based

The data exchange hub and the need to automatically move information between the software systems remains the foundation of the project. It is important to note that additional development will be needed to adapt the software scheduling systems to consume and produce this data and to provide interfaces with the mobile data terminals.

VI. Operational Scenarios

Overview

This chapter summarizes the operational scenarios that are anticipated, building from information contained in prior chapters. This will enable us to develop a deeper understanding of how the proposed system will operate. We begin by describing several functions and how they occur today in Longmont. Remember that this is the existing system and Via operates all services that are involved in the Longmont coordination model.

Chapter II explained the mechanics of the Longmont Coordination model. This model, while it works, was designed based on the existing capabilities of the scheduling systems. To be able to replicate the system, it will be necessary to automate as much of the process of exchanging information as possible. At present a full-time staff person is needed to manage the coordination of trips in one CNR service area. In order to extend this to additional areas without hiring additional staff a data exchange hub is needed to automatically exchange data regarding passenger trips. A data exchange hub will reduce the work involved with various manual processes (such as manually addressing trips). Combining all information on a single mobile data terminal would enable Dispatchers and Reservationists to work from a single screen and could eliminate the need for two tablets in the coordination vehicles. The staff time for these required manual processes offsets the savings resulting from more effective use of the vehicles. SRC and Broomfield Easy Ride do not have a staff person who could dedicate time to this.

The operating scenarios described in this chapter are the current scenario and a proposed scenario that includes a data exchange hub and adaptation of software to enable all information to be shown on the single mobile data terminal (tablet) for each scheduling system. The various modes of operation (such as maintenance mode or degraded mode will be handled as they are at present. In general, if there are problems in the systems caused by weather, driver shortage, or other incidents, trips would not be exchanged and providers would revert to a manual mode with telephone calls to address trips that have been accepted by an agency but which the agency may be unable to operate. Once an agency accepts a trip, it is their responsibility to notify the owner of the trip if problems occur that are outside the control of the agency now responsible for providing the trip. The objective of these protocols is to assure all passengers are served and if this is not possible, that they are notified in advance. The most anticipated issue is snow, and when agencies need to shut down, all agencies will be affected. If it appears there may be problems, agencies may pre-emptively cancel trips so no one is stranded or may prioritize critical trips such as dialysis.

For these operating scenarios the stakeholders are: Via Mobility Services, RTD Call-n-Ride services, Seniors' Resource Center, and Broomfield Easy Ride program. Only the first two agencies participate in the current system.

Current System

The current system for Longmont has evolved as the bugs have been worked out and clean data streams have been developed. Today, the Mobility Coordinator and dispatchers work on manually scheduling trips and in keeping data clean throughout the data processes.

- The Mobility Coordinator and dispatchers work with trips in the LIVE or "day-of" as well as future trips environments. Agents input trip requests through the Agent Booking system and RM in appropriate manner to get them onto CNR system. Mobility Coordinator and dispatcher watch schedules closely to ensure trips are completed on time and there are no errors in import/export processes in need of manual intervention (Failed Trips are a particular issue between services because they are, by system-design, manual trips).
- When things are not going as planned (Agent Booking pops off line, import/export fails, there are questions re how to input a trip, an address needs to be Geocoded in RTD's system, information does not get properly changed in RM once a trip is accepted in Agent Booking, etc.), the Mobility Coordinator works with dispatcher and reservationists to address such issues: keep things clean during data processes, and cleans up when things go wrong (or there were tech or human errors in data flow).

In addition, there is the task of installing upgrades and enhancements. This might include upgrading the Mobility DR system, devices, etc. as needed to address loopholes or other system or technological issues that arise. The Mobility Coordinator is also involved in cross-service negotiations of many kinds between RTD, DT, RM, CNR in order to address ongoing issues (mapping, hardware, training, reporting, customer satisfaction, etc. Additionally Mobility Coordinator works with driver competency measurements and retraining (this includes drivers for both Via and CNR) as well as reservationist training and retraining as necessary.

Initially there was substantial manual data input for the CNR trips. Over time, various minor improvements have been made and procedures have been established to ensure the data stream is clean. Today there are 5-20 trips a day (out of 40) that need attending in some way. The time it takes to respond to these trips with thorough follow-through could take up to two hours. Each of these requires research, follow up to clean the data trail (adjustment of notes, call made to clients or organizations, talking to Drivers, Driver Supervisor, working with Reservationists, working in the system (RM and Mobility DR systems) all to fine-tune what in data flow would potentially run smoothly with a Hub.

With AAR trips there are 5-20 requests daily and it takes approximately 0.5 to 1.5 hours to get them input into the system and scheduled (collaborating with Scheduling). Via and RouteMatch have recently taken steps to improve the time required to complete these tasks by creating a "Funding Source" in RM to track the AAR trips and pull reports monthly regarding trip counts. This replaces the more manual data collection originally done to track numbers on an Excel spreadsheet. The trips exchanged in day-of scenarios can still take 0.5 to 1.5 hours, but there is less data entry required than before.

However, in addition to ridership counts, an easy way is still needed to extract Rider ID, pick-up/drop-off mileage, times and addresses, fare info, guest information and guest fare information, and PCA data Via currently simply does not track that detailed information but a data exchange hub would greatly assist in clean data exchange and all aspects of reporting needs. Even if the entire AAR booking processes are not automated, this is a way in which the data exchange hub would greatly assist with AAR process.

Comparison with Proposed System

The core of the proposed system is automatically exchanging data between services that use different scheduling software. This will greatly reduce the amount of manual intervention required as noted in Table 2. The agency operating the service will still have to manually accept a trip, ideally through a single click of the mouse. This could fit within the normal flow of scheduling and dispatch activities.

Table 2: Current and Proposed Functions for Via MSAA Project

Item	Current System	Once the Hub is in Place / Proposed System
Reservations/ Mobility Coordinator/ Scheduling	Overflow on Longmont CNR Service: Rider calls CNR and finds service cannot accommodate the trip. Rider then calls Via to schedule on Via service. If they can be accommodated, the rider is scheduled through RM software. This request could end up on either a Via vehicle (regular route) *OR* a Via or CNR coordination vehicle Via Riders on CNR Rider calls Via and reservationist cannot place rider on Via service. This trip is marked a Denial in Via's system and a reservationist sees if CNR has room to schedule individual (this is done in Agent Booking) If yes, Via schedules rider on CNR using Agent Booking (online scheduling software linking to CNR system).	The premise regarding the Hub is that it would streamline all of the systems articulated under "Current System". Those processes are not yet defined but the desired outcomes are significantly less manual steps involved in input and scheduling of trips. • *Example: Rider could call CNR, find service cannot accommodate their request and that request that was input into CNR system would immediately be batched through the data exchange hub, alleviating the step of the caller calling into Via call center.* In the Via call center, a similar method would be employed as is now used with the Reservationist / Mobility Coordinator inputting data through an interface. But, with the data exchange in place that information could be batched to any number of different services to scan for availability. (As the system is expanded this might include additional providers.) This would greatly increase the likelihood of trip completion. If that data is automatically sent to varied providers the amount of manual input/export required would be reduced and errors would also be reduced.
Dispatch / Mobility Coordinator/ Delivery	Via dispatches and delivers CNR trips through the RM system, displaying the trip (by import/export processes) on the drivers' manifest (CNR Tablet). Mobility DR runs updates regarding trip changes or cancellations (in the file). Updated information is reflected on the driver's manifests in the live environment. A driver starts/ends/no-shows a trip using the CNR MobilityDR manifest. Notes are not included, so when there is a specific note related to the trip, this must also be entered manually. Failed trips (where the passenger is told their trip was accepted but in reality there is not time in the schedule to complete the trip) in CNR result in day-of manual intervention.	Less manual intervention by Mobility Coordinator and Dispatch will be require in the day-of or live environment. The way that various aspects of the current coordination model work with details (notes, changes applied to system in day-of environment, in-service vs. out of service times, issues with synching data, etc.) often result in issues between systems. • *For example, a driver might have to Quick Board a client when the trip can actually be completed due to how the database has broken down the in-service vs. out of service times.* Based on the experience in Longmont, the data exchange hub can be built to support what the history of the program has shown is needed. Currently Dispatch/Mobility Coordinator looks at a secondary manifest (not a RM manifest) to track day-of happenings between services. In the single-tablet solution, we would ideally be able to look at and track all data on the RM database, eliminating having to switch between screens. Failed Trips in CNR process remain an issue and investigation of possible solutions is warranted.

Item	Current System	Once the Hub is in Place / Proposed System
Reporting	MobilityDR creates an export file (CSV) each night that is uploaded to the FTP site with the current day's trip information. Route Match picks up the file and updates its database with the completed trips details from MobilityDR. Trips are reconciled in monthly reports, currently a time-consuming manual process, completed by the Mobility Coordinator. She goes into the system and reconciles swapped out vehicles, has to hunt down where trips were completed and enter/adjust trip data manually. Was it a route split on two different vehicles? Are there any vehicle trips that need to be deleted due to the standard vehicle being re-assigned? This manual effort has to do with the way the technology is currently set-up for Longmont Coordination.	The data exchange hub will be able to import and export reporting data that designates the service responsible for the trip, the system delivering the trip, and related cost and fare information. This will greatly simplify the reporting process and enable the simple generation of invoices and reports each month.
Payment	Both services are operated by Via, so no exchange of money is in place.	The fare and cost information will be built into the data exchange hub. This is critical to expanding to SRC and Broomfield as well as to other users in the future. The desired outcome is to be able to coordination with services not operated by Via.

OTHER IMPACTS

Some of the service areas where expansion of the coordination model is planned are in the SRC and Broomfield Easy Ride service areas. These systems do not have staff available to do the manual intervention that Via has been carrying out. Expansion to these other providers is only a possibility if automatic data exchange is used.

The ability to have all information be shown on a single tablet is a high priority in this project. SRC and Broomfield Easy Ride services do not operate the CNR services in Northwest Denver, so they will not have access to the CNR tablets used with the Mobility DR software.

Two other areas that impact the staff time required for interventions are "Failed Trips" in the Mobility DR software and the need to transmit notes. Consideration of what it will take to address both of these issues is warranted.

Measuring Performance: Before and After

A key measure of success in the Longmont Coordination model has been the increase in productivity. The riders per hour that are carried on both the Via trademark service vehicles and on the CNR vehicles is a key performance measure. Capturing ridership and riders per hour on the current services and on expanded services once the data exchange hub is in place will continue to be a key metric.

Other metrics might be the staff time required to coordinate trips, the number of trips requiring manual intervention, and the number of steps involved in coordinating. The latter would be a one-time change with the initiation of the data exchange hub. It is difficult to measure staff time, as several people may play a part in the manual intervention required, but an effort was made under the description of the current system to estimate the level of staff involvement. Measuring the number and percent of coordinated trips requiring manual intervention might be a good long-term metric. Both staff time and percent of trips requiring intervention are anticipated to change gradually as the system is initiated and bugs are worked out.

Other costs have not been measured, but it would be useful to do so and consider these costs as part of the overall savings resulting from coordination. For example, capturing the savings in staff time and the costs associated with maintaining a new piece of software will be important. Some of the savings gained through increased productivity will need to be reinvested in the system to maintain the software. All of these costs should be included when charges are set for providing service for another provider.

VII. Relationship to the National ITS Architecture

The provisions of the Federal transportation authorizing legislation (currently Fixing America's Surface Transportation Act or the FAST Act) require that ITS projects carried out using Federal funds be in conformance with the National ITS Architecture and Standards. CDOT, under federal guidelines, is one of the agencies with a responsibility to ensure this conformance for ITS projects within the State of Colorado.

The Denver Regional ITS Architecture was developed in 2007 and is currently being updated. It can be viewed at:

https://drcog.org/sites/drcog/files/resources/RegionalITSArchitecture.pdf

The Denver Regional ITS Architecture ("Architecture") complies with the National ITS Architecture, and was built using the Turbo Architecture Version 4.0. This document is a technical companion document to the *Denver Regional Intelligent Transportation Systems Strategic Plan*. The Architecture does recognize the importance of being able to exchange data, however it does not include the demand response mode as one of its components.

Greg MacKinnon at Denver Regional Council of Governments has mapped out the necessary communications linkages and will include all the components necessary to cover Via's MSAA project in the update to the Denver Regional ITS Architecture in the update that is being prepared currently.

Appendix A

(Incomplete)

Appendix B

(Incomplete)

Appendix C – Definitions and Acronyms

API - Application Programming Interface

Adaptor – a software connection that translates incoming and outgoing information from the hub into a format that is readable by host system scheduling software.

Automated Message Exchange - provides for automatic exchange of data through a hub that has the ability to store data for the duration of the trip cycle.

Business Rules – user-defined rules describing how a system functions. Software scheduling systems have a set of business rules that define how the system responds to a variety of circumstances.

CSV – Comma Separated Value file

Data Exchange Hub (Hub, Neutral Hub) **–** a database for active trips that allows information to be uploaded and downloaded in message sets. The hub responds to host system requests (automated or manual). It is considered neutral in that it favors no particular software system or provider.

Data Elements – each field necessary to form message sets that describe trips and their status. A data element might be a passenger name (first, last, suffix) street number, street name, pickup time, etc.

Failed trips – A term describing a trip where the passenger is told their trip was accepted but in reality there is not time in the schedule to complete the trip. Requires manual intervention.

FTP – File Transfer Protocol

FAST Act: Fixing America's Surface Transportation Act, the current Federal transportation funding bill.

Host System – the scheduling software used by each participating transportation provider. Host system's originate trip requests and accept or reject available trips from the hub.

Message Types – strings of information (data elements) that support necessary data exchange among all the host software systems responsible for originating or performing trips. Standard message sets include the trip reservation request, scheduling acceptance, trip confirmation, and trip completion notice.

National ITS Architecture and Standards - The National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. The architecture defines the functions required, physical entities or subsystems where these functions reside, and the information and data flows that connect these functions and physical subsystems together into an integrated system.

Passenger No Show / Cancellation or Late Cancellation – terms describing how what can occur with scheduled trips.

Quick Board – a term used in the Longmont Coordination Model for the system for entering a client into the system when the trip can actually be completed but shows as unavailable due to how the database has broken down the in-service vs. out of service times.

Trip Denial – A trip request is denied, generally due to lack of capacity.

Trip Life Cycle – Trip from inception to completion. Stages typically include Reservation, Scheduling on Vehicle, Delivery, and Reporting. Other stages such as rescheduling or cancellation are also part of the Trip Life Cycle.

User Interfaces – for determining status of system and rides, allowing providers to determine the status of all stages of the provision of service, including trip data, confirmation and tracking, reporting, and billing.

Web Portal – a specially designed web site that brings information together from diverse sources in a uniform way. Usually, each information source gets its dedicated area on the page for displaying information; often, the user can configure which ones to display.