SMART COLUMBUS

Mobility Assistance for People with Cognitive Disabilities Trade Study

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1 Executive Summary

Purpose

The Smart Columbus vision is to empower our residents to live their best lives through responsive, innovative and safe mobility solutions. The purpose of this Trade Study is to identify the best technical solution among a set of proposed viable solutions for the Mobility Assistance for People with Cognitive Disabilities (MAPCD) Project – one (1) of nine (9) projects in the Smart Columbus portfolio.

This project's goal is to enable people with cognitive disabilities to travel more independently on fixed-route bus service. The project team includes City of Columbus staff, subject matter experts with the Central Ohio Transit Authority (COTA) and Ohio State University (OSU), and participating individuals with cognitive disabilities.

Problem Definition

The goal of the Americans with Disabilities Act (ADA) is to promote the independence, integration and self-sufficiency of people with disabilities.[1] Consistent with these goals and ADA regulations, COTA offers origin-to-destination shared ride (paratransit) services, called Mainstream, for eligible riders who are unable to ride fixed-route bus service due to their disabilities.

The problem here is twofold: first, people with cognitive disabilities who wish to independently use public transportation must either qualify for paratransit services in accordance with the ADA, or they must be sufficiently independent that they are able to safely use fixed-route bus service without assistance. Second, the cost of providing paratransit service continues to grow. Like other transit systems across the U.S., COTA is seeking ways to encourage paratransit riders to consider riding fixed-route service which, at an average trip cost of $6.18, is much less expensive to provide than a paratransit trip, which averages $35.86. While COTA offers free bus fares to paratransit customers as an incentive to use the fixed-route service, few have made the switch; paratransit ridership has remained relatively unchanged despite the free bus fare incentive, at approximately 278,000 trips per year according to COTA.

To provide additional, cost-efficient mobility options and a greater degree of independence to residents with cognitive disabilities, a mobility assistance solution is needed that will allow riders to use fixed-route bus services in a safe and easy-to-use manner. In addition to moving people from paratransit to fixed-route service for costs savings, the project holds a secondary objective of moving people from being transported by a caregiver in a privately-owned vehicle to independent travel. This fulfils the Smart Columbus vision of empowering citizens to live their best lives, and also attracts new users with cognitive disabilities who are not already using bus or paratransit services.

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[1] Transportation Cooperate Research Program Synthesis 76: *Integration of Paratransit and Fixed-Route Transit Services.*

Use of the term "cognitive disabilities" was decided by subject matter experts at OSU and COTA to include clinical diagnoses of autism, Down Syndrome, Traumatic Brain Injury (TBI) and dementia along with less severe cognitive conditions such as Attention Deficit Disorder (ADD), dyslexia (difficulty reading), dyscalculia (difficulty with math) and learning disabilities.

Evaluation Criteria

Criteria to evaluate the solution options were developed based on input from COTA and professionals at OSU who are directly responsible for evaluating and assisting people with cognitive disabilities who want to use public transportation services. Each evaluation criteria (Section 3.2) was weighted in accordance with user needs as determined by the project team. Evaluation criteria determined to be of higher importance ("essential" needs and "desirable" needs) were weighted higher than other criteria ("setup/deployment" and "costs"). By assigning a numeric value to each evaluation criteria and summing the weighted values, the solution with the highest overall score was determined to be the best solution for the project.

The Solution Options

The method of analysis described in this Trade Study included identifying six (6) solution options (Section 3.3). Based on literature review and discussions, the project team identified two existing commercial solution options: Wayfinder by AbleLink and Compagnon by Mass Factory. Both are mobile device applications that provide users with cognitive disabilities turn-by-turn navigation to complete trips. Options one (1) through four (4) examined either these existing apps or a customized variation (Wayfinder "Plus" and Compagnon "Plus). The fifth option was a Hackathon, a one-time event meant to bring together coders, programmers and developers for an intense development session to solve a specific problem. Option six (6) was to issue a Request for Proposal (RFP) to invite new vendors to the process.

Recommendations

Based on the evaluation, AbleLink's WayFinder solution is the preferred option for Columbus provided that AbleLink successfully integrates functionality to actively track an individual on a route. This functionality is currently in development according to AbleLink. Continued testing in partnership with OSU is recommended, as well as continued engagement with AbleLink Technologies to further customize the product to meet the needs of the Smart Columbus program. Negotiations with Mass Factory, the producer of the App&Town Compagnon, may be necessary in the event AbleLink is unable to meet the needs of Columbus in terms of additional testing and modifications to the solution.

2 Introduction

2.1 Purpose

As the winner of the United States Department of Transportation (USDOT) Smart City Challenge, the Smart Columbus vision is to empower our residents to live their best lives through responsive, innovative and safe mobility solutions. The purpose of this Trade Study is to identify the best technical solution among a set of proposed viable solutions for the Mobility Assistance for People with Cognitive Disabilities (MAPCD) Project – one (1) of nine (9) projects in the Smart Columbus portfolio.

This project's goal is to enable people with cognitive disabilities to travel more independently on fixed-route bus service. The project team includes City of Columbus staff, subject matter experts with the Central Ohio Transit Authority (COTA) and Ohio State University (OSU), and participating individuals with cognitive disabilities.

Use of the term "cognitive disabilities" was decided by subject matter experts at OSU and COTA to include clinical diagnoses of autism, Down Syndrome, Traumatic Brain Injury (TBI) and dementia along with less severe cognitive conditions such as Attention Deficit Disorder (ADD), dyslexia (difficulty reading), dyscalculia (difficulty with math) and learning disabilities.

Currently, COTA offers origin-to-destination shared ride (paratransit) services, called Mainstream, for eligible riders who are unable to ride fixed-route bus service due to their functional limitations. The overarching goals of COTA's paratransit service are to provide mobility and maximum independence for residents, while maintaining safety at all times. Residents who qualify for paratransit service also receive passes to use fixed-route buses free of charge. This is an incentive for riders to take a trip that costs less for COTA to provide, which in turn would enable COTA to serve more customers within its existing budget. The Smart Columbus Program intends to build upon COTA's existing framework to maximize mobility and independence while maintaining safety and improving cost efficiency. The mobility assistance project seeks a solution that will allow people with cognitive disabilities to safely transition from using paratransit services to using fixed-route bus service, as well as to attract new users with cognitive disabilities who are not already using bus or paratransit services. To do this, the project must provide a solution that offers accurate, turn-by-turn navigation with other support features to ensure that users with cognitive disabilities can safely and accurately complete a trip using fixed-route bus service.

The project team decided upon a "caregiver response model" to assist users, in which a relative or caregiver of the traveler monitors the trip and intervenes as necessary. The alternative to this model involves external support from an outside agency or call center to monitor trips and intervene as necessary. Call center support from COTA was evaluated early in the study and determined to not be a feasible model due to costs and limited staff resources.

In March and April of 2017, representatives from OSU conducted functional assessments of two existing commercial applications, Wayfinder by AbleLink and Compagnon by Mass Factory, and identified

strengths and opportunities for improvements with both. Based in part on these assessments, reviews of product information, telephone conversations with company representatives and other factors, the project team scored the available commercial alternatives. At that phase of the evaluation, the Compagnon solution was observed to be more in line with the objectives of Smart Columbus primarily because of its ability to actively track a user through use of global positioning satellites (GPS). However, because each solution was believed to be viable, the Smart Columbus team moved both options forward for consideration by potential users.

In July and August of 2017, representatives from OSU conducted an evaluation and field study of people with cognitive disabilities using both applications under the guidance of the OSU Pre-vocational Integrated Education and Campus Experience (PIECE) program. PIECE is funded by the OSU Nisonger Center in cooperation with the Franklin County Board of Developmental Disabilities, in which people with cognitive disabilities participate in a six-week internship on campus or within proximity to campus. During the study, staff members and interns completed a "Weekly Journal Entry" noting their personal experiences and pros/cons of each app. Interns and staff members also provided a summary of their experiences with the previous app at the start of each training session. The interns suggested improvements to both applications but generally found each app equally viable in helping them navigate fixed-route bus service. The complete OSU evaluation is provided in **APPENDIX E.**

Based on the OSU evaluation and updates to the scoring criteria in **APPENDIX A**, the project team was able to recommend a solution. Next steps, beyond finalization of the Trade Study, are listed below to ensure essential user needs are met, and to allow adequate testing by OSU and Franklin County Board of Developmental Disabilities prior to deployment.

- Prepare and Submit Draft Interface Control Document (ICD)
- Begin Institutional Review Board (IRB) Process
- Prepare Draft Contract with AbleLink
- Finalize Contract with AbleLink
- Submit Final ICD
- Develop Test Plan for OSU & Franklin County PIECE Program
- OSU & Franklin PIECE Program Application Testing
- AbleLink Update Application Based on PIECE Program Feedback
- IRB Approval
- Volunteer Recruitment
- Final Testing
- Training
- Deployment

This approach, which is outlined in Section 2.1 of the Smart Columbus Systems Engineering Management Plan (SEMP), will build confidence in the selection of a preferred solution and provide transparency in the justification for its selection.

As noted in the SEMP, the Trade Study is the predecessor for the buy recommendation for the vendor product and will require a contract with AbleLink. The contract will include system requirements that trace back to the uniquely identified "essential" and "desirable" items described in the Trade Study. Any data that are required by Columbus from AbleLink to support evaluation will also be identified in the

contract as well. The Interface Control Document (ICD) will describe in detail the actual interface to the Smart Columbus Operations System () based on vendor participation, as well as interface to COTA for General Transit Feed Specification (GTFS) data. In deciding to procure or partner with an existing solution, Columbus is not required to produce a Concept of Operations (ConOps) document or System Requirements Specification (SyRS).

2.2 References

The following stakeholder working group sessions, meetings and documents were referenced in developing the Mobility Assistance Trade Study document:

- Working Groups/Meetings
    - Smart Columbus Mobility Assistance Working Group: January 24, 2017
    - COTA Paratransit Assessment Facility Tour: February 24, 2017
    - COTA Mobility Advisory Board Meeting: March 8, 2017
    - COTA and Smart Columbus Project Team Meeting: March 9, 2017
    - Telephone interview with AbleLink: March 15, 2017 (**APPENDIX D**)
    - Telephone interview with Mass Factory: March 16, 2017 (**APPENDIX C**)
    - COTA Accessible Transportation Advisory Committee: May 22, 2017
    - Telephone interview with AbleLink: August 10, 2017
- Documents
    - Transportation Cooperate Research Program Synthesis 76: *Integration of Paratransit and Fixed-Route Transit Services*
    - Compagnon Service Control Panel Web App User Manual v0.9.pdf
    - Mass Factory Compagnon.pdf
    - Mass Factory App&Town Compagnon System Installation and Configuration.pdf
    - Cloud-based WayFinder Service - Short Description.pdf
    - (WayFinder) GPS Travel.pdf
    - (WayFinder) Stock et al GPS Transportation.pdf
    - (WayFinder) White Paper SMART Travel 2012.pdf
    - https://www.dhs.gov/sites/default/files/publications/guide-interacting-with-people-who-have-disabilties_09-26-13.pdf
    - Wayfinding Apps: Evaluations (**APPENDIX E**)

3 Evaluation

3.1 Problem Definition

As summarized by the Transportation Cooperate Research Program Synthesis 76: *Integration of Paratransit and Fixed-Route Transit Services*, the goal of the Americans with Disabilities Act (ADA) is to promote the independence, integration and self-sufficiency of people with disabilities. Consistent with these goals and ADA regulations, COTA offers origin-to-destination shared ride (paratransit) services, called Mainstream, for eligible riders who are unable to ride fixed-route bus service due to their disabilities.

The problem the MACPD Trade Study sets out to address is twofold: first, people with cognitive disabilities who wish to independently use public transit services must either qualify for paratransit services in accordance with the ADA, or they must be sufficiently independent that they are able to safely use fixed-route bus service without assistance.

Second, the cost of providing paratransit service continues to grow. Like other transit systems across the U.S., COTA is seeking ways to encourage paratransit riders to consider riding fixed-route service which, at an average trip cost of $6.18, is much less expensive to provide than a paratransit trip, which averages $35.86. While COTA offers free bus fares to paratransit customers as an incentive to use the fixed-route service, few have made the switch; paratransit ridership has remained relatively unchanged at approximately 278,000 trips per year according to COTA.

Currently, residents interested in receiving paratransit services submit a two-part written application to COTA, which is prepared by both caregivers and medical professionals. The application asks why the resident believes they qualify for services under federal law. After the application is reviewed, residents attend a one-hour session at COTA's paratransit assessment facility where they are interviewed by professional staff and asked to navigate a state-of-the-art simulated bus stop. During the simulation, staff asks the resident to move across different ground surfaces, negotiate curbs, and enter and exit a bus based on audial and visual cues embedded in the simulation. Based on the information contained in the application, the interview and the performance of the resident during the simulation, a determination is made about the resident's eligibility to use paratransit services.

To provide additional, cost-efficient mobility options and a greater degree of independence to residents with cognitive disabilities, a mobility assistance solution is needed that will allow riders to use fixed-route bus services in a safe and easy-to-use manner. Some level of mobility assistance is needed to move riders from paratransit services to fixed-route bus service.

Problem definition in this context is being shaped by collection and analysis of user needs from those who work with, and advocate on behalf of, users with cognitive disabilities, as well as direct interaction with people with cognitive disabilities. A thorough aggregation and understanding of these needs helps ensure the proposed solutions address real-world problems experienced by end-users.

User needs for mobility assistance were gathered through working group sessions with project team members and discussions with COTA and OSU staff who are directly responsible for evaluating and assisting persons with cognitive disabilities that wish to use paratransit services. Direct input by people with cognitive disabilities was provided through field testing of the applications and expressed in caregiver reports and journal entries (**APPENDIX E**) and through the COTA Accessible Transportation Advisory Committee.

The project team identified the following essential user needs (Table 1), emphasizing convenience, accessibility and safety as most important items.

Table 1. Evaluation Criteria

ID	Evaluation Criteria	User Class	Priority
MAPCD-UN001-v01	Phone-based application (Android and IOS)	Traveler	Essential
MAPCD-UN002-v01	Knowledge of real-time transit info (COTA GTFS)	Traveler	Essential
MAPCD-UN003-v01	Voice and turn-by-turn directions	Traveler	Essential
MAPCD-UN004-v01	Ability for the traveler to speak to the caregiver (safety)	Traveler	Essential
MAPCD-UN005-v01	Ability to send alerts to the caregiver (passive monitoring)	Caregiver	Essential
MAPCD-UN006-v01	Ability to track an individual (active monitoring)	Caregiver	Essential
MAPCD-UN007-v01	Caregiver experience*	Caregiver	Essential
MAPCD-UN008-v01	WCAG 2.0AA standard / 508 compliant	Traveler	Essential

*The caregiver experience is a qualitative measure of the degree to which the application meets the primary needs of the caregiver, which are ease of use, ability to create routes, and ability to tailor the end-user experience to suit the needs of an individual user.

Collectively, these essential needs represent the minimum required functionality for a mobility assistance solution to be viable. Solutions that meet these essential needs should be considered for evaluation as potential preferred alternatives. However, there are additional criteria that will be useful in evaluating a preferred mobility assistance solution. These additional criteria are discussed in the following section.

3.2 Evaluation Criteria

This section identifies the method in which the solution options will be evaluated. As set forth in the previous section, all potential solutions must satisfy essential needs as a precondition for further evaluation. For those solutions that meet this standard, there must be a predefined set of evaluation criteria above and beyond minimum functionality that serves as the basis for selecting one option over another. Stakeholders have established the criteria in Table 2 as important factors in determining the preference of qualifying solutions.

Table 2. Evaluation Criteria Definitions

ID	Priority	Criteria for Analysis	User Need
MAPCD-UN001-v01	Essential	Phone-based application (Android and IOS)	Travelers need the mobile application to be available on both Android and iOS devices to allow for personal choice and user preferences.
MAPCD-UN002-v01	Essential	Knowledge of real-time transit info (COTA GTFS)	Travelers need the mobile application to display real-time bus location information and alerts for them to complete trips using COTA's fixed-route bus system. Travelers need to be alerted to any changes in scheduled service that might impact their ability to complete a trip.
MAPCD-UN003-v01	Essential	Voice and turn-by-turn directions	Travelers need the mobile application to guide them using voice commands and step-by-step visual instructions to complete a trip.
MAPCD-UN004-v01	Essential	Ability for the traveler to speak to the caregiver (safety)	Travelers need to be able to speak to a caregiver for assistance in cases of emergency to feel safe and secure while on route.
MAPCD-UN005-v01	Essential	Ability to send alerts to the caregiver (passive monitoring)	Caregivers need the mobile application to send notifications of a traveler's progress on route via SMS or email messages to be assured that the traveler is safely on route and progressing toward a destination.
MAPCD-UN006-v01	Essential	Ability to track an individual (active monitoring)	Caregivers need an interface to view a traveler's progress in real-time on a map to be assured that the traveler is safely on route and progressing toward a destination.
MAPCD-UN007-v01	Essential	Caregiver Experience	Caregivers need the mobile application to be easy to use, allow them to easily and effectively create routes, and to be able to tailor the end-user experience to suit the individual needs of a traveler. Caregiver experience is a qualitative measure of the degree to which the application meets these needs.
MAPCD-UN008-v01	Essential	WCAG 2.0AA standard / 508 compliant	Travelers need the mobile application to meet the established standards for accessibility for people with cognitive disabilities to ensure safe and effective use of the application.
MAPCD-UN009-v01	Desirable	Roles-based permissions (caregiver, traveler)	Caregivers need roles-based permissions to manage system access for individual

			users to perform tasks, such as view, create or modify a route.
MAPCD-UN010-v01	Desirable	Simple, non-cluttered user interface	Caregivers need a simple, non-cluttered user interface that works effectively when performing tasks such as view, create or modify a route. Travelers need a simple, non-cluttered user interface to promote usability and user comprehension.
MAPCD-UN011-v01	Desirable	Ability to customize map (COTA GIS web services)	Caregivers need to be able to add custom map functionality to the mobile application, which includes options for adding additional map layers and data, or additional tools to assist in the creation of routes or execution of a route by a traveler.
MAPCD-UN012-v01	Desirable	Ability for user to "check in" on route	Travelers need the mobile application to provide the ability to check in with caregivers. Caregivers need to receive alerts from the traveler as to the status of an individual on route.
MAPCD-UN013-v01	Desirable	API (Application Programming Interface)	Columbus needs the application to integrate with the Smart Columbus Operating System (SCOS) via APIs. The SCOS will be the source for collecting and reporting performance metrics to monitor and evaluate the application.
MAPCD-UN014-v01	Desirable	Ability to create custom reports	Caregivers need to be able to create custom reports on a traveler's application usage and travel behavior to make informed decisions, such as updates to existing routes or to determine the need for additional training or instruction.
MAPCD-UN015-v01	Deployment	Data storage options	Columbus needs the system to provide data storage options to allow for future growth and expansion.
MAPCD-UN016-v01	Deployment	Application hosting options	Columbus needs the system to provide a flexible hosting plan to allow for future growth and expansion. The system may be hosted internally or externally to the city.
MAPCD-UN017-v01	Deployment	Hardware options	Columbus needs the system to provide hardware options for hosting solution to allow for future growth and expansion.
MAPCD-UN018-v01	Deployment	Perception of rapid deployment	Columbus needs the solution to deploy quickly to meet the needs of the Smart Columbus program schedule.
MAPCD-UN019-v01	Deployment	Perception of ease of use/configuration	Columbus needs the system to be easy to use and configure to meet the needs of the Smart Columbus program.

MAPCD-UN020-v01	Deployment	Security and automatic updates	Columbus needs the system to allow security updates to be pushed to the traveler's phone to support safe use of phone.
MAPCD-UN021-v01	Deployment	Web-based administrator interface	Columbus needs the system to provide a web-based administrator interface to effectively maintain and support the system.
MAPCD-UN022-v01	Costs	Initial purchase costs	Columbus needs the initial purchase costs (acquisition costs) of the application to meet the needs of the Smart Columbus budget.
MAPCD-UN023-v01	Costs	Recurring costs	Columbus needs the regularly occurring costs such as annual maintenance or license renewal costs to meet the needs of the Smart Columbus budget.
MAPCD-UN024-v01	Costs	Training costs	Columbus needs the costs associated with training end users of the application to meet the needs of the Smart Columbus budget. Columbus needs the system provider to train COTA ("train the trainer") so that COTA can train end users of the system.
MAPCD-UN025-v01	Costs	Development costs	Columbus needs the costs associated with developing new features of the application to meet the needs of the Smart Columbus budget.

Table 3 provides the relative importance of the criteria used in the evaluation in **APPENDIX A**. Weights and scores were developed in concurrence with subject matter experts at OSU and COTA.

Table 3. Evaluation Criteria and Weighting

Category	Relative Importance (Weight)	Maximum Raw Score	Total Possible Score (Weight * Raw)
Meets Essential User Needs	56	5	280
Additional Features	18	5	90
Deployment	10	5	50
Cost	16	5	80
TOTAL	100	5	500

As shown in the column labelled "Relative Importance," satisfactorily meeting all the minimum user needs accounts for 56 percent of the overall evaluation criteria for each alternative solution. The remaining 44 percent of the evaluation criteria are made up of the broad categories of additional features, deployment and cost. Each of these broad categories is in turn composed of several sub-categories. The full listing of each sub-category of evaluation criteria can be found in **APPENDIX A**.

To allow for greater variation in scoring, each solution was permitted to receive up to a total of five points for each major category of criteria. Multiplying the weight of each major category by the score received for that category yields a maximum possible score of 500 points for each potential solution.

Additional features refer to solution functionality above and beyond the ability to meet minimum user needs. As an example, the ability to incorporate role-based profiles into the application is not an essential need but would qualify as an additional feature. Role-based profiles refer to the ability of the application to accommodate distinct types of users with differing levels of administrative rights. Examples might include admins, caregivers and travelers. The role to which a user is assigned dictates which menus a user sees as well as what functionalities are available to them. Other examples of additional features include the ability for users to "check in" at various locations during their trip and the ability of the solution to offer custom reporting for administrators interested in understanding overall performance.

Deployment refers to the ease and speed with which a solution can be implemented. As an example, solutions that are rapidly and easily deployable are scored higher than solutions that require custom development or otherwise cannot be as quickly deployed.

Finally, costs refer to the expenditure of monetary resources over a 5-year implementation lifecycle. In addition to initial purchase costs, other costs include recurring costs, training costs and customization costs.

The weights of the broad categories reflect the relative priorities of Columbus and COTA in achieving their goals for the mobility assistance project. Columbus is focused on developing a solution which meets core user needs and does so at a reasonable cost. This focus reflects the desire to serve the largest community of users possible given that financial resources are limited both in amount and in time. A successful project is one that helps move the maximum number of travelers from paratransit services to fixed-route bus services in as safe a manner as possible. While additional features and straightforward deployment schedules are important for a successful project, their importance relative to core functionality and cost are low.

It is important to note that the broad categories presented here are summarized and simplified for ease of understanding. A complete list of each sub-category can be found in **APPENDIX A**. The level of granularity and detail presented there is much greater. This increased degree of detail and specificity allows for accuracy and precision in measurement and scoring. As defined here, "additional features" is sufficiently broad enough that it would be very difficult for an independent scorer to objectively quantify and evaluate a solution's "additional features". Only when that broad category is disaggregated into six (6) detailed, specific sub-categories does it become possible to objectively evaluate each proposed solution. In instances where complete information was not available, scoring was performed with a degree of conservatism to ensure that solutions were not evaluated in an unrealistic light.

3.3 Solution Options

The project team identified six (6) solution options shown in Table 4 that merited consideration. Since the functionality provided by Compagnon and WayFinder most closely align with the needs of the project as determined by the project team, COTA and OSU, the scope of the Trade Study was limited to

not include a broad assessment of all commercially available solutions for people with cognitive disabilities.

Table 4. Solution Options

Option	Solution Name	Solution Description
1	Compagnon	Mass Factory application
2	Compagnon "Plus"	Mass Factory application with custom development
3	WayFinder Community Access	AbleLink Technologies application
4	WayFinder "Plus"	AbleLink Technologies application with custom development
5	Hackathon	Open competition
6	Request for Proposal	Incorporate mobility assistance user needs into an RFP for the Smart Columbus Multi-Modal Trip Planning Application

Option one (1) is the original Compagnon solution proposed by Mass Factory. Compagnon is a mobile device application that provides turn-by-turn navigation to users with cognitive disabilities to complete trips that include both a transit component and a walking component. The application allows a remote operator to plan routes for a traveler, actively monitor his or her progress throughout the trip and intervene in instances where the traveler deviates from the route or makes an unplanned stop. Information concerning Compagnon was gathered from various marketing materials, user guides, implementation schedules and cost estimates received from Mass Factory representatives in October 2016. Additionally, the project team held discussions with representatives of Mass Factory in March 2017 covering more detailed topics such as test environments and hosting requirements. Additional notes on the Compagnon application solution can be found in **APPENDIX C**.

Option two (2) envisions integration and custom development beyond what was originally proposed by Mass Factory. This option allows for complete customization and maximum leveraging of existing technology to produce a product specifically designed to fulfill user needs for Smart Columbus.

Option three (3) is a commercially available smart phone application named WayFinder, designed by AbleLink Technologies in Colorado Springs, CO and currently deployed in Albuquerque, NM. WayFinder is a turn-by-turn application designed to assist travelers with cognitive disabilities to complete trips that include both a transit component and a walking component. The user taps a picture of the desired destination, and then WayFinder loads a pre-defined, customized route to the destination. WayFinder reminds travelers when bus stops prior to their scheduled stop are not meant for them, and then prompts the traveler to stay on the bus even though other passengers are boarding and exiting. The system is highly configurable with simple interfaces. It allows caregivers or support professionals the ability to create stops and passively monitor the trip through email and text messages. WayFinder information was gathered from various marketing materials and documents on the internet. Additionally, project team members held telephone calls with a representative of AbleLink in March and August 2017. Additional notes on the WayFinder application solution can be found in **APPENDIX D**.

Like option two (2), option four (4) represents the ability for custom development on top of an existing technology. Option four (4) represents custom development of the WayFinder solution beyond what is commercially available. This option allows maximum leveraging of existing technology to produce a

product specifically designed to fulfill user needs for Smart Columbus. For example, AbleLink is currently developing an active tracking component to the WayFinder application.

The criteria which require custom development to fulfil options 2 and 4 are listed in Table 5 under the "Compagnon + Changes" and "Wayfinder + Changes" columns.

Table 5. Changes Needed to Meet Criteria

ID	Criteria	Weight	Priority	Compagnon + Changes	Wayfinder + Changes
MAPCD-UN001-v01	Phone-based application (Android and IOS)	7	Essential	X	
MAPCD-UN002-v01	Knowledge of real-time transit info (COTA GTFS)[2]	7	Essential	X	
MAPCD-UN003-v01	Voice and turn-by-turn directions	7	Essential		
MAPCD-UN004-v01	Ability for the traveler to speak to the caregiver (safety)	7	Essential		
MAPCD-UN005-v01	Ability to send alerts to the caregiver (passive monitoring)	7	Essential		
MAPCD-UN006-v01	Ability to track an individual (active monitoring)	7	Essential		X
MAPCD-UN007-v01	Caregiver Experience	7	Essential		
MAPCD-UN008-v01	WCAG 2.0AA standard / 508 compliant	7	Essential		
MAPCD-UN009-v01	Roles-based permissions (caregiver, traveler)	3	Desirable		X
MAPCD-UN010-v01	Simple, non-cluttered user interface	3	Desirable	X	
MAPCD-UN011-v01	Ability to customize map (COTA GIS web services)	3	Desirable	X	X
MAPCD-UN012-v01	Ability for user to "check in" on route	3	Desirable		
MAPCD-UN013-v01	API (Application Programming Interface)	3	Desirable		
MAPCD-UN014-v01	Ability to create custom reports	3	Desirable	X	X
MAPCD-UN015-v01	Data storage options	1	Deployment	X	X
MAPCD-UN016-v01	Application hosting options	1	Deployment	X	X
MAPCD-UN017-v01	Hardware options	1	Deployment		
MAPCD-UN018-v01	Perception of rapid deployment	2	Deployment		
MAPCD-UN019-v01	Perception of ease of use/configuration	1	Deployment		

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[2] Wayfinder demonstrated knowledge of COTA real-time transit info during OSU evaluation.

MAPCD-UN020-v01	Security and automatic updates	2	Deployment	X	
MAPCD-UN021-v01	Web-based administrator interface	2	Deployment		X
MAPCD-UN022-v01	Initial purchase costs	4	Costs		
MAPCD-UN023-v01	Recurring costs	5	Costs		
MAPCD-UN024-v01	Training costs	1	Costs		
MAPCD-UN025-v01	Development costs	6	Costs		

Option five (5), known as a Hackathon, is a one-time event meant to bring together coders, programmers and developers for an intense development session to solve a specific problem. In this case, Columbus would put out a call for industry experts to come together to design and construct a solution specifically tailored to meet the mobility assistance needs of the Smart Columbus Project. Hackathons have the advantage of being very fluid and flexible but come with the distinct disadvantage – from an evaluation standpoint – of not having known outcomes before they occur. It would be difficult, if not impossible, to describe in any detail the solution that would evolve from a Hackathon for a mobility assistance solution beyond a generic description of the user needs it would meet. As such, there is no way to quantify and evaluate the additional features, deployment and cost aspects of a hackathon-based solution in advance.

Option six (6) involves developing the user needs identified for mobility assistance into a Request for Proposal (RFP). An advantage of this approach would be the potential to introduce new vendors into the evaluation process and get existing vendors to justify their services. A disadvantage is that the RFP process would require additional time to advertise, negotiate, contract with and then educate a new vendor when Smart Columbus already has two vendors interesting in partnering.

Before completing the solution options scoring matrix, the project team invited OSU to conduct field assessments of both Compagnon and WayFinder to confirm or revise the project team's understanding of their functionality. These tests were conducted in March and April of 2017, and then again in July and August of 2017. These results can be found in **APPENDIX E**.

Table 6, below, summarizes the scores for each alternative based on the four broad categories of essential items, desirable items, deployment and costs. The figure does not include scores for the Hackathon or RFP alternatives because those alternatives by their nature have unknown outcomes until the results of the Hackathon and/or RFP responses become available. However, there is sufficient information available to evaluate options one (1) through four (4). A detailed breakout of the scoring summarized below is available in **APPENDIX A**.

Table 6. Summary Scoring Matrix

Solution	Essential Items (Possible 280)	Desirable Items (Possible 90)	Deployment (Possible 50)	Cost (Possible 80)	TOTAL SCORE (Possible 500)
Compagnon	259	81	33	16	389 (3rd)

Compagnon "Plus"	273	90	39	34	436 (2nd)
WayFinder	231	57	37	44	369 (4th)
WayFinder "Plus"	273	90	41	66	470 (1st)
Hackathon	-	-	-	-	-
Request for Proposal	-	-	-	-	-

Essential Items – Compagnon and WayFinder score very well with respect to meeting basic user needs. Compagnon (without customization) scores higher than WayFinder (without customization), due to WayFinder's lack of active monitoring (ability to track an individual on route in real-time). However, with customization, both solutions score equally well in core functionality to meet user needs.

Desirable Items – Compagnon scores higher than WayFinder due to its inclusion of roles-based permissions and route customization features. Again, this disparity can be addressed through custom development which puts both applications on equal standing.

Deployment – WayFinder scores higher than Compagnon due to differences in perception of rapid deployment. Because there is not currently an iOS version of Compagnon, the time it will take to deploy and fully test a new platform detracts from the perception of a rapid and smooth deployment. Lack of app store integration for Compagnon also contributes to a lower score.

Costs – Differences in the cost model result in a much higher score for WayFinder. Custom development costs are yet unknown and cannot be adequately measured, therefore custom development costs are treated as mostly equal; however, WayFinder has a much lower initial cost for the software licenses and no recurring costs. Compagnon, on the other hand, has recurring costs equal to the initial software licensing which is more than twice that of WayFinder.

Regardless how well the detailed scoring matrix is constructed, there will always be some degree of subjectivity in scoring the options. Reasonable individual scorers will invariably disagree over whether a score of "3" or "4" best reflects a solution's ability to deploy quickly or incorporate some additional feature. However, even with the inherent subjectivity involved in scoring the detailed matrix, some general trends emerge when examining the summary scores that inform recommendations for moving forward. Results from each scoring category are discussed below.

Based on these scores, it is clear the custom development is well worth the investment and possible schedule impacts to achieve additional desired functionality. For this reason, overall scores increase for each customization option when compared to simply leveraging each existing solution. Even though both solutions demonstrate the ability to meet user needs, WayFinder "Plus" scores better overall than does Compagnon "Plus" for reasons of cost and ease of deployment. More detailed information on scoring is contained in **APPENDIX A** and more detailed information on cost is contained in **APPENDIX B**.

Although it is not possible to score the Hackathon and RFP options in advance, it is possible to make some general comments about those approaches relative to adopting legacy alternatives and/or legacy alternatives with customization. The Hackathon is likely to produce a solution that scores very well with respect to essential and desirable items, perhaps even pushing the boundaries of the scoring matrix

employed here. On the other hand, the Hackathon is more likely to lead to a solution that is minimally viable and less likely to lead to a comprehensive solution that addresses all needs of the program. Issuing an RFP to meet essential user needs is undesirable when Columbus has identified a preferred vendor and can expedite the development process.

3.4 Final Recommendation

The WayFinder "Plus" solution is the preferred solution for Columbus provided that AbleLink successfully integrates into their solution the functionality to actively track an individual on a route. This functionality is currently in development according to AbleLink. Next steps, beyond finalization of the Trade Study, are listed below to ensure essential user needs are met, and to allow adequate testing by OSU and Franklin County Board of Developmental Disabilities prior to deployment.

- Prepare and Submit Draft Interface Control Document (ICD)
- Begin Institutional Review Board (IRB) Process
- Prepare Draft Contract with AbleLink
- Finalize Contract with AbleLink
- Submit Final ICD
- Develop Test Plan for OSU & Franklin County PIECE Program
- OSU & Franklin PIECE Program Application Testing
- AbleLink Update Application Based on PIECE Program Feedback
- IRB Approval
- Volunteer Recruitment
- Final Testing
- Training
- Deployment

This approach, which is outlined in Section 2.1 of the Smart Columbus Systems Engineering Management Plan (SEMP), will build confidence in the selection of a preferred solution and provide transparency in the justification for its selection.

As noted in the SEMP, the Trade Study is the predecessor for the buy recommendation for the vendor product and will require a contract with AbleLink. The contract will include system requirements that trace back to the uniquely identified "essential" and "desirable" items described in the Trade Study. Any data that are required by Columbus from AbleLink to support evaluation will also be identified in the contract as well. The Interface Control Document (ICD) will describe in detail the actual interface to the Smart Columbus Operations System (SCOS) based on vendor participation, as well as interface to COTA for General Transit Feed Specification (GTFS) data. In deciding to procure or partner with an existing solution, Columbus is not required to produce a Concept of Operations (ConOps) document or System Requirements Specification (SyRS).

Negotiations with Mass Factory, the producer of the App&Town Compagnon, may be necessary in the event AbleLink is unable to meet the needs of Columbus in terms of additional testing and modifications to the solution. The risks associated with pursuing the Wayfinder "Plus" solution will be tracked as part

of a Risk Management program so that the project team may determine if and when it might need to begin similar negotiations with Mass Factory.

Before final acceptance of the WayFinder solution, it is incumbent upon Columbus to systematically evaluate the mobility assistance needs of its residents through further field testing, to prioritize the criteria for determining which solution best meets those needs, and then to evaluate possible solutions against those criteria. This approach will build confidence in the preferred solution and provide transparency in the justification for its selection.

Appendix

Appendix A. Detailed Scoring Matrix

	ESSENTIAL ITEMS		Vendor Alternatives							
			Compagnon		Compagnon +		WayFinder		WayFinder +	
ID	Criteria	Weight[1]	Rating[2]	Score[3]	Rating[2]	Score[3]	Rating[2]	Score[3]	Rating[2]	Score[3]
001	Phone-based application (Android and IOS)	7.00	4[3]	**28**	5	**35**	5	**35**	5	**35**
002	Knowledge of real-time transit info (COTA GTFS)	7.00	4	**28**	5	**35**	4	**28**	5	**35**
003	Voice and turn-by-turn directions	7.00	5	**35**	5	**35**	5	**35**	5	**35**
004	Ability for the traveler to speak to the caregiver (safety)	7.00	5	**35**	5	**35**	5	**35**	5	**35**
005	Ability to send alerts to the caregiver (passive monitoring)	7.00	5	**35**	5	**35**	5	**35**	5	**35**
006	Ability to track an individual (active monitoring)	7.00	5	**35**	5	**35**	0	**0**	5	**35**
007	Caregiver Experience	7.00	4	**28**	4	**28**	4	**28**	4	**28**
008	WCAG 2.0AA standard / 508 compliant	7.00	5	**35**	5	**35**	5	**35**	5	**35**
	Total Score[4]	**56**		**259**		**273**		**231**		**273**

[1] Assigns a weight (1-5) to each criterion based on its importance in the final decision

[3] While Compagnon lacks an iOS version at present, they have assured the project team their codebase is ready to deploy for iOS; however, it may take several months to deploy to iOS.

(2) Assigns a rating (1-5) to each criterion based on vendor solution

(3) Score = Rating * Weight

(4) Total Score = SUM(Scores)

DESIREABLE ITEMS

ID	Criteria	Weight[1]	Compagnon		Compagnon +		WayFinder		WayFinder +	
			Rating[2]	Score[3]	Rating[2]	Score[3]	Rating[2]	Score[3]	Rating[2]	Score[3]
009	Roles-based permissions (caregiver, traveler)	3.00	5	**15**	5	**15**	0	**0**	5	**15**
010	Simple, non-cluttered user interface	3.00	4	**12**	5	**15**	5	**15**	5	**15**
011	Ability to customize map (COTA GIS web services)	3.00	4	**12**	5	**15**	0	**0**	5	**15**
012	Ability for user to "check in" on route	3.00	5	**15**	5	**15**	5	**15**	5	**15**
013	API (Application Programming Interface)	3.00	5	**15**	5	**15**	5	**15**	5	**15**
014	Ability to create custom reports	3.00	4	**12**	5	**15**	4	**12**	5	**15**
	Total Score[4]	**18**		**81**		**90**		**57**		**90**

SETUP/DEPLOYMENT

ID	Criteria	Weight[1]	Compagnon		Compagnon +		WayFinder		WayFinder +	
			Rating[2]	Score[3]	Rating[2]	Score[3]	Rating[2]	Score[3]	Rating[2]	Score[3]
015	Data storage options	1.00	4	**4**	5	**5**	4	**4**	5	**5**
016	Application hosting options	1.00	4	**4**	5	**5**	4	**4**	5	**5**
017	Hardware options	1.00	5	**5**	5	**5**	5	**5**	5	**5**

ID	Criterion	Weight												
018	Perception of rapid deployment	2.00	2	**4**	1	**2**	5	**10**	1	**2**				
019	Perception of ease of use/configuration	1.00	4	**4**	4	**4**	4	**4**	4	**4**				
020	Security and automatic updates	2.00	1	**2**	4	**8**	5	**10**	5	**10**				
021	Web-based administrator interface	2.00	5	**10**	5	**10**	0	**0**	5	**10**				
	Total Score[4]										**10**	**33**	**39**	**37**	**41**

COSTS

ID	Criteria	Weight[(1)]	Compagnon		Compagnon +		WayFinder		WayFinder +	
			Rating[(2)]	Score[(3)]	Rating[(2)]	Score[(3)]	Rating[(2)]	Score[(3)]	Rating[(2)]	Score[(3)]
022	Initial purchase costs	4.00	2	**8**	2	**8**	4	**16**	5	**20**
023	Recurring costs	5.00	1	**5**	1	**5**	5	**25**	5	**25**
024	Training costs	1.00	3	**3**	3	**3**	3	**3**	3	**3**
025	Development costs[4]	6.00	0	**0**	3	**18**	0	**0**	3	**18**
			Total Score[(4)]		**16**	**16**	**34**	**44**	**66**	

TOTAL OVERALL SCORE

Vendor Alternatives			
Compagnon	Compagnon +	WayFinder	WayFinder +
389	436	369	470

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[4] Assumes no development cost other than configuration for both Wayfinder and Compagnon, which is required of any deployment.

Appendix B. Five Year Cost of Ownership

Compagnon Basic	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Cost of Application/Licenses	$65,000	$65,000	$65,000	$65,000	$65,000	$325,000
Total Cost of Compagnon*	**$65,000**	**$65,000**	**$65,000**	**$65,000**	**$65,000**	**$325,000**

*Assumptions:

Annual license cost $65,000

Initial number of users   30

Caregiver or third party for Compagnon provides phone and data plan

WayFinder Basic	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
Cost of Application/Licenses	$29,970	$-	$-	$-	$-	$29,970
Total Cost of WayFinder**	**$29,970**	**$-**	**$-**	**$-**	**$-**	**$29,970**

**Assumptions

Price per application $999

Initial number of users   30

Phones are provided with Wayfinder pre-installed. The cost of a phone service and/or a data plan is not included in the cost of the bundled WayFinder App and a phone. The Android phones are unlocked devices. WayFinder can be used on phone devices that do not have a data plan associated with then as it uses the GPS location data to trigger the prompts to individuals while they are travelling. In this scenario, notifications are only accessible when connected via Wi-Fi.

Appendix C. App&Town Compagnon

Overview

App&Town Compagnon serves as an assisted transport platform for people with cognitive disabilities (requiring assistance in travel due to disability, age or contextual disability) to travel safely and self-sufficiently. It is an end-to-end software solution for assisted transport comprises the following key features:

1. An accessible mobile application for providing users with high-precision guidance during their trips when walking, using public transportation or accessing indoor facilities
2. A web-based control panel for caregivers to monitor their position, receive alerts when the user leaves the defined route or faces some sort of problem or emergency

Caregiver experience

Caregivers are responsible for registering users through the web-based control panel and for downloading and configuring the Compagnon app on the user's Smartphone. The caregiver will also create routes for the user which are available on their Smartphone. When a user is ready to start a trip, the caregiver is responsible for their supervision on route through the web-based control panel and for managing any incident that might occur along route. The user's location is transmitted in real-time to the caregiver through the web-based control panel to be able to respond to alerts, track their trips and ensure their safety.

User experience

The user is responsible for opening the Compagnon app, choosing a route and following the instructions to reach their destination.

Notes

The following notes were compiled from an interview with Mass Factory on March 16, 2017. Additional information can be found at https://www.appandtown.com/

- Information was gathered from publicly available sources and written and verbal communications with Mass Factory
- Mass Factory was created in 2012 as a spinoff to a University in Barcelona, Spain
- App&Town Compagnon is deployed in Laval, Canada and piloted in Barcelona, Spain and Lyon, France
- Mass Factory has staff dedicated to development, quality assurance, hosting and support
- Compagnon operates through both a web application and a mobile application
- The web application is used by supervisors, operators and assistants to create and modify user profiles as well as to build custom routes for users
- The mobile application is used by the traveler to navigate the route
- The mobile application can only function with Android OS, but Mass Factory believes they can develop an iOS version in approximately 6 months

- The system uses Amazon Web Services (AWS) for application hosting and storage. The AWS environment is owned by Mass Factory and billed to the customer monthly.
- The system takes advantage of load balancing
- The system uses Open Street maps which allow for additional data layers for inputting additional map data
- The system can integrate with all three current COTA General Transit Feed Specification (GTFS) streams including vehicle location, alerts and the fixed-route system.
- The system allows for active and passive monitoring of users and for the creation of waypoints where a user will receive instructions which can be in the form of text or pictures
- The system uses a geo fence around the prescribed route to send an "out of route" alert which is sent to the web application
- The alert could be customized for e-mail and SMS/text alerts, but that would represent custom development
- A user can hit a "panic" button to call a pre-programmed number that reaches an operator or caregiver
- Conversely, an operator can reach the user remotely if they are alerted to an "out of route" condition
- Costs for the system include initial purchase, ongoing licensing, device hardware, device data costs, training and operating expenses for supervisors and operators.

Screenshots
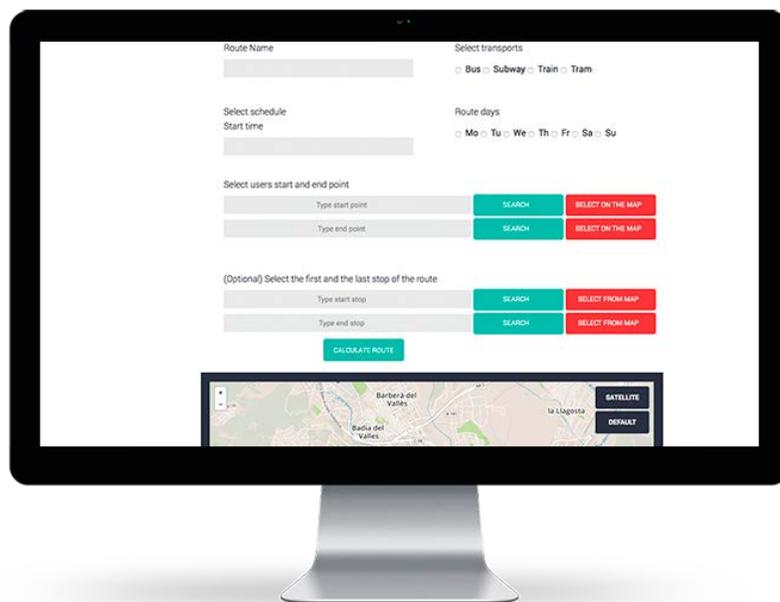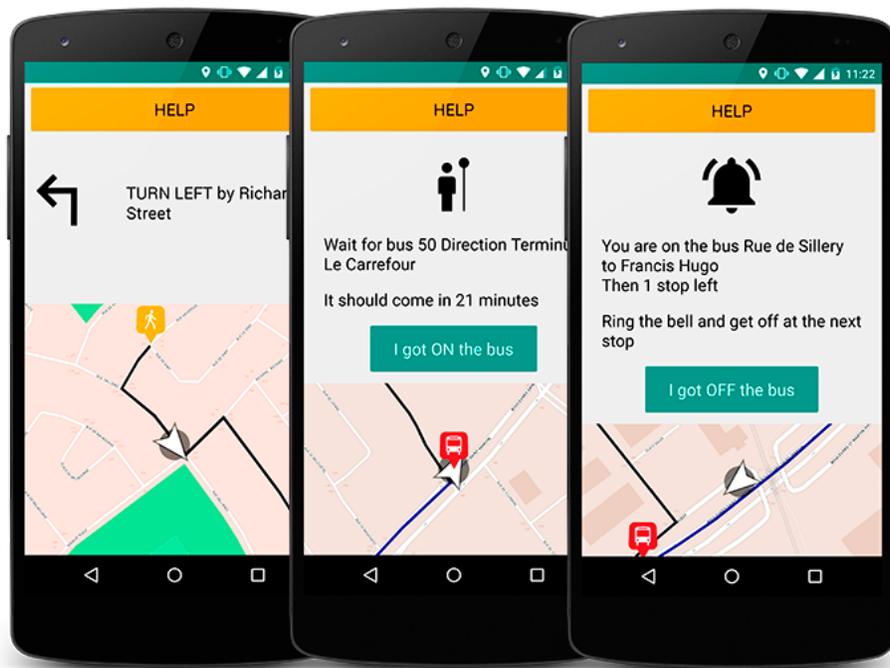
Appendix D. Wayfinder

Overview

WayFinder was developed specifically for individuals with cognitive disabilities to allow them to take fixed-route public transportation independently without requiring more costly paratransit services to travel. The system was developed through research funding from the U.S. Department of Education and the National Institutes of Health.

Users of the WayFinder system can choose to have email or text messages sent automatically to a caregiver. These messages contain a map link showing the user's exact location at any time. Similar messages are sent automatically when the user starts their route and then again when they arrive at their destination. This is designed to provide reassurance to both the individual traveling and their family or caregivers concerned with their whereabouts and safety.

Caregiver experience

Caregivers are responsible for route building for the end-users. A simple wizard guides the caregiver to record audio prompts, select images and create steps the user will experience along the way. Once a route is under way, time-stamped location updates can be viewed by caregivers if desired, ensuring peace of mind. From the WayFinder App, a caregiver can review an online library of previously created routes, and then select for a selected route that was previously created. For example, a previously created route may be from a recurring point of origin to a regular destination. This route can be downloaded directly to WayFinder running on a smartphone. The route he or she downloads can include picture prompts, audio instructions in a language of choice and specific instructions for helping the user travel independently on a bus or train, etc. The route will be able to be used as is, or the caregiver can choose to modify the route with specific pictures or audio prompts that are helpful for the individual. For example, a picture and audio prompt can be added to the individual's downloaded bus route indicating they are half-way to work or school. Another prompt may be added to remind them to look around to make sure they did not leave anything on their seat before they leave to get off at their stop. The system will provide specific location-based prompts when it is time to signal the driver to stop the bus at the next stop.
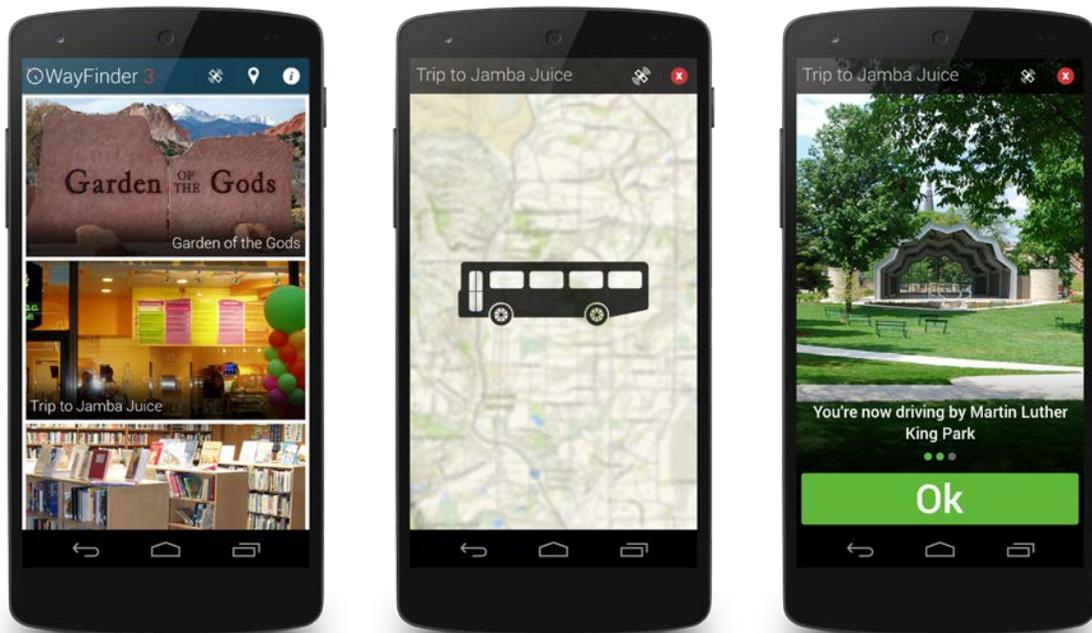
User experience

The GPS-based tracking triggers WayFinder to safely guide the user with step-by-step visual and audio instructions. WayFinder can help assure the traveler that they are on the correct route by pointing out important landmarks along the way, even telling them "this is not your stop" when they see others departing.
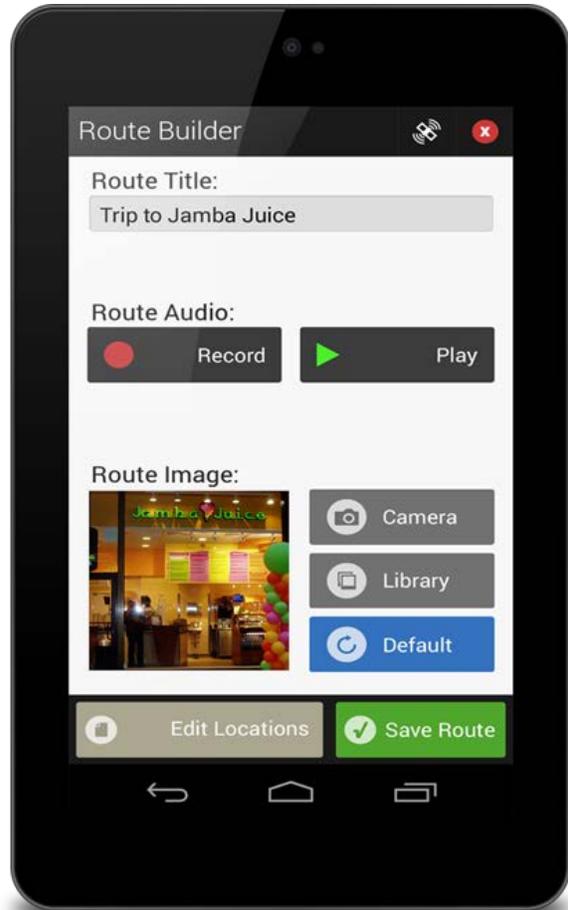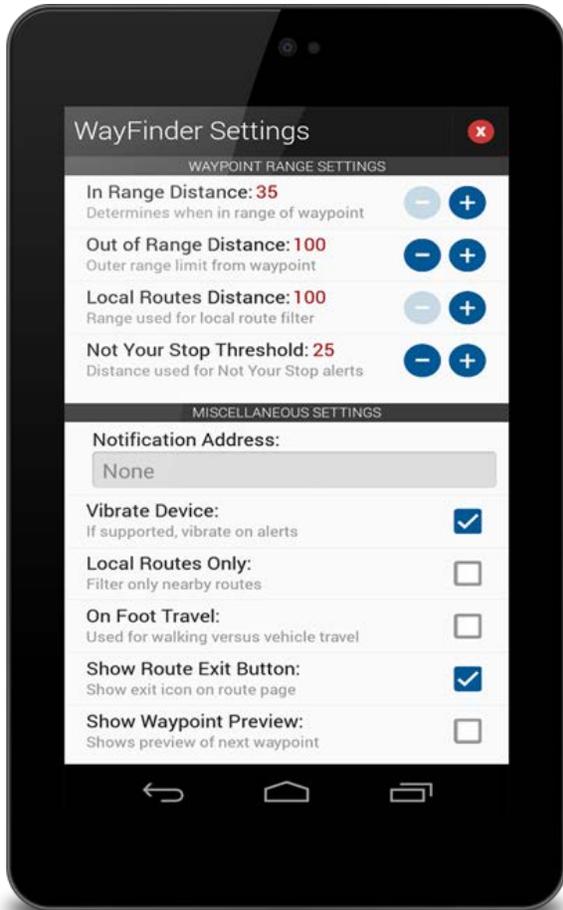
Notes

The following notes were compiled from an interview with AbleLink Technologies on March 15, 2017. Additional information can be found at http://www.ablelinktech.com/[5].

- AbleLink was created in 2009 and has done research for the Department of Education and the National Institutes of Health
- WayFinder has been deployed in the City of Albuquerque, NM with promising results
- WayFinder is a mobile application only, there is no web application component
- The mobile application is used by caregivers to create custom routes for travelers
- The mobile application is used by the traveler to navigate the route
- The mobile application is available for both the Android and iOS operating systems
- The current system allows for passive monitoring of users and for the creation of waypoints where a user will receive instructions, which can be in the form of text or pictures
- Alerts can be sent via e-mail or text at configurable frequencies down to every five minutes and can include map location
- A user can hit a "panic" button to call a preprogrammed number that reaches an operator or supervisor
- Conversely, an operator can call the user remotely if they are alerted to an "out of route" condition
- Costs for the system include a one-time purchase cost for the application which includes devices

Screenshots

WayFinder Settings

WAYPOINT RANGE SETTINGS

In Range Distance: 35
Determines when in range of waypoint

Out of Range Distance: 100
Outer range limit from waypoint

Local Routes Distance: 100
Range used for local route filter

Not Your Stop Threshold: 25
Distance used for Not Your Stop alerts

MISCELLANEOUS SETTINGS

Notification Address:
None

Vibrate Device: ☑
If supported, vibrate on alerts

Local Routes Only: ☐
Filter only nearby routes

On Foot Travel: ☐
Used for walking versus vehicle travel

Show Route Exit Button: ☑
Show exit icon on route page

Show Waypoint Preview: ☐
Shows preview of next waypoint

Route Builder

Route Title:
Trip to Jamba Juice

Route Audio:
● Record   ▶ Play

Route Image:

[Camera]
[Library]
[Default]

[Edit Locations]   [✓ Save Route]

Appendix E. Ohio State University Evaluation

Wayfinding Apps: Observations

Olivia Vega S/OT

The Ohio State University

August 4, 2017

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1. Description and Introductions
2. Summary of Findings from Users and Staff Members
3. Summary of Findings from Route Creator
4. Summary of Each Training Session
5. Appendix
   a. Caregiver Report
   b. Weekly Journal Entry

[REFER TO ATTACHED REPORT]