USDOT ATTRI Program

International Innovation Coordination Plan

www.its.dot.gov/index.htm
Final Report — December 2016
FHWA-JPO-17-499

Source: USDOT

U.S. Department of Transportation

Produced by Booz Allen Hamilton
U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology

Notice

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-JPO-17-499		

4. Title and Subtitle	5. Report Date
International Innovation Coordination Plan for the USDOT ATTRI Program	December 2016
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Sudharson Sundararajan, Arris Bahrami, Ram Kandarpa, Richard Bishop, Bernardine Dias and Carol Schweiger	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Booz Allen Hamilton, Bishop Consulting, Diyunu Consulting and Schweiger Consulting	11. Contract or Grant No.

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S. Department of Transportation Federal Highway Administration 1200 New Jersey Avenue, SE Washington, DC 20590	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Transportation plays a critical role in enhancing access to education, jobs, healthcare, recreation, leisure, and other activities. The United States Department of Transportation's (USDOT's) Accessible Transportation Technology Research Initiative (ATTRI) program leads the research, development, and implementation of transformative technologies, solutions, applications, and systems that allow people of all abilities to effectively and independently plan and execute their travel. ATTRI is a joint USDOT initiative, co-led by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), with support from the Intelligent Transportation Systems Joint Program Office (ITS JPO), and other federal partners. This ATTRI International Research Coordination project aims to: (1) identify promising transportation technologies and applications around the world; (2) establish communications with relevant program leads; and (3) develop an International Coordination Plan to guide future international coordination and collaboration efforts. Based on the results of Task 3, which explored eight international initiatives, the project team selected two initiatives for further collaboration with the USDOT ATTRI program. This report focuses on an international coordination plan for initiatives identified in the United Kingdom and Japan. The agencies within these two countries are the Center for Connected and Automated Vehicles (CCAV) in the United Kingdom and the Ministry of Land Infrastructure Transport and Tourism (MLIT) and Strategic Innovation Creation Program – Automated Driving for Universal Services (SIP-adus) in Japan.

For each selected international agency, the team developed a detailed coordination plan that outlines the short-term and long-term strategies to build on the relationships established through this project, continue dialogue, and realize one or more collaboration activities. This coordination plan is expected to help identify a variety of collaboration opportunities with the identified parties. These opportunities could include sharing of data, testbeds, technologies and solutions, lessons learned, and implementation strategies on projects that are similar in nature via a twinning agreement. The parties could also jointly showcase results at an international conference and/or conduct joint demonstrations of prototypes being developed through an establishment of a memorandum of understanding (MOU) or such cooperative agreements to foster technology transfer and capacity building.

17. Key Words	18. Distribution Statement
International collaboration, ATTRI, accessibility, disabilities, navigation and wayfinding, automation, robotics, concierge	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	40	NA

Table of Contents

List of Tables

List of Figures

Executive Summary

Transportation plays a critical role in enhancing access to education, jobs, healthcare, recreation, leisure, and other activities. The United States Department of Transportation's (USDOT's) Accessible Transportation Technology Research Initiative (ATTRI) program leads the research, development, and implementation of transformative technologies, solutions, applications, and systems that allow people of all abilities to effectively and independently plan and execute their travel. ATTRI is a joint USDOT initiative, co-led by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), with support from the Intelligent Transportation Systems Joint Program Office (ITS JPO), National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR), and other federal partners.

This ATTRI International Research Coordination project aims to: (1) identify promising transportation technologies and applications around the world; (2) establish communications with relevant program leads; and (3) develop an International Coordination Plan to guide future international coordination and collaboration efforts. Based on the results of Task 3, which explored eight international initiatives, the project team selected two initiatives for further collaboration with the USDOT ATTRI program. This report focuses on an international coordination plan for initiatives identified in the United Kingdom and Japan. The agencies within these two countries are the Center for Connected and Automated Vehicles (CCAV) in the United Kingdom and the Ministry of Land Infrastructure Transport and Tourism (MLIT) and Strategic Innovation Creation Program – Automated Driving for Universal Services (SIP-adus) in Japan.

For each selected international agency, the team developed a detailed coordination plan that outlines the short-term and long-term strategies to build on the relationships established through this project, continue dialogue, and realize one or more collaboration activities. This coordination plan is expected to help identify a variety of collaboration opportunities with the identified parties. These opportunities could include sharing of data, testbeds, technologies and solutions, lessons learned, and implementation strategies on projects that are similar in nature via a twinning agreement. The parties could also jointly showcase results at an international conference and/or conduct joint demonstrations of prototypes being developed through an establishment of a memorandum of understanding (MOU) or such cooperative agreements to foster technology transfer and capacity building.

CCAV is an organization within the UK Government that funds and oversees several vehicle automation projects (related to both policy and technology) with increasing emphasis on supporting people with disabilities and older adults. The organization is focused and moves at a fast pace. CCAV representatives appear open to collaborating with the ATTRI program despite their organization having a quicker pace than ATTRI. The project team considers their quick pacing to be an advantage. The team identified GATEway, UK Autodrive, and INSIGHT as ongoing projects (funded by CCAV) of interest to the ATTRI program for potential collaboration. The agency is also in the process of funding several relevant future projects that will provide opportunities for twinning with the USDOT ATTRI projects.

MLIT and SIP-adus are government agencies in Japan that fall under different ministries. These agencies are working on several innovative technologies and applications to improve mobility options for older adults and people with disabilities, with a special focus on the 2020 Olympics and Paralympics. The cultural and language barriers with Japan limits the availability of information, thus slowing the pace of building a relationship for collaboration with the USDOT ATTRI program. Developing this relationship will take time and will require following the right protocols for effective communication. While it is important to reach out through appropriate channels, it is equally important to be specific about ATTRI's approach and desired outcomes. Current ongoing projects of interest to the ATTRI program that show potential for collaboration include the Pedestrian Information Communication System (PICS) and the first/last mile automation mobility research projects, which are sponsored by SIP-adus, and the Indoor High-Precise Positioning project, which is sponsored by MLIT. The nature and type of this collaboration can be better defined and pursued once the ATTRI Broad Agency Announcement (BAA) projects are selected.

We expect that the phasing of collaboration will focus on ramping up activities with CCAV in the short to mid-term (3 to 6 months) while at the same time developing the relationship with MLIT and SIP-adus further. Active collaboration with MLIT and SIP-adus is more likely in the mid to long-term (6 to 12 months). These collaboration activities are expected to bring significant benefits to the ATTRI program. For example, in the short term, ATTRI could leverage existing technology advances from around the world and adapt the same technologies for U.S. adoption. This will accelerate the deployment of innovative applications that improve travel options for people with disabilities and older adults. It will also allow the USDOT to stretch the investment dollars to see greater benefits. In the medium to long term, harmonizing accessible data standards will enable easy sharing of data among public agencies. These open data sets can then be used by the private industry to develop innovative transportation applications that enhance accessibility for people of all abilities.

Chapter 1. Introduction

Along with several federal partners, the USDOT's ATTRI program conducts research to improve the mobility of travelers with disabilities through the use of ITS and other advanced technologies. ATTRI leads the research, development, and implementation of transformative technologies, solutions, applications, or systems for people of all abilities to effectively plan their personal and independent travel.

ATTRI Vision

ATTRI is a joint USDOT initiative, co-led by the FHWA and FTA, with support from the ITS JPO and the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR). ATTRI works cooperatively with federal partners, such as the Interagency Committee on Disability Research (ICDR), the U.S. Access Board, the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC), and other public and private organizations. Working with these organizations, ATTRI can leverage technologies and innovations from disability research and development activities to improve accessible transportation for travelers with disabilities, and extend these benefits to all travelers.

ATTRI will enhance the capability of travelers to reliably and safely execute independent travel. ATTRI will identify, develop, and deploy new transformative technologies, applications, or systems – along with supporting policies and institutional guidance – to address the mobility challenges of all travelers, and particularly travelers with disabilities. ATTRI research will focus on the needs of three stakeholder groups (people with disabilities, veterans with disabilities, and older adults) and four functional disabilities (visual, hearing, cognitive, and mobility) within these groups. ATTRI will then develop technological solutions to lower or remove the transportation barriers that affect these stakeholder groups with the specified functional disabilities.

ATTRI leverages recent advances in vehicle, infrastructure, and pedestrian-based technologies, as well as accessible data, mobile computing, robotics, artificial intelligence, object detection, and navigation. The technology is enabled by wireless communications that connect travelers and their mobile devices with other travelers, vehicles, and infrastructure. The technologies used by ATTRI provide almost ubiquitous access to a wealth of real-time situational data sources, including data specific to transportation, municipalities, and points of interest; crowd-sourced information; and accessibility data. Five technology areas have emerged as ATTRI focus areas:

1. Wayfinding and navigation
2. Assistive technologies
3. Automation and robotics
4. Data integration
5. Enhanced human service transportation.

Overview of ATTRI

Target Population

Transportation plays a critical role in enhancing access to education, jobs, healthcare, recreation, leisure, and other activities. ATTRI research is targeted towards addressing the needs of three stakeholder groups, which are described in detail below. Throughout the documents, they are also referred to as (ATTRI) users or stakeholders.

People with Disabilities

In 2012, the U.S. Census found that there were 56.7 million people in the United States with some form of disability, representing 18.7 percent of the U.S. population.[1] The U.S. Bureau of Labor Statistics reports that in 2013, only 17.6 percent of persons with a disability, or one in six, were employed.[2] In contrast, the employment-population ratio for those without a disability was 64 percent. Lower employment has a direct impact on economic well-being. People with disabilities have half of the household income of people without disabilities and are three times more likely to be living in poverty. This problem is compounded with the fact that people with disabilities usually have considerably higher costs for daily tasks, such as transportation.

Veterans with Disabilities

As of January 2007, 1.4 million U.S. service men and women had been deployed to war zones, and more than one-third of recent veterans report having a service-connected disability.[3] In 2012, the percentage of working-age civilian veterans with a VA determined Service-Connected Disability was 20.2 percent.[4] Since veterans acquire their disabilities as adults, many are not familiar with using transit or paratransit services as part of daily life. Moreover, 40 percent of veterans reside in rural areas, where public transportation services are less available.[5]

Older Adults

There are 40.3 million people age 65 or older living in the United States, according to the 2010 U.S. Census.[6] Of those living outside nursing homes, 19.2 million – or roughly 50 percent – reported some kind of disability. The incidence of disability increases dramatically as the population ages.[1] With the aging of the Baby Boomer generation, the number of people age 65 or older is expected to grow to 88.5 million by the year 2050.[7] A majority of those 50 years and older intend to live independently in

[1] http://www.census.gov/prod/2012pubs/p70-131.pdf
[2] http://www.bls.gov/cp
[3] http://papers.ssrn.com/sol3/papers.cfm?abstract_id=939657
[4] http://disabilitystatistics.org/reports/2012/English/HTML/report2012.cfm?fips=2000000&html_year=2012&subButton=Get+HTML
[5] http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rrd_99.pdf
[6] https://www.census.gov/prod/cen2010/briefs/c2010br-09.pdf
[7] https://www.census.gov/newsroom/releases/archives/facts_for_features_special_editions/cb12-ff07.html

their homes and communities, a recent American Association of Retired Persons (AARP) study found.[8]

Technology Areas

ATTRI focuses on five (5) technology areas to improve transportation for stakeholders: wayfinding and navigation, assistive technologies, automation and robotics, data integration, and enhanced human service transportation. An overview of each technology is provided in Figure 1-1 and the text that follows.

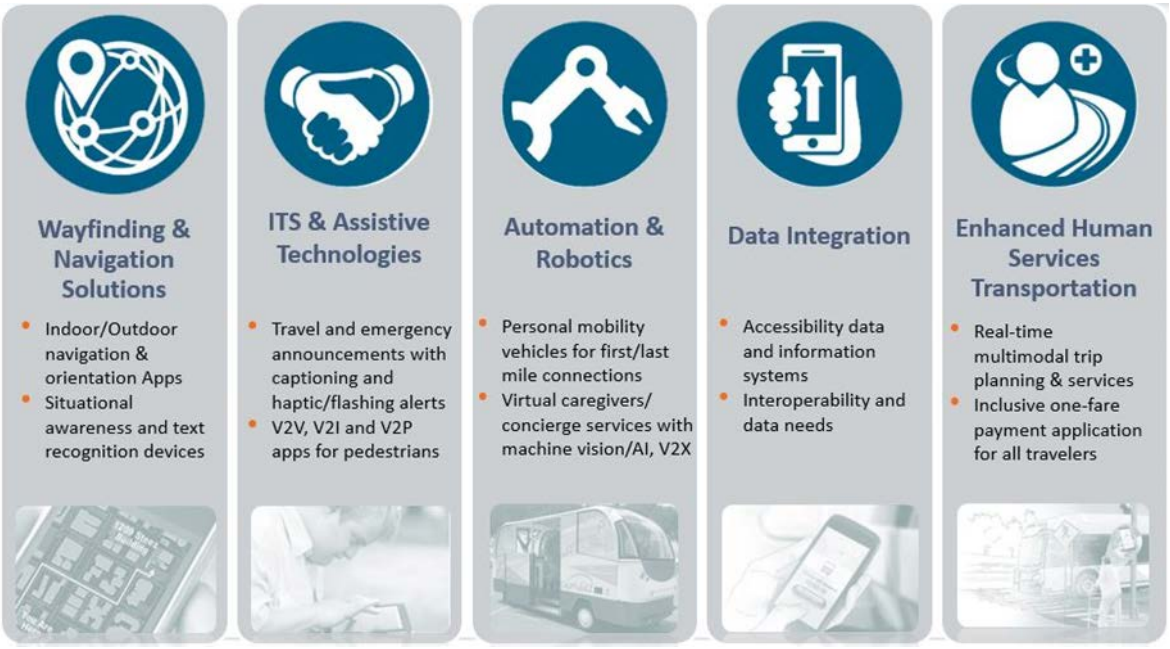

Figure 1-1. Five ATTRI Technology Areas (*Source: USDOT ATTRI*)

Wayfinding and Navigation

Wayfinding is the determination of a route of travel. *Navigation* refers to the means at the individual's disposal by which they can traverse that route, such as following a textured pavement or moving from one landmark to another. Processes that comprise wayfinding and navigation include familiarization, localization and orientation, path planning, path traversal (locomotion), guidance, annotation, update, and communication.

This area consists of exploration and developing situational awareness and assistive navigation solutions that can provide obstacle avoidance and intelligent wayfinding capabilities in indoor and outdoor environments. These solutions assist with waypoint navigation, path planning, and advanced warning of events by using Global Positioning System (GPS), geographic information system (GIS), and ITS equipment and technologies. These applications can recognize and detect stationary objects

[8] http://www.aarp.org/content/dam/aarp/research/public_policy_institute/liv_com/2014/what-is-livable-report-AARP-ppi-liv-com.pdf

(e.g., doors, elevators, stairs, crosswalks, and traffic lights); read and recognize important text and signage based on a user's query; and detect, track, and represent moving objects and dynamic changes to a traveler's environment (e.g., people, shopping carts, doors opening, and moving vehicles). Wearable sensors, such as cameras, three-dimensional orientation devices, and pedometers, may be used in conjunction with a display unit to provide auditory and tactile guidance.

ITS and Assistive Technologies

An *assistive technology* is a technology that facilitates the functional independence of a user in any one of the four transportation challenge areas. The broad range of wireless and sensor-based communications and information technology employed in ITS, combined with a number of other assistive technologies, can create new and innovative accessible transportation solutions. This includes the traditional accessible, assistive, and adaptive devices that currently help with daily living activities as well as new nomadic or carry-on devices. Together, these technologies will help track the user's movements, infer map information, and discover key sensor signatures to create routes and provide information in different accessible communication formats: audible, tactile, and haptic. The devices used may include new innovations from the "the Internet of Things (IoT)" being applied to wearable technology, such as wristbands, glasses, or clothing. These technologies will also integrate with vehicles, infrastructure, and pedestrians using Dedicated Short Range Communication (DSRC) or other communication technologies to provide vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communications, which allow for connectivity throughout a trip. This area will also explore other emerging technologies within the connected vehicles, connected automation, and connected cities initiatives under the USDOT's connected vehicle research program.

Automation and Robotics

Automated vehicles and robotics are expected to improve mobility for those unable or unwilling to drive. They are also expected to enhance independent and spontaneous travel capabilities for travelers with disabilities. One area of particular interest is exploring the use of vehicle automation to solve first mile/last mile mobility issues, possibly providing connections for all travelers to existing public transportation or other transportation hubs. Applications in this area may also include collaborative robots that not only assist with activities in daily life such as walking, but also work with individual travelers and human transportation services to provide related concierge services at different stages of their travel and hence improve personal mobility across the transportation network. Some other areas of interest include machine vision, artificial intelligence, assistive robots (potentially partially humanized), and facial recognition software to solve a variety of travel-related issues for people with disabilities in vehicles, devices, and terminals. These technologies could be used to create virtual caregivers, concierge services, and other applications to guide travelers and assist decision making.

Data Integration

This technology area includes solutions that enable the integration of data and information systems to create new accessible transportation applications. The data integration technology area has two main aspects: information that travelers with disabilities need and information that travelers with disabilities can provide. Travelers with disabilities need in-depth accessibility information about points of interest (POIs), infrastructure, facility amenities, and potential obstacles, integrated with maps and other information for their intended route. In addition, a traveler with accessibility needs can provide his or

her specific information to build a standardized user profile that allows for location-based services both locally and nationally. Applications can be developed based on user profiles to alert relevant authorities in advance of a user's trip that the traveler may require special accommodations, such as a wheelchair at the airport.

Enhanced Human Service Transportation

Human service transportation is transportation for clients of a specific human or social service agency. The focus of the *enhanced human service transportation (EHST)* technology area is real-time, multimodal trip and services planning, and traveler decision support applications that assist travelers with finding and choosing accessible transportation solutions that best meet their mobility needs. This may include pre-trip planning and information that integrates multimodal options into a complete origin to destination trip. Applications in this area could include an integrated payment system where travelers can use the same smart card or mobile app to pay for various types of transportation, mobility options, and parking. Other applications of interest are linking paratransit, demand-response transportation, and fixed-route transit in order to increase flexibility and options for travelers with disabilities.

Application Areas

The ATTRI Program also conducted a series of user needs and challenges workshops in 2015. Four applications areas and four foundational considerations were identified from these workshops. They are described below.

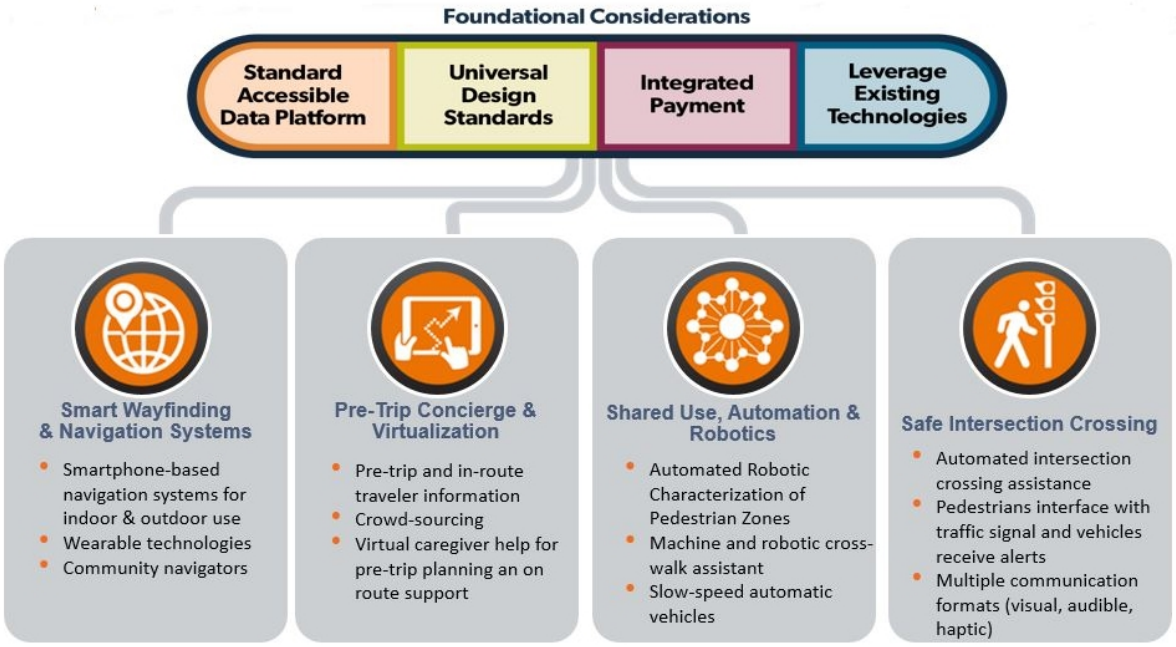

Figure 1-2. Four Application Areas and Four Foundational Considerations (*Source: USDOT ATTRI*)

Application Area 1: Smart Wayfinding and Navigation Systems

Applications developed within the smart wayfinding and navigation realm will provide real-time, en-route assistance and situational awareness to ensure travelers can safely reach their destinations while traveling independently. These technologies could include, but are not limited to:

- Wayfinding and navigation systems for indoor and outdoor use
- Beacons or electronic tags to interact with the built and pedestrian environment
- Transmittable data in multiple communication formats (e.g., visual, audible, haptic) including multiple languages
- Wearable technologies acting as discreet assistive navigation tools; connection with assistive mobile devices already in use (e.g., white cane, wheelchairs, smartphones)
- The use of community volunteers providing accessibility data on neighborhoods, buildings, and infrastructure elements, including crowd sourced public/private maps for indoor and outdoor spaces for the real-time use of travelers with disabilities.

Processes that affect wayfinding and navigation include familiarization, localization and orientation, path planning, path traversal (locomotion), guidance, annotation, update, and communication. Wayfinding and navigation solutions will assist with waypoint navigation, path planning, advanced warning of events, recovery from route mistakes, navigation in unfamiliar locations, and changes in environment by using Global Positioning System (GPS), geographic information system (GIS), information and communication technology (ICT), and ITS equipment and technologies. These applications will then recognize and detect stationary objects (e.g., doors, elevators, stairs, crosswalks, and traffic lights); read and recognize important text and signage based on a user query; detect, track, and represent moving objects and dynamic changes to a traveler's environment (e.g., people, shopping carts, doors opening, and moving vehicles); and provide one button push notification to send location information from a smartphone to a van or bus. Wearable sensors – such as cameras, three-dimensional orientation devices, and pedometers – may be used in conjunction with a display unit to provide auditory and tactile guidance.

While there is useful data in existing map systems, they often lack critical data relevant to ATTRI stakeholders. For example, a points of interest database may give the location of a store, but not where the entry door is, whether there are steps at the door, or if the location has an accessible bathroom. In addition, wayfinding and navigation systems can support the transition from paratransit to fixed route transit services.

Application Area 2: Pre-Trip Concierge and Virtualization

Technology solutions focusing on providing pre-trip concierge services and route virtualization could include, but are not limited to:

- Providing pre-trip and en-route traveler information throughout the trip
- Design for people with blindness, low vision, cognitive, and mobility issues
- The ability for passengers to "see" their entire routes on an app with landmarks – removing fear and facilitating independent mobility
- Contextual details with augmented voice overlays

- Virtual caregiving technology to help plan routes, track travelers' movement, and provide connectivity to caregivers and family members.

Applications in this area could include new technology solutions that assist travelers with activities in everyday life, such as walking or getting to work seamlessly with unique traveler mobility needs and human transportation services to provide concierge services at different stages of travel. Applications could improve personal mobility by learning and remembering transportation network routes. Applications can accomplish this by integrating data, personal needs, and profiles alongside available services. Pre-trip concierge and visualization applications could also relay traveler information for multiple transportation choices – including cost, accessibility accommodations, distances, travel times, and integration with other modes for first mile/last mile options. Machine vision, artificial intelligence, assistive robots, and facial recognition software could help solve a variety of travel-related issues for people with disabilities in vehicles. Devices, virtual caregivers, or concierge services at terminals could help guide and travelers with decision making while connecting with their caregivers and family members. For example, if applications in this area where applied to transit systems and stations, virtual exploration devices could help visually impaired travelers familiarize themselves with the layout of a building or of the overall transportation network. In addition, for users of paratransit and taxicab type services, applications could track vehicle location and how long it would be before it arrives at the pickup location. Additional examples of applications in this area could include:

- Planning, reservations, and travel itinerary solutions for people with disabilities
- Pre-trip and en-route crowd-sourced traveler information
- Technical design solutions for stakeholder (particularly people with blindness, low vision, cognitive, and mobility issues)
- Technologies that enable passengers to view their route on an app with landmarks
- Virtual caregiver applications that help plan routes and track traveler movements, including the creation of voice assistant applications (similar to Apple's Siri) with a family member's voice overlay to help those with cognitive disabilities.

Accessible transportation applications in this area may leverage emojis to allow stakeholders to easily interpret information on smartphone apps and transportation infrastructure.

Application Area 3: Safe Intersection Crossing

Safe navigation of crosswalks can be a key challenge for people who need more time to traverse an intersection. For example, if there is no mid-intersection safe island zone then signal light duration becomes very important. Within this application area, key focus areas are providing safe intersection crossing assistance for all unique travelers as they interface with existing traffic, signals, vehicle types, and assistive devices. It is imperative that technological solutions, (including design) focus on assistive tools for people with blindness, low vision, cognitive, and mobility issues. Assistive tools may be in the form of personal nomadic devices, wearable technologies, and kiosks on streets corners to allow for ubiquitous access to connected services.

Applications in this area should provide guidance, notifications, and alerts in various communication formats that assist pedestrians and all transportation system users to safely navigate through intersections. The applications should focus on providing precise and concise information when it is

needed to promote decision making and actions. These applications could include, but are not limited to, the following components:

- Pedestrians interface with traffic signals, vehicles, nomadic devices, and automated intersection crossing assistance
- Sensors or electronic tags to interact with the built and pedestrian environment, including support for multiple languages and sharing of real-time information.

Applications should provide contextual information, including GIS and crowdsourced based information on curb cuts, bus stop locations, sidewalk grade and slope, and any disruption of the built environment (e.g., damaged infrastructure, dead ends, potholed) to aid all travelers. Additional examples could include futuristic and innovative approaches to solving this issue with automated intersection crossing assistance; technical design solutions for people with blindness, low vision, cognitive and mobility issues; or integrated beacons or electronic tags to interact with the built environment.

Application Area 4: Shared Use, Automation, and Robotics

Applications in this area include robotics and automation technologies that have the potential to bring about many transformational changes to independent living and overarching transportation barriers (such as lack of or inaccessible signage, maps, and announcements; lack of information on arrival times, transfer times, and travel distance; and inconsistent accessible pathway infrastructure). Research efforts show the potential benefits of robotics and automation for personal independent mobility. Robotic and automation technologies affect our lives behind the scenes every day, and now these technologies are becoming more apparent in our everyday lives. Applications in robotics that are currently under development include collaborative robots that not only assist with activities of daily life (such as walking), but also work with individual travelers and human transportation services to provide related concierge services at different stages of their travel. These applications could improve personal and independent mobility across the entire transportation network, including transportation terminals, home, work, and healthcare destinations.

Major efforts to support the development of fully autonomous vehicles (FAVs) are underway in both the public and private sector. For instance, the USDOT has recently launched the Automated Vehicle Research program. USDOT research aims to enable and accelerate the development and deployment of connected and automated vehicles; ensure safe and efficient operations of emerging technologies and systems; and maximize public benefits by leveraging connected vehicle technologies, infrastructure-based solutions, and other approaches. Private sector technologists, companies, and car manufacturers are also developing and testing personal automated vehicles. Similarly, in Europe, research and development activities, such as CityMobil2, have been implementing and testing automated transit vehicles in urban environments.

For surface transportation, advances in these emerging technologies offer a promise of improved mobility including greater safety, energy efficiency, and better multimodal connectivity and accessibility. FAVs and robotics are expected to improve mobility for those unable or unwilling to drive, and enhance independent and spontaneous travel capabilities for all travelers – including solving first mile/last mile mobility issues, providing connections to transportation hubs, and addressing “door through door” travel. These technologies and other such applications, whether incorporated into

vehicles, personal devices or within terminals, might also enable virtual caregivers or concierge services to guide travelers and assist with decision making.

Foundational Considerations

The ATTRI application development process seeks to spur innovation among accessible transportation concepts to provide inclusive and seamless door through door independent mobility to all travelers, including those with disabilities. Foundational considerations should be reviewed together as elements of each application and work tangentially to the degree possible. Foundational considerations are listed below:

Standard Accessible Data Platform

Data standardization and interoperability is critical for developing applications that aspire to enhance the personal mobility of those with the greatest needs. Data must begin to work across service providers; utilize available real-time data sources; and communicate in an efficient, succinct, and adaptable manner to meet individual user needs with various degrees of abilities. Technology applications to be considered for ATTRI development will provide almost ubiquitous access to a wealth of real-time, situational data sources, including data specific to transportation systems, municipalities, points of interest, and crowd-sourced information in accessible formats utilizing inclusive ICT. Applications may consider standardized data to create user profiles, allowing smoother access and transfers between accessible transportation services.

Universal Design Standards

Universal design standards incorporate a philosophy that promotes maximizing the applicability of a technical solution to the needs of all user groups. In relationship to ATTRI application development, it is presumed that all work attributed to building applications for ATTRI stakeholder use will pursue universal design principles including inclusive ICT solutions. Implementing these principles during development could include leveraging existing solutions and enhancing them to meet the needs of all users, as such user center and responsive design approaches, personalization techniques are expected to be followed for applications including implementing multiple communication formats (e.g., visual, audible, haptic) where possible. Likewise, consideration should be given to incorporate user profiles and documented needs from all stakeholder and ability groups, and creating user experiences with information sharing on any display associated with such applications in built and pedestrian environments including wearable and nomadic devices. The feasibility of mainstream adoption of such technological solutions should also be considered for all functional disabilities types.

Integrated Payment Solutions

Integrated payment systems typically incorporate interoperable electronic fare payment media and technologies that can be utilized across all modes of transportation, at all times – perhaps for multiple consumer purposes, including leisure, recreational and healthcare expenses. The vision for a multimodal integrated payment system is to deliver the ease of use and convenience that comes from one real-time electronic payment system and extend that ease across modes and through institutional and technical collaborations. Integrated payment solutions should accommodate all users, including those with mobility, vision, hearing, and cognitive disabilities. In such cases where possible,

consideration should be given to integrate payment solutions with any application or device, such as embedding it on a power wheelchair or on a robotic device.

Leverage Existing Technologies

To maximize the impacts of ATTRI and to respond most effectively to the needs of all users and stakeholders, any application being developed under the initiative should leverage, to the degree possible, existing technologies, including, but not limited to:

- ITS JPO
- Application Program Interface (API)
- Software Development Platform
- Software Development Kit
- On-demand technologies
- Data standards
- Innovative smartphone and mobile technology
- Wearable technology
- Accessible transportation technologies
- Other assistive and enabling technologies, operations, and/or techniques, whether currently being pursued in research, or readily available in the market.

Report Organization

This concludes Chapter 1 of this report, which serves as the report's introduction and provides an overview of the ATTRI program and its various components that include target population groups, focus technology areas, and application areas. Chapter 2 provides an overview of the ATTRI International Coordination project and describes the approach taken by the project team to develop this international innovation coordination plan. Chapter 3 describes the first coordination plan with the CCAV group and Chapter 4 describes the second coordination plan with MLIT and SIP-adus in Japan. Finally, Chapter 5 provides strategic recommendations for continued dialogues and coordination to help ATTRI achieve its goal of international collaboration.

Chapter 2. International Research Coordination

Overview

Transportation professionals and disability advocates around the world are currently exploring various technologies and approaches that aim to address the needs of travelers with disabilities, including older adults. For instance, CityMobil2 demonstrated automated transport systems in several unique environments across Europe. Japan is evaluating the use of new technology that incorporates automation to ease the issues of mobility on their growing older adult population.
There are many other examples around the world where researchers are developing innovative technologies and solutions focusing on accessible transportation. Many of these systems and/or services are already being implemented in Europe and Asia, and could possibly be applied in the United States.

Specific objectives of this International Research Coordination project include:

- Identifying current accessible transportation technologies and applications around the world, especially in the fields of automation and robotics for human transportation
- Establishing communications with relevant accessible transportation technology research programs underway around the world for in-depth assessment of U.S. applicability
- Prioritizing promising accessible transportation technologies around the world for further coordination with ATTRI for short-term, mid-term, and long-term considerations.

Scope

In order to meet the goals of the ATTRI International Research Coordination project, four main tasks were executed:

- Task 1: Project management
- Task 2: Identify relevant accessible transportation technologies around the world and assess and prioritize opportunities for USDOT collaboration and partnership
- Task 3: Conduct and facilitate coordination dialogues between the USDOT and selected international research and development initiatives
- Task 4: Develop an International Innovation Coordination Plan.

Approach

To successfully deliver the requisite deliverables, the team researched international applications in all ATTRI technology and application areas, including other related accessible transportation technologies, that serve the transportation needs of the ATTRI program's target population. The team then established a working relationship with the creators and purveyors of those technologies and prioritized these initiatives for future collaboration.

Task 2: Identify Relevant Accessible Transportation Technologies Around the World and Assess and Prioritize Opportunities for USDOT Collaboration and Partnership

The goal of this task was to identify, assess, and prioritize the most promising technology initiatives around the world that address mobility challenges faced by the ATTRI target user community. This process involved three steps. First, the team relied on subject matter experts and extensive online research to identify approximately 50 relevant accessible transportation technologies from around the world. Second, the convened international expert panel members were engaged to prioritize the list of projects and recommend any projects that were not in the list. Based on the expert panel feedback and qualitative analysis, a list of the top 20 projects were selected for further assessment. Detailed summaries were developed for the top 20 projects and a list of 12 criteria for assessment were defined based on the goals of the project. Third, the top 20 projects were quantitatively scored based on how well each project met the set of criteria.

The criteria were weighted based on their level of importance to the ATTRI program and the weights were applied to the scores each project received to calculate their weighted average. For qualitative analysis, the team looked at the potential for collaboration, project timelines, and funding agency information. Based on the weighted average and qualitative analysis, a prioritized list of eight projects were selected for further investigation. The final eight projects identified for consideration are provided below (in no particular order):

1. Cities Unlocked (Microsoft 3D Soundscape Headset) (United Kingdom)
2. Pedestrian assistance systems by SIP-adus (Japan)
3. Blindsquare (Finland)
4. Green Man + (Singapore)
5. Inclusive Design Research Center (IDRC) (Canada)
6. assisted Mobility for Older aNd impaired users (SIMON)
7. Singapore-MIT Alliance for Research and Technology (SMART)
8. Wheelmap (Germany).

Task 3: Conduct and Facilitate Coordination Dialogues between USDOT and Selected International Research and Development Initiatives

The goal of this task was to identify relevant points of contacts for the top eight projects identified in Task 2 and facilitate coordination dialogues between the USDOT ATTRI program and the selected international agencies. The final prioritized list had projects from Japan, the United Kingdom, Singapore, Germany, Finland, and Spain. The team reached out to respective project leads and held preliminary calls to better understand their objectives, timeline, and next steps. The summaries of the coordination dialogues and materials exchanged were captured in either a white paper or a field visit report. The rationale for choosing the method of coverage is described below.

White Papers

The initial conference calls helped the team determine which of these projects warranted a white paper versus a field visit to get more details. For example, the initial conference call with Wheelmap confirmed that the project was entirely cloud based and there was nothing tangible to see or learn from a field visit to Germany, where the project is based. Another example is Green Man +, a Singapore based project that was of high interest to the ATTRI program. The initial calls indicated that there were no plans or interest in the near future to enhance their technology further to accommodate international deployments. There were no other projects of interest in Singapore and hence the cost of travel would outweigh potential benefits from a trip there. Similarly, Spain and Finland also fell off the list of field visit candidates. Instead, detailed white papers, based on information available and information obtained from the conference calls with respective points of contact, were developed. These white papers were consolidated into a separate report which outlines the communications dialogue held, technical information gathered on the projects, project timelines, costs, willingness to collaborate, relevance to ATTRI, and recommended next steps. The six whitepapers developed include:

1. BlindSquare
2. Green Man Plus
3. Inclusive Design Research Center (IDRC)
4. assisted Mobility for Older aNd impaired users (SIMON)
5. Singapore-MIT Alliance for Research and Technology (SMART)
6. Wheelmap.

Field Visits

As the team engaged in preliminary conference calls and exchanged background materials with project leads in the United Kingdom and Japan, multiple initiatives of interest to the ATTRI program came to light. Due to this strong focus on ATTRI-relevant goals and robust government funding, Japan and the United Kingdom were identified as strong candidates for field visits. Visits to the United Kingdom and Japan helped understand the potential for collaboration and to gauge interest of various agencies in those countries. A separate fact finding report was produced for each field visit.

Task 4: Develop International Innovation Coordination Plan

All the projects/organizations the team met during field visits were different in nature and scope and thus could not be directly compared to one another. Instead these organizations were evaluated based on a set of criteria similar to the ones established in Task 2. As more information became available from continued dialogue with the international project leads, the Task 2 criteria evolved to the following:

- ✓ Relevance to the ATTRI program
- ✓ Target communities
- ✓ Willingness to collaborate
- ✓ Structure of the organization

- ✓ Potential for long term collaboration such as twinning[9] opportunities
- ✓ Potential for joint demonstrations.

Based on these criteria, the nature of the discussions, field visits, and the team's analysis, two international agencies were selected for further collaboration activities. The United Kingdom's Center for Connected and Autonomous Vehicles (CCAV) was one of the agencies. Both CCAV and ATTRI have procurements open for competitive bid and will choose the candidate projects early next year (2017). The ATTRI procurements are focused on developing prototypes for the program's four application areas (wayfinding and navigation, automation and robotics, pre-trip concierge and virtualization, enhanced human service). The CCAV procurements are focused primarily on automation. The timeline for both agencies align nicely and set the stage for exploring twinning opportunities as more details become available.

Japan's Ministry of Land Infrastructure, Transport and Tourism (MLIT) and the Strategic Innovations Program – Automated Driving for Universal Service (SIP-adus) were identified as the other agencies for collaboration. These public agencies fund several transportation technology projects to improve mobility options by the 2020 Olympics and Paralympics for all people, including older adults and those with disabilities. Though potential for collaboration with the Japanese agencies are still not very clear, there is huge potential for mutual benefit from continuing conversations and exchanging plans regarding upcoming projects and activities. Details of the coordination plan are described further in Chapters 3 and 4.

[9] The concept of twinning is to run in parallel in an integrated fashion, research projects of similar scope, objectives and timeline that are aligned for the mutual benefit of both sides. Sponsoring agencies on either side identify project areas that are suitable for twinning and include twinning elements in their Request for Proposals (RFPs) / Statement of Work (SOW). A twinning agreement is developed by project teams and approved by all funding agencies before project commences. Project activities feature regular interaction between project teams including at least one face-to-face meeting each year and there is no transfer, sharing, or mixing of project funds between funding entities.

Chapter 3. Coordination Plan #1: CCAV in the United Kingdom

Overview of Collaborative Opportunity

CCAV offers both short-term and long-term collaboration opportunities with the USDOT, given its interest in including accessibility in their connected and automated vehicle (CAV) projects. For example, they re-scoped the GATEway Greenwich project (autonomous shuttles for public transportation) so that it will now have a strong focus on travelers with disabilities. CCAV also noted one category of mobility challenged people as those with limited motor control who are able to drive in general but have difficulty performing maneuvers such as parking. So, for this group, they are researching a smartphone application that will facilitate remote parking. They are also focused on home delivery robots (such as STARSHIP developed by Digital Greenwich) because such technology could help older adults stay in their homes longer, even when they cannot leave to shop, rather than moving to a nursing home. The following characteristics of CCAV makes it attractive as a collaborative partner to the USDOT ATTRI program:

- ✓ CCAV is an overarching government agency that funds and manages several initiatives related to connected and automated technologies, collaborating with Innovate UK for program delivery.
- ✓ As a funding agency, CCAV has advance knowledge of scope and budget for upcoming solicitations for new projects; and have the authority to include international collaboration as part of the solicitation requirements.
- ✓ As a government agency, they are interested in innovative technologies and the policy, implementation, and infrastructure perspectives that support new technology to improve mobility options for all travelers. In other words, they have a focus similar to that of the USDOT and have the authority to sign twinning agreements or initiate MOUs.
- ✓ GATEway, UK Autodrive, and INSIGHT are some ongoing projects, funded by CCAV, and of special interest to the ATTRI program. CCAV is also in the process of funding several relevant future projects and can convene key implementation experts and evaluators to work with similar players in the ATTRI program.

CCAV is also analyzing “social behavior” relevant to CAVs. The study focuses on the question of “how should automated vehicles (AVs) operate around people (of all abilities)?” The study is being conducted by the University College of London, with the report expected by the end of this year (2016). The scope of the next CAV research and development competition has now been published and it can be found here: https://www.gov.uk/government/publications/funding-competition-connected-and-autonomous-vehicles-2.

These projects are expected to start early next year and will last three (3) years. Funding of approximately £30 million has been allotted for these projects, which will focus on an “L4 Grand Challenge” type approach. This will provide several collaboration opportunities for the ATTRI program.

Chapter 3. Coordination Plan #1: CCAV in the United Kingdom

The CCAV is a joint effort across the UK Government, located within the Department for Business, Innovation, and Skills. It is not common for the UK Government to establish cross-cutting groups like this, which emphasizes the importance of CAVs to the UK Government. The CCAV is a policy unit to help ensure that the United Kingdom remains a world leader in developing and testing CAVs by:

- Leading innovative policy development in this sector
- Delivering a program of research, development, demonstration, and deployment activity, worth up to £200 million, through Innovate UK
- Providing coordination across the Department for Transportation (DfT), the Business, Energy and Industrial Strategy (BEIS), formerly BIS, and the rest of government
- Being the single contact point for stakeholder engagement.

CCAV's policy framework is described in more detail in Figure 3-1.[10]

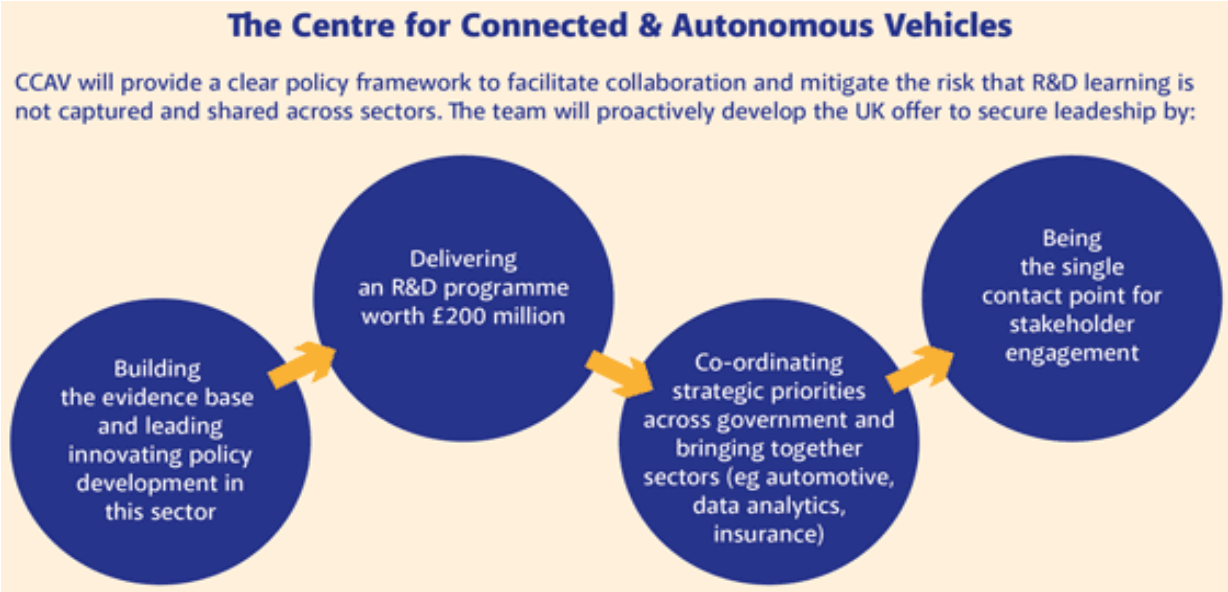

Figure 3-1. CCAV Policy Framework (*Source: ITS UK Review)*[10]

CCAV released their "First Consultation," geared at reforming regulations, in July. The First Consultation sought inputs from industry and others regarding specific AV issues. This process appears to be essentially the same as the "Request for Information" that is used by the U.S. Government. More information on the Consultation is provided here: https://www.gov.uk/government/news/new-measures-to-help-britain-lead-the-way-in-developing-driverless-technology.

[10] http://www.its-ukreview.org/establishing-the-uk-as-the-centre-of-excellence-for-connected-and-autonomous-vehicle-technologies/

Collaboration Structure and Governance

Though the CCAV is flexible and open to collaboration, the structure of the collaboration with the USDOT ATTRI program is not defined at this point. As new projects are funded by CCAV and ATTRI, both organizations need to continue dialogue and build on the relationship that was established through this project. Our team has already identified the points of contact and initiated several dialogues, which sets the stage for future collaboration. Regular communications will help both organizations to identify mutually beneficial collaboration opportunities and respective methods of governance. Once this is well understood, the structure for collaboration in identified areas of mutual interest can be better defined. In the short term, we recommend twinning agreements at the project level for upcoming projects on each side. In the mid to long term, as a first step, we anticipate setting up of a memorandum of understanding (MOU) to facilitate agency-level collaboration.

Identification of Agreement Type

While no official MOU or other official declaration of agreement has been reached with CCAV at this time, leadership from both sides have spoken via conference call and affirmed interest in collaborating on accessibility-related research and development projects. As mentioned above, we recommend setting up an MOU to better define agency-level collaboration aspects, such as scope, schedule, and anticipated results. The MOU can also state either side's interest for collaboration and mutual agreement to share data, lessons learned, and implementation strategies on similar ongoing or upcoming projects without direct transfer or sharing of monies.

Level and Scope of Collaboration

Both ATTRI and CCAV have built a relationship based on mutual interest for collaboration. The two teams are still in the process of scoping this relationship based on upcoming project selections. As a result the level and scope of the collaboration is not clearly defined at this stage. There are several short-, mid-, and long-term opportunities described in the sections that follow.

Short Term:

The key to collaboration is pinpointing specific areas of interest in ongoing CCAV activities and establishing an agreement for coordinated efforts. The CCAV-funded projects of interest to the ATTRI program and potential areas for collaboration are shown in Table 3-1 below.

Table 3-1. Potential Collaboration Opportunities with CCAV

Project/Agency	Potential Collaboration Opportunities For ATTRI
GATEway/Transport Research Lab (TRL)	• Research on barriers of AV technology for people (of all abilities) in a mixed environment • AV design to accommodate people with disabilities • Testing and identifying AV systems to be more inclusive
INSIGHT (CCAV)	• AV design to meet the needs of people with disabilities • Understand interaction of AVs with users of all disabilities in an urban environment • Haptic screens for visually impaired users to experience outside topography
New Projects Funded by the Agency	• Sharing of data, lessons learned in development, regulatory, insurance, liability, etc. • Methodology for user trials and evaluation of results • Opportunities for jointly showcasing results

These projects were further dissected by mapping them to technology areas, applications areas, and foundation considerations of the ATTRI program. Table 3-2 shows how projects and CCAV focus areas map to ATTRI attributes. The boxes shaded in green show areas for potential collaboration.

Table 3-2. UK Projects' Applicability to ATTRI
(Boxes highlighted in green indicate areas for potential collaboration with ATTRI)

Project	Shared Use, Automation and Robotics	Wayfinding and Navigation	Pre-Trip Concierge and Virtualization	Safe Intersection Crossing	ITS & Assistive Technologies	Data Integration	Enhanced Human Service Transportation	Standard Accessible Data Platform	Universal Design Standards and ICT	Integrated Payment Systems	Leverage Existing Technologies and Research
GATEway											
INSIGHT											
CCAV Focus Areas											

The GATEway and INSIGHT projects are already underway and may be complete by the time an agreement is in place between USDOT and CCAV. However, lessons learned from these developments, user trials, and data sharing methods could be beneficial to similar USDOT efforts. Both CCAV and ATTRI have open competitive procurements for projects focused on improving transportation accessibility for people of all abilities. While the ATTRI procurements are focused on developing prototypes for the program's four application areas (wayfinding and navigation, automation and robotics, pre-trip concierge and virtualization, and safe intersection crossing), the CCAV procurements cover a variety of research and development (R&D) projects to make AVs more

accessible to people with disabilities. Both ATTRI and CCAV are scheduled to select their projects by February 2017. These comparable project timelines create an opportunity for establishing twinning agreements between applicable projects on the CCAV and ATTRI sides.

Mid to Long Term:

In the mid to long term, the first step is to establish an MOU or a similar cooperative agreement between ATTRI and CCAV to better define agencylevel collaboration aspects, such as scope, schedule, and anticipated results. Once established based on the desired outcomes defined at the outset, other twinning methods could be implemented in future procurements. Specific tasks in projects on each side could direct researchers to coordinate with their overseas colleagues, including face-to-face meetings.

It would be effective to build the twinning agreements or MOUs so that they fund tasks within projects on either side that will facilitate regular communications and sharing of information with each other. For example, less than 5 percent of a project's overall budget can be allocated for travel to have in-person meetings with similar projects abroad and maintain regular communications to share data and lessons learned. Good intentions for collaboration can have some results but are subject to being de-prioritized when projects come under pressure to deliver based on funded tasks.

Functions of Potential Working Groups

The new projects to be selected by the CCAV and ATTRI in early 2017 will help to better identify the nature and scope of collaboration to take place. As these new projects go forward, three levels of working groups could be implemented:

1. CCAV-ATTRI high-level coordination
2. Technical working groups across all relevant projects
3. Project and topic specific working groups.

These working groups, if established, can be structured to explore several topics of mutual interest to advance technology applications that will improve transportation options for people with disabilities in both countries. Topics to be explored by these working groups could include:

- ✓ Sharing of data, including data elements and formats, for field tests
- ✓ Lessons learned in the development process transferred to commercialization community
- ✓ Lessons learned regarding regulatory, insurance, and liability factors
- ✓ Methodology for user trials and evaluation of results
- ✓ Opportunities for jointly showcasing results at ITS World Congress and other important international events of relevance.

Major Collaboration Activities and Schedule

As part of this project, we narrowed down CCAV as a potential collaborator and established relations with the agency. However, given where CCAV and ATTRI are in their respective programs, specific

collaboration activities were challenging to define at this stage. Preliminary collaboration activities in the planning stage include:

1. USDOT will schedule a meeting (either remotely or in person) with CCAV members in Spring 2017. This meeting will explore twinning opportunities based on new projects that are funded from both sides and initiate a dialogue regarding establishing an MOU.
2. In mid to late 2017, USDOT and CCAV should scope out and formalize an MOU to facilitate agency-level coordination and future twinning opportunities.

Once the scope of newly funded projects are well understood, areas of mutual interest can be identified. Major collaboration activities around these areas of interest and a schedule for the activities can then be defined. Thus, as a next step, continuing communications with the CCAV can help explore the nature, type, and scale of collaboration envisioned. At a minimum the following should be explored:

- ✓ Collaboration structure and governance
- ✓ Identification of agreement type
- ✓ Level and scope of collaboration
- ✓ The need for working groups, if any
- ✓ Major collaboration activities and schedule
- ✓ Key benefits expected for both sides.

As one potential example, pilots of automated shuttles or robo-taxis to support the mobility of mobility-challenged persons could be running in both the United Kingdom and the United States. Data elements in datasets to be collected, methodology for user trials, and vehicle design to accommodate different disability types could be harmonized during the project definition process. Once underway, ATTRI and CCAV can share lessons learned and findings from user questionnaires, which will lead to a more holistic evaluation of the pilots.

Key Outcomes and Expected Impacts

Collaboration with CCAV can be vital for several reasons. It helps promote innovations in research endeavors and provide common understandings of automated vehicles deployments and other technologies in accessible transportation to enhance travel experience for people with disabilities and older adults. Additionally, the collaborative process fuels itself: endeavors can help uncover additional fertile opportunities for future research. It can reduce costs for those items such as standards development that are applicable across regions, and Industry is generally supportive of cross-governmental collaboration since it helps create more universal solutions to common problems. Specifically for the ATTRI program, benefits could include:

- ✓ Defining a common research methodology that can encourage twinning project agreements, joint user trials and joint evaluation of prototypes and results
- ✓ Showcasing research results or demonstrating a prototype in collaboration with CCAV at an international conference/event
- ✓ Motivating public agencies in the United States and the United Kingdom to invest in technologies that support mobility-challenged citizens

- ✓ Harmonizing design standards for automated shuttles to be more inclusive of people with disabilities and older adults. This will enable development of automated shuttles that could be deployed in both the United States and the United Kingdom catering to people of all abilities.

Leveraging existing technology advances from the United Kingdom and adapting the same for U.S. adoption. This will accelerate deployment of innovative applications that improve travel options for people with disabilities and older adults in the United States.

Chapter 4. Coordination Plan #2: MLIT and SIP-adus in Japan

Overview of Collaborative Opportunity

Both SIP-adus and MLIT offer short-term and long-term collaboration opportunities with the USDOT, given their goal to improve transportation options for people of all abilities and older adults prior to the 2020 Olympics and Paralympics scheduled to take place in Tokyo. To achieve this goal the agencies are focused on developing, testing, and piloting innovative technology applications in Tokyo. The following characteristics of MLIT and SIP-adus makes them attractive as a collaborative partner to the USDOT ATTRI program:

- ✓ Both are overarching government agencies that fund and manage several initiatives related to innovative technologies for all people, including people with disabilities and older adults.
- ✓ They are specially focused on delivering results prior to the 2020 Olympics and Paralympics, and thus align well with the ATTRI program's timeline.
- ✓ As funding agencies, both of these agencies will have advance knowledge of scope and budget for upcoming new project solicitations; and they have the authority to include international collaboration as part of the solicitation requirements.
- ✓ As a government agency, they are interested in innovative technologies and the policy, implementation, and infrastructure perspectives that support new technology to improve mobility options for all travelers. In other words, they have a focus similar to that of the USDOT and have the authority to sign twinning agreements or initiate MOUs.
- ✓ Some on-going projects of interest to the ATTRI program include:
  - ✓ First/Last Mile Mobilit Research sponsored by METI but led by SIP-adus
  - ✓ Pedestrian Information Communication System (PICS) sponsored by SIP-adus
  - ✓ Indoor High-Precise Positioning project sponsored by MLIT.

However, collaboration with Japan comes with cultural protocols and language barriers that necessitate a methodical approach to building relationships. A few logistical factors the team kept in mind while initiating and maintaining communications with Japanese agencies include:

- The Japanese fiscal year begins on April 1. Many personnel changes take effect that day.
- Formal communications protocol should be strictly followed in order to effectively communicate. Usually any form of communication to the Japanese government should be initiated by USDOT counterparts.
- SIP-adus is sponsored by the Japanese Cabinet and staffed by private industry, such as Original Equipment Manufacturers (OEMs) like Toyota, Honda, Suzuki, and others).
- Collaboration and coordination takes time due to material translation issues.
- It will take time and effort to translate documents and materials related to projects of interest both to and from Japanese for bi-directional communication.
- As a first step, it is important to identify the right contacts at the Cabinet level and at MLIT for collaboration and then reach out to these contacts through the appropriate JPO channels.

SIP-adus

The Cabinet Office's Council for Science, Technology, and Innovation established SIP as a new program to promote effective measures across ministries and to create innovation beyond the borders of disciplines, ministries, and sectors. Their main focus is to promote end-to-end research and development, from basic research to practical application and commercialization, and then utilize these results in regulations, systems, special wards, and government procurement. The SIP also manages an intellectual property management system facilitating strategic corporate use of research results.

In addition to the advancement of safety and driving support technology, the SIP program aims to make automatic traveling system as a means of transport and become a leader in the same. The Cabinet Office leads and promotes cooperation between the ministries and agencies by developing ITS (Intelligent Transport Systems) technologies. Until now, they have transferred budget to relevant ministries and agencies, while sharing responsibilities among ministries and agencies. They promote R&D, aiming at practical application and commercialization. The automatic traveling system promotion committee is the site of decision making. Three working groups (listed below) were set-up to study specific areas and solve technical problems. The working groups comprise of members from the industry, academia, and government.

- ✓ System practical use working group
- ✓ International collaboration working group
- ✓ Next-generation urban transportation.

SIP-adus funds several automation-related projects with special focus on improving transportation options for all travelers during the 2020 Olympics and Paralympics. Of these projects, the Pedestrian Information Communication System (PICS) is of interest to the ATTRI program.

MLIT

MLIT was established as part of the administrative reforms of January 6, 2001, which merged the Ministry of Transport, the Ministry of Construction, the Hokkaido Development Agency, and the National Land Agency. MLIT is organized into 16 bureaus and is the largest Japanese ministry in terms of employees, as well as the second-largest executive agency of the Japanese government after the Ministry of Defense. The ministry oversees four external agencies, namely the Japan Transport Safety Board, the Japan Tourism Agency, the Japan Coast Guard, and the Japan Meteorological Agency.

MLIT funds several types of projects and of special interest to the ATTRI program is their indoor and outdoor navigation project being tested in and around the Tokyo Station.

Collaboration Structure and Governance

Though the two Japanese agencies are interested in collaborating with the USDOT ATTRI program, the structure of this collaboration is not defined at this point. Coordinating on ongoing projects would be challenging, but it is expected that both agencies in Japan have upcoming projects that focus on improving accessible transportation options for all travelers, with a special focus on the 2020 Olympics and Paralympics. Similarly, the ATTRI program is in the process of selecting projects in the four applications areas of interest. Regular communications will help both organization identify mutually beneficial collaboration opportunities and

respective methods of governance. Once this is well understood, the structure for collaboration in the identified areas of mutual interest can be better defined. In the short term, we anticipate more dialogue with Japanese agencies to better communicate ATTRI's specific areas of interest based on projects that are selected in early 2017. In the long term, we anticipate setting up of an MOU to facilitate agency-level collaboration and twinning opportunities.

Identification of Agreement Type

While no official memorandum of understanding or other official declaration of agreement has been reached with MLIT or SIP-adus, there is a mutual desire to exchange information and continue dialogue to identify the appropriate agreement type for collaborative activities. It is important to engage the Japanese via appropriate USDOT channels to determine if there is value in developing an MOU for the long run.

Level and Scope of Collaboration

ATTRI and the Japanese agencies have built a preliminary relationship based on mutual interest in improving transportation options for people with disabilities and older adults. ATTRI is in the process of selecting projects that will define areas of interest in the short term. Once defined, the level and scope of collaborations can be better identified in cooperation with the Japanese agencies. There are several short-, mid-, and long-term opportunities that are described in the sections that follow.

Short Term:

The key to collaboration is to pinpoint specific areas of interest in ongoing activities within these agencies and establish an agreement for coordinated efforts. The SIP-adus and MLIT-funded projects that are of interest to the ATTRI program and have potential areas for collaboration are shown in Table 4-1 below.

Table 4-1. Potential Collaboration Opportunities with SIP-adus and MLIT

Project/Agency	Potential Collaboration Opportunities For ATTRI
Ongoing R&D/SIP adus	• First/Last mile mobility research – autonomous shuttles for people of all abilities • Pedestrian information communications system (PICS) • Lessons learned from user trials and deployment efforts
Indoor High-Precise Positioning/MLIT	• Twinning with project selected for wayfinding and navigation under ATTRI BAA • Lessons learned from development and user trials

These projects were further dissected by mapping them to technology areas, applications areas, and foundation considerations of the ATTRI program. Though the first/last mile project currently does not focus on features for the ATTRI target user group, there is a high probability that the project team in the future will focus on design features that address the needs and challenges of people with disabilities. Table 4-2 below shows how the projects identified in Japan map to a variety of ATTRI attributes. The boxes shaded in green are areas for potential collaboration. It is important to note that the Japanese agencies are working in almost all areas of interest to the ATTRI program.

Table 4-2. Japan Projects' Applicability to ATTRI

(Boxes highlighted in green indicate areas for potential collaboration with ATTRI)

Project	Shared Use, Automation and Robotics	Wayfinding and Navigation	Pre-Trip Concierge and Virtualization	Safe Intersection Crossing	ITS & Assistive Technologies	Data Integration	Enhanced Human Service Transportation	Standard Accessible Data Platform	Universal Design Standards and ICT	Integrated Payment Systems	Leverage Existing Technologies and Research
First/Last Mile Mobility Research											
PICS (SIP-adus)											
Indoor High-Precise Navigation (MLIT)											
New Projects Funded by MLIT and SIP-adus											

Mid to Long Term:

As a mid- to long-term initiative, it is recommended that a plan be developed to explore specific opportunities for collaboration based on ATTRI BAA awards. We recommend as a first step, the establishment of an MOU between ATTRI and Japanese agencies to better define agency-level collaboration aspects, such as scope, schedule, and anticipated results. Once established, based on the desired outcomes defined at the outset, twinning methods could be implemented on future procurements. Specific tasks in projects on each side could direct researchers to coordinate with their colleagues overseas, including face-to-face meetings. Furthermore, ATTRI should consider reactivating the ATTRI sub-group under the automation tri-lateral group or starting a separate working group focused around the four application areas.

It would be effective to build the twinning agreements or MOUs so that they would fund tasks within projects on either side that will facilitate regular communications and sharing of information with each other. For example, less than 5 percent of a project's overall budget can be allocated for travel to have in-person meetings with similar projects abroad and maintain regular communications to share data and lessons learned. Good intentions for collaboration can have some results but are subject to being de-prioritized when projects come under pressure to deliver based on funded tasks.

Functions of Potential Working Groups

As mentioned earlier, ATTRI is in the process of selecting new projects to be funded. The announcement regarding those selected projects is expected in early 2017. These projects will help better identify the nature and scope of collaboration. As these new projects go forward, ATTRI should consider reactivating the ATTRI sub-group under the automation tri-lateral group or starting a separate working group focused around the four application areas. However, starting a separate international working group could be rather challenging given the nature of the process and time involved in setting up a working group. It requires identifying and working

with relevant international points of contact with aligned interests and a passion to improve transportation accessibility.

In the short term, we suggest developing a working committee to explore priority areas of interest to both the United States and Japan. To facilitate effective communications, it will be beneficial to develop a set of questions and list of ATTRI priority areas before scheduling a discussion with Japanese counterparts. This exercise will help them better understand what the ATTRI program is looking for and to identify the right projects and initiatives within their departments for collaboration. List of priority areas could include:

- ✓ Sharing of accessible data, including formats, for field tests and repository development
- ✓ Sharing of technology and test beds
- ✓ Lessons learned in the development process transferred to commercialization community
- ✓ Lessons learned regarding regulatory, insurance, and liability factors
- ✓ Methodology for user trials and evaluation of results
- ✓ Opportunities for jointly showcasing results at ITS World Congress and other important events for ATTRI
- ✓ Opportunities for joint technology demonstration at the 2020 Tokyo Olympics.

Major Collaboration Activities and Schedule

As part of this project, we narrowed down SIP-adus and MLIT as public agencies in Japan for potential collaboration and established preliminary relations with the agencies. However, given the institutional set-up of these Japanese agencies, more deliberate conversations are needed to define major collaboration activities and a schedule.

The ATTRI program is slated to select new projects to fund in early 2017. Once the nature of these projects are known, areas of mutual interest, major collaboration activities around these areas, and a schedule for the activities can then be defined. Thus, the next step is a USDOT in-person visit to Japan to meet with their Japanese counterparts in the summer of 2017. This in-person trip will be beneficial to explore the nature, type, and scale of collaboration. At a minimum, the following should be discussed:

- ✓ Collaboration structure and governance
- ✓ Identification of agreement needed
- ✓ Level and scope of collaboration
- ✓ The need for working groups, if any
- ✓ Major collaboration activities and schedule
- ✓ Key benefits expected for both sides.

As one potential example, both the United States and Japan could run pilots of safe intersection crossing and/or smart wayfinding and navigation applications. Data elements in datasets to be collected, methodology for user trials, and vehicle design to accommodate different disability types could be harmonized during the project definition process. Once underway, it is important that the United States and Japan share the lessons learned and findings from user questionnaires since this collaboration will lead to a more holistic evaluation of the pilots and potential joint demonstrations at international conferences.

Key Outcomes and Expected Impacts

As with the CCAV in the United Kingdom, collaboration with Japan can also be vital for several reasons. It helps promote innovations in research endeavors in all ATTRI application areas to enhance the travel experience of people with disabilities and older adults. The collaborative process fuels itself and endeavors can help uncover additional fertile opportunities for future research. It can reduce costs for those items, such as standards development, that are applicable across regions. Industry is generally supportive of cross-governmental collaboration since it helps create more universal solutions to common problems. Specifically, for the ATTRI program benefits could include:

- ✓ Defining a common research methodology that can encourage twinning project agreements, joint user trials, and joint evaluation of prototypes and results.
- ✓ Showcasing research results or demonstrating a prototype in collaboration with SIP-adus and/or MLIT at an international conference/event.
- ✓ Motivating public agencies in Japan and the United States to invest in technologies that support mobility-challenged citizens.
- ✓ Harmonizing accessible data standards for developing innovative wayfinding and navigation applications that enhance accessibility for people who are visually impaired. This will enable easy sharing of accessible data among public agencies, thereby creating business models that will help the private industry with commercialization activities.
- ✓ Leveraging existing technology advances from Japan and adapting the same in U.S. adoption. This will accelerate deployment of innovative applications that improve travel options for people with disabilities and older adults. For example, safe intersection crossing applications currently explored by SIP-adus can be adopted at appropriate urban intersections in the United States

Chapter 5. Recommended Strategy

The two field visits have identified key agencies in both the United Kingdom and Japan that have great potential for international collaboration with the USDOT ATTRI program. It is important to build on the relationships that have been established with United Kingdom's CCAV group and Japan's MLIT and SIP-adus groups. However, developing relationships with Japan and the United Kingdom will require different approaches.

Collaboration with CCAV

For working with CCAV, in the **short term** we recommend a work plan with the objective of establishing twinning agreements at the project level. This would to take the following form.
First, map all ATTRI-funded projects (current and new) to all CCAV-funded projects to identify projects of functional overlap and common goals.

Second, for each project pair identified in the first step, convene project leaders to explore collaboration opportunities and make recommendations (including approach and outcomes) across areas such as:

- ✓ Sharing of data, including data elements and formats
- ✓ Sharing of technology and test beds
- ✓ Lessons learned in development process
- ✓ Lessons learned regarding regulatory, insurance, and liability factors
- ✓ Methodology for user trials and evaluation of results
- ✓ Opportunities for jointly showcasing results.

Third, work with project leaders and CCAV leadership to prioritize these opportunities and make selections for moving forward based on available resources.
Fourth, formalize project task descriptions to enable international collaboration. In other words, specific project tasks on either side could direct researchers to coordinate with their colleagues overseas, including face-to-face meetings.
Fifth, jointly publicize the twinning arrangements.
Finally, set up a schedule for assessing progress, as well as "re-playing" the process above as both programs develop. This could take the form of an annual meeting/web conference in which leaders of all relevant projects discuss their activities to restart the process. On the USDOT side, potentially other CV/AV program offices (in addition to ATTRI) would be involved to identify twinning opportunities unrelated to ATTRI.

In the **mid to long term**, we recommend setting up a high-level collaboration agreement between USDOT-ATTRI and CCAV, building on the goodwill already expressed by both sides for such a collaboration. This could be in the form of a relatively simple MOU that addresses:

- ✓ Structure and schedule for ongoing coordination meetings (in-person, on the phone, and electronic). A recommended structure is two in-person meetings per year (one in the United States and one in the United Kingdom), along with bi-monthly teleconferences.
- ✓ Affirmation of desire to explore twinning of selected project activities.

- ✓ Agreement to jointly develop a work plan.
- ✓ It is recommended that the duration of agreement be set for three years.

Collaboration with MLIT and SIP-adus

The interactions between MLIT and SIP-adus are not fully understood, but it appears that the respective programs are going forward separately. Therefore, the approach described here may best be implemented as two parallel efforts, one for MLIT and another for SIP-adus. For both cases, we recommend the following strategic steps.

In the **short term**, we recommend developing a work plan with the objective of establishing twinning agreements at the project level. This would to take the following form:

First, from the U.S. side, map all ATTRI-funded projects, both current and new, to the MLIT/SIP-adus funded projects described in the Task 3 report in order to identify projects of functional overlap and common goals. These ATTRI projects should be further categorized based on the ATTRI technology and application areas as well as the foundational considerations similar to Table 4-2 in this report. This will help identify specific opportunities for collaboration and will better define ATTRI needs. The U.S. side should take the first step to provide these findings in a simple and straightforward manner to Japanese counterparts. These could include areas such as:

- ✓ Sharing of data, including data elements and formats
- ✓ Lessons learned in development process
- ✓ Lessons learned regarding regulatory, insurance, and liability factors
- ✓ Methodology for user trials and evaluation of results
- ✓ Opportunities for jointly showcasing results.

Second, convey these potential collaboration areas to colleagues in Japan for their initial reactions. Hold discussions as appropriate on areas of high mutual interest.

Third, gain agreement to work together and address any resource issues for the Japanese side, while arranging for resources to be applied from the U.S. side.

Fourth, jointly publicize the twinning arrangements, as appropriate.

Finally, set up a schedule for assessing progress.

In the **mid to long term**, we recommend setting up a structure for collaboration agreement between USDOT-ATTRI and MLIT/SIP-adus. This could be a new agreement (likely to take more time to set-up, but with potentially greater impact in the long run) or a reactivation of the ATTRI sub-group under the Automation in Road Transport Systems Tri-Lateral Working Group (currently SIP-adus appears to have the lead here for Japan). High-level collaboration documents (formal or informal) could address:

- ✓ Structure and schedule for ongoing coordination meetings (in-person and electronic)
- ✓ Affirmation of desire to explore “twinning” of selected project activities
- ✓ A relatively simple work plan.

Joint Collaboration with Both UK and Japanese Researchers

As collaborations are established with both UK and Japanese projects, opportunities for three-way collaboration may become clear. For example, from preliminary collaboration with both the United Kingdom and Japan, it appears that there is common interest in standardizing data sets for applications that support the visually impaired user group. We envision that such a standardization endeavor could start as a bilateral effort but all parties will soon find greater benefits in turning the effort into a trilateral collaboration with the United States, the United Kingdom, and Japan. However, it is too early at this stage to develop a specific plan for such a setup.

Appendix A. List of Acronyms

ATTRI	**Accessible Transportation Technology Research Initiative**
AV	**Autonomous Vehicle**
BAA	**Broad Agency Announcement**
CCAV	**Center for Connected and Automated Vehicles**
CV	**Connected Vehicle**
EHST	**Enhanced Human Service Transportation**
EU	**European Union**
FHWA	**Federal Highway Administration**
FTA	**Federal Transit Administration**
GPS	**Global Positioning System**
ICT	**Information and Communication Technology**
IoT	**Internet of Things**
ITS	**Intelligent Transportation Systems**
ITS JPO	**Intelligent Transportation Systems Joint Program Office**
MOU	**Memorandum of Understanding**
MLIT	**Ministry of Land, Infrastructure, Transport, and Tourism**
NIDILRR	**National Institute on Disability, Independent Living, and Rehabilitation Research**
OEM	**Original Equipment Manufacturer**
POC	**Points of Contact**
R&D	**Research and Development**
RFP	**Request for Proposal**
SIP-adus	**Strategic Innovation creation Program – Automated Driving for Universal services**
SOW	**Statement of Work**
UK	**United Kingdom**
USDOT	**United States Department of Transportation**
V2I	**Vehicle to Infrastructure**
V2P	**Vehicle to Pedestrian**
V2V	**Vehicle to Vehicle**
WG	**Working Group**

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

FHWA-JPO-17-499

U.S. Department of Transportation