

Phase 2 System Test Plan (STP)

Heart of Iowa Regional Transit ITS4US Deployment Project

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16. Abstract Heart of Iowa Regional Transit Agency (HIRTA) is one of four awardees for Phase 2 of the ITS4US program for its proposed concept <i>"Health Connector: Bridging the Gap Between Healthcare and Transportation"</i> (Health Connector) by the United States Department of Transportation (USDOT). Per the goals of the program, Health Connector project is focused on improving transportation access to healthcare for all groups in Dallas County, Iowa. This document serves as the System Test Plan (STP) for HIRTA and defines the system test strategy for the program. This report includes a high-level overview of the types of testing accomplished during each stage, which include Unit testing, Functional testing, Installation testing, User Acceptance (UA) testing and revenue testing. Each stage of testing also includes a schedule showing when these stages will be accomplished and interdependencies between activities in each stage. The STP is supported by the Requirements Traceability Matrix which includes detailed traceability of verification methods for each requirement and progress tracking for each stage of testing.			
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1 Introduction

The System Test Plan (STP) is organized into the following sections:

1. **Introduction** - Provides information about the purpose of this document and relevant project background.
2. **System Test Plan Overview** – Provides a high-level description of the test stages and processes, test program schedule, types of testing, verification methods and test documentation described in this document.
3. **Unit/Functional/Installation Testing** – For each subsystem, provides an overview of the following test stages: Unit Testing, Functional Testing, and Installation Testing. Each test stage is broken down into a testing activity overview, description of test stage dependencies, and testing schedule.
4. **User Acceptance Testing** – Provides an overview of the User Acceptance test stage, description of test stage dependencies, and testing schedule.
5. **Revenue Testing and Operational Readiness Demonstration** – Provides a high-level overview of the Revenue Testing and Operational Readiness Demonstration which will be further described in the Operational Readiness Test Plan (ORTP) and the Operational Readiness Demonstration Plan (ORDP).
6. **Software Development Test Process** – Provides an overview of the development process and test procedures anticipated in the development of the middleware products.
7. **Defect/Deficiency Tracking and Resolution Processes** – Provides an overview of the defect/deficiency categorizations to be used throughout testing and their respective impacts on testing and resolution procedures, as well as a description of the methodology used for tracking and reporting.

Format and content of this document incorporate recommendations outlined in IEEE Standard 1016-2009 (IEEE Recommended Practice for Software Design Descriptions) [1].

1.1 Intended Audience

The intended audience for this document is the HIRTA project team, the United States Department of Transportation (USDOT), vendor teams, and project stakeholders. This audience also includes future deployers and developers who might learn or build upon the development work described in this document for future deployments of a similar nature.

1.2 Project Background

HIRTA provides over 300,000 customer rides and operates 95,000 hours (2019 estimates; pre-pandemic) along with 1.3 million miles of service within the seven-county region encircling the Des Moines urban area. HIRTA provides demand response services to customers for all trips booked from 24 hours to up to 14 days in advance. If capacity is available, HIRTA also provides trips to meet same day requests. HIRTA also acts as a service provider for the State of Iowa Medicaid broker, Access2Care.

Health Connector is an innovative solution that will address various bottlenecks associated with transportation access to healthcare for HIRTA communities. Some of these challenges are key reasons behind missed appointments or the unacceptable level of preventive or as-needed healthcare in the HIRTA service area. For this deployment, the HIRTA team plans to implement a scalable and replicable solution that enables access to non-emergency medical transportation for all travelers by resolving transportation barriers with the use of advanced technologies. This solution will allow Dallas County residents without access to transportation who may be seeking a medical appointment to explore their transportation alternatives and book both medical and transportation appointments at the same time through a smart device (e.g., smartphone) application or equally effective alternate method. Further, this solution will include information and wayfinding services to guide them at every step of their trip.

This deployment will provide enhanced transportation access to healthcare options for all travelers in Dallas County with a specific focus on underserved communities, rural travelers, older adults, and veterans. In addition to addressing mobility needs, the proposed deployment will recognize the net impact that access to health services has on patient healthcare outcomes as well as both the financial and health outcomes from the perspective of the healthcare community/Dallas County Health Department (DCHD).

HIRTA was awarded a Phase 2 agreement of the ITS4US contract for its proposed concept *“Health Connector: Bridging the Gap Between Healthcare and Transportation”* (Health Connector) by the United States Department of Transportation (USDOT) to showcase innovative business partnerships, technologies, and practices that promote independent mobility for travelers regardless of location, income, or disability.



Figure 1. Overview of Health Connector (Source: HIRTA team)

For more information about the key capabilities of the proposed Health Connector technology, refer to the Phase 2 concept of operations (ConOps) and Phase 2 System Requirements Specifications (SyRS) documents [3].

There are five main goals for the Health Connector Concept, which include:

1. Improved health outcomes through increased access to medical transportation for Dallas County residents
2. Self-reliance and spontaneity for all including underserved groups
3. Efficient transportation management capabilities for medical transportation services
4. Financial sustainability of medical transportation programs
5. Safe medical transportation services

For more information regarding these goals and more detailed objectives and performance measures, please refer to the Phase 2 Performance Measurement and Evaluation Support Plan (PMESP) [4]. Throughout, 'Traveler' refers to those individuals who will use Health Connector services to access healthcare appointments.

1.3 Purpose of the Plan

This report describes the approach to the various stages of testing that will be conducted prior to full deployment of Health Connector. In this report, Unit Testing, Functional Testing, Installation Testing and User Acceptance (UA) testing are described in detail alongside test stage schedules showing the timing of each stage and interdependencies between various stages. Security testing is conducted throughout the test stages listed above.

The STP is supplemented by the Requirements Traceability Matrix (RTM) [5], which details the specific requirements related to each subsystem [5]. The requirements listed in the RTM will be tested according to test procedures and test cases, developed for each subsystem and stage of testing, including those related to security of the subsystems and components. These test procedures are documented in the Operational Readiness Test Plan (ORTP) and provide traceability to the requirements tested through each procedure[10]. As system testing is performed, the RTM will be updated to include comments on each requirement as they relate to their associated test procedure and document the result of testing against each requirement [5]. The goal of the RTM is to show traceability between every system requirement, its test verification method and the specific test procedure that it will be verified in. All subsystems, components, subcomponents and interfaces identified in the ICD and SDD will be included in testing, with the exception of external systems identified in the SDD that are not tied to requirements or within the scope of this design [7][8].

The STP will also document the overall test process for the project, including how test failures are handled, how deficiencies and defects are handled and reported, and how the test results from Unit, Functional, Installation and UA testing are reported. More specific testing schedules are also provided in the Complete Testing Schedule [12].

2 System Test Plan Overview

This section described the structure of the STP, including an overview of the system test stages and processes, test identifiers, verification methods, and references to test documentation.

2.1 System Test Overview

2.1.1 Physical System Overview

Figure 2 represents the block diagram of the systems and interfaces in the HIRTA Health Connector system. This view illustrates the result of design decisions made by the HIRTA team for implementing the Health Connector systems and its subsystems. Furthermore, these figures present the physical architecture that is used by the project team to establish plans for system integration and testing, as well as to track and report readiness for deployment. The next subsections describe each entity in the figure and the logical connections between them.

- **Traveler-end Subsystem** includes the tools and technologies (phone/interactive voice response (IVR), mobile/smart devices, web-based tools) to be used by Travelers seeking transportation services for their healthcare appointments as part of their pre-trip, during trip, on arrival, and return trip activities. This includes both a mobility-on-demand (MOD) application for planning, booking, and payment, as well as a wayfinding application for more detailed guidance within care facilities.

This application, provided by Via, the selected MOD vendor for Health Connector, also provides real-time status of trips on demand and through push notification services and allows Travelers to discover options and plans trips. Mobile/smart devices will be used as part of the Traveler-end subsystem but are not a part of this procurement.

- **Transportation Management Subsystem (TMS):** includes the technologies used to assist customer care and operations staff with Traveler registration, eligibility management, reservations, scheduling, dispatching, billing, and administration activities. These products are commercially available from various providers of paratransit/demand response vendors.

While Via is providing the MOD platform TMS, the interfaces between the MOD platform and the State of Iowa Medicaid transportation broker(s) as well as the EHR system are being developed from scratch. These interfaces (middleware) are being developed by the HIRTA team and made freely, publicly available on GitHub under a permissive license. This middleware will be external to the MOD Platform TMS but sits within the broader HIRTA TMS which includes functions that support health connector from outside of the MOD Platform TMS. Further details on these interfaces are described in Sections 5.6 and 5.7 of the ICD [8][8].

- **Vehicle Subsystem:** refers to the technologies deployed on vehicles to support driver-end functions for driver-dispatch communications, manifest management, support just-in-time dispatching, turn-by-turn navigation and outdoor wayfinding (e.g., to locate Travelers at the time of pickup), on-board information and fare payments. On all HIRTA-owned vehicles, drivers will use tablets running the driver app. On other vehicles, drivers may use the driver app on their tablet or their phone.
- **Wayfinding Subsystem:** refers to the technologies and infrastructure to be used for providing outdoor wayfinding, indoor positioning, orientation, and navigation on request to travelers. It may also assist with translation functionality. One or more commercially available wayfinding system providers may be used. One of those providers will be NaviLens.
- **External Systems:** These systems, external to Health Connector, have been identified for close coordination among HIRTA and partners for providing efficient transportation services for medical trips or for collecting data for performance measurement needs.
 - **Medicaid Transportation Broker:** refers to the State of Iowa Medicaid broker. Currently, Access2Care's system is used for booking and managing Medicaid trips. HIRTA is one of the providers used by Access2Care. Medicaid trips will continue to be booked by Access2Care when requested by Travelers. Medicaid trips will be ingested in the HIRTA system when assigned to HIRTA. At that point, a Traveler using Medicaid benefits will be able to use Health Connector Traveler tools.
 - **Health Navigator- and Healthcare-end Subsystem** refers to the limited access MOD Platform TMS that will be available to health navigators and healthcare customer care staff to request trips, modify trip requests, and check on trip status on behalf of Travelers. Additionally, health navigators and the health administrator at the Dallas County Health Department (DCHD) use a Microsoft Access-based information and referral (I&R) product to track the status of referral activities and for coordination with Dallas County residents' health navigation/social care services.
 - **EHR/Medical Record Subsystem:** refers to the systems used by partner hospitals and clinics for booking medical appointments and maintaining their appointments, including discharge and any subsequent referral activities. Healthcare partners use different EHR services, including Epic EHR, which provides a publicly available API. Health Connector will develop a new interface with at least one healthcare partner's EHR system.
- **Other:** Additional relevant details for the system to be deployed are as follows:
 - **Supporting systems:** These are existing systems that are unchanged by Health Connector but will interface with new tools and/or data as part of the project. The TMS will exchange data with these systems or HIRTA staff may interact with these systems for certain operational functions, as needed. Specifically, this refers to driver or vehicle information management, vehicle maintenance management, customer service management, safety event reporting, and other systems and processes for data collection and reporting, such as CyBox for data

storage and the ISU Performance Management System for data reporting. HIRTA currently uses capabilities within the Via application for completing some such functions, but other off-the-shelf products are also commercially available.

- **Data storage:** Traveler applications will store data locally as allowed by their devices and as authorized by Travelers. Vehicle and TMS subsystems will communicate over cellular data communication for operational data exchange. All data is exchanged in real time (at a configurable frequency). Data is temporarily stored on the vehicle to support offline operations in the event of communication failures. On the central side, TMS data will be stored in a relational database in the AWS cloud storage. Data is stored in a live database to support real-time operations and then processed and archived for reporting in an historical database.

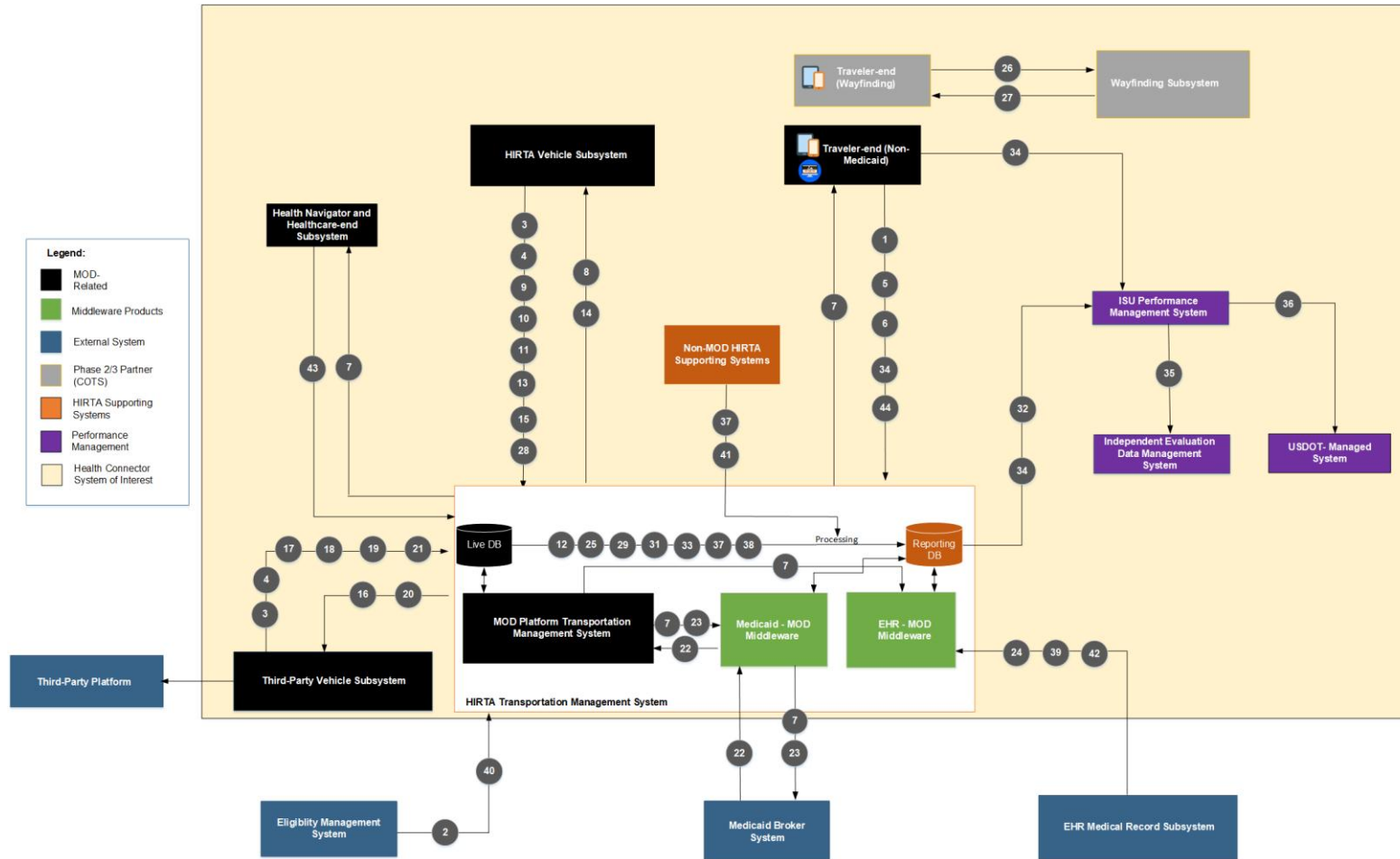


Figure 2. Health Connector System of Interest Diagram (Source: HIRTA team)

The system of interest diagram outlines the data that will pass between systems as part of Health Connector. Keeping the replicability of Health Connector in mind, these datasets and terms used are common in paratransit/demand response industry and are applicable to most commercially available platforms/solutions. The labels referencing data flow IDs in Figure 2 refer to IDs described in Table 1. Data Needs Summary (please see the Phase 2 DMP for further reference) [6].

Table 1. Data Needs Summary

ID	Data	High-level Description	System(s) of Interest Involved
1	Traveler profile	Traveler's personal details as provided as part of registration.	MOD platform TMS
2	Traveler eligibility	Traveler's eligibility for a funding source or program; also verified with funding entities (e.g., Medicaid).	Eligibility management system/funding source
3	Fleet information	Details on HIRTA's vehicles; also, details on third-party vehicles.	MOD platform TMS; third-party platform
4	Driver information	Details on HIRTA's drivers; also, details on third-party vehicles.	MOD platform TMS; third-party platform
5	Trip request	Traveler request for a trip from a web or mobile device; some Travelers may request over phone and use concierge/ customer care service.	MOD platform TMS
6	Trip modification or cancellation	Traveler's request to cancel an existing scheduled trip. To modify an existing trip, Travelers will cancel existing reservations and submit new booking requests.	MOD platform TMS
7	Trip status	Current information on upcoming trip.	MOD platform TMS
8	Manifest	Time and location details on Travelers to be picked up and dropped off by a driver during a shift.	MOD platform TMS
9	Vehicle location	Location and heading along with other details for a vehicle in service.	MOD platform TMS
10	Trip performance	Trip-level log of actual time and location for trips on the manifest along with any no-shows and cancellation events.	MOD platform TMS
11	Driver performance	Driver-level log of operational performance on log on, on-time performance, manifests completed.	MOD platform TMS
12	Travel time	Time needed to perform on-board component of a trip.	MOD platform TMS
13	Driver messages	Messages sent by drivers to dispatchers.	MOD platform TMS
14	Dispatcher messages	Messages sent by dispatchers to drivers.	MOD platform TMS
15	Fare payment log	Log of amount paid for a trip and method of payment.	MOD platform TMS

ID	Data	High-level Description	System(s) of Interest Involved
16	Request for third-party trips	Time and location details on Travelers to be picked up and dropped off by a third-party driver during a shift.	MOD platform TMS
17	Trip performance (third party)	Trip-level log of actual time and location for trips on the manifest along with any no-shows and cancellation events for trips delivered by a third-party provider.	Third-party platform
18	Vehicle location (third party)	Location and heading for a vehicle in service along with other details for a third-party provider.	Third-party platform
19	Driver messages (third party)	Messages sent by drivers to HIRTA dispatchers.	MOD platform TMS
20	Dispatcher messages (third party)	Messages sent by HIRTA dispatchers to drivers.	MOD platform TMS
21	Fare payment log (third party)	Log of amount paid for a trip and method of payment.	Third-party platform
22	Medicaid trip requests	HIRTA-accepted request for Medicaid-funded trips through Medicaid broker platform.	Medicaid broker system
23	Medicaid trip performance	Trip-level log of actual time and location for trips on the manifest along with any no-shows and cancellation events for trips delivered for Medicaid-funded trips.	MOD platform TMS
24	Medical appointment details	Consists of medical appointment date, time, and location (facility address and doctor's office) for a particular Traveler.	EHR
25	Aggregated summary	Aggregated data on driver, vehicle, and trip performance.	MOD platform TMS
26	Traveler wayfinding request	Requests initiated by Travelers to the wayfinding system.	Wayfinding Subsystem
27	Traveler wayfinding guidance	Log of wayfinding information provided to Travelers.	Wayfinding Subsystem
28	Safety event	Log of incidents and accidents by vehicle/driver/trip.	MOD platform TMS
29	Safety event report	Detailed reports by a safety event (incident, accident) with response.	MOD platform TMS
31	System performance	Log of system performance, including any failures.	MOD platform TMS; HIRTA supporting systems

ID	Data	High-level Description	System(s) of Interest Involved
32	Anonymized and/or aggregated data for performance evaluation	Anonymized/aggregated Traveler, trip, and operations data (as described in Table 3. Scope and Availability of Private Data in the Data Privacy Plan [13] to support Health Connector performance evaluation.	MOD platform TMS
33	Traveler complaints log	Log of Traveler complaints received and actions taken.	MOD platform TMS
34	Traveler survey results	Customer data and survey conducted by ISU (including through the MOD platform) of human use participants and control group.	MOD platform TMS; local data system at ISU
35	Processed data for controlled sharing	Controlled-access data available to researchers and the Independent Evaluation team.	Local data system at ISU
36	Data for public access	Aggregated trip summary at Census tract and/or traffic analysis zone (TAZ) level as defined in DMP (or another unit as refined in Phase 2) will be provided. Other data such as fleet, vehicle, and safety event (incident/accident) will also be provided.	Local data system at ISU
37	Cost and revenue data	Cost and revenue data by trip, including actual cost, fare paid, funding source share.	MOD platform TMS
38	Wheelchair failure log	Summary of events referring to situations when wheelchair lift could not function at the time of pickup or drop-off.	HIRTA
39	Medical appointment status	Real-time status of progress on a medical appointment resulting in an impact on the pick-up time.	EHR
40	Discount coupon/credit	Discount coupons or credits applied by trip.	Eligibility management system/funding source
41	Call center log	HIRTA call center statistics available from phone systems or manual logs.	HIRTA supporting systems
42	Missed medical appointments linked to lack of transportation access	Anonymized missed appointments linked to transportation access.	EHR
43	Trip request (partners)	Trips requested by DCHD and healthcare providers using MOD platform. To be tracked separately to assess the benefit of such capability.	MOD platform TMS

ID	Data	High-level Description	System(s) of Interest Involved
44	Traveler wayfinding rating data	Travel rating of wayfinding requests provided prior to pick up and after drop off.	Wayfinding Subsystem

2.1.2 Overview of System Test Stages and Processes

For the purposes of testing, the subsystems described in the Section 2.1.1 above have been grouped into the following vendor-based categories, which will be further described in the ORTP [10].

1. **MOD Platform TMS** – Provided by Via
2. **Wayfinding Subsystem, Kiosks, and Infotainment Devices** – Provided by NaviLens (NL), Redyref and SafeFleet
3. **MOD-Medicaid Middleware** – Developed by Arcadis IBI Group
4. **MOD-EHR Middleware** – Developed by Arcadis IBI Group

Applicable components for each subsystem listed above will undergo each of the following test stages defined in the STP, which are described in Section 2.2, as part of the overall testing process:

1. **Unit Testing** – According to subcomponent
2. **Functional Testing** – According to subcomponent
3. **Installation Testing** – According to subcomponent
4. **User Acceptance (UA) Testing** – Full system testing

Test stages 1-3 will be described for subsystems 1-4 in Vendor Testing (Section 3). The User Acceptance test stage will be described for all subsystems In User Acceptance Testing (Section 4). For each subsystem, testing will be conducted by a member of the team that was not directly involved in the design, development, or requirements related to that subsystem. Each subsystem will undergo Unit, Functional and Installation testing at an individual subsystem level. Testing responsibilities during UA testing will fall under a member of the team not directly involved in the development of the requirements related to the overall system, and the team member that develops the test procedures will not be the same person conducting that conducts testing. Further information regarding testing responsibilities will be documented in the ORTP [10].

2.1.3 High Level Test Program Schedule

Testing is anticipated to occur between October 2023 and June 2024. A high-level schedule overview of the primary test stages is as follows; it is important to note that some of these stages may overlap:

- **Test Readiness Review** – A Test Readiness Review will be conducted at the end of January 2024 to confirm that test plans, documentation, facilities, and personnel are ready for testing. Testing for the MOD-EHR and MOD-Medicaid middleware products will occur throughout the course of development, beginning in October 2023 and readiness for integration of the middleware products with other subsystems will be evaluated during this review.
- **Unit Testing** – Unit Testing for the middleware products will occur concurrently with development and functional testing between the end of October 2023 and will be complete in February, 2024 due to the nature of software development testing, which is further described in Section 6. Unit testing for the MOD Platform TMS and Wayfinding Subsystem will occur in February 2024.
- **Functional Testing** – Functional Testing for the middleware products will occur concurrently with development and unit testing and will take place between the end of October 2023, and will be complete in February 2024. Functional testing for the MOD Platform TMS and Wayfinding Subsystem will occur in March 2024.
- **Installation Testing** – Installation Testing will take place in mid-March 2024, following the completion of Functional Testing
- **User Acceptance Testing** – User Acceptance Testing will take place during the second week of May 2024, following participant recruitment and training.
- **Operational Readiness Demonstration** – The Operational Readiness Demonstration will take place during the second week of June 2024.
- **Revenue Testing** – Revenue Testing will take place over the course of one month in August 2024.

Details on each test stage schedule are provided for each subsystem and relevant test stage throughout the STP. A full system test schedule can be found in the Complete Testing Schedule [12], which will be updated to track progress as testing is completed. These dates will also be tracked in the regular project schedule and will be reported on monthly.

2.2 Types of Testing

This section describes the types of testing that will be used for Health Connector and specifies which stages are described within the scope of this document. The stages, activities, associated plan and objectives are summarized in the RTM [5]. These include:

- **Unit Testing** – During Unit Testing, component units will be verified per requirements and design to ensure components are ready for integration.
- **Functional Testing** – During Functional Testing, integrated subsystems will be verified using simulated environments and test databases to ensure subsystems are ready for installation.

- **Installation Testing** – During Installation Testing, all components will be installed and tested in a field setting to verify integration between subsystems. Actual database and vehicles will be used for testing with HIRTA and partner test subjects to ensure the integrated system is ready for use.
- **User Acceptance Testing** – During User Acceptance Testing, the installed and entire integrated system will be verified using actual data and recruited test participants (2-3), HIRTA employees, or partner staff for non-revenue trips. Participants will be recruited and trained prior, per the PTSEP.
- **Revenue Testing** – During Revenue Testing, the system will be run in live operation with a slightly larger group of actual users, who will be recruited and trained prior to this test stage and observed for 30 days. The goal of this stage is to ensure the system is ready for all real-world use cases. This test stage is not included in the scope of this STP, however, will be described in the Operational Readiness Test Plan.
- **Operational Readiness Demo** – During the Operational Readiness Demo, the integrated system will be evaluated to validate that all use case needs are met. The goal of this stage is to ensure the system is ready for at least 20% at-scale deployment. This test stage is not included in the scope of this STP, however, will be described in the Operational Readiness Demonstration Plan.

	Stage	Activity	Plan	Objectives
Test	Document Testing Approach	<ul style="list-style-type: none"> Outline system testing stages, schedules, and dependencies 	STP	Describe approach in more detail
	Unit Testing	<ul style="list-style-type: none"> Verify component units per requirements and design 	ORTP	Components are ready for integration
	Functional Testing	<ul style="list-style-type: none"> Verify integrated subsystems Use simulated environment Use test database 	ORTP	Subsystems are ready for installation
	Installation Testing	<ul style="list-style-type: none"> Install equipment Verify integrated subsystems Use actual database and vehicles Use HIRTA, and partners for testing 	ORTP	Integrated system is ready for use
	UA Testing	<ul style="list-style-type: none"> Verify installed and integrated system with actual participants Provide training 	ORTP	Integrated system is ready for live operation
	Revenue Testing	<ul style="list-style-type: none"> System run in live operation Punchlist of issues is maintained and addressed as they arise 	ORTP	System is ready for all real world use cases
Demo	Operational Readiness Demo	<ul style="list-style-type: none"> Demonstrate and validate that the integrated system meets use case needs 	ORDP	System is ready for at least 20% at-scale deployment

Figure 3. System Test Stages

2.3 Test Identifiers

Tests will be identified using the following format: *Test Name_Version Number*. All test identifiers can be mapped to individual subcomponents and components as represented in the RTM [5].

2.4 Verification Methods

The following verification methods will be utilized to verify the requirements, as outlined in the Requirement Traceability Matrix [5], are met:

- Test Result (TR)** – Where the requirement is verified by running a test and demonstrating a specific capability or action as the result of such test. Demonstration is usually verified during the execution of the test itself, where you witness the capability accomplishing the requirement.
- PMESP Analysis (PMESP)** – Where the requirement is verified by a test that is run and then later analysis is conducted on the data collected during the test. Often, the outcome of a test cannot be determined by visual inspection, and it requires data analysis to determine if a requirement has been met. As an example, Mean Time Between Failure

(MTBF) requirements are usually verified by analysis since it may not be feasible to wait months for a potential failure of a component.

- **Inspection (I)** – Where the requirement is verified by visual inspection. This verification method is primarily related to the Installation test stage.
- **Design Review (DR)** – Where the requirement is verified by review of design specifications outlined in the System Design Document (SDD), which outline how a requirement is being met. This includes features that already exist in the system and have been verified through screenshots or demonstration.
- **Contract Review (CR)** – Where the requirement is verified by review of contractual specifications. This includes requirements related to Service Level Agreements and blanket requirements for the system that apply to all vendors.
- **Vendor Specification Review (VSR)** – Where the requirement is verified by specifications or approaches written by 3rd party software or hardware providers. This includes requirements related to data that are not directly testable, such as Mean Time Between Failure conditions.
- **Report Verification (RV)** – Where the requirement is verified by review of published reports. This verification method will primarily refer to review of Via's reports, applicable to performance requirements.

2.5 Test Documentation

Test documentation related to test procedures, comments and results will be contained in the RTM to allow traceability to each requirement and tracking of test results for each test stage [5]. For each requirement, the following testing information has been documented for test verification:

1. **Verification Method** – As defined in Section 2.4. For each requirement, the method by which each test procedure will be verified to ensure appropriate functionality of each system component.
2. **Verification Stage** - The verification stage is defined as the applicable test stages for each requirement, which will include at least one of the following: Unit Testing, Functional Testing, Installation and User Acceptance Testing.
3. **Final Sell Off Stage** – For requirements that require testing at multiple stages, this will be defined as the final stage of testing for the relevant component. Some requirements may have a final sell off stage of unit testing, while others should be tested through installation and user acceptance testing and would not be marked as fully validated until that point.
4. **Test Identifier** – Details which test procedure will be used to verify and validate each requirement. Test procedures are developed according to each subcomponent and address specific functionalities. Within each test procedure a series of steps will guide the order of execution, execution conditions, and acceptance criteria for each step of testing. These test procedures will be included as part of the ORTP [10].

The RTM will then break out testing for each requirement according to the applicable test stage, including Unit Test, Functional Test, Installation Test, and User Acceptance Test [5]. For each stage, the following information will be documented:

1. **Test Result** – Describes the results of each conducted tests.
2. **Comment** – Describes any additional information collected during the test stage relevant to each requirement.

As testing is performed according to each requirement, the RTM will be updated to reflect testing results, until all test procedures and test cases have been addressed. Each requirement will be addressed through at least one test procedure and traceability to the related test procedure will be included in the RTM. Failure of a test case will be handled as per the processes described in Defect/Deficiency Tracking and Resolution Processes (Section 7), which utilizes a spreadsheets within the RTM to track defects/deficiencies and resolution procedures [5]. Details on specific test procedures will be included in the ORTP [10].

2. System Test Plan Overview

Requirement Text as of Contract Signage (May 2023)	Verification Method	Verification Stage	Final Sell off Stage	Test Identifier	Unit Test		Functional Test		Installation Test		User Acceptance Test	
					Result	Comment	Result	Comment	Result	Comment	Result	Comment
Health Connector shall allow new Travelers to register and create their profile	Test Result											
The customer profile shall include at least the following information: first and last name, address, contact information (e.g., home and mobile phone number, email address), eligible funding sources, travel preferences (e.g., mobility aid, notification preferences) and favorite locations.	Test Result											
The customer profile data shall not be stored locally on devices unless such consent is received from the Traveler.	Vendor Specification Review											

Figure 4. Snapshot of RTM Test Results Tracking.

A snapshot of the test result tracking is shown in Figure 4. Full tables for the tracking methods described above can be found in the RTM [5].

Additional information regarding the specific subsystems, components, and subcomponents are documented in the Phase 2 System Design Document (SDD). Interfaces between these subsystems are documented in the Phase 2 Interface Control Document (ICD) [7] [8]. Both documents include references to the relevant requirements included in the RTM related to each subsystem and interface [5].

3 Vendor Testing

This section describes the testing procedure for the Health Connector subsystems identified in Section 2.1.2. Detailed descriptions of these subsystems can be found in the Phase 2 System Design Document (SDD) [7]. For each subsystem, testing activities for Unit Testing, Functional Testing, and Installation Testing are described. These tests will be performed according to the test procedures and test cases that will be outlined in the ORTP and tracked in the RTM [10][5]. Traceability to the verification method for each requirement can also be found in the RTM [5]. This section also described any dependencies for each stage of testing, as well as an overview of the proposed schedule.

3.1 MOD Platform

3.1.1 Unit Testing

3.1.1.1 Testing Activity Overview

The focus of the Unit Testing stage will be to verify that the applications associated with the MOD Platform TMS provided by Via, including the Driver Application, Traveler Application, and central applications (Via Operations Center (VOC) and Health Navigator and Healthcare-end Subsystem) meet user requirements relevant to these subsystems. This stage will be performed in a laboratory setting. For testing purposes, a laboratory setting is defined as a controlled, non-revenue setting in which test data is used to perform testing. Testing will include activities such as the inspection of the applications' user interfaces for items such as correct coloring or display settings. Specifically, each application will be evaluated based on the look, feel and accessibility of specific configurable functions.

3.1.1.2 Dependencies

To begin unit testing on the MOD Platform, the MOD Platform TMS applications provided by Via, including the Driver Application, Traveler Application, and central applications, referred to as the VOC and limited access VOC for the Health Navigator and Healthcare-end subsystem must be available for demonstration. This means configuration of Health Connector service within Via will need to be complete prior to testing.

3.1.1.3 Unit Testing Schedule

Unit Testing for the MOD Platform TMS is expected to occur over the course of approximately one week, anticipated for the second week in February 2024. This, alongside other test stages for the MOD Platform TMS can be seen in Figure 5.

3.1.2 Functional Testing

3.1.2.1 Testing Activity Overview

The focus of the Functional Testing stage will be to verify that the Driver Application, Traveler Application, and central applications (VOC and Health Navigator and Healthcare-end Subsystem) meet user requirements in a simulated environment. End-to-end testing of the subsystem in this stage will be performed using test data in a lab setting to evaluate system functionality, however, performance accuracy will not be evaluated during this stage. The test database will be built to reflect HIRTA's operating environment and include accurate service zones. Testing will include activities such as providing an origin-destination request in Via's sandbox environment to evaluate whether the system is able to return trip options. The goal of this stage is to ensure that all components of the MOD Platform TMS, including the Driver Application, Traveler Application, and central applications can work together.

3.1.2.2 Dependencies

To begin functional testing on the MOD Platform TMS, a test database built upon actual HIRTA data must be developed. This will require establishment in the test databases of HIRTA service zone configurations. A sandbox environment will be required for testing of each application. The sandbox environment will allow testing of the MOD Platform TMS using a test database in an isolated environment before full integration with other subsystems and as subcomponents are developed and integrated. This sandbox environment will provide full functionality of the subsystem.

3.1.2.3 Testing Schedule

Functional Testing for the MOD Platform TMS is expected to occur over the course of approximately one week, anticipated for the first week in March 2024. This, alongside other test stages for the MOD Platform TMS can be seen in Figure 5.

3.1.3 Installation Testing

3.1.3.1 Testing Activity Overview

The focus of the Installation Testing stage will be to verify that all MOD components provided by Via, including the Driver Application, Traveler Application and central applications (VOC and Health Navigator and Healthcare-end Subsystem) are able to function in a field setting. During this stage, the system will be installed on at least 2 vehicles using test data and HIRTA drivers. Test passengers (e.g., HIRTA team members) will be used.

3.1.3.2 Dependencies

To begin installation testing for the MOD Platform TMS, the Via Driver Application will need to be deployed on two separate tablets on HIRTA-owned vehicles. The Driver Application and Traveler Application will need to be available for download to both HIRTA-owned on-board equipment (OBE) on the vehicles and test Traveler mobile applications. Two HIRTA drivers and test participants, which can be members of the HIRTA team, will need to be recruited for testing.

3.1.3.3 Testing Schedule

Installation Testing for the MOD Platform TMS is expected to occur over the course of approximately one week, anticipated for the third week in March 2024. This, alongside other test stages for the MOD Platform TMS can be seen in Figure 5.

The full testing schedule for Unit Testing, Functional Testing, and Installation Testing, as well as the anticipated setup of a sandbox environment from Via, are shown in Figure 5 below. A complete schedule can be found in the Complete Testing Schedule [12].

	<div style="text-align: right; border: 1px solid black; padding: 2px;">* onsite event</div>																															
Critical Milestones	Sep-23				Oct-23				Nov-23				Dec-23				Jan-24				Feb-24				Mar-24							
MOD/Via	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15	w16	w17	w18	w19	w20	w21	w22	w23	w24	w25	w26	w27	w28				
Sandbox setup (Via only)																																
Unit testing																																
Functional testing																																
Installation testing																																

Figure 5. MOD Platform TMS Testing Schedule

3.2 Wayfinding Platform, Kiosks, and Infotainment Devices

3.2.1 Unit Testing

3.2.1.1 Testing Activity Overview

The focus of the Unit Testing stage will be to verify that the NaviLens wayfinding application (NaviLens/NaviLens GO) and NaviLens QR codes can separately meet all the wayfinding subsystem requirements relevant to those components. In this context, the NaviLens QR codes refer to an enhanced QR code that allows greater ease of use by visually impaired travelers, allowing Travelers to scan the codes at up to distances of 12 meters without requiring focusing of a camera. This test stage will include inspection of the application’s user interface for look, feel and accessibility of configurable options as well as visual inspection of the QR codes and associated specifications for durability, usability, legibility, and other related requirements. Testing will be conducted by the project team during this stage.

This test stage will also include inspection of the wayfinding kiosks and infotainment devices through inspection, vendor demonstration, and specifications review.

3.2.1.2 Dependencies

Prior to unit testing for the Wayfinding Platform, NaviLens must be able to demonstrate functionality of a Wayfinding Application. Additionally, specifications for the QR codes must be available at this stage.

For infotainment devices, an infotainment device must be equipped on-board HIRTA vehicles, and display updates to the relevant trip.

3.2.1.3 Unit Testing Schedule

Unit Testing for the Wayfinding Platform, Kiosks, and Infotainment Devices is expected to occur over the course of approximately one week, anticipated for the third week in February 2024. This, alongside other test stages for the Wayfinding Platform & Kiosks can be seen in Figure 6.

3.2.2 Functional Testing

3.2.2.1 Testing Activity Overview

The focus of the Functional Testing stage will be to verify that the NaviLens wayfinding application (NaviLens/NaviLens GO) and test NaviLens QR codes can meet requirements related to the wayfinding components in a lab setting. This will include activities such as scanning a test QR code and evaluating whether the application returns a proper response, which could be based on test data relevant to HIRTA or care facility operating context. Testing will be conducted by the project team during this stage.

This test stage will also include testing of the wayfinding kiosk for functionality in a laboratory setting, and infotainment devices for functionality on-board HIRTA vehicles. This could involve testing a modified version of the Via traveler application on kiosks or uploading static information to see if it can be properly used in a care facility. Infotainment devices will be tested for displaying information related to the relevant trip.

3.2.2.2 Dependencies

Prior to functional testing for the Wayfinding Platform, a contract with NaviLens must be complete and a physical QR code must be made available. The test version of the Wayfinding Application must be available for download on a mobile device to allow for scanning of the test QR code. For kiosks, a vendor must be selected, and hardware must be made available for testing.

3.2.2.3 Testing Schedule

Functional Testing for the Wayfinding Platform & kiosks is expected to occur over the course of approximately one week, anticipated for the first week in March 2024. This, alongside other test stages for the Wayfinding Platform & Kiosks can be seen in Figure 6.

3.2.3 Installation Testing

3.2.3.1 Testing Activity Overview

The focus of the Installation Testing stage will be to verify that the NaviLens wayfinding application (NaviLens/NaviLens GO) and NaviLens QR codes can meet requirements related to the wayfinding components in the field. During this stage, at least 10 QR codes will be installed at one of the partner facilities (e.g., Dallas County Hospital) to simulate the first few and/or last few feet of a customer's journey. Testing will be conducted by the project team during this stage to ensure correct guidance is being provided by the wayfinding system.

This test stage will also include testing of a Wayfinding Kiosk installed at the partner facility, Dallas County Health Department (DCHD), and infotainment devices installed on-board HIRTA

vehicles. During this stage, the kiosks and infotainment devices will be installed in the field and testing will be conducted by the project team to ensure kiosks are installed correctly.

3.2.3.2 Dependencies

Prior to installation testing of the Wayfinding Platform, at least 10 physical QR codes must be installed at one of the partner facilities. This will require planning of the QR code test placements prior to installation. The Wayfinding Kiosk will also need to be installed at the partner facility, requiring planning surrounding the placement of the kiosk for accessibility and integration with power supply.

3.2.3.3 Testing Schedule

Installation Testing for the Wayfinding Platform & kiosks is expected to occur over the course of approximately one week, anticipated for the third week in March 2024. This, alongside other test stages for the Wayfinding Platform & kiosks can be seen in Figure 6.

The full testing schedule for Unit Testing, Functional Testing and Installation Testing, as well as the anticipated setup of a sandbox environment from NaviLens, are shown in Figure 6 below. A complete schedule can be found in the Complete Testing Schedule document [12].

Critical Milestones	Sep-23		Oct-23				Nov-23				Dec-23				Jan-24				Feb-24				Mar-24					
	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15	w16	w17	w18	w19	w20	w21	w22	w23	w24	w25	w26	w27	w28
WF/NL																												
Sandbox setup (NL only)																												
Unit testing																												
Functional testing																												
Installation testing																												*

Figure 6. Wayfinding Platform, Kiosks, and Infotainment Devices Testing Schedule

3.3 MOD-Medicaid Middleware

3.3.1 Unit Testing

3.3.1.1 Testing Activity Overview

The focus of the Unit Testing stage will be to verify that following units work as specified:

- Request of data from Access2Care (A2C) Medicaid Trip API (T-API)
- Translation of received T-API data to native data format of MOD-Medicaid Middleware
- Translation of native data into a format expected by MOD Platform TMS’s Trip API
- Ingestion of data into MOD Platform TMS’s Trip API
- Request of data from MOD Platform’s Trip API
- Translation of received MOD Platform TMS’s Trip API data to native data format of MOD-Medicaid Middleware
- Translation of native data into a format expected by T-API
- Ingestion of data into A2C’s platform via T-API

Details on the specific methodologies for testing are described in Section 6.1.

3.3.1.2 Dependencies

Prior to Unit Testing of the MOD-Medicaid Middleware, it will be necessary to have a sandbox environment setup with both Via and with Lyft, who developed the T-API on behalf of Access2Care. The sandbox environment will allow for adequate unit testing of the MOD-Medicaid middleware using test data and is currently available. There are no dependencies on the MOD Platform TMS during this stage.

3.3.1.3 Unit Testing Schedule

Unit Testing for the MOD-Medicaid Middleware is expected to occur throughout the course of the software development process, which is anticipated to begin in October 2023 and continue through March 2024. This, alongside other test stages for the MOD-Medicaid Middleware can be seen in Figure 7.

3.3.2 Functional Testing

3.3.2.1 Testing Activity Overview

The focus of the Functional Testing stage will be to verify flows between individual components of the subsystem can meet the requirements, using test data in a simulated environment, for:

- Ingesting Medicaid trips into the MOD Platform TMS
- Performing trip functions for Medicaid assigned trips in the MOD Platform TMS
- Reporting trip status back to the Medicaid Platform

Details on the specific methodologies for testing are described in Section 6.1.

3.3.2.2 Dependencies

This stage of testing will require the same dependencies as Unit Testing for the MOD-Medicaid Middleware. The sandbox environment will allow for adequate unit testing of the MOD-Medicaid middleware using test data. There are no dependencies on the MOD Platform TMS during this stage.

3.3.2.3 Testing Schedule

Functional Testing will occur concurrently with Unit Testing for the MOD-Medicaid Middleware, as per the software development process to be specified. Functional Testing for the MOD-Medicaid Middleware is expected to occur throughout the course of the software development process, which is anticipated to begin in October 2023 and conclude by the end of March 2024. This, alongside other test stages for the MOD-Medicaid Middleware can be seen in Figure 7.

- Translation of received MOD Platform TMS's Trip API data to native data format of MOD-EHR Middleware
- Presentation of a combined view of medical appointment and Trip API data

Testing will be performed using a developer registration through Epic, which allows the setup of a sandbox environment. Details on the specific methodologies for testing are described in Section 6.1.

3.4.1.2 Dependencies

Prior to Unit Testing of the MOD-EHR Middleware, it will be necessary to have a sandbox environment setup with both Via and Epic or another equivalent EHR system. This requires an API key for Epic's API, which is currently available and can be accessed at the onset of testing. This sandbox environment will provide all functionality required for testing using a test dataset.

3.4.1.3 Unit Testing Schedule

Unit Testing for the MOD-EHR Middleware is expected to occur throughout the course of the software development process, which is anticipated to begin at the end of October 2023 and continue through March 2024. This, alongside other test stages for the MOD-EHR Middleware can be seen in Figure 8.

3.4.2 Functional Testing

3.4.2.1 Testing Activity Overview

The focus of the Functional Testing stage will be to verify flows between individual components of the subsystem can meet the requirements, using test data in a simulated environment, for:

- Ingesting Medicaid trips into the MOD Platform TMS
- Proving trip information and status from MOD Platform TMS to middleware
- Reporting appointment time and location from HER to middleware

Details on the specific methodologies for testing are described in Section 6.1.

3.4.2.2 Dependencies

This stage of testing will require the same dependencies as Unit Testing for the MOD-EHR Middleware. All functionality for testing will be available within the sandbox environment.

3.4.2.3 Testing Schedule

Functional Testing will occur concurrently with Unit Testing for the MOD-EHR Middleware, as per the software development process described in Section 6. Functional Testing for the MOD-EHR Middleware is expected to occur throughout the course of the software development process, which is anticipated to begin in October 2023 and conclude by the end of March 2024. This, alongside other test stages for the MOD-EHR Middleware can be seen in Figure 8.

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4 User Acceptance Testing

4.1 User Acceptance Testing Overview

User Acceptance (UA) Testing will follow the completion and verification of Unit, Functional, and Installation testing for all subsystems. The purpose of this test stage is to demonstrate that the system is able to function in the real world for its intended audience. During this stage, the Health Connector team will have recruited and trained a subset of participants per the Participant Training and Stakeholder Education Plan (PTSEP) [9]. The goal of this stage will be to test the installed and integrated system in order to verify end-to-end functionality and readiness for live operation. Throughout this test stage, data will be collected to verify the quality and accuracy of the data and evaluate full system performance. All requirements related to performance will be tested and can be identified in the RTM [5].

4.2 Dependencies

Prior to beginning User Acceptance Testing, all subsystems will need to be installed and integrated to perform full system testing. As such, verification of Unit Testing, Functional Testing and Installation testing must be complete. The sandbox and test environments used during the Unit, Functional and Installation test stages included all functionality that needed testing prior to commencing User Acceptance testing. Therefore, test procedures covering these requirements should not need additional testing once the system is taken off the sandbox environments.

This test stage will also require the recruitment and training of test participants, which must be conducted prior to commencing UA Testing. To perform participant recruitment and training for UA Testing, IRB approval must first be obtained. Specifics details on participant recruitment and training procedures will be outlined in the PTSEP [9].

Lastly, baseline data will need to be collected prior to User Acceptance Testing, to allow for comparison with the data collected during this test stage.

4.3 User Acceptance Testing Schedule

User Acceptance Testing will occur following the completion of Unit, Functional and Installation Testing for all subsystems. IRB Approval is expected to be obtained by the end of February 2024, before the first batch of participant recruitment over the first three weeks of March 2024 begins. Both participant and partner training are expected to occur in the first week of April 2024. Baseline data will be collected for USDOT review throughout March 2024. User Acceptance Testing is expected to occur in 2024. A full schedule for all test stages through User Acceptance Testing, including dependency events, can be seen in Figure 9.

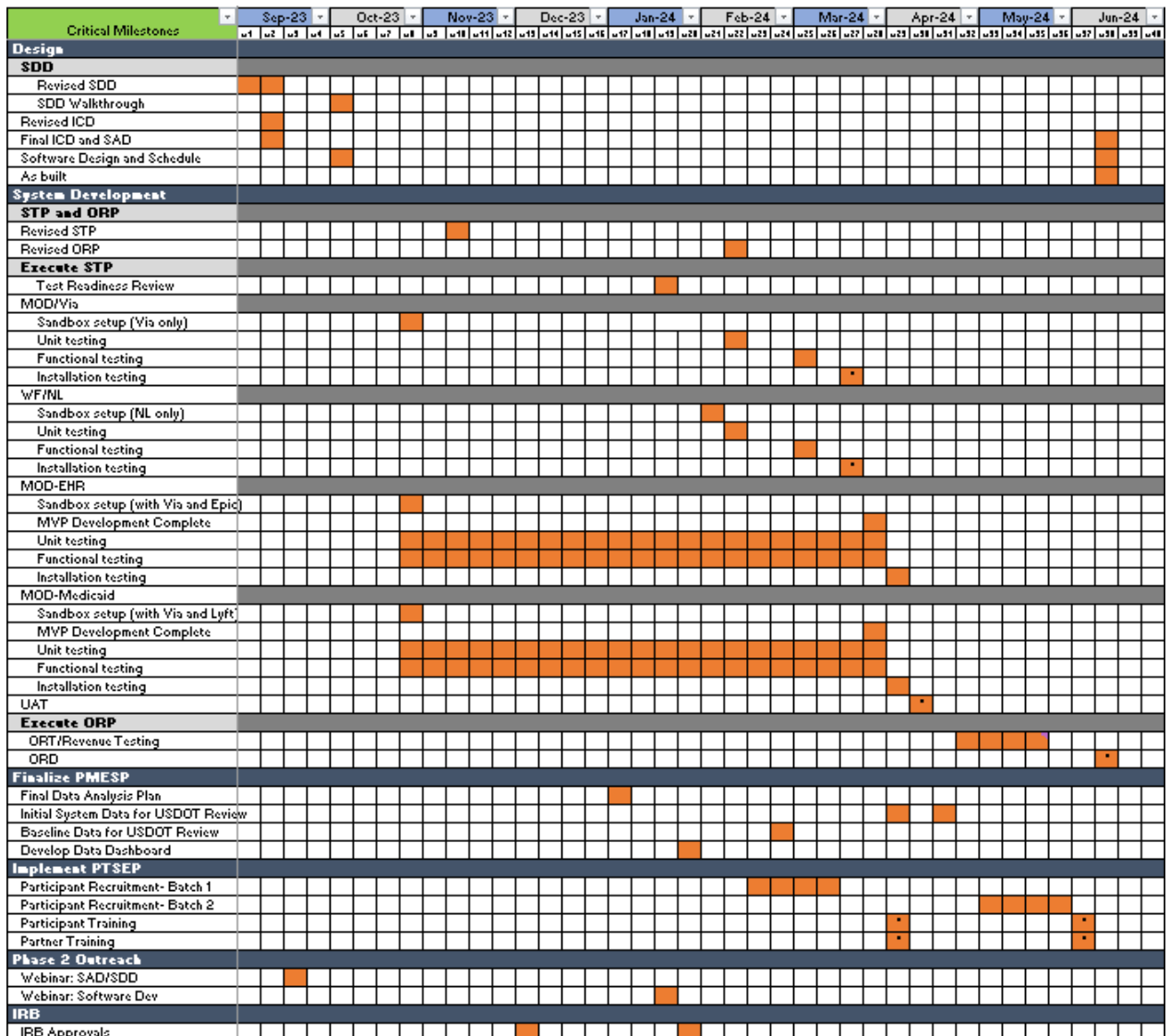


Figure 9. Full Testing Schedule through UA Testing

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5 Revenue and Operational Readiness Testing

This section provides a high-level description of the Revenue Testing and Operational Readiness Demonstration Overview stages of system testing. Further details on these test stages will be defined in the Operational Readiness Test Plan (ORTP) and the Operational Readiness Demonstration Plan (ORDP) [10] [11].

5.1 Revenue Testing Overview

Revenue Testing refers to the test stage in which the system is run in live operation. This stage will utilize the same set of participants as User Acceptance Testing, however, for revenue trips. During this stage, observations related to system functionality and performance will be collected and issues will be addressed. Revenue Testing is anticipated to occur over 30 days. Revenue testing is also referred to as 20% scale deployment. Further details on Revenue Testing will be described in the ORTP [10].

5.2 Operational Readiness Demonstration Overview

The Operational Readiness Demonstration refers to the demonstration of the system to the USDOT. This demonstration will validate that the integrated system meets all use case needs defined in the Concept of Operations (ConOps) [2]. The goal of this demonstration is to verify that the system is ready for at least 20% at-scale deployment across HIRTA's vehicle fleet and is able to meet 100% functionality as specified in the design and requirements. The Operational Readiness Demonstration is anticipated to occur over 3-4 days at the end of June 2024 and prior to the commencement of phase 3. Further details on this demonstration will be described in the ORDP [11].

5.3 Dependencies

Commencement of Revenue Testing will be dependent on the completion of User Acceptance Testing and Operational Readiness Demonstration and associated dependencies. The second round of participant recruitment and training as well as partner training will occur prior to the Operational Readiness Demonstration.

6 Software Development Test Processes

6.1 Software Development Testing Overview

Like other parts of the project, the middleware development includes (1) development, review, and refinement of needs and requirements, (2) development of design specifications and interface prototypes (3) software development and unit testing, and (4) integration and acceptance testing, with select agile development processes employed iteratively across all components through the review and revision of various user interface prototypes and betas. The MOD-Medicaid Middleware and MOD-EHR Middleware described in Sections 3.3 and 3.4 are two separate middleware products, however, are included in the same development project and will therefore follow the same software development testing procedures described in this section.

Project testing will involve testing the individual components/requirements identified in the Requirements Traceability Matrix and design documentation for the software development team. The development team will perform unit testing for the interface modules and interfaces. However, unit testing for the purposes of software development differs slightly from the definition of unit testing for other components. Below are some of the unit tests that will be performed:

Module interface tests: Check to make sure the information is properly flowing in and out of the program unit (or module).

Local data structure tests: Ensure that the local data within the module is stored properly.

Independent path tests: Verify that the code is properly executing their task and terminating at the end of the program.

Error handling path tests: Ensure that any errors encountered are handled properly.

Like other testing procedures, the HIRTA team will document internal subsystem test results in the RTM [5] for previously identified and approved test cases and identify whether the test passed or failed the test case used to verify the requirement [5]. If a system requirement does not pass the test case, the team will analyze the requirement and implement a resolution. This process will continue until the test case passes and the requirement is complete. Once unit testing is verified, test cases will be created for end-to-end system testing for the system modules and interfaces. The systems testing evaluates the completed/integrated system, and all dependencies. This testing also ensures that the software package meets all defined stakeholder needs.

6.2 User Demonstrations

The Middleware development team anticipates the ability to demonstrate a show of progress through a demo environment that can be exposed to the client for confirmation and feedback. The frequency of such progress demonstrations will be determined upon further development of the software.

7 Defect/Deficiency Tracking and Resolution Processes

7.1 Defect/Deficiency Categorization

Defects and/or deficiencies that cause failures in meeting the requirements and test procedures outlined in the RTM will be identified, documented, and tracked until resolution [5]. Defects and deficiencies identified during each test stage of this project will be categorized into various severity ratings, depending on their impact to the system as a whole. The sections below define the defect/deficiency severity ratings based on the type of system being tested.

7.1.1 Commercial-off-the-Shelf (COTS) Products

COTS products include the MOD Platform TMS, Infotainment Devices, and Wayfinding System components, including the Wayfinding Application, NaviLens Codes, and Wayfinding Kiosk. For testing of COTS, each test case will be evaluated as either a pass or failure based on the verification method assessment, as defined below:

1. **Pass** – Evaluation of the test case per the verification method assessment yields expected results and meets the requirement.
2. **Fail** - Evaluation of the test case per the verification method assessment yields results that do not align with expectations, meaning the requirement is not met.

COTS products include:

- MOD Platform TMS;
- Infotainment Devices and;
- Wayfinding System Components

For defects/deficiencies identified for COTS products, or verification method assessments marked as “Fail”, individual vendor processes for resolving issues will be followed and will be treated as external to the project management process. For each issue identified, a timeline for resolution by the Vendor will be requested.

For commercial-off-the-shelf products, it is assumed that vendors will notify the HIRTA team before the release of any new software that will impact Health Connector. These releases will also have undergone testing by the Vendor prior to release and should not warrant retesting of the requirements identified for Health Connector.

7.1.2 New Software Development Products

Testing for software development of the middleware products will follow the process outlined in Section 6 above. It is anticipated that defect/deficiency testing for middleware products will follow a similar Pass/Fail tracking method as COTS products.

Changes to COTS products impacting the middleware, such as changing APIs, will trigger a notification to the software development team and identified Health Connector team members. This will be used to address changes that could require testing revisitation.

7.1.3 Defect/Deficiency Identification and Anticipated Impacts

During Revenue Testing, the system will be observed for defects/deficiencies. Those found will be documented to address these issues following this test stage. Defects/deficiencies identified during testing will be handled differently based on the severity of the issue identified. The resolution actions according to severity level will be further described in the ORTP and ORDP [10] [11]. The following severity ratings and anticipated impacts of each defect/deficiency severity level to be used during Operational Readiness Testing are described below:

1. **Minor Defect/Deficiency** – Defined as small or insignificant issues that does not impact the functionality of the component and has no impact on the subsystem. This could include cosmetic defects impacting the look or feel of the subcomponent, including issues such as spelling errors, alignments, or fonts. These types of defects/deficiencies do not require immediate attention nor cessation of all testing.
2. **Medium Defect/Deficiency** – Defined as a moderate issue where a feature is not behaving as expected and not meeting its requirements or use case(s), however, it does not have a major impact on the usability overall subsystem and is limited to the specific component. This could include defects causing inconvenience to user experience or minimal loss of functionality. These types of defects/deficiencies require immediate attention but do not require cessation of all testing until the root of the issue is identified and corrected.
3. **Major Defect/Deficiency** – Defined as a significant issue where the intended functionality of a feature is not being met entirely nor meeting its requirements or use cases(s), causing a major impact on the overall subsystem. This could include defects such as incorrect data persistence, data issues or wrong application behaviors that would not allow the system to function as intended. These types of defects/deficiencies require immediate attention and cessation of all testing until the root of the issue is identified and corrected.
4. **Critical Defect/Deficiency** – Defined as a defect that completely hampers or blocks testing of the system, requiring the cessation of all testing until the root of the issue is identified and corrected. This could include defects such as an application crash or data breach, leading to the non-usability of the system. Testing of all subsystems will not be possible due to such a failure. As such, testing must cease until the root cause of the issue is identified and the defect/deficiency is resolved.

7.2 Defect/Deficiency Tracking and Reporting

Defects/deficiencies will be reported and tracked in the RTM [5]. Each stage of testing will have a separate spreadsheet/punch list containing an issue tracking punch list dedicated to that stage of testing. As issues are identified and resolved, this spreadsheet will be updated to track progress and reported to development teams on a weekly basis. The punch list will include the following fields:

1. **Date** – Date of issue identified
2. **Issue** – Issue identification, as described in Section 2.3 Test Identifiers.
3. **Issue Description** – Detailed description of issue identified
4. **Test Procedure** – Test Procedure ID from RTM
5. **Subsystem** – Impacted subsystem
6. **Component** – Impacted component
7. **Requirement Impacted** – Requirement ID from RTM
8. **Descendent Requirement** – Requirement ID from RTM
9. **Severity** – Severity classification (Minor, Medium, Major, Critical) as defined above
10. **Assigned To** – Vendor, team, or partner responsible for addressing the issue identified
11. **Partner Ticket Number** - Ticket number for issue tracking by Partner
12. **Partner Comments** – Any comments on the issue by the Partner
13. **Additional HIRTA CCB Comments** – Any comments on the issue by HIRTA
14. **Resolution Date** – Date issue was resolved
15. **Resolved By** – Name of person/team that resolved issue
16. **Resolved By** - Name of person/team that conducting testing on the resolved issue
17. **Resolution** - Description of resolution to the issue

8 References

- [1] IEEE Standard 1016-2009 (IEEE Recommended Practice for Software Design Descriptions) <https://standards.ieee.org/ieee/1016/4502/>
- [2] Phase2 Concept of Operations (FHWA-JPO-21-859) <https://rosap.ntl.bts.gov/view/dot/57469> (to be updated)
- [3] Phase 1 Systems Requirements Specifications (SyRS) Document (FHWA-JPO-21-882) <https://rosap.ntl.bts.gov/view/dot/61724> (to be updated)
- [4] Phase1 Performance Measurement and Evaluation Support Plan (PMESP) (FHWA-JPO-21-877) <https://rosap.ntl.bts.gov/view/dot/60580> (to be updated)
- [5] Phase 2 System Requirements Traceability Matrix (attached)
- [6] Phase 1 Data Management Plan (FHWA-JPO-22-975) <https://rosap.ntl.bts.gov/view/dot/61727> (to be updated)
- [7] Phase 2 System Design Document (SDD), to be published
- [8] Phase 2 Interface Control Document (ICD), to be published
- [9] Phase 1 Participant Training and Stakeholder Education Plan (FHWA-JPO-21-902) (to be updated)
- [10] Phase 2 Operational Readiness Test Plan (ORTP), to be published
- [11] Phase 2 Operational Readiness Demonstration Plan (ORDP), to be published
- [12] Complete Testing Schedule
- [13] Phase 2 Data Privacy Plan (DPP), to be published

Appendix A. Definitions, Acronyms, and Abbreviations

Term	Name	Description
Access2Care		A transportation broker for State of Iowa Medicaid program that performs booking and scheduling and works with service providers such as HIRTA for successful delivery of Medicaid-eligible trips.
API	Application Programming Interface	Software interface that allows two devices or applications to exchange data with each other
Billing		Refers to the process of invoicing third-party funding sources (e.g., Medicaid) after a successful delivery of a trip. Billing is typically done on a monthly basis.
COTS	Commercial Off-The-Shelf	A software/hardware that is commercially ready, made and available for sale, lease, or license to the general public
DCHD	Dallas County Health Department	One of the project Partners who will lead integration with health care services.
Dispatching		Refers to an operations management function which involves assigning vehicle, tracking fleet location, managing schedule adherence, managing trip manifests and other operational functions.
DMP	Data Management Plan	The Data Management Plan describes the approach for data collection, processing, storage and utilization.
EHR	Electronic Healthcare Record	Refers to the healthcare information management system used by hospitals for patients' healthcare-related appointments, transactions, and records management
HIRTA	Heart of Iowa Regional Transit Agency	Rural, regional public transit agency in central Iowa. HIRTA will serve as Proposer/Applicant for the ITS4US project.

Term	Name	Description
ICD	Interface Control Document	The Interface Control Document describes the data flows and sub flows between systems in detail
IVR	Interactive Voice Response	Technology that allows telephone users to interact with a computer-operated telephone system through the use of voice and inputs using a keypad
KPI	Key Performance Indicators	Represents primary metrics used to assess the success of a project or operations
MOD	Mobility-On-Demand	Refers to the ability of individuals to utilize varying transportation modes to make their journeys more efficient or complete
PMESP	Performance Measurement and Evaluation Support Plan	Documents the KPIs, targets, goals, and objectives that will be evaluated as the project launches
SyRS	System Requirements Specifications	Refers to the requirements developed to guide implementation of the system
TMS	Transportation Management System	Refers to the technologies used to assist customer care and operations staff with Traveler registration, eligibility management, reservations, scheduling, dispatching, billing, and administration activities.
Vehicle Subsystem		Refers to the technologies deployed on vehicles to support driver-end functions for driver-dispatch communications, manifest management, support just-in-time dispatching, turn-by-turn navigation and outdoor wayfinding (e.g., to locate Travelers at the time of pickup), on-board information and fare payments.
VOC	Via Central Software	Central operations software used by HIRTA operations for scheduling, dispatching, ride monitoring and reporting
Wayfinding Subsystem		Refers to the technologies and infrastructure to be used for providing outdoor wayfinding, indoor positioning, orientation, and step-by-step guidance on request to travelers.

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