Accessible & Barrier Free

Full Report

autonomous vehicle alliance

ITS AMERICA

Mobility on Demand Alliance

AARP®

POCO Labs

Accessible and Barrier Free Research Opportunity

An accessible and barrier-free vehicle with complementary infrastructure is a commonly cited need across municipal, aging and healthcare ecosystems.

The understanding of what a barrier-free, accessible vehicle could be is evolving thanks to universal/inclusive design, emerging mobility trends and evolving technologies in transportation.

So what are the varying and common needs between different customers and how might people of various abilities interact with these vehicles and infrastructure?

The AVA's Accessible and Barrier Free Research attempts to answer these questions from a holistic viewpoint.

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What is Considered a Barrier?

Mobility is an important part of everyday life – fundamentally impacting one's ability to obtain and maintain employment, attend school, access goods and services and engage with the world.

Often, issues of accessibility are discussed with the disabled community in mind. While overcoming barriers faced by members of these groups are critically important for a transportation network that is accessible to all, there are a range of other factors that can also inhibit independent mobility.

Physical limitation or disability (Loss of hearing, vision, mobility, dexterity)

Cost (Financial barrier, such as prohibitively expensive fairs or membership fees)

Coverage (Issues of distance or time. Gaps in transportation service or availability)

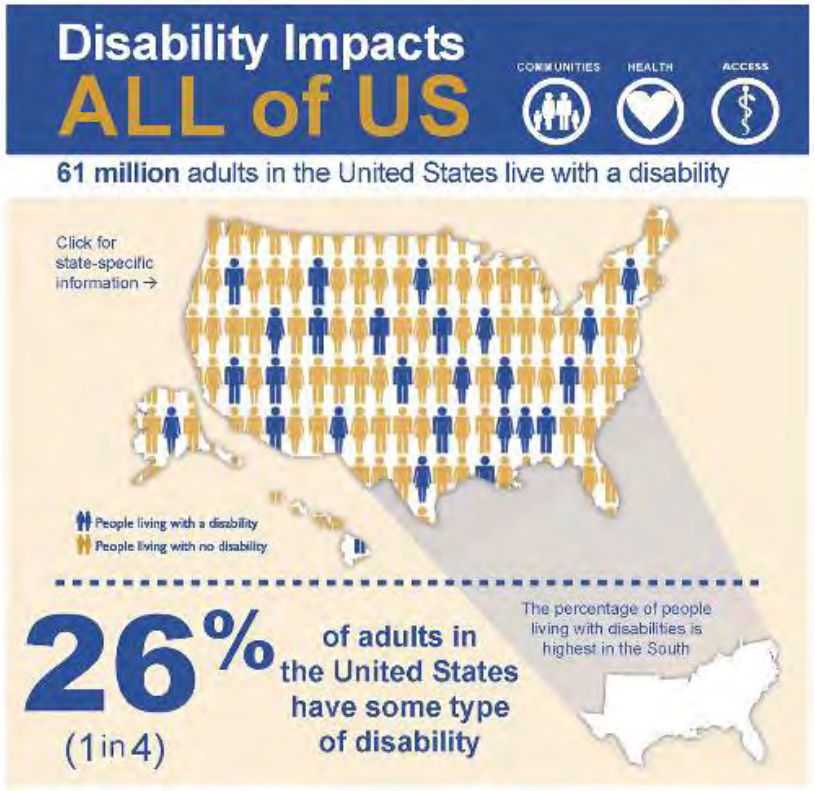
Safety/Security (Physical well being, data privacy, etc.)

Awareness (Limitations associated with knowledge or understanding of available transportation options, related devices/services, eligibility for reduced fair program, etc.)

Technological Limitations (Inability to access or use technology due to lack of smartphone, credit card, etc.)

Design/Upkeep (A system/services capacity to function smoothly/effectively for all users. Limitations associated with road layout, pavement quality/maintenance, congestion or design bias towards under-represented groups)

The Market Size



- There is an increasing population of “vulnerable” and “underserved” communities in the world.
- There are 703 million persons aged 65 years or over in the world today.
- The world’s population of the 65+ age group is estimated to double to 1.5 billion by 2050. (link)
- Currently, 1 billion+ people globally are living with a disability
- More than 60% of people with disabilities report major obstacles as it relates to travel / mobility
- An additional 2 billion+ caregivers are directly impacted by caring for someone with a disability (including the stress in dealing with mobility issues).

Identified Opportunities

Section 1:
Merging the Physical World with Digital Wayfinding Tools

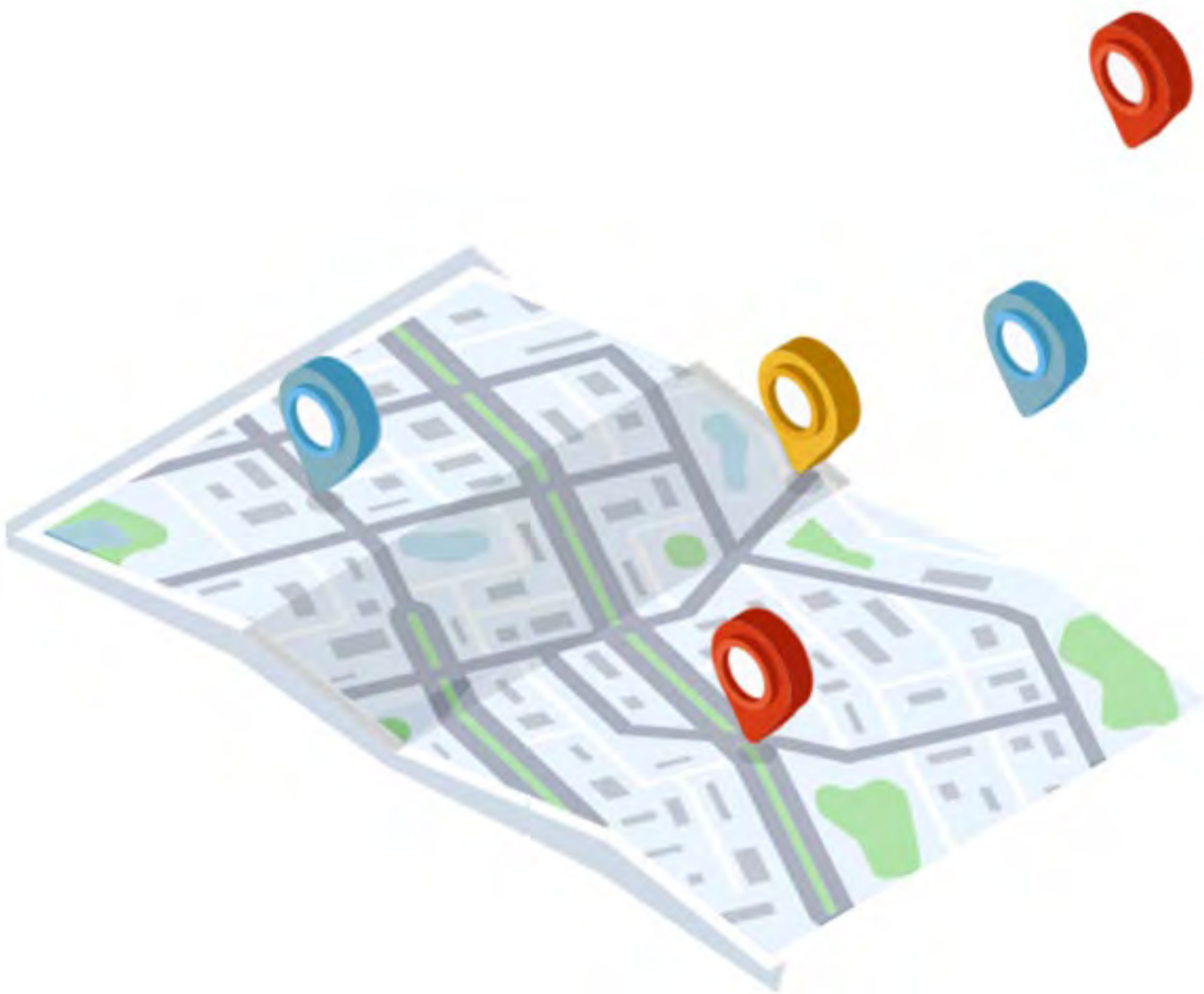
- Personalization of The Mobility Experience
- Importance of Audio Cues
- Accessible Real Time Information
- Unbanked Alternatives
- On-Demand Booking
- Wayfinding for Curbs and Sidewalks

Section 2:
Understanding How Universal Design Language Could Impact AVs

- Vehicle Interior Features
- Zero Entry Importance
- Head Clearance Importance
- Vehicle Design Cues
- Designing for Usability by 85% of the Public

Section 3:
Coordination of Design Languages Between Vehicles and Infrastructure

- Coordinating Vehicle and Infrastructure Design Language
- The Vehicle Creating its Own Infrastructure Where Needed*
- Addressing Curb Opportunities and Rural and Suburban Pick Up / Drop Off



Merging the Physical World with Digital Wayfinding Tools

Personalization of the Mobility Experience

If the vehicle and infrastructure are designated as the physical world, how can we seamlessly merge with digital tools and software? Doing so would help everyone be able to successfully navigate through mobility challenges, while making their experience more personalized.

Some examples might include:

Prompts (Ex: Turn left when exiting the vehicle, your destination is 100 ft on the right).

Take the pain away from traveling somewhere for the first time (first time trips can cause stress, especially for those individuals with limited abilities where planning demands a lot of time).

Create digital payment alternatives beyond apps with simple tech such as wearables, RFID tags, etc. (for the unbanked and people with financial barriers).

Identify exactly where the vehicle will pick me up, so I am standing in the right place at the right time (not on the opposite side of the street, causing confusion).

Incorporate audio and visual prompts, both in the physical world and on appropriate digital devices.

Importance of Audio Cues

The use of audio cues and appropriate digital devices onboard the vehicle is beneficial for all riders. With announcement options such as route information, estimated times of arrival and current stops being broadcast through a speaker, all riders will stay continuously informed and be prepared for what's coming next.

Audio cues are especially helpful for:

People with visual impairments.

First time travelers.

People in crowded areas of the vehicle who may not be able to easily see displays.

People who do not speak English as a first language (emphasis on audio annunciation is important for clarity).

People multi-tasking while onboard.

Accessible Real Time Information

An example of this would be having large displays onboard that would assist riders with continuous route information such as;

- Stop information
- Estimated time of arrival
- Current location

This information could also be available on the rider's digital device and could include an interactive component if a rider has a question. The use of different communication methods providing the same message helps all types of riders easily comprehend pertinent information.

This type of approach is currently happening at the Salesforce Transit Center, they are showing visitor information through large schedule boards, digital signage and have mobile application aware technology.

Unbanked Alternatives

An easy-to-use payment system and ridership program will be key to address the needs of unbanked riders. Some options to help resolve current ridership issues could include the following:

- Low-cost wearables
- RFID tags

These options could be preloaded at a physical place, rather than requiring the rider to have a digital device for payment.

On-Demand Booking

With the ability to enable spontaneity while still maintaining reliability for all riders, on-demand mobility is the optimal scenario.

In addition to spontaneity, this type of service could:

Be made available for use at a nearby location or by dial in number for those who do not own a smartphone.

Make the trip an even more personalized experience by allowing the rider to arrange a set location ahead of time for their pick-up (e.g., north west corner of main street in front of the supermarket), making the interaction quicker and more effective for everyone when the vehicle arrives.

Include a personalization option in the system. The rider can specify their needs (in their profile) and the system could alert the driver or vehicle of any special requirements prior to pick up, making the interaction a seamless experience.

Wayfinding for Curbs and Sidewalks

"We are pedestrians 99% of the time."
Eric Sinagra, Pathvu

While the vehicle experience is important, pedestrian navigation is still a part of the wayfinding travel experience. Having the ability to utilize wayfinding for not only transportation, but while the user is also a pedestrian would make this a complete trip experience. This could be especially beneficial for users if they are in a new area.

Giving the rider a way to get from A to B in an accessible way while feeling confident doing so can change someone's entire overall experience. This could be accomplished by:

- Including the vehicle/infrastructure design language into sidewalk directions
- Showing known facts about the surrounding areas e.g., the sidewalk is 8' wide with a steep hill, etc.

Understanding How Universal Design Language Could Impact AVs

Vehicle Interior Features

Vehicle interior was top of mind when discussing important vehicle qualities, ranging from simple requests such as:

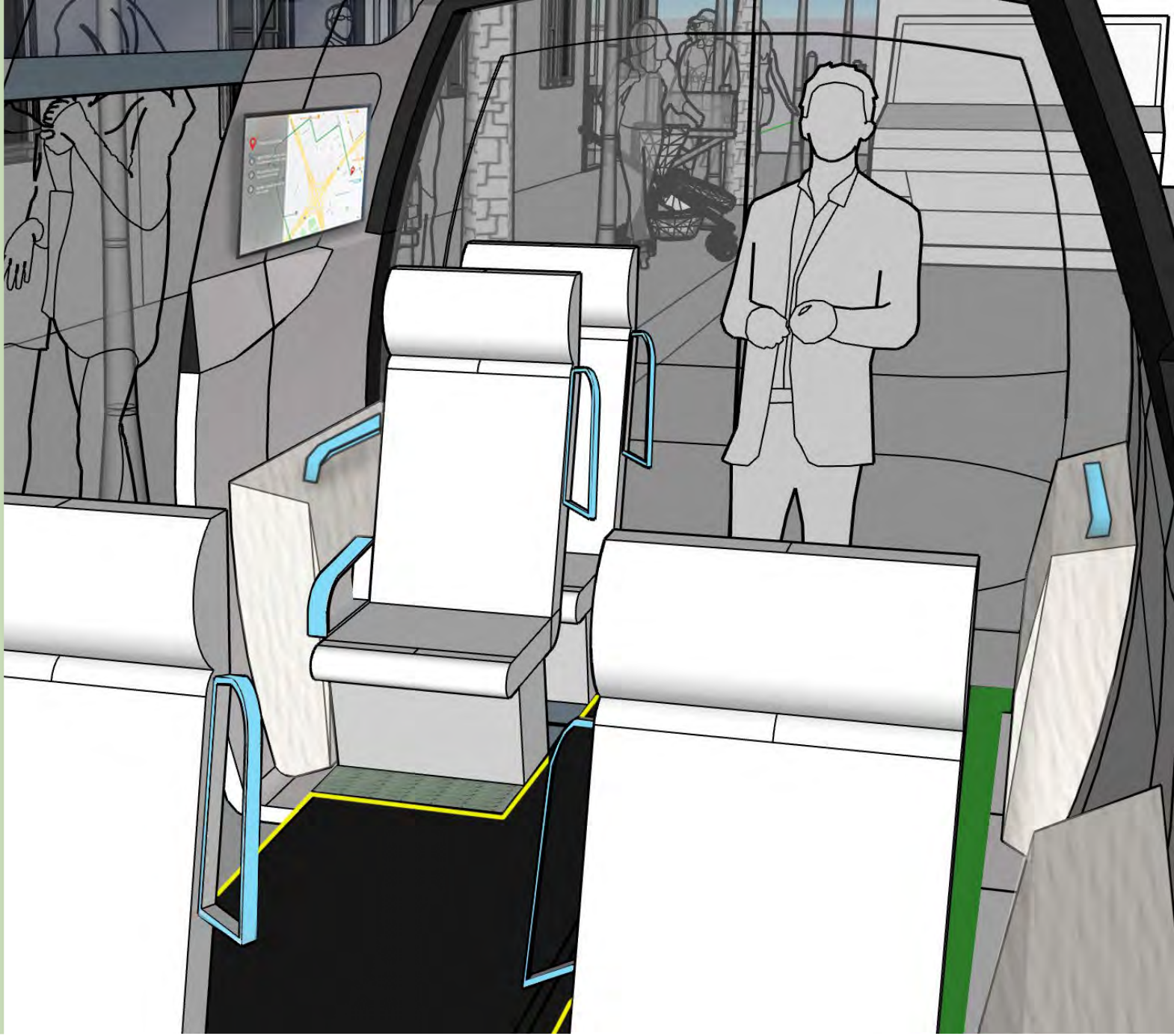
- flexible seating to keep riders from feeling excluded from their group and others (if the vehicle can not accommodate the rider and their group, it should not arrive as an option).
- grab bars for easy maneuverability.

to more complex requests like:

- being able to sanitize the vehicle in between rides.

It is noted that when people with limited abilities travel with others, they are often separated because of their special seating accommodations. It is preferable that a vehicle could accommodate anyone in any seat so a group can stay together. They do not want to feel "different" and want the same respect as the other passengers.

"Seeing a new mode of transportation with how we live life (TNCs), not one was accessible in the beginning and didn't serve people with disabilities. Nobody tried to have something that was for everybody. So many people are shut out. Unforgivable." –Drennen



Zero Entry Importance

People with varying abilities often have common complaints such as stairs and height of vehicle entry.

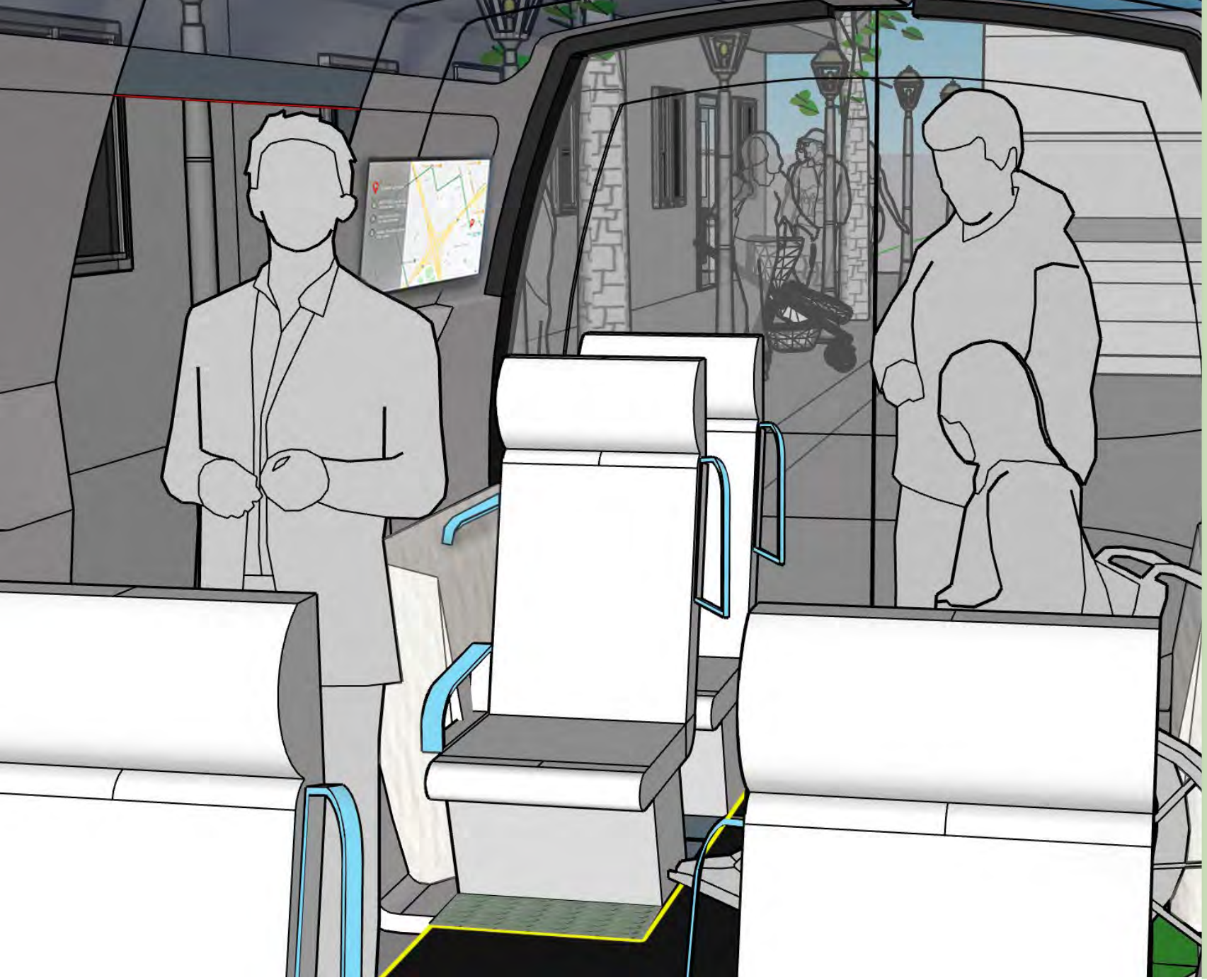
Some of these issues stem from:

Having a hard time stepping up and keeping their balance.

Having a large device with them (luggage, stroller, walker).

The mobility device they are using doesn't allow them to easily maneuver getting in and out of the vehicle.

For riders who are in wheelchairs, the issue is even greater. They must wait for the driver to open a special entrance and deploy a ramp (which is often not very wide and can be steep), assist them aboard and then secure them and their wheelchair before continuing the route. Having an accessible vehicle with zero entry or "level boarding" could allow people with many different abilities the opportunity to freely enter the vehicle on their own, potentially lessening their need for extensive assistance which can cause delays.



Head Clearance Importance

While boarding, in a standing room area and sometimes even while seated, 1 in 10 riders have issues with head clearance.

Designing for the majority of the general public and having a tall entrance/exit and adequate height from seats to ceiling is an important comfort factor for all riders.

Vehicle Design Cues

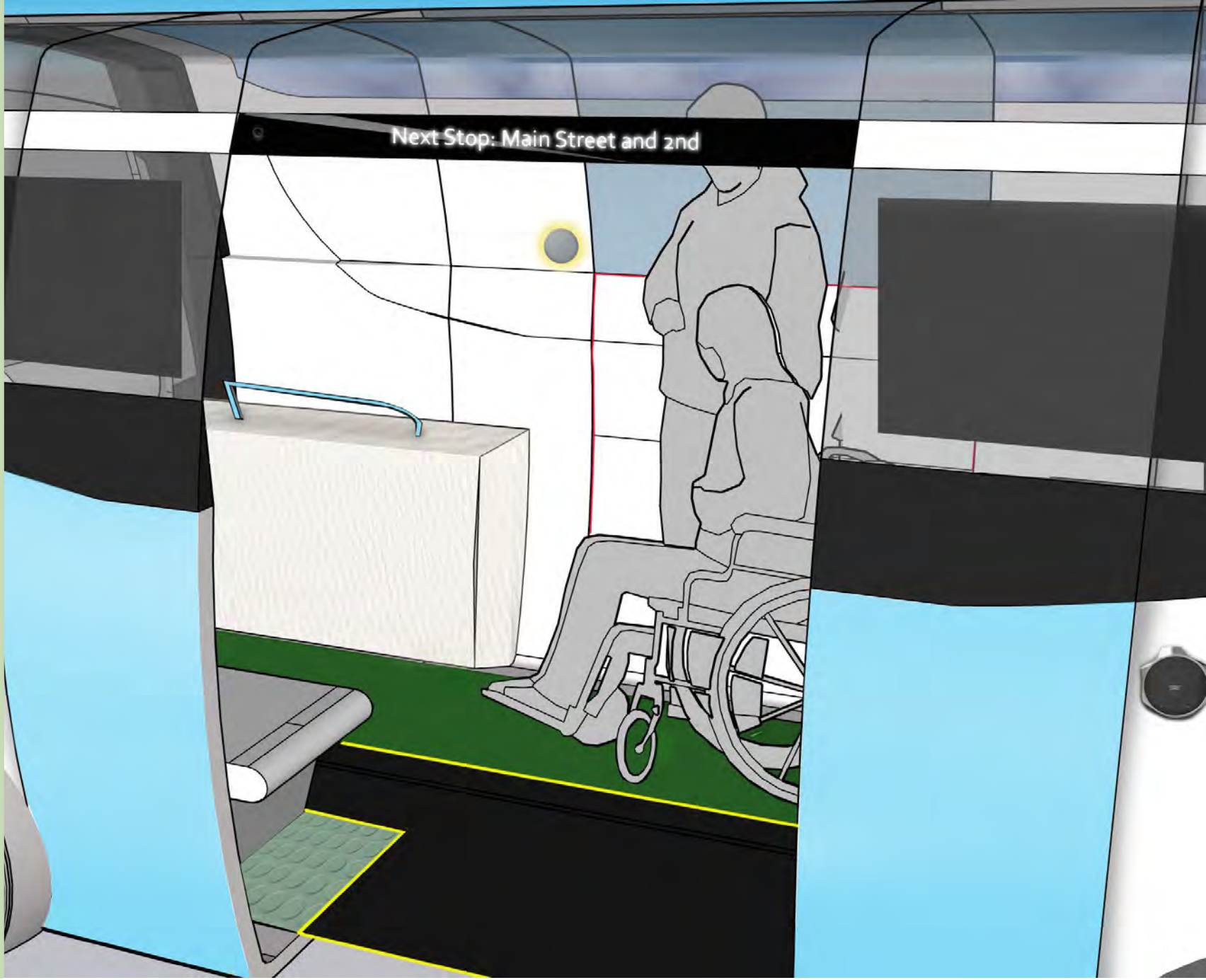
Having a standardized design language for the vehicle interior could be intuitive and informational for riders.

The use of sound, textures, colors, materials and lights could be standardized across vehicles to help denote where users are supposed to stand, not stand, or where they should exit the vehicle. For example, when you enter the vehicle standing room is in the green area, rather than the yellow area.

<u>Supported by Proven Needs:</u>

Chris Downey, a blind architect in San Francisco is a committed transit user as he can no longer drive. He promotes the use of universal design because it not only accommodates people with disabilities, but it is also just as appealing to people without them.

https://www.cbsnews.com/news/architect-chris-downey-goes-blind-says-hes-actually-gotten-better-at-his-job-60-minutes-2020-07-05/

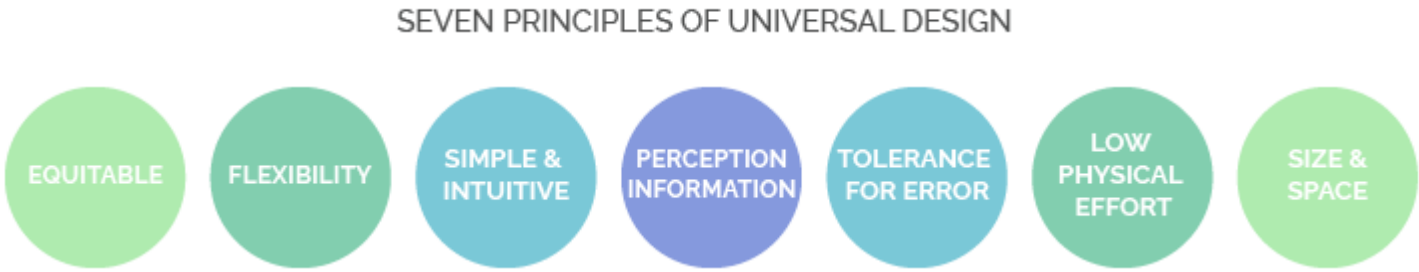


Designing for Usability by 85% of the Public

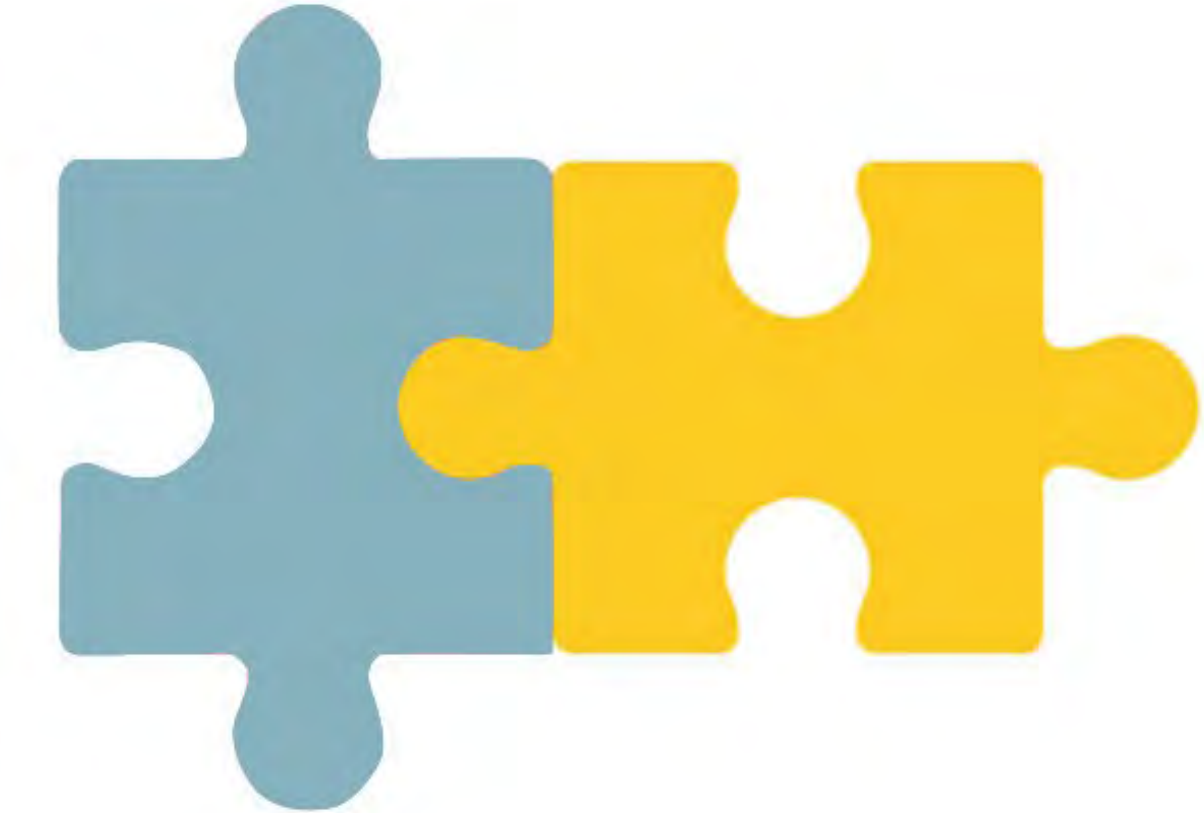
Universal and Inclusive design is the design of buildings, products or environments to make them accessible to more people, regardless of age, disability or other factors.

This could benefit the users:

- Quality of life.
- Self esteem.
- Work and social life.



"The biggest issue overall is getting away from thinking about accessibility as being something targeted to a specific group (cognitive or physical disabilities) and getting to solve it as more of a universal application. If you made it easier for everyone to use, would it solve 80-85% of the problem? The last 15% is going to take double the effort of the first 85%"
Graeme Masterson- Global planning transit lead at Stantec



Coordination of Design Languages Between Vehicles and Infrastructure

Coordinating Vehicle and Infrastructure Design Languages

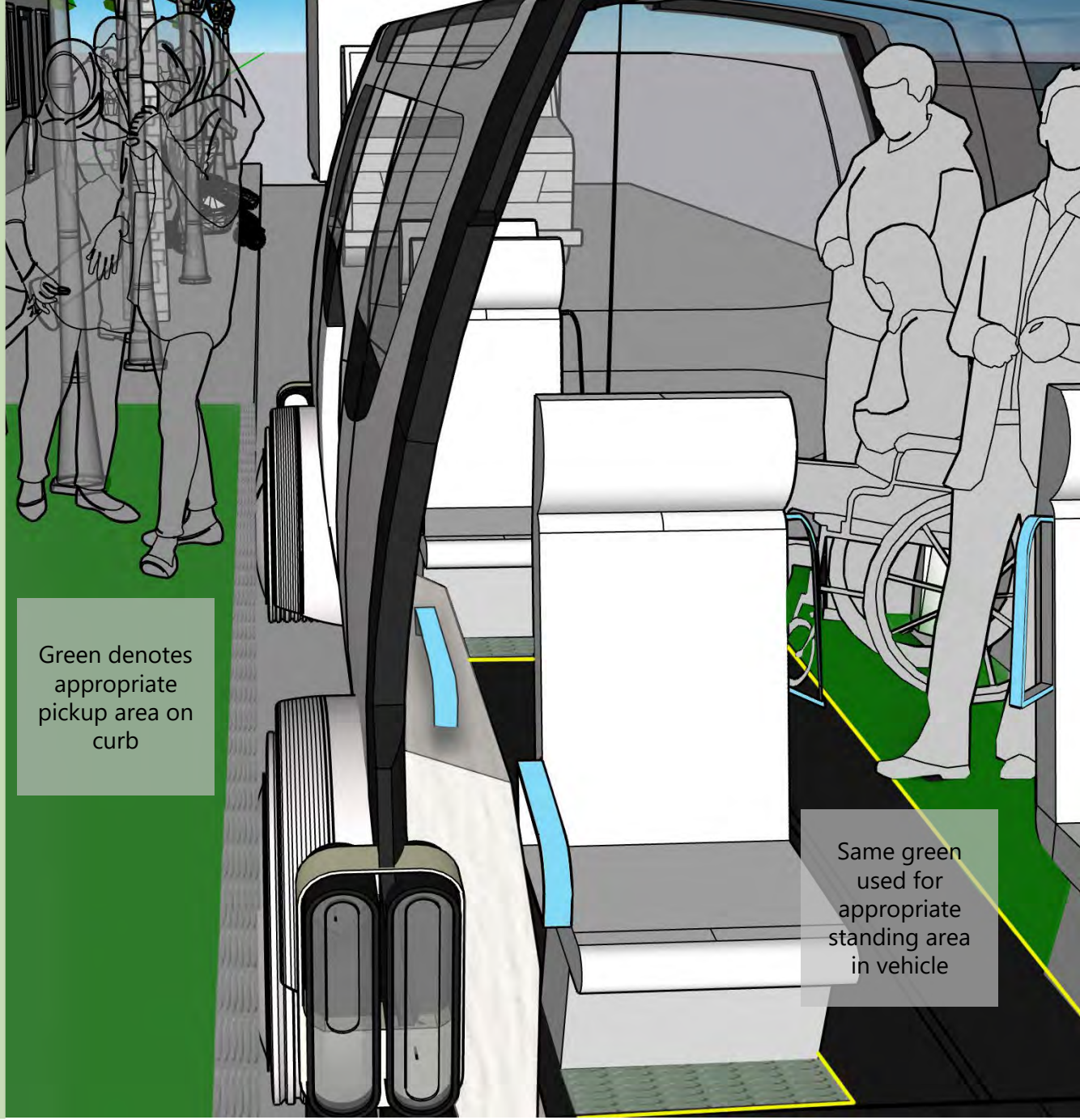
There is an opportunity for vehicles and infrastructure to work together as one unified design language. One way this could be accomplished is using the same design cues from the vehicle interior (such as color, texture or lights) at the onboarding areas as well.

The use of technology could also be a key factor to use in coordination with a unified design language. Sensors at the onboarding area could interact with the connected pickup vehicle before it's arrival, speeding up the onboarding process.

For example, the onboarding area sensor could utilize the rider's phone app or connected wearable and note someone's abilities, then notify the pickup vehicle if extra accommodations are necessary, before arrival. A clear path and seating area could be made available using a light notification before that rider ever gets onboard, making the pickup smooth for all.

Beyond passenger vehicles, this type of coordination could also be useful for the delivery market.

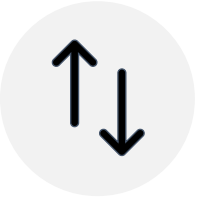
The use of interior passive messaging to riders (a light or something in a preferred seating area, etc.) would be helpful. Using tech to help people navigate, something to let them know where the bus stop is and where to stand, etc. -Elliott



Addressing Curb Opportunities & Rural/Suburban Pick-Up and Drop-Off

Due to crosswalk and sidewalk availability being unpredictable (particularly in suburban and rural areas), a vehicle that address the wayfinding challenges found by riders in areas without crosswalks and sidewalks will be key to their ability to access mobility solutions of all types.

Issues to consider are:



Ground clearance disparities

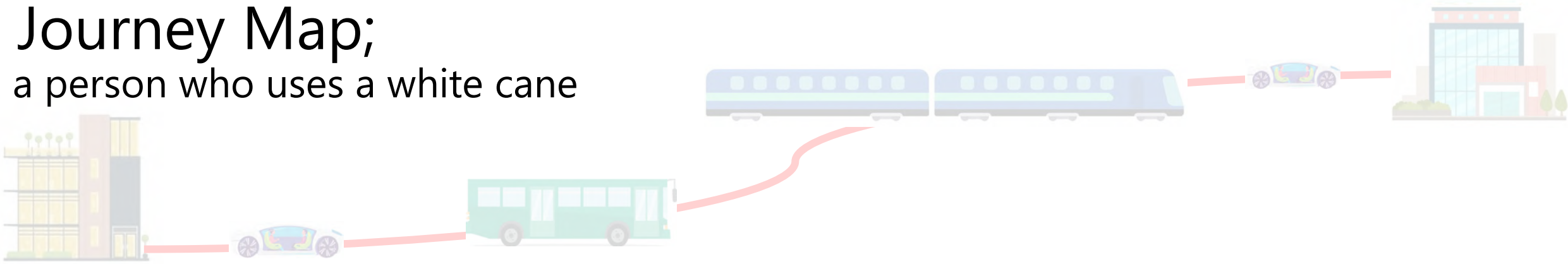
Limited sidewalk availability

Ramp heights are often uncomfortably high from the ground for the user and service animals

Journey Maps

The following Journey Maps represent a maximized accessible and barrier free vehicle, infrastructure and an enabling digital backend. We have included individuals with various abilities and circumstances to call out functional details and needs in those areas. These Journey Maps represent a fully integrated approach to mobility and potential new customers for an autonomous fleet vehicle.

Journey Map;
a person who uses a white cane

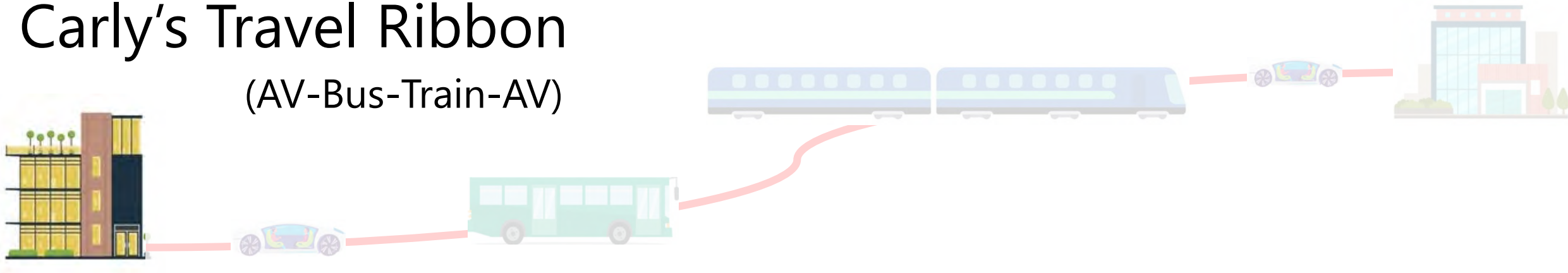


Carly is a 32 Years old African-American woman with a vision impairment. She lives on the south side of Chicago in the Douglas neighborhood. Carly is a Customer Service Consultant. She can recognize primary colors but is considered legally blind which results in Carly using a cane to navigate her way through the world. Today, Carly is going to a new client's office for the first time, making this a new journey for her. Her new client is in Schiller Park on Chicago's west side. She will be using her new CTA App to plan her trip; this allows her to plan her journey door to door.

*This trip is paid for through the app and is verified for payment by sensors installed at the entrances/exits to various vehicles. The sensor will pick up the user's phone or a wearable they have on them.

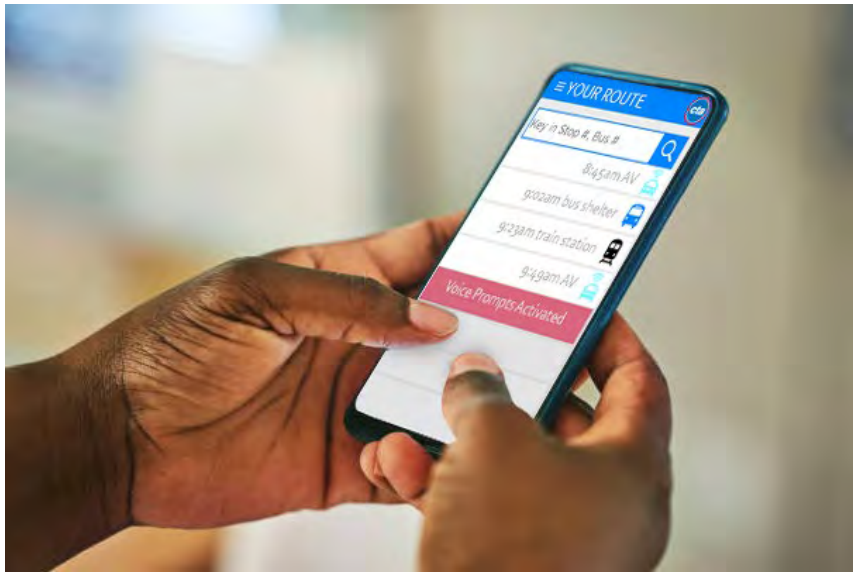
Carly's Travel Ribbon

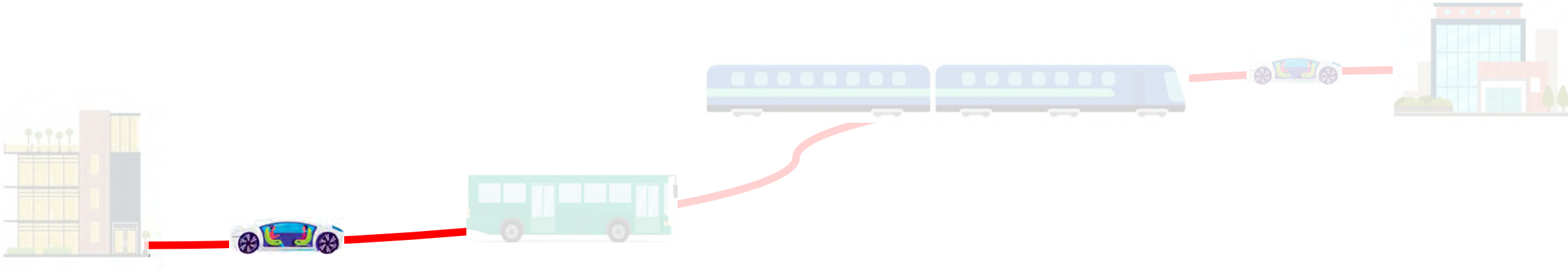
(AV-Bus-Train-AV)



7:30 AM

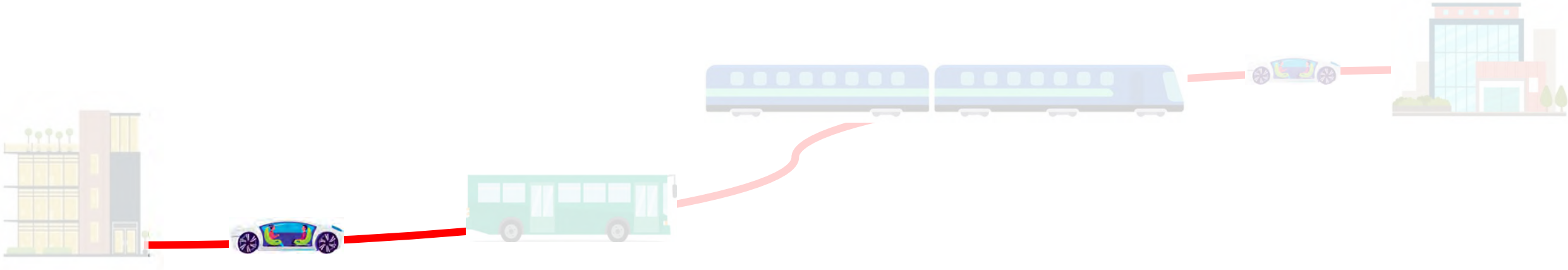
Carly opens her CTA App which allows her to plan her trip with audio prompts. The CTA app is a fully integrated mobility platform and considers all forms of private and public transportation options. The CTA app will aggregate those options to maximize the efficiency of her trip. The app asks, "what is your point of origin?", Carly responds by giving her condo address. The app then asks, "what is your final destination?", Carly respond with the office address of her client. Finally, the app asks, "what time do you need to be at your final destination?", Carly responds 10:00 AM. Within ten seconds the app responds with her itinerary letting her know an Automated Vehicle will pick her up at the curb outside her building at 8:45 AM. The app asks, "do you want to confirm this trip?", Carly responds yes. Carly can review her mobility options at any time during her trip. The app will identify each type and mode of transportation, for this trip it will include an AV, bus, train and end with another AV.





8:45 AM

At the designated time, a four person AV Shuttle owned by CTA pulls to the front curb at her condo. The AV has the ability to move both up or down 6 inches, this helps the vehicle create a zero-entry capability with a small slide out ramp that covers the gap between the vehicle and sidewalk. Because Carly has created a profile with CTA on the app, the vehicle knows in advance that Carly is a person with a vision impairment and that she uses a cane to maneuver. As soon as the AV stops, it laser measures the curb height and raises two inches to deploy the ramp. The vehicle also projects a green square onto the sidewalk where the entrance to the vehicle is. Because Carly can make out primary colors this helps her navigate into the vehicle. The vehicle not only has a zero-entrance capability, but also has high head clearance (6Ft) so she can walk right in without ducking.

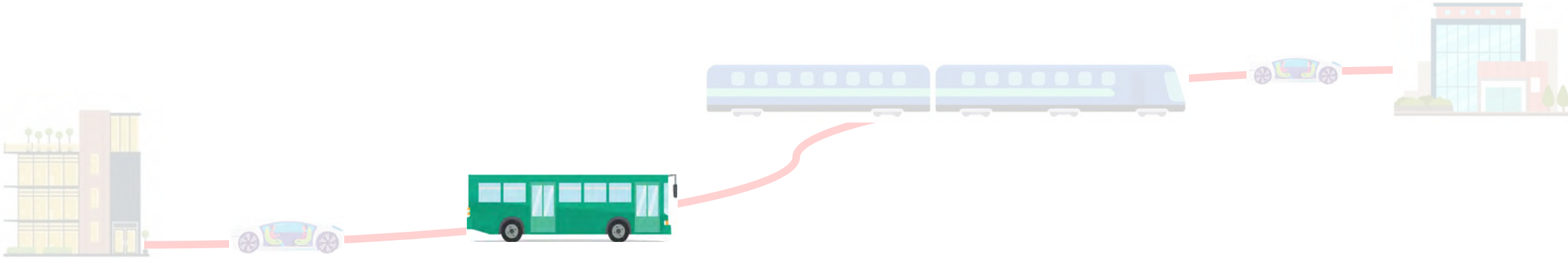


8:50 AM

As the doors start to close behind her Carly gets an audio prompt through her headphones that the green areas on the floor of the vehicle indicate seating areas. Carly uses her cane to identify an open seat and sits down.

9:00 AM

Carly gets an audio prompt that her AV will be arriving at the bus stop in the next two minutes and to gather her things.

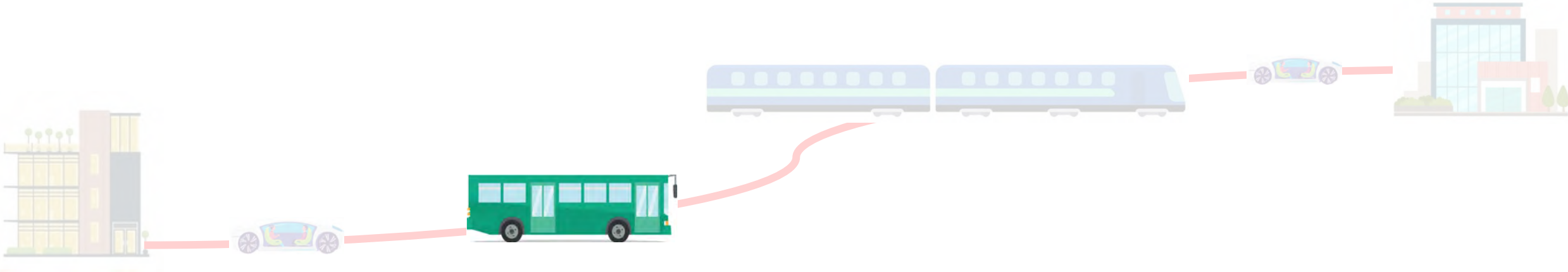


9:02 AM

Carly's AV arrives at the bus stop shelter and she is instructed to wait for the bus which will arrive in 5 minutes. The shelter itself uses the same primary color scheme to denote safe areas to stand and sit. The shelter also uses texture concrete to delineate where the edge of the curb is. This design language has been coordinated with the vehicles interior design language to help all passengers navigate easily.

9:07 AM

Carly's bus arrives and uses the same technology used in the AV, laser measuring the curb and deploys the ramp which is used by all the passengers boarding. In addition, the bus projects the green entrance square onto the sidewalk surface to mark the entrance to the bus.

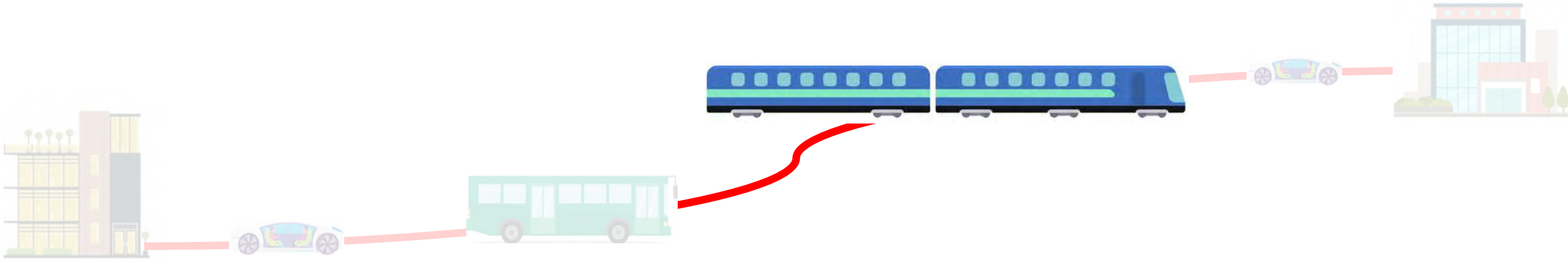


9:08 AM

Carly's bus doors close and she listens to the audio prompts and follows primary colors to identify seating inside. The CTA app lets her know that she will arrive at the train station in 15 minutes.

9:21 AM

Carly receives an audio prompt that her bus will arrive at the train station in two minutes and to gather her things. The audio prompts also inform her that the elevator to the raised platform is 25 ft to her left as she leaves the bus.

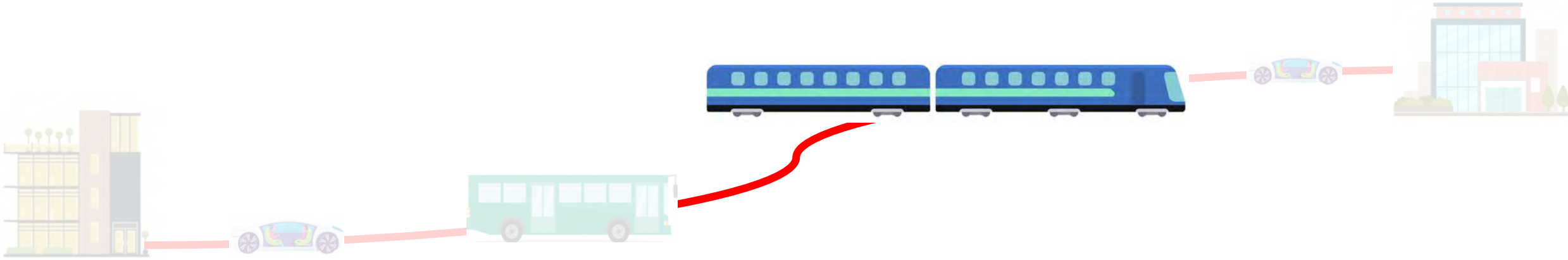


9:23 AM

Carly arrives at the train station and makes her way to the elevator. As she is exiting the bus the app lets her know that her train will arrive in 3 minutes.

9:26 AM

Carly's train arrives. The same design language used in the AV, bus and bus shelter are also used here on the train platform. The same primary colors and floor texturing are used to denotes all areas. As the train stops on the platform it similarly projects green squares onto the platform to show where the doors are.

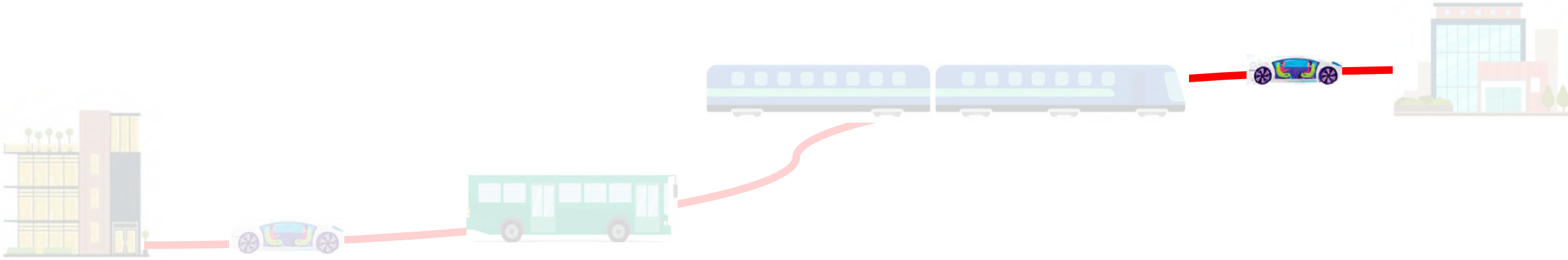


9:26 AM

The doors close behind Carly and she makes her way to a seat. The audio prompt informs her that the ride out to Schiller Park will take two minutes longer then expected due to slow downs on the line. Total time to Schiller Park is 20 minutes.

9:45 AM

Carly is informed that her train will arrive at the Schiller Park station in two minutes. Carly gathers her brief case and bag.

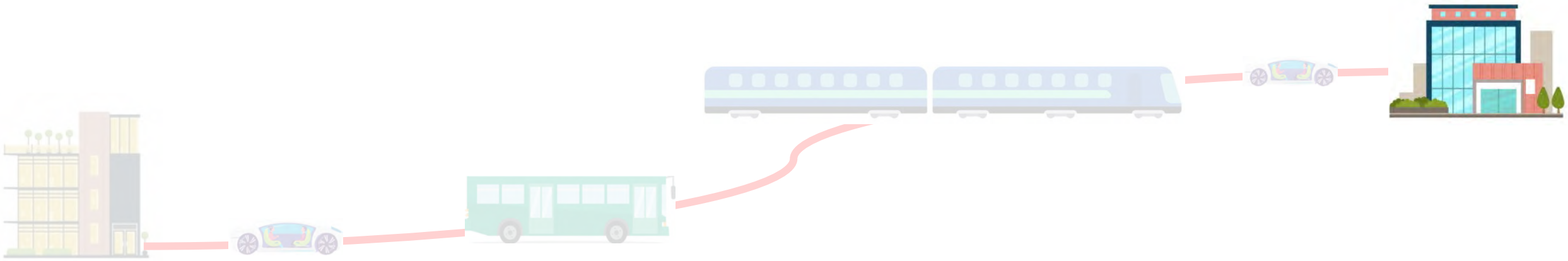


9:47 AM

Carly's train arrives and she receives an audio prompt that her AV shuttle is parked on her side of the street 50 ft to the left as she exits the train platform.

9:49 AM

Carly enters the AV. As she finds her seat, she receives an audio prompt that the AV will arrive at her final destination at 9:58.



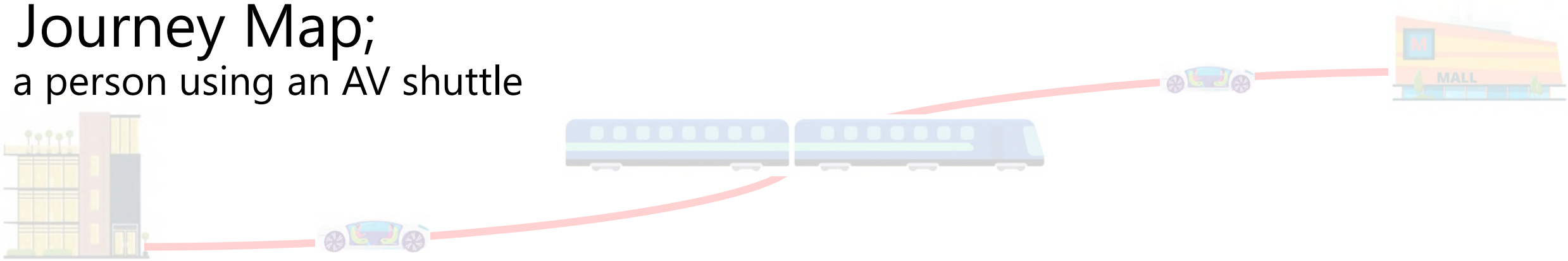
9:58 AM

Carly arrives at her client's offices. As she exits the AV her audio prompt informs her that the entrance door for her client is 75 ft directly in front of her.

10:00 AM

Carly arrives at her final destination.

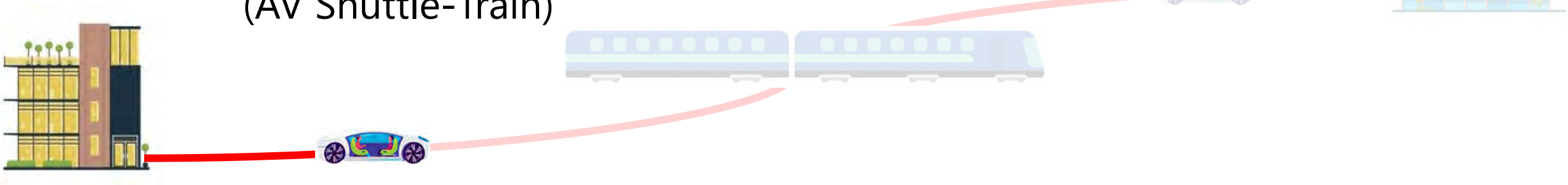
Journey Map;
a person using an AV shuttle



Camille Morales is 28 years old and shares a townhouse with two roommates. Camille works full time at the Coach Store at Fair Oaks Mall in Tysons Corner VA. She lives across DC in Ardwick Park. Camille does not own her own car and relies on the Washington Metro AV Shuttles and the Orange Line Train to get to and from work. This is her normal work commute on a Thursday morning. Camille's phone will interface with the AV shuttle and Orange Line train as she enters and exits those vehicles confirming payment to Washington Metro.

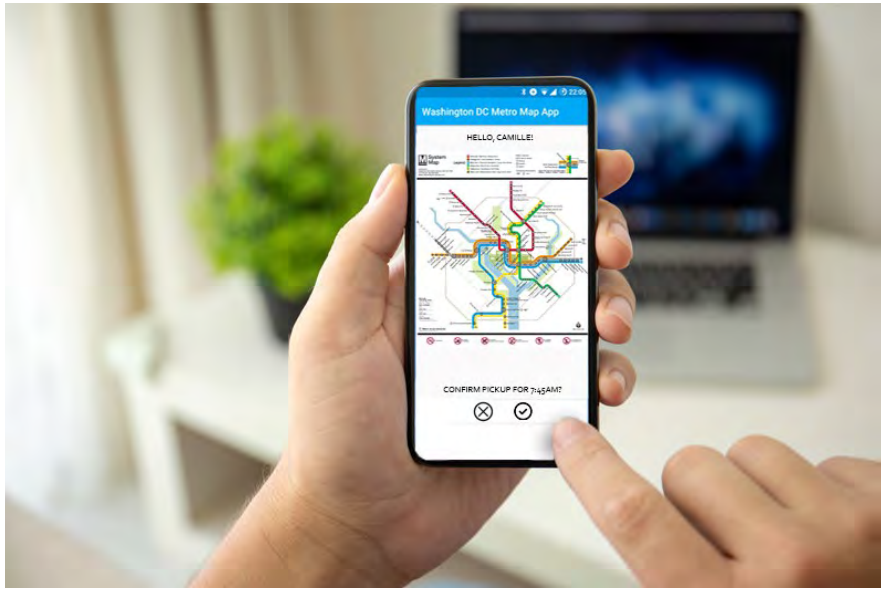
Camille’s Travel Ribbon

(AV Shuttle-Train)



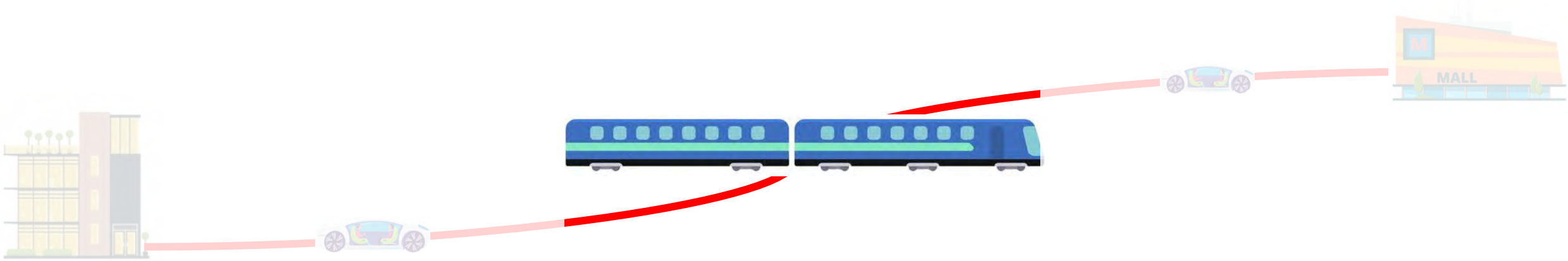
7:00 AM

Camille gets a text from Washington Metro confirming her 7:45 AM pickup from her townhouse. Because she has filled out her profile on her Metro App and has a regular work schedule of Tuesday through Saturday, all she needs to do is confirm her pickup location and time. Camille taps the confirm button and finishes getting ready and making her coffee for her commute.



7:45 AM

Camille is waiting outside her townhouse when her Metro Shuttle pulls up. She enters the shuttle and finds a seat. Morning rush hour means there are typically 4 other passengers all headed to the Landover Station to pick up the Orange Line into the city. The notification on her phone says she will arrive at the Landover Station in 10 minutes.

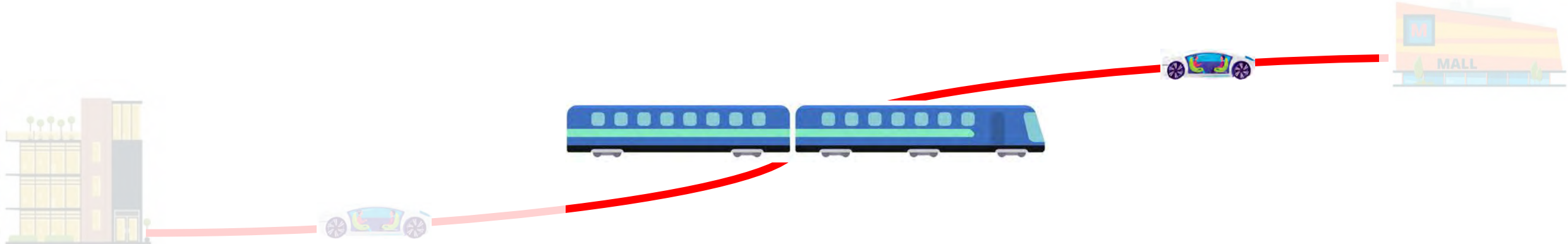


7:55 AM

Camille's Metro Shuttle pulls up to the Landover Station and she disembarks. She receives a notification on her phone that the next Orange Line train will arrive in 5 minutes and makes her way to the platform.

8:00 AM

The Orange Line train slows to a stop and projects green squares onto the platform that identifies cars that have available seating. Camille will take this Orange Line train to the end of the line and the Vienna/Fairfax Station. Upon entering the train car Camille receives a text that the train ride will take 45 minutes to her destination.

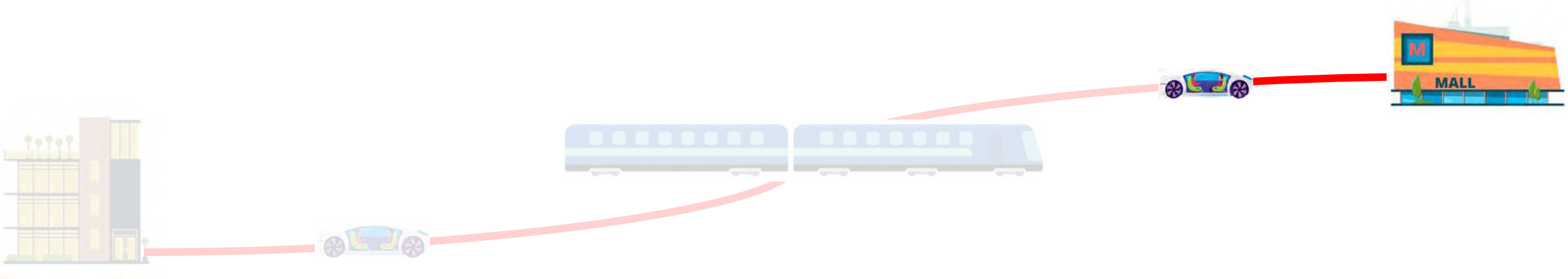


8:00 – 8:43 AM

Camille settles into her seat and catches up on the latest news on her phone. At 8:43 an audio prompt comes over the train speaker that they will arrive at the Vienna/Fairfax Station at 8:45 AM. Camille gathers her bag and lunch and prepares to disembark.

8:45 AM

Camille's Orange Line train pulls into the station. Because this is the end of the line every remaining passenger disembarks. Camille receives a text on her phone that the Fair Oaks Employee AV Shuttle will be at the AV pick up drop off area at the train station.



8:50 AM

Camile boards the Fair Oaks Shuttle. The Fair Oaks shuttle is owned by the Taubman Company which owns the Mall. Taubman provides transportation to and from the mall for employees of the retailers located there. Providing last mile transport to the mall provides incentive to the retailors who lease there.

8:55 AM

The doors to the shuttle close and waiting employees get an audio prompt that their shuttle will arrive at the Mall in 8 minutes.

9:03 AM

Camille's shuttle pulls under the valet portico at the Fair Oaks Mall. Camile disembarks the shuttle and makes her way to the Coach Store.

Journey Map;
a person with a prosthetic limb using a Healthcare AV

Ernie is a 46-year-old Iraq War Vet; he is living with a below the knee amputation and uses a prosthetic limb. Ernie lives in Detroit, MI to be close to his extended family and friends and recently had surgery at the VA hospital downtown to put in a stent for a blockage in his arteries. Today, he will be using a Healthcare AV to and from the VA Hospital for a post-surgery follow up appointment with his primary care physician.

Ernie’s Travel Ribbon

(Healthcare AV)

6:00 PM

Ernie receives a text message from the VA hospital confirming his post-surgery follow up appointment for tomorrow morning at 10am. The text reads “Hello Ernie! Our Healthcare Autonomous Vehicle will be arriving at 9:30am to pick you up for your post-surgery care appointment with Dr. Smith. A member of our team will text you upon arrival, please be ready 5 minutes prior to your scheduled pick-up time. Your medical assistant for this visit will be Sarah H. Please type ‘C’ to confirm your ride.” Ernie confirms the appointment. Once confirming, Ernie receives another text asking him to “pin” his preferred location pickup point. Ernie sets the pin at the curb right outside of his apartment building. Ernie receives another text message confirming his requested pickup location.

9:20 AM

Ernie starts getting ready for the arrival of his Healthcare AV, gathering medical documents from his surgery discharge and medication list just in case it is needed. As he is putting on his coat, he receives a text message that his Healthcare AV will be arriving in 10 minutes.

9:25 AM

Ernie exits his apartment building and heads to the curb where he placed his pin to wait for his vehicle.

9:30 AM

Ernie's Healthcare AV and a medical assistant named Sarah arrive. Sarah exits the AV and introduces herself and confirms Ernie's identity, she then motions Ernie into the vehicle. Sarah explains she will be taking Ernie's vitals prior to their arrival at the VA hospital to help expedite the check in process. The zero entry and high head clearance of the vehicle are particularly helpful for Ernie as he is able to walk right in rather than having to use steps, lifting his prosthetic too high for a step is cumbersome for him at times.

9:32-9:48 AM

Ernie and Sarah are now both sitting in the Healthcare AV on their way to the hospital. Ernie is in a specialized chair that is able to take his weight for record and Sarah sits across from him for questioning. Ernie asks Sarah if she needs his paperwork, but she confirms she already has his information in her tablet that is connected to the VA hospital. While on the way to the VA hospital Sarah is able to take Ernie's blood pressure, she notices it is a little high and makes note of this on her tablet. The Healthcare vehicle is able to take Ernie's temperature with a scan device while Sarah also confirms with Ernie that he has been taking his prescribed medications, then asks if he has been having any issues or concerns post-surgery. Ernie confirms he has been taking his prescribed medications and has no concerns at this time.

9:49 AM

Ernie and Sarah arrive at the main entrance of the VA hospital. Sarah escorts Ernie inside, they take an elevator to the 4th floor and upon arrival in the waiting room the desk attendant is able to confirm with Sarah Ernie's identify and confirm the charting she received from the vehicle tablet is correct. Ernie then waits a couple minutes for the doctor.

9:55 AM

Dr. Smith is able to see Ernie's vitals recorded by Sarah prior to seeing him in the exam room, he takes note of Ernie's blood pressure reading.

10:00 AM

Ernie is called into the exam room. His post-surgery follow-up appointment is completed with Dr. Smith.

10:30 AM

Ernie exits the exam room and receives a text. His care team has notified the hospitals standard AV of his completed appointment and his ride home will be ready at the main entrance in 7 minutes, giving Ernie enough time to get to the elevator and back to the main floor again. Ernie asks the desk attendant before leaving if he needs to check out, she explains to him that further care recommendations and check out will be completed in the AV.

10:33 AM

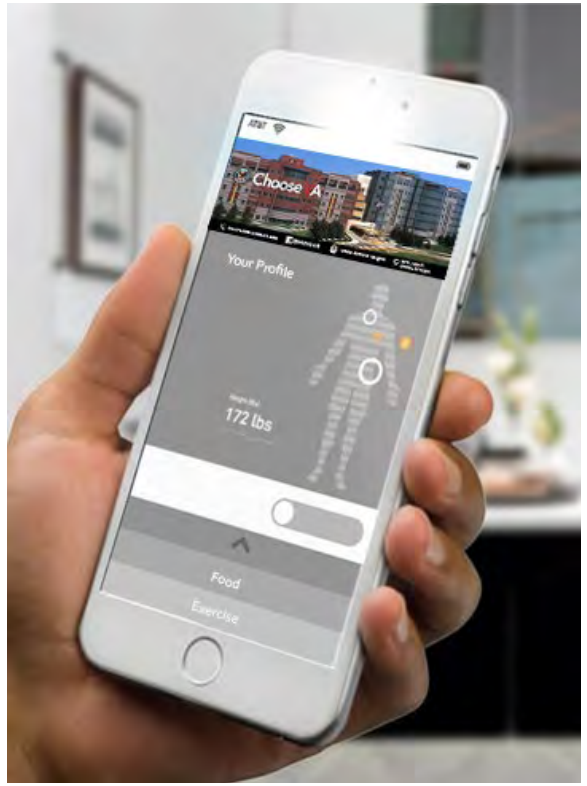
Ernie arrives at the main entrance to find his AV, which is displaying a 4-digit code on the outside. Once near the vehicle Ernie gets a confirmation text with the same 4-digit code confirming that his vehicle has arrived, he then enters the vehicle.

10:30 AM

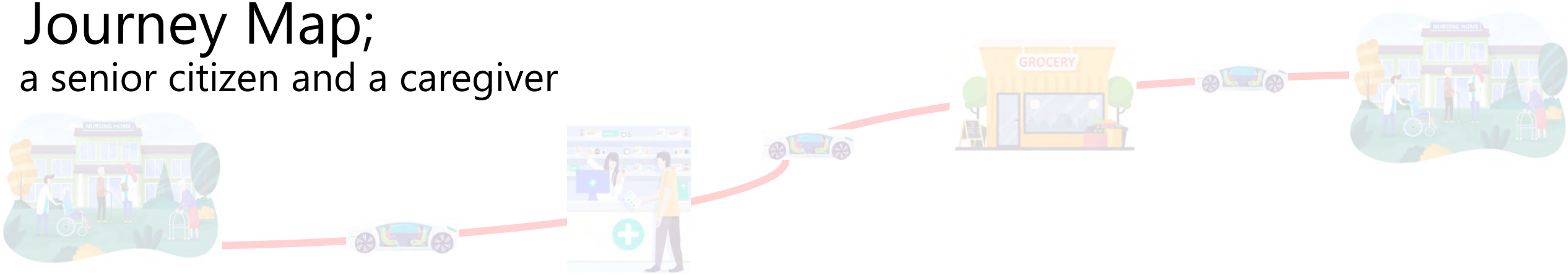
This time Sarah, the medical assistant, is not physically present but virtually present on a video screen inside the vehicle. While on the way to Ernie's home, Sarah confirms with Ernie the new blood pressure medication he was prescribed today and the proper dosage for it, as well as importance of the continuation of taking his cholesterol medication. Beyond medication, Sarah reminds Ernie it is important to maintain a healthy lifestyle with his food choices and exercise routine. She then shows him a couple of exercises and easy food options on screen that would be particularly helpful for his condition. Sarah then emails Ernie the food and exercise suggestions they have discussed. Ernie confirms he understands the importance of his medications and healthy lifestyle and taps a 'confirm' button on screen, giving his electronic signature of compliance. Sarah completes the appointment and says goodbye.

10:33 AM

Ernie receives an email from Sarah with his new food and exercise plan suggestions just as his Healthcare AV arrives back at his home.



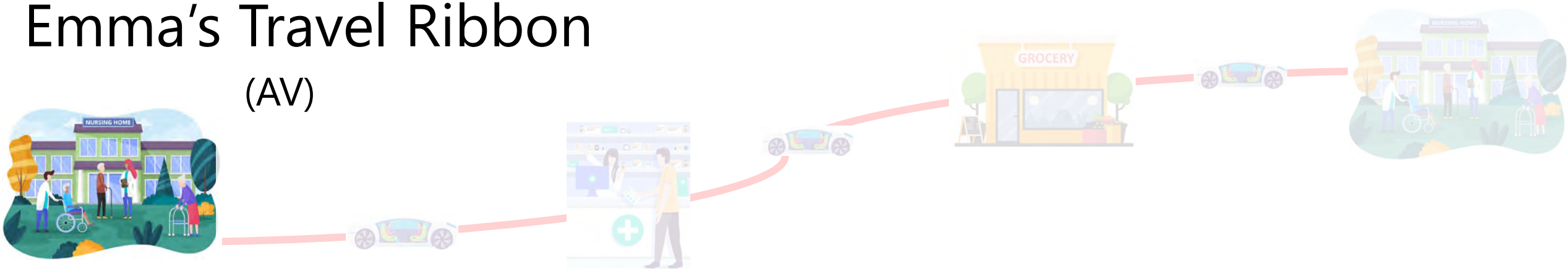
Journey Map;
a senior citizen and a caregiver



Emma is an 82 years old widower who uses a walker. She has spent most of her life in the Pacific Northwest and has raised three, now grown, children. Her daughter and two sons live out of town as life has taken them to distant jobs. Emma's family helped set her up at the Brookdale West Seattle Assisted Living Facility where she can get more supervised care. Krista a 24-year-old caregiver works at the Brookdale assisted living facility and part of her job is accompanying residents to visits beyond the walls of the facility to places like the doctor's office and grocery store. Today, she and Emma will take one of the facility owned AV Shuttles to the grocery store and pharmacy.

Emma’s Travel Ribbon

(AV)

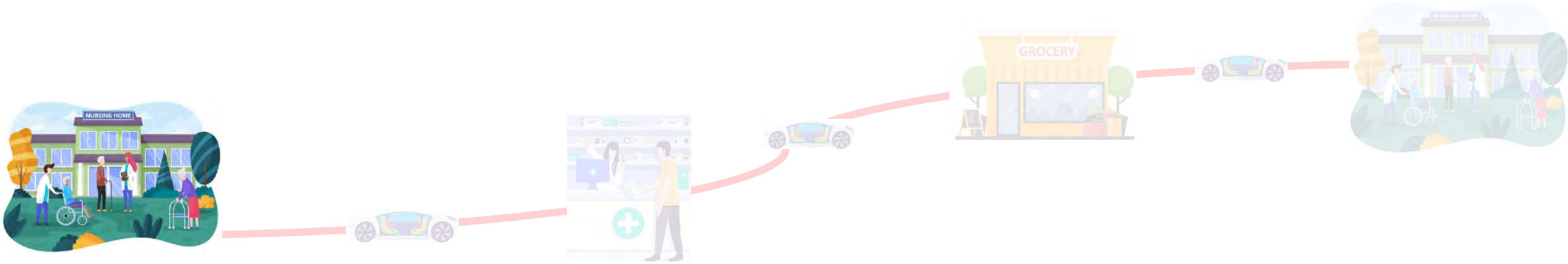


10:00 AM

Krista receives a text from her supervisor that Emma, who she ran into at breakfast, would like to make a run to the grocery store and pharmacy. Although residents have the option to have grocery and pharmacy products delivered, many take advantage of getting out into the world and enjoy a certain level of independence and socialization.

10:05 AM

Krista checks the vehicle schedule on her app and see’s that a shuttle is available at 1:00 PM today. She calls Emma’s room and asks if that time is ok. Emma confirms that she will be ready and down in the main lobby at that time. Krista asks her which Grocery store she would like to go to in the area and what pharmacy has her prescription. Emma responds the nearest Trader Joes and Walgreens.

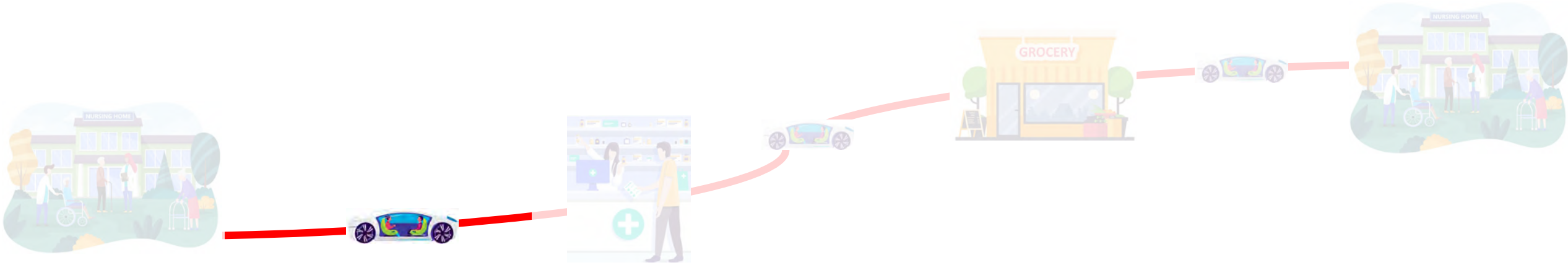


10:10 AM

Krista puts the destination address into her vehicle app and designates the first and second stop (Pharmacy then Grocery) and the app confirms her destinations and time of pickup.

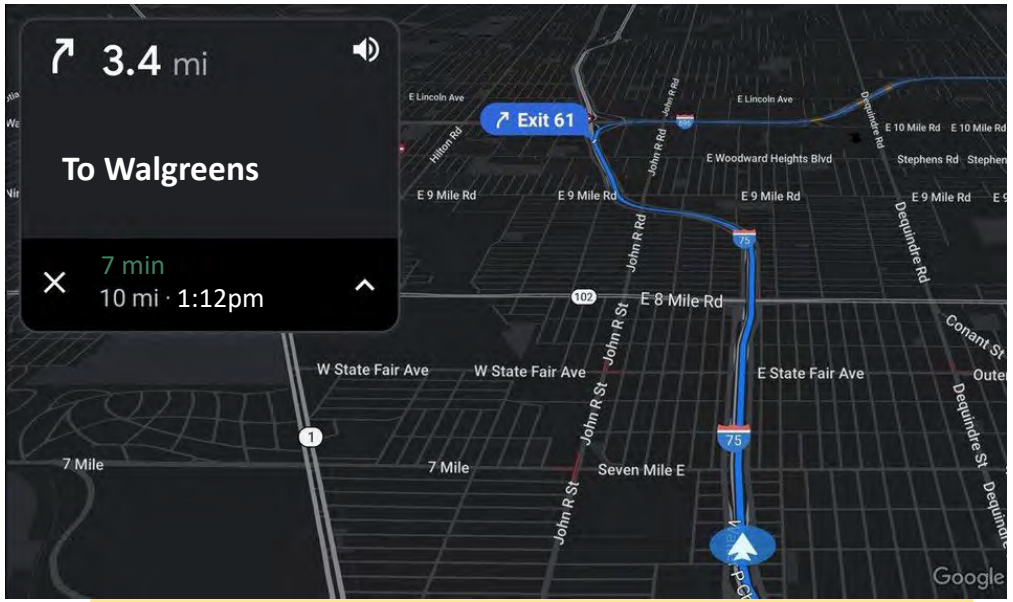
1:00 PM

Krista arrives in the lobby and finds Emma eagerly waiting for her. Through the doors Krista can see the Shuttle parked under the covered portico. It's lightly drizzling outside. As Emma and Krista exit the automatic doors the shuttle senses Krista's phone and begins lowering itself six inches and deploying its ramp. By doing so the incline into the vehicle is minimal and Krista walks behind and monitors Emma as she enters the vehicle. Emma prefers to do as much as she can alone and without assistance.



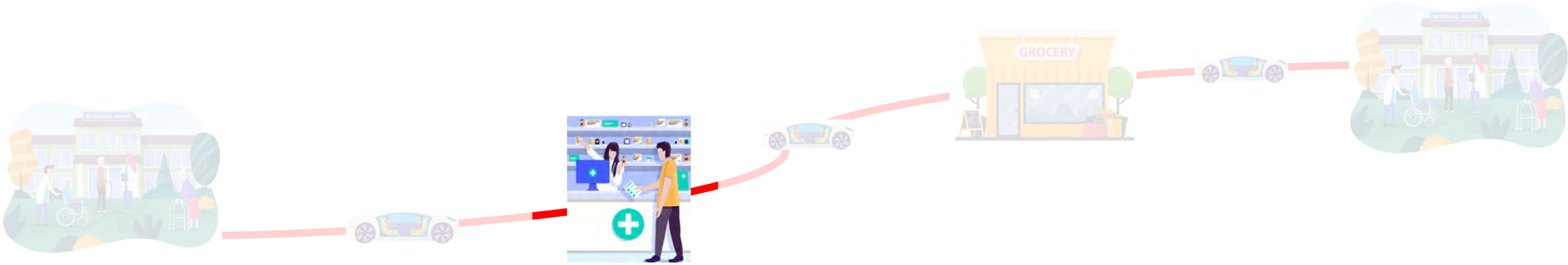
1:05 PM

Emma finds a seat and puts on her seat belt. Krista secures her walker with straps that can be pulled out of the vehicle walls. She quickly locks the straps and takes her seat. Krista gives an audio command to the vehicle that everyone is secure, and the vehicle begins to move slowly from under the portico. On the large display screen in the vehicle it shows a route map for their trip and the time to their first destination Walgreens which is 7 minutes away with traffic.



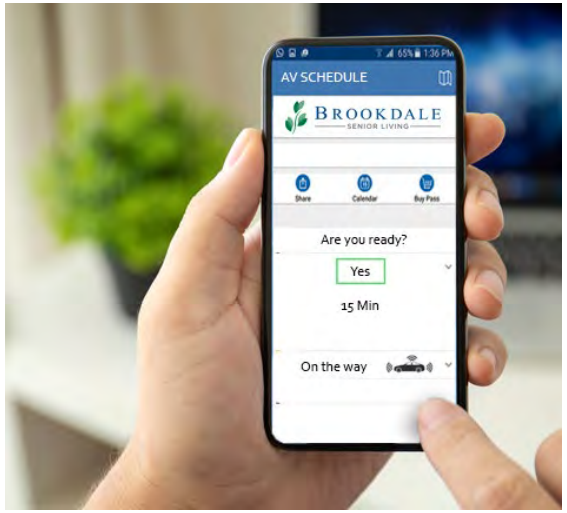
1:06 PM

Krista engages Emma in conversation. Krista asks her about her children and grandchildren and what Emma wants to pick up at Trader Joes.



1:12 PM

The Brookdale AV Shuttle pulls to the front door of Walgreens and laser measures the curb in front. The vehicle raises itself 2 inches and deploys its ramp. Krista helps Emma fix a stubborn zipper on her raincoat and opens an umbrella to cover them as they enter the pharmacy building. Krista again walks behind Emma and watches for any trip hazards.

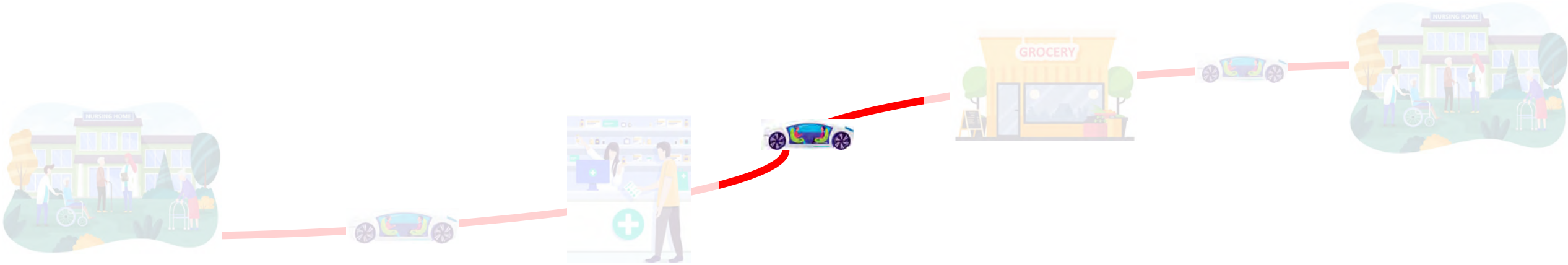


1:14 PM

Krista and Emma enter Walgreens and the door closes behind them. The AV shuttle then moves away from the front door and finds an open spot and parks itself.

1:34 PM

As Emma is checking out with the cashier in the pharmacy Krista calls the vehicle to pick them up at the front door. Emma and Krista make their way through the store and to the front entrance.

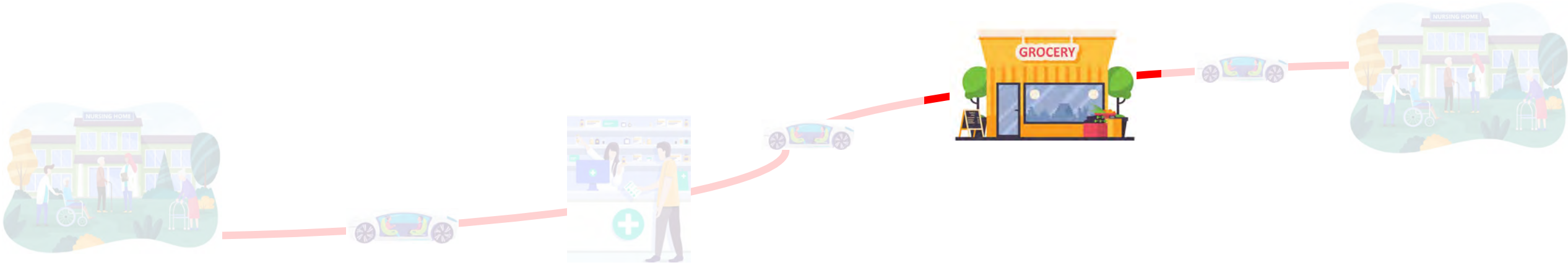


1:37 PM

Krista pops open the umbrella and follows Emma into the vehicle. As they take their seats and secure their seat belts the vehicle displays the route map to Trader Joes as their next destination with a travel time of 10 Minutes.

1:38 PM

Krista places Emma's prescriptions in a secure storage locker in the vehicle with a key code. Emma and Krista talk about how they both love weather like this and getting out into the world. They both agree "it's a Seattle thing" that most people would not understand.

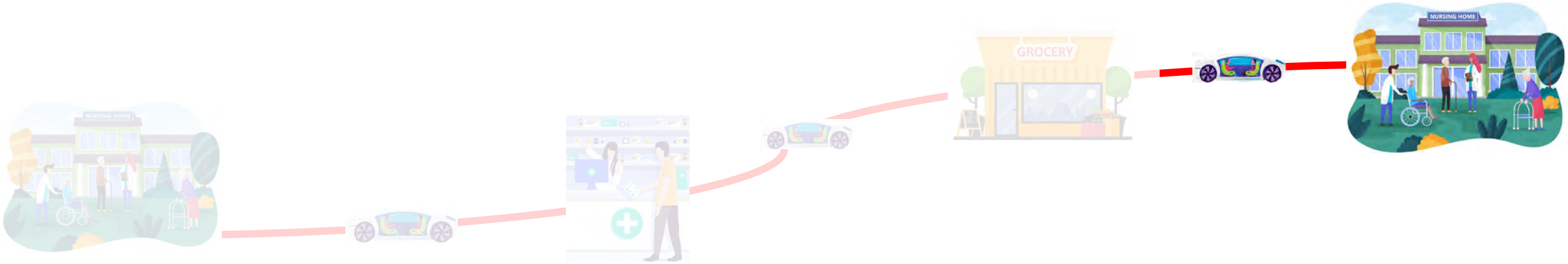


1:47 PM

The AV Shuttle pulls as close to the main entrance to Trader Joes as possible. Trader Joes has automated vehicle restrictions that don't allow AVs to block an entrance and the vehicle is aware of these restrictions. The vehicle measures the curb height and lowers itself 3 inches and deploys the ramp. Emma and Krista exit the vehicle and again the vehicle finds appropriate parking and waits to be recalled.

2:20 PM

Krista is helping Emma manage the cart and groceries in the checkout line. She calls the vehicle to return and receives a message from the vehicle that it will be ten feet to the left of the main entrance as they exit.

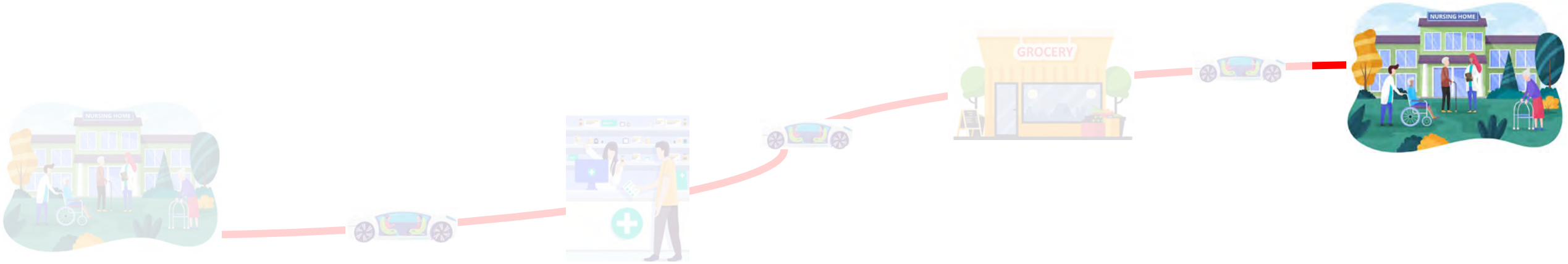


2:23 PM

Emma and Krista exit Trader Joes with several bags carried by Krista. Krista helps Emma into the vehicle and accesses a larger storage unit in the vehicle to secure the grocery bags. They both take their seats, and the vehicle begins its journey back to Brookdale Seattle West. The route map tells them that with traffic they should arrive at 2:45 PM.

2:45 PM

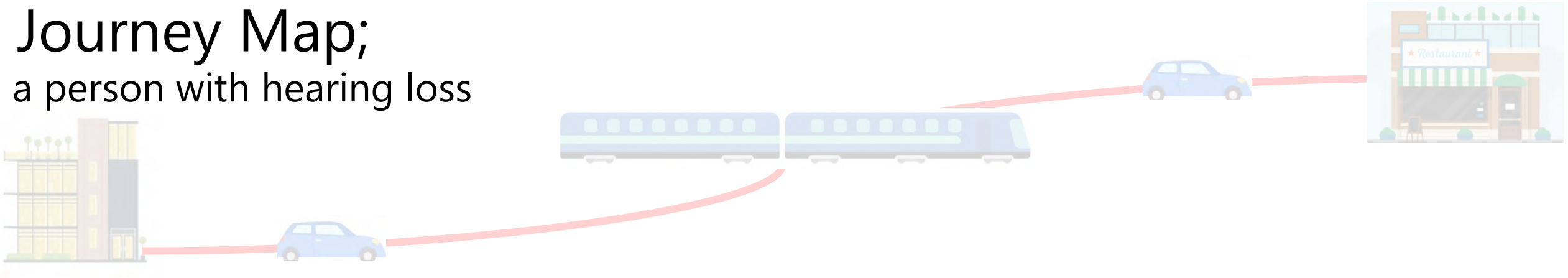
The Brookdale AV Shuttle pulls under the portico and deploys its ramp. Krista and Emma walk down the ramp as Krista carries Emma's grocery bags. They both enter the building when Krista gets a notification from the vehicle that a package has been left behind in the small storage locker. Krista informs Emma and puts the grocery bags down inside the lobby to return to the vehicle and retrieve the pharmacy bag.



2:49 PM

Krista returns from the vehicle and helps take all the bags to Emma's apartment. The vehicle slowly pulls from under the portico and parks itself for charging in the employee lot.

Journey Map;
a person with hearing loss

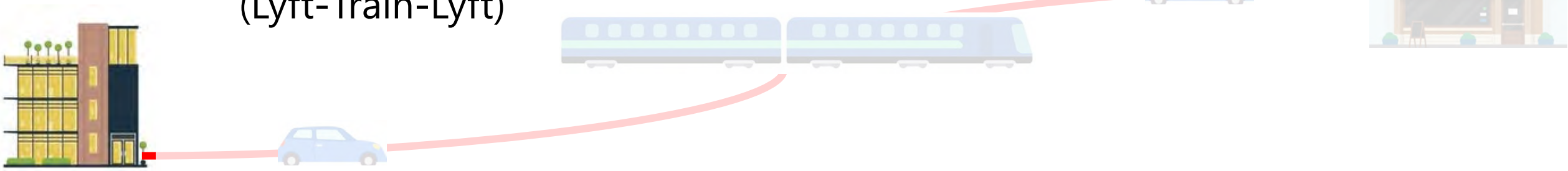


Carl Young is a 25-year-old recent college graduate that works for Dell in Austin Texas. Carl has hearing loss in both ears and can only hear 25% in his right ear and 30% in his left ear. He is saving his money for cochlear implants but having just started his new job as a project manager he is a couple of years out from that. His job takes him to different parts of Texas and the country working with clients. Carl has his own vehicle but prefers to ride public transportation for work commutes and if socializing with friends on the weekend. This evening Carl is meeting college friends at Yard House in North Austin to have dinner and drinks at the Domain at 8:30 PM

Carl is using Cap Metro's new integrated mobility app that fully integrates public and private transportation resources. Carl recently completed his personal profile on the app. His profile takes into account his most frequently traveled routes, his hearing disability and preferences on modes of travel and payment method. Carl lives in the South Austin neighborhood of Riverside.

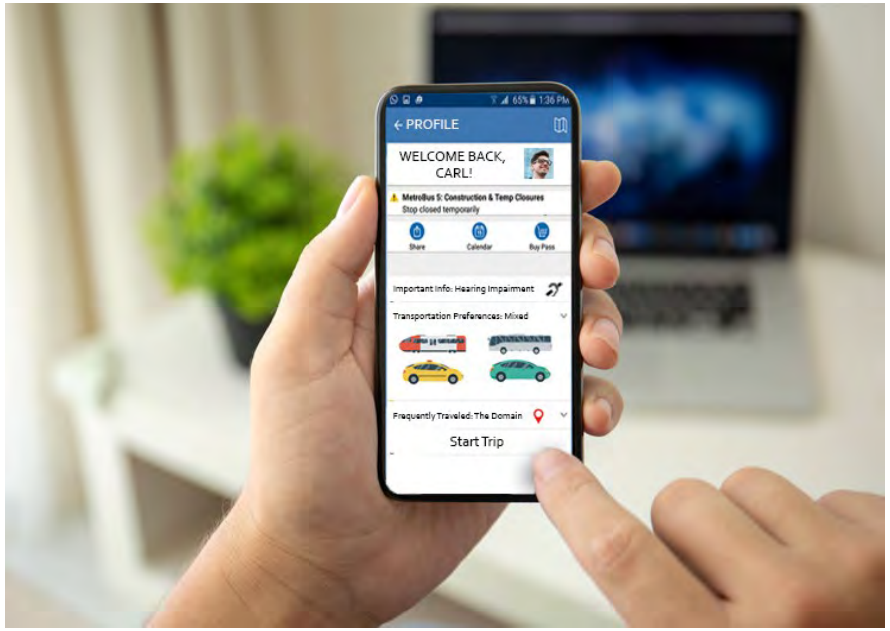
Carl’s Travel Ribbon

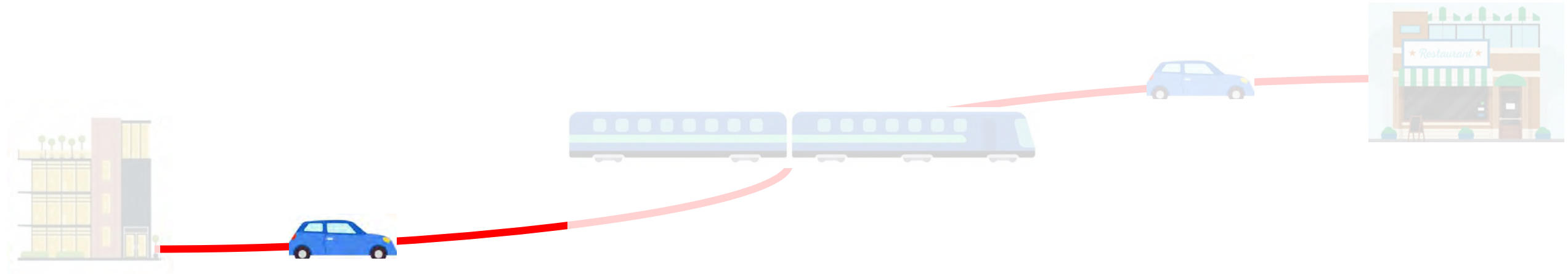
(Lyft-Train-Lyft)



7:00 PM

Carl opens his Cap Metro app and begins booking his trip out to the Domain. Carl’s preference in his profile leans towards taking (Rideshare) Lyft to get to and from Bus and Commuter rail stations as it is more direct. Using the visual prompts in the app Carl confirms pickup outside his apartment building at 7:30 PM. His app confirms his itinerary which includes a Lyft ride to the Downtown Metrorail Station, a train to the Kramer Station in North Austin and a Lyft to the Yard House in the Domain. Conveniently his app will store this journey and will help him route his way home at the end of the evening if necessary.



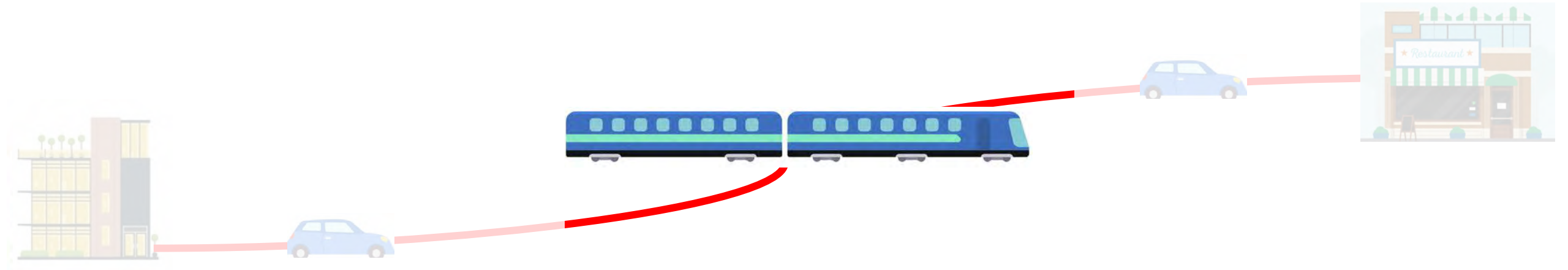


7:30 PM

Carl exits his building and receives a notification from the app the Eddie his Lyft driver is outside his building on the opposite side of the street in a red Hyundai Sonata. Carl walks across the street and enters the vehicle. Carl confirms his identity and destination by using the touchscreen in the backseat of the vehicle. In certain cases, this identification can be confirmed using sensors built into the vehicle that pick up his phone ID and Cap Metro app information.

7:35 AM

Carl's Lyft leaves the front of his apartment building and makes its way to the Downtown Station. His phone app and the screen in the rear seat of the vehicle confirms the trip will take 10 minutes to the station.



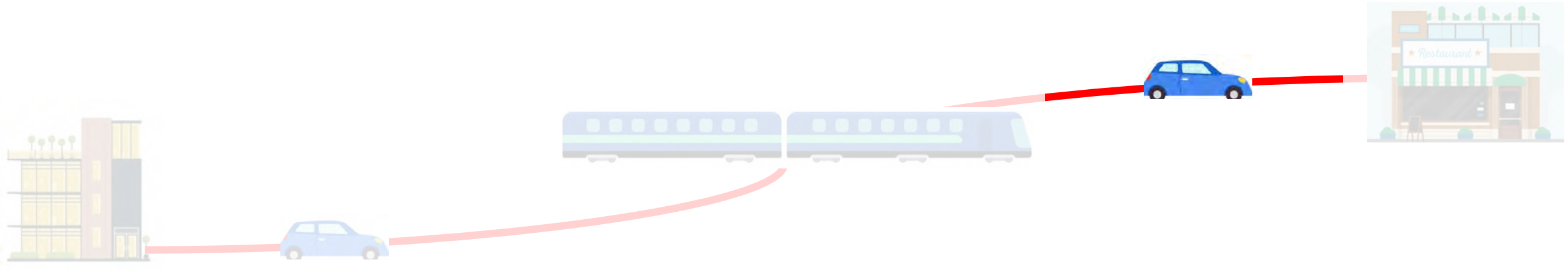
7:45 PM

Carl's Lyft arrives at the downtown station and he receives a notification on his app that the train will arrive in 10 minutes

7:55 PM

Carl's train to the Kramer station arrives at the downtown station. Carl enters the car and notices the large screens at the front and side entrances of the car. These screens display real time information on the time to the next several stops on the route overlaid on a Map of the surrounding area. The next couple of stations such as Satillo Station arrival in 5 minutes and MLK Jr. Station in 15 minutes are highlighted on the screens.

Carl receives a notification on his phone that he should be arriving at the Kramer Station at approximately 8:20 baring no slowdowns on the line.

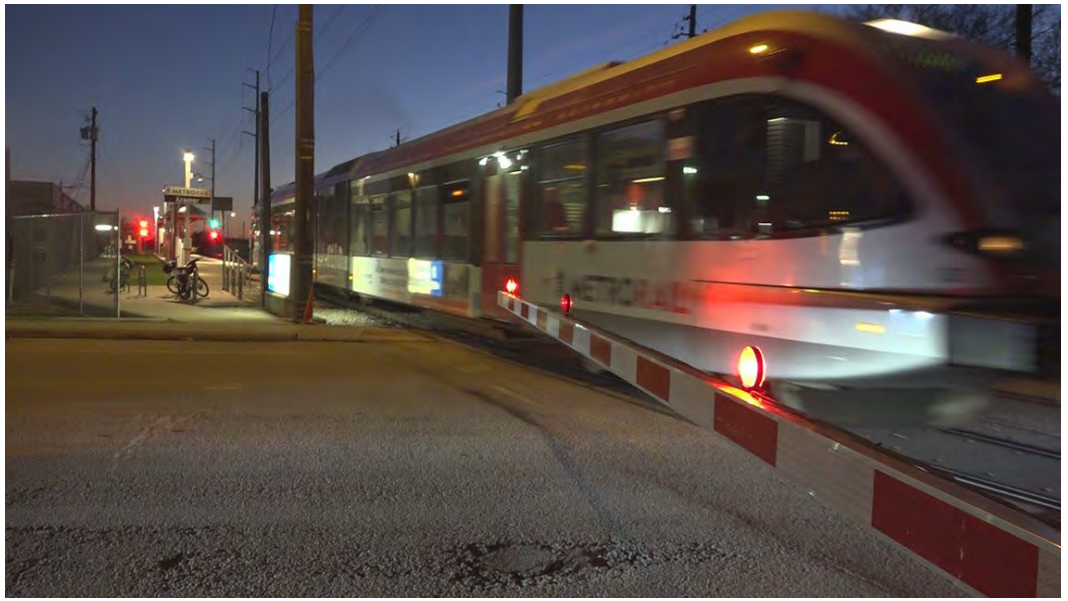


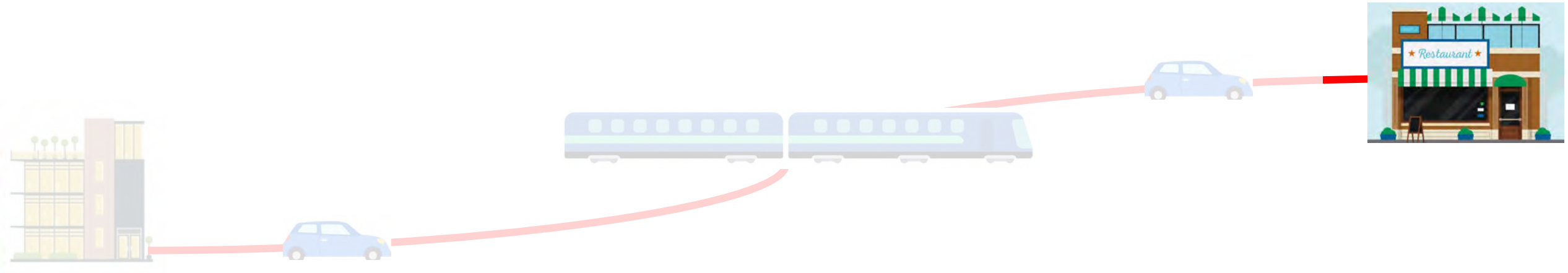
8:17 PM

Carl gets a notification that his train will arrive at the station in 2 minutes and to gather his personal belongings.

8:19 PM

Carl arrives at the station and is instructed through a notification on his phone that his Lyft is parked at the street curb 50ft to his right (graphic arrows on phone display) upon exiting the rail car. He is told to look for Ben in a White BMW 5 Series.





8:21 PM

Carl acknowledges his arrival and identification on the Cap Metro app for his Lyft driver. The driver is notified and understands that Carl is hearing impaired and gives him a visual welcome on the rear seat display. Carl takes his seat and is notified that his time to the Yard House is 8 minutes away.

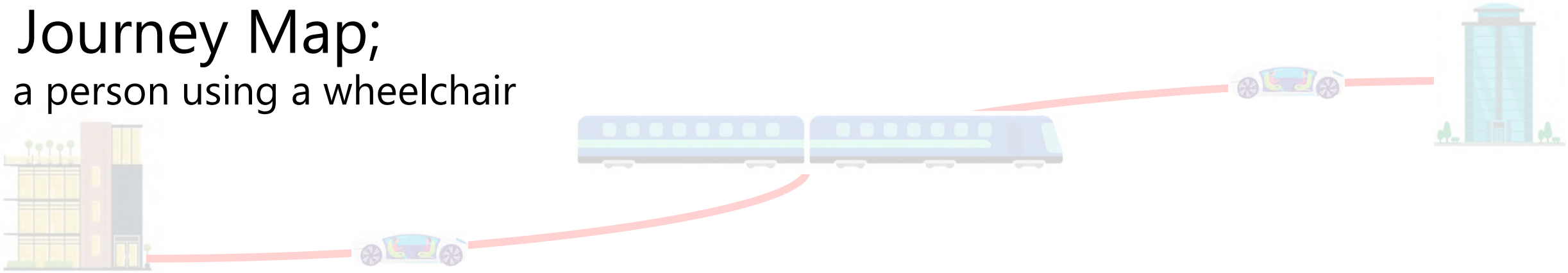
8:29 PM

Carl arrives at the front door to the Yard House and sees one of his friends waving. Carl sends a Thank you to the Lyft Driver and gives him a 5-Star rating! At this time Carl's app automatically charges his credit card on file with Cap Metro for his complete trip based on the interaction of his phone with the vehicle sensors.

8:30 PM

Carl waits outside of the Yard House waiting for his other friends to arrive.

Journey Map;
a person using a wheelchair



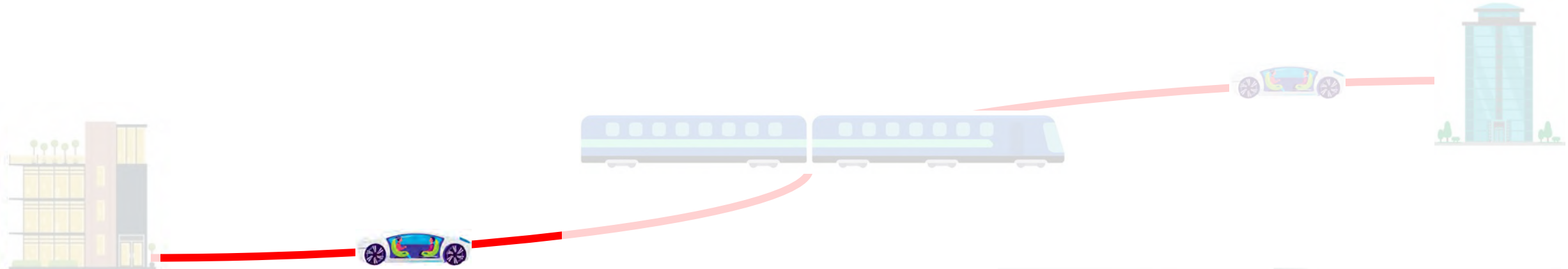
Marcus Pennington is the Director of Inclusion and Diversity at NCR Corporation located in Midtown Atlanta. Marcus navigates the world with his manual wheelchair which he typically breaks down and places into his own car to go places. Marcus however does not drive into the city for his job. Instead, Marcus prefers to take the train in to Midtown to avoid the city rush hour traffic. Marcus lives in a tidy townhouse in Sandy Springs GA. This is his journey.

Marcus' Travel Ribbon

(MARTA AV Shuttle-MARTA Train-MARTA AV Shuttle)

6:30 AM

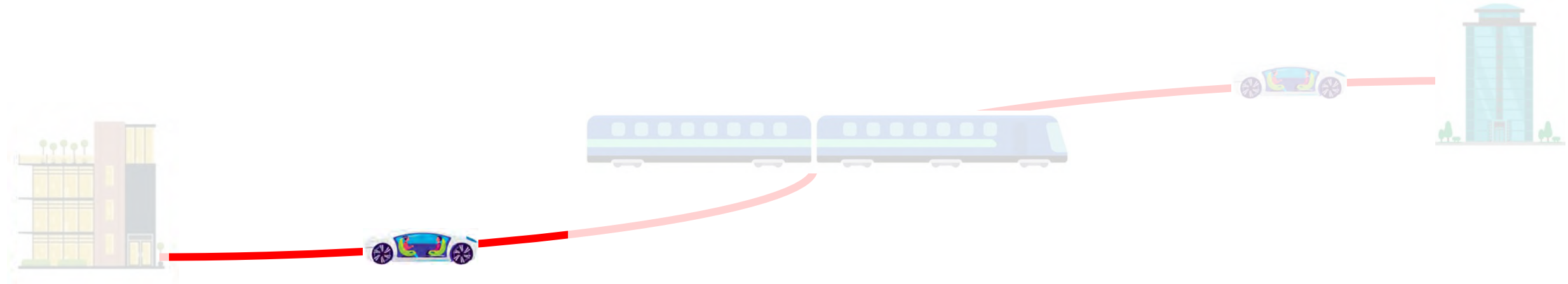
Marcus is having his first cup of coffee of the morning and gets a text notification from his MARTA app. The text is to confirm his morning pickup outside his townhouse at 7:30 AM. Marcus hits the ACCEPT button and his trip is confirmed. MARTA's mobility application allows Marcus to set up everyday trips (like his morning and evening commute to work) in his profile and preferences. Marcus heads to his room to take a shower and get ready.



7:30 AM

Marcus is waiting outside his townhouse at the curb as his MARTA AV shuttle pulls to a stop. The shuttle measures the curb height and raises two inches to create a zero entry and deploys a small ramp to bridge the gap between the shuttle and sidewalk. Marcus rolls forward into the shuttle. The wide-open space in the center of the shuttle allows him enough maneuverability to quickly turn around and back into the open wheelchair space. The wheelchair area is demarked by two green lines on the floor of the shuttle. Marcus backs up between the lines. Automatic securements extend and lock his chair into place requiring no additional help. This allows for a safe journey to the office.

Janell, his friend and coworker is seated near by as she is most mornings. Because wheelchair securements are located throughout the cabin Marcus can easily be part of the conversations on the way to work.

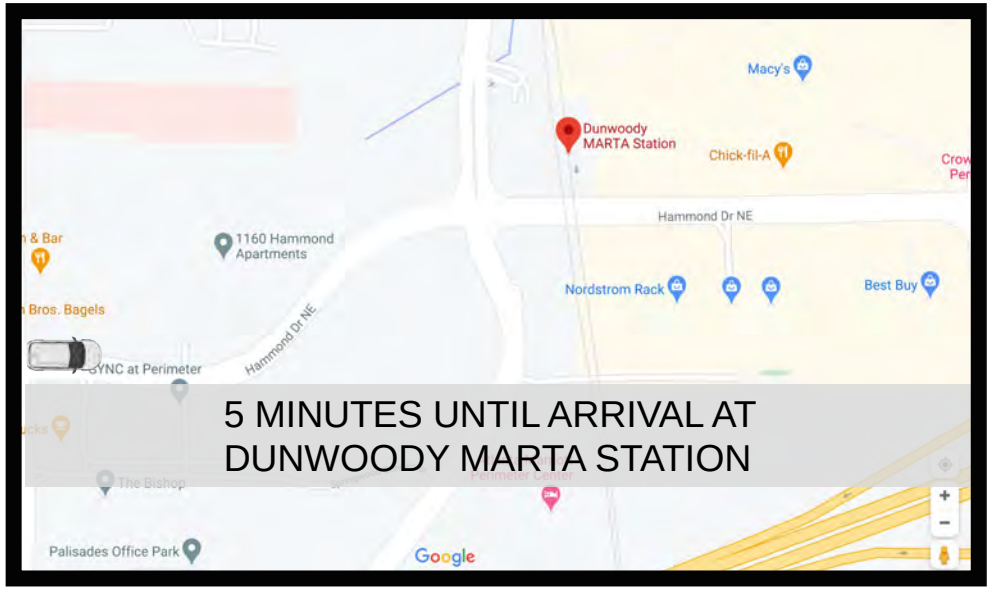


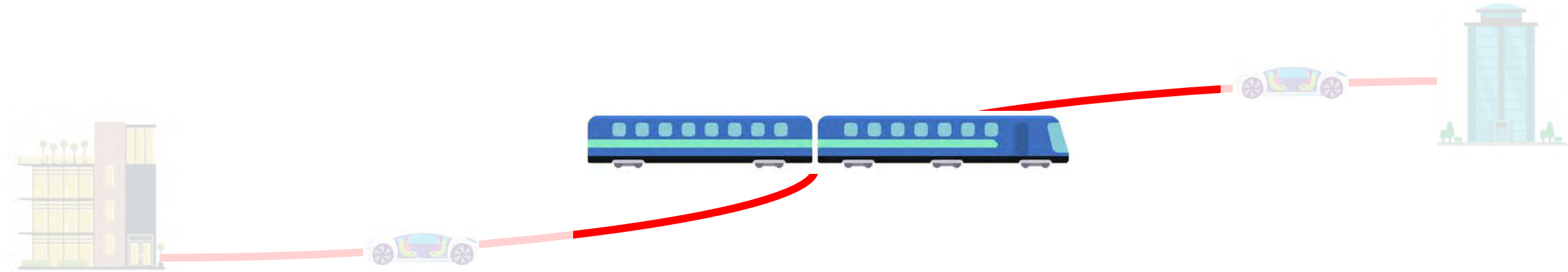
7:35 AM

Marcus looks up to monitor on the interior wall of the shuttle. This monitor displays real time journey information and Marcus notices that he is 5 minutes out from the Dunwoody MARTA Station. He and Janell grab their briefcases and prepare to disembark.

7:40 AM

Marcus and Janell's AV shuttle pulls to a stop at the Dunwoody station. Marcus presses the unlock button on the post next to his chair which releases his securement. They proceed up the ramp to the train platform. An announcement comes over the speaker that the train to Midtown, Downtown and Hartsfield Airport will arrive in the next 3 minutes. Both Marcus and Janell move to the edge of the platform for boarding.



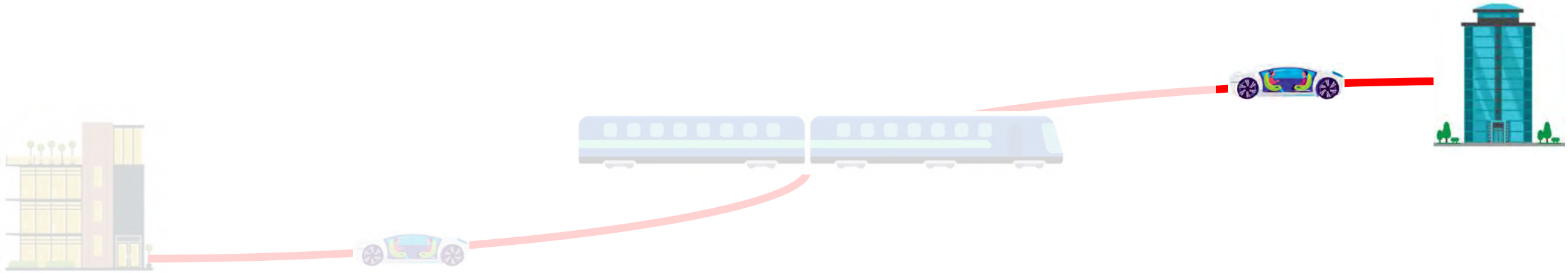


7:45 AM

The MARTA Red Train pulls to a stop and Marcus and Janell quickly enter allowing others to exit first. In the same way the AV shuttle had easy interior maneuverability, so does the train. Marcus swings his chair around and backs into the wheelchair space between the green lines. Once again, the securement arms automatically extend from the interior of the train car wall and lock his chair into place. A seat is opens across from Marcus and Janell takes a seat. The trip to the Midtown will take 3 minutes longer (20 minutes all together) because of a small slow down on the line.

8:05 AM

The Red Train slows to a stop at the Midtown Station. Marcus and Janell make their way to the elevator and take it to ground level. Marcus receives a text notification that their AV Shuttle is located on their side of 10th Street NE, 20 feet to their left as they exit the station.



8:07 AM

Marcus and Janell enter the MARTA AV Shuttle and take their seats for the short 5-minute trip to the office.

8:12 AM

Marcus and Janell's AV Shuttle pulls to a stop outside the main entrance to NCR at the vehicle drop off area. Marcus releases his securement and exits the shuttle with Janell and heads into the office.

Appendix

Stakeholder Interviews

Valerie Lefler

Executive Director at Feonix Mobility Rising

Feonix
MOBILITY RISING

General Notes:

- Feonix is a 501C3 non-profit, working in multi states with partners like AARP driver safety, Toyota north America, engagement with united way and centers for independent living. Collab with each partner focusing on underserved communities and people who have fallen through the cracks when accessing services. User centered design and how we set up the service is important. Supporting single moms getting to work. Tech deployments with 3rd party vendors to customize for older adults, accessible buttons and screen readers.
- Coastal bend in Texas is an area of service.
- Sometimes there is no service in rural areas and people with disabilities had no trans options.
- "Freedom drivers' volunteers get people from A to B. Center for independent living does eligibility qualifications (income, disability), competitive bid processes, every ride gets provider bids (volunteers get mileage), then ride gets trip fulfilled.
- Multiple ways to get transportation. For wheelchairs they work with transit services. Has to be requested when getting ride. Visual impairment is also supported by "door to door" transportation support. Longer load time budgeted for the driver, driver education (asking before reaching and moving, take time, secure wheelchair safely). Service animals being accommodated, etc.
- Caregivers are a "luxury", current ridership, 10-25% have a caregiver with them during the ride.
- Emotional support during trips, may be only person they see during that week or month.
- They crave touch, not uncommon for riders to try to hold the driver's hands.
- Training for drivers for service animals, adjust seats to give it room, don't talk to it or touch it, ask permission, etc.
- 1 Person with or w/out service animal 80-85% **vs** shuttle scenario 15-20%
- DDot (& other companies)- 50-60% multi load shuttles, Feonix primarily does individual rides.
- People request a van rather than sedan because they can't get down to sit.
- People tend to not be on the smaller side and can't fit well in the compact cars. Smaller vehicles are not preferred.

General Notes (cont.):

- Need adequately sized seats.
- Bariatric wheelchair rides are premium rides, $70 an hour.
- The vehicles that are used are lower floored mini vans, sedans, SUVs or Jeeps
- A lot of patients have walkers & pivoting on their knee is a huge issue…one leg can't hold entire weight to sit and then move rest of body into the vehicle.
- Majority of the time service is arranged for private sector wheelchair accessible providers, public transportation, volunteer drivers, Uber/Lyft. They have somebody call to ask questions & verify so info can be passed along to the driver before the ride happens. Drivers doing 300mile rides a day "They have 24 characters of space in the app to say what the persons needs were, 24 characters doesn't go very far when your talking about someone who schizophrenic, may have a service animals, may be hard to get into their home…"
- *"For example, with the AARP driver safety project, it's not uncommon for someone to call us 3 times about a Lyft ride. Especially the first time, they want to see what is it, do I feel comfortable about it, then I got to check with my friends who use the service, then I call back to schedule the ride, then I call that morning to make sure the ride is still coming, and then maybe I get there and I'm ready for the ride but I don't see the driver and so I need to find out what vehicle was that again?"*
- The Lyft API sends out 3 different texts, this is your ride on its way, click to view ride details and progress, vehicle type, license plate # and the drivers name. Not all smartphone users are text savvy, they want to talk to a person. Seniors 75/85+ commonly have to have human aspect to feel safe & secure.
- First vehicles just purchased for Feonix (8 total) were mini vans, sedans and SUVs. Biggest component is an efficient fleet, not all passengers need to have wheelchair accessible. Sometimes driving 300 miles a trip and want to be efficient and accessible, sedans used to try and get that and also looking for electric options.
- "For the costal bend of Texas, I don't have to worry about ground clearance but if I was purchasing for Wisconsin, I wouldn't get anything low because it would get stuck in the snow." Fuel efficiency and cost efficiency of the purchase, 300mile rides are usually getting people to specialists. Some people can't get into a sedan and they need more seat space, that where SUV came in, can't sit in front comfortable but sitting in back comfortably.
- EV interest is fuel efficiency, want to reduce cost of gas when going long distances. They are working with service agencies that are on a budget and want to find the most affordable way to get someone to A to B as humanly possible. "For the charging time and planning routes, a lot of times you'll be going from a rural area and get into the interstate, fortunately in a lot of states there is a decent infrastructure along major corridors. We can look for a vehicle that does both, electric sometimes and gas others so you can kind of balance that as well."
- 70% of people with disabilities are unemployed and they want jobs, but they can't get there.

Post Interview Additional Input:

"I realized that I had forgotten a very important aspect to address in the vehicles and that is the shocks/suspension must be solid. One of the BIGGEST complaints we hear of is the quality of the ride. Often vehicles for passengers with disabilities have the worst quality of ride. 'It's almost like riding on a plank board on the back of a hayrack pulled by a tractor. You darn near fall off the seat.' Back, hip, and knee pain are not uncommon, and the quality of the seat cannot be those little vinyl shallow benches you see in some of these vehicles I saw at ITS World Congress in Singapore.

Also, as a side note, the seat material cannot be slick or must have some type of attachable seat cover that has more traction, so it has more grab for passengers who have to sit hunched over due to back issues. Often they have no stability and the constant pulling of themselves back-up on the seat is very painful. "

Vehicle Pain Points:

- Seat size and making sure the passenger is comfortable. If the wrong vehicle is sent to point of service it can cause a lot of challenges (rider can't get up or down into vehicle), it can make riders miss or delay appointments. **“Every trip matters.”**
- Making sure there is enough room for the rider, and it is easy to access from an entry point once in the vehicle.
- Seat belts commonly dig in.
- AC is a huge issue especially in southern states, too hot in the vehicle. Managing the overall temp of the vehicle.
- Height of vehicle- rider has to duck (even when seated). 1 in 10 have issues with height of vehicle, depending on height of the person- but it’s not the biggest complaint.
- Often, they don’t have the right securements in the vehicle for all different types of wheelchairs (sizes and heights).

Vehicle Recommendations:

“If I could waive a magic wand there would be a lever that could change the height of the vehicle (by the door). Adjust based upon height. A place for storage that accommodated walkers that may not even fit in a standard trunk, the fact that they can see out and have windows is very important, lots of windows is so incredibly important especially for folks who are isolated. If there was a way for, an AV or semi AV, then the driver has better ability to interact with the passenger, the experience can be improved. The ability for the rider to adjust the temperature, give them control. ‘It’s 72 degrees, would you like it to be hotter or colder?’ They would be blown away; it would be so amazing. The ability to integrate telehealth into the vehicle in any meaningful way, a lot of these folks don’t have internet in their homes and to be able to integrate medical providers as part of this so when they get to the facility, they have their blood pressure taken and temperature taken. I think if there were the ability to have some type of ramp that could come or be detachable to get someone in and out of their home or in and out of the vehicle. A lot of times the social aspects of the transportation becomes important and the AI of Google and Siri, ‘hey google let play a game’, those are the kind of things that if the driver was able to initiate those kind of things some, they would be so excited when they vehicle came because 1 I get out of my house and 2 I’m going to have fun on my journey, things like that matter. Sometimes the ramp isn’t long enough if someone has a walker, the slope is too steep or it’s not deep enough to take 2 or 3 steps to get into the vehicle with my walker ahead of me. User testing is important. AVs out are much taller, definitely having some head clearance and the ability to have space to sit down and some personal space especially post Covid-19. Definitely a slide door, if you sit in a wheelchair and try to open the door towards yourself it can get really awkward. Widest opening when possible. A handle or something for them to grab onto once they are in the vehicle before they sit down, so they can have help grabbing on. Driver becomes customer service/companion on the ride for seniors or people with complex healthcare needs, as a safety perspective, for liability reasons if nothing else.”

Infrastructure Pain Points:

- Slope of ramps are often too high.
- Sometimes have to go backwards down the ramp.
- Ramps are critical overall as well as the steps being even and the curb cuts (making sure the passenger can get from the side of the street into the vehicle).
- Sometimes there are no handrails or ramps.
- From time to time public transit can't go down some roads because of flooding (costal bend, TX),
- Door weight is often an issue, people can't always open the doors.
- **"You don't know what you're going to walk into when you get there."**

Infrastructure Recommendations:

- Having the ability to know exactly where the vehicle should go for each passenger, the location and mapping wise. The driver doesn't know where to put the vehicle so that the passenger knows where it's at (which door, where on the driveway etc.).
- Addressing has to be far more accurate.
- Having doors and windows in the facility that will allow passengers to see outside from the inside, so they know when their ride has arrived.
- Having adequate sidewalk to and from the front of the building that's at a decent slope.

Dave Bullkowski

Executive Director at Disability Advocates of Kent County

DisabilityAdvocates

General Notes:

- Disability Advocates of Kent County used to be GR center for independent living in 1981.
- Federally recognized center for independent living for Kent and rural counties to east/north. Crip Camp on Netflix, roots of independent living movement. 27 on staff, 15 around the state. “Disability network Michigan”.
- Most of the service presents is a heat map in metro areas, very good presence, cool off when you get into rural communities. “Most non-profits take culture and priorities from executive director, I’m a community organizer by trade.”
- 51% of staff for decision making staff must be people with disabilities. “Cross disabilities” = all disability types. Provide direct support to people with disabilities, also have a federal mandate to systems change work. Good success locally, people with equal passion, community connectivity and power.
- Key messages, “Nobodies number 1 issue is mobility, everybody’s number 2 issue is mobility.” Always had a minimum FTE working on it.
- Their volunteers are people with disabilities.
- GoLux, 24/7, compared to most services it very expensive.
- “Wave card”, speed up service on bus, no change, etc.
- 45 test pilots- “it’s people who have been engaged in our work through the years.” Someone on the team was completely blind and their input was insightful and even helpful with teaching people the correct language to use. “The challenge for us is giving folks meaningful stuff to do.” Different partnerships throughout the years, test pilots hung out with May mobility. “People are excited about how we’re starting to experience other people’s interest in accessibility.”
- Need an accessible pathway and parking guide, more standard crosswalk and ramp configuration. “Another barrier for people is the lack of predictability, you don’t know what the physical environment is going to be until you get there the first time.”
- Want to conduct end user interviews with riders.

Vehicle Pain Points:

Biggest stumbling blocks- embarrassment. If there's a wheelchair at the bus stop, the driver will radio in to say they have a wheelchair, which basically means the route is going to be slowed down. They have to lower the bus, get the ramp out, get the wheelchair in, secure the chair and bring ramp back in. The person with the mobility device that needs that ramp feels like they're slowing everybody down. Onboarding and disembarking, that takes a lot of time. Some of it is a training issue, how dignified are the people? It's an emotionally fraught situation.

Mass Transit Pain Points:

There are first mile, last mile issues. For the edges of the community it's the first/last 2 or 3 miles. How do people get to main lines? Paratransit services- the massive frustrations related to communication, when and where pick ups will be. People have huge stories of frustration related to getting picked up and then once picked up, a 20min car ride could be a 2-hour paratransit ride. There's not a good enough utilization of existing tech. Need to be working on rapid on demand- If someone called right now and a ride was available, they could get picked up in a half an hour and the trip movement is way more dynamic. Today, you have to call by 430 to get a ride tomorrow and most of tomorrows rides are scheduled and routed tonight. If someone is a no show or cancels, the system doesn't have enough flexibility to appropriately interact with the real world. Some tech not being used is some basic new scheduling software, Ridelink funded by senior millage (60+ people), only operates from 830-5 Mon-Fri and limited sat service. Some are using paper manifests still. Ridelink 38% increase in rides, 0% increased capacity, different ride options.

Vehicle Recommendations:

With having a driver, what's going to be important is still ease of boarding, disembarking and securement. Driver has to do everything manually and all of it takes times. Would be optimal if the rider could easily get on and then there was an opportunity for a couple of wheelchair spaces next to them and comfortable seating for their companions, not just a jump seat. A jump seat isn't that accessible for someone with limited mobility or minor physical impairments. How many seats do you really need? A group of people could go together, 3 or 4 folks, like a standard vehicle for the most part. Ramps deployed outside door or back with a low floor vehicle, less moving parts to break and more opportunity to make it manual. Head room is important. Turning radius is important, most people prefer to travel facing forward so how you enter the vehicle matters and how much does somebody have an ability to back up.

Infrastructure Pain Points:

How good are the sidewalks to get there? What are the distances for sidewalks? All bus stops are ADA accessible where the lift drops you on the pad, but after that, the sidewalks aren't good. $600 a square (sidewalk).

Infrastructure Recommendations:

Rapid bus line (silver line) has low floor busses with the elevated stations, so there is no ramp or step for anybody, the bus lines right up with the station. Those vehicles can only stop at those specific stops and the cost of elevating the bus stop would be expensive. Having a vehicle that can raise and lower- kneeling busses- can help with the angle of ramp. "We want to get to a better standard, and we want municipalities to build and rebuild new things to that standard. Concrete mistakes are expensive to fix, or they last a long time. What is a better universal design for ADA?"

William Purves

Executive of Planning & Program Development at Ann Arbor Center for Independent Living

ANN ARBOR Center for Independent Living

General Notes:

- In this position for 2.5 years, started out doing strategic planning and organizing. 1 of 13 facilities across MI.
- Does 90% of the grant writing and management with private, non-government entities.
- Organizes collaboration projects and seeks out new relationships.
- Focus around mobility on an individual level, assist people with disabilities and mobility training, groups/classes from schools, advocacy work. His staff serves on local advisory councils for regional transit authorities.
- Will services on long range planning and strategic planning with Ann Arbor transit authority and city of Ann Arbor mobility solutions group. He's active in the governor's mobility challenge, that's how he connected with Valerie Lefler (Feonix Mobility Rising). He also does consult work with engineering firms who work in the AV space, and participates/hosts research projects through U of M primarily on AV design and accessibility. Simulating different kinds of disabilities and see how it affects their design process so they're very specific to the stage of design work that they're doing. Prompts the question to them that they need to start earlier in the design process. Someone in a powerchair with a puffer to move around. Takes the bus and shared rides and has the luxury to make those decisions economically where other people don't. End user for research.

Vehicle Pain Points:

The main point of conversation initially and at the tail end, is how are you as a design firm or a production facility are thinking about the range of people who are going to be using your product in the most inclusive way possible? Snapshots- conversations with big groups of engineers starting to think about communicating in AVs that they're rolling out, there's a "driver" or "conductor" or "monitor", what communication issues is there if someone doesn't speak, or uses sign language? Give everyone a pad of paper to write down stuff? What other possibilities do you have? An 'Ah ha' moment was a white board surface inside the vehicle so we can use it as a communication tool. That turned into going forward, a flat screen that could display text or some interface.

Vehicle Recommendations:

How are you including and thinking about people with disabilities in your design process? That's the richest conversations. After these questions there's "ah ha" moments as folks start to encounter their product or go through the design process with a new or revised view. Awareness building, having a conversation on a regular basis…repeated conversation, lets broaden the vision.

Even entry. How does someone using a wheelchair/puffer enter and get secure etc. For visual limitations- use of surfaces, markers or specific functionality. Flooring, walls and door frames, if you're not supposed to stand in an area can you make it rougher on the floor? Different textures could be different colors for people with cognitive disabilities "when you get in, stand in the green area, not the yellow area" so there is clear color coding. Useful for people with macular degeneration as well. Universal colors- yellow line towards from to stand behind. There's a design language with use of color. Example, picking someone up with a walker and there was an ice storm, but they have to go to the dr. Someone can't negotiate down the ice, what do you do? Human interface. Not necessarily a driver but still a person there, repurposed to customer service role

Infrastructure Pain Points:

Arranging for a rides. Will uses Lyft a lot- the driver coming to pick him up won't be made aware of his disability ahead of time, it's not in the system. It would help is there was a specific place you could arrange ahead of time (for driver and rider) so it doesn't cause frustration on either end. Training of the driver is very important. If the system could know the rider specifically and know specifically where to pick them up- everything is now personalized. Universal design plays into the economic factor.

Infrastructure Recommendations:

Rapid bus line (silver line) has low floor busses with the elevated stations, so there is no ramp or step for anybody, the bus lines right up with the station. Those vehicles can only stop at those specific stops and the cost of elevating the bus stop would be expensive. Having a vehicle that can raise and lower- kneeling busses- can help with the angle of ramp. "We want to get to a better standard, and we want municipalities to build and rebuild new things to that standard. Concrete mistakes are expensive to fix, or they last a long time. What is a better universal design for ADA?"

Mark Hynes

Livingston Center for Independent Living

ANN ARBOR Center for Independent Living

General Notes:

- Livingston center for independent living. Livingston division or AA center. All ages and varying disabilities. Was doing transportation advocacy before COVID, paratransit only, access could be difficult for more rural sections of the county where there is limited population. It takes 30-45min to get to destinations.
- Has a guide dog to help navigate and uses paratransit himself and understands how it works and experiences it every day, so it's near and dear to his heart.
- Joined the Livingston transportation coalition a couple years ago, last year was elected to the steering committee. Connectivity to ride is hard, getting through to the service is difficult- only goes through the phone, not an app.
- Has 28 paratransit vehicles currently, diverse feet- 28 passenger busses all the way down to a 3-passenger van
- Riders now- Going to work/early am appts, 4-6 individuals going to a relatively similar area. Sometimes have to go way out of the way to accommodate riders. @ end of the day, 15 passenger busses could be completely full, and they'll take a group from work skills need to get back home/to an evening job. They have a main pickup point and it takes about 2 hours to drop everybody off just between Howell and Brighton. All handled through calls, route management radios into drivers to make dynamic pickups. Working on being able to see where the busses are specifically at and won't have to radio in.
- Inside the vehicle- textures. The current bigger busses have little markers on the floor to show where the wheels of the wheelchair go and they're slightly raised. Beneath the seats on the floor there is a texture, so you understand where the seats are. The steps are difficult, but they're clearly marked with slightly raised edges.
- Riders travelling with a caregiver, sometimes, to help get on and off (drivers are also helpful and do most of the assistance with getting on and off the bus). People love going out and doing stuff even if they aren't doing it 'correct' it's a way for them to get out.
- Livingston is aging, more 65+ are moving into the county.
- Rides between 5am-10pm. Utilization 6am-930am and 230pm-6pm every vehicle is full and out running. Middle of the day 930am-230pm up to 3 people on the bigger busses and the vans may have 1 or 2. Sometimes there's only 1 person on a giant bus because its basically whatever vehicle is available at the time. Fridays are a bigger ridership day (community outing day for alternative transition school)

Vehicle Pain Points:

- It's cumbersome in some senses because the lift has to come out and down and have to make sure the person is secure on the ramp and sometimes people don't like the height. His service dog hates it. But the drivers can get people on and off in 2 minutes- they have it down to a science.
- Biggest paint point is steps on the busses, some are uneven or really tiny, less than 8in.
- The amount of noise and rattling on the bus, especially with the lift. (when its secured on the bus it rattles a lot and it's almost impossible to talk).

Vehicle Recommendations:

- A lot of automatic components, ramp coming out automatically if it's on demand for a wheelchair. Ex: a van that is lower to the group but it has room for 2 wheelchairs instead of just 1. They can roll in through the back and can fit 2 wheelchairs and the side seats can flip up to the side to be out of the way.
- There needs to be amble room.
- Some people have very limited mobility so they cant strap themselves in, they might need an automatic clip/hook in and will protect them from outside factors (other cars). Flexible interior, seats that can flip up and out of the way. Quadriplegic or MS have a remote to move chair but cant strap themselves in- our paratransit driver currently hooks then in.
- Door- auto opens for you when you're close or there is a button on the door the can open it (push to open, like a train door between cars). Don't want any doors to open out, prefer to slide. Helps the door get secured better too.
- Varying weather conditions pose problems (snow, ice), need a vehicle that can operate in all conditions.
- There needs to be a way for the individual to pay if this is a driverless system and be able to confirm where they're going (near the door). A lot of the aging population doesn't have smart phones.
- Having a customer service people (concierge) in case someone needs help.
- Could AI be available for riders to ask questions (how far away is the door, etc)? Responds "It's 40 meters to the door on your right)

Infrastructure Pain Points:

- People who live on dirt roads, there is no sidewalk to get to the vehicle. Some ground clearance disparities.

Infrastructure Recommendations:

- Interacting with the sidewalk, maybe there is opposite marking contrasts on the sidewalk or raised so you know where to stand behind.
- Button in bus shelters to show when bus will be arriving- make sure it stands out for everyone to be able to navigate.

Drennen Shelton

Planner at The Metropolitan Transportation Commission, San Francisco Bay Area

METROPOLITAN TRANSPORTATION COMMISSION

General Notes:

- Works with the population involved in coordinated public transportation plans- seniors, the disabled, veterans, low income etc. Works on funding programs. Primarily focused on helping service providers coordinate (health dept, county, para transit, cities). Works with over 100 agencies. Usually involved in any pilots taking place, receives updates or plan out what the service might entail (even before the pilot gets partners, she helps work through title 6 issues). Also involved a little bit with TNC access for all act.
- "Handing off" example- Rider is travelling from 1 city to another, they may use 2 different systems at a county boundary or a service area boundary (a hand off). Hand offs between modes of transportations are supposed timed (frequently are not because of congestion, etc.) and there may be a conflict in policy between 2 agencies. 1 agency may have a "drop and roll", (drop off and take off) and some only do a hand to hand pass off of the passenger.
- Company does a lot of "travel training" – teaching someone how to ride a form of transportation (paratransit, TNC, shuttle, etc.). 1 on 1 classes or group training then they go on a field trip together. People sign up for it and it's a high request. They try to have the programs in every county. Highly successful and people go on to use those services (not always completely independently and sometimes takes the class again). Travel training beings with "where do you want to go, what do you want to do?" Helping people use an app to figure out a walk or complicated trip like using 3 forms of transportation to get to a special destination. She gives money to these programs and helps coordinate.
- COVID has completely changed their rider situation. Trying to get seniors on busses again is going to be extremely difficult. How do they ensure it's safe and instill confidence? Travel training will change after this pandemic. Everybody has pivoted, but usual busy lines are doing more demand on response trips.
- Most agencies has gone to 1 rider per vehicle, in some cases they will do 2. Rather than group rides during COVID- creating a bigger need for more vehicles. There has not been any driver shortages.
- Planning for next year or 2- "we don't really know yet." It might take people a while to get on public transit again. They're already counting on people not travelling as much. She expects people to use their personal vehicles at a higher frequency then before for personal safety. Anticipates less ride demand.

Vehicle Pain Points:

- 1 federal funding source that is set aside to procure accessible vehicles for older adult and the disabled for community based trans (non-profits), very small amount. The need is growing. Volunteer driver programs (not accessible vehicles), difficult to procure appropriate vehicles. Expensive. Only a few makers of appropriate vehicles. Significant maintenance problems with the vehicles. "They don't match the geography". Ex: San Fran lots of hills and start/stops, it's hard on vehicles that are more suited to rural areas. It's hard to get the right vehicle for the right service that is accessible. The minivan taxis that are accessible tend to work better.
- **On demand transportation does not exist.** Anyone who wants to be spontaneous does not have that option. All groups want this. People ask about Uber and want to understand how it works so they could potentially use it. Trying to focus in on Apps. "Everybody wants on demand transportation" Especially the folks who use paratransit, already have to book 24 hours in advance, inconvenient. On Demand- "It's the thing that's shouted the loudest."
- Some public transportation agencies try to shift the types of vehicles they use, not always a van, but try to mix up the fleet a little better but she doesn't get into that. 1 agency she works with has a big mixture of vehicles and they even have regular sedans, sedans started to pose problems for older people (hard to get in and out of overall). [Outreach and Escort]
- Paratransit ADA service is door to door (not door THROUGH door). Ready to go when vehicle pulls up and be at a place where the driver can assist you into the vehicle.
- Door THROUGH door, there would be a physical assist with the passenger or help is needed carry packages or handing off to another person at a destination (caretaker, front desk).
- So many levels of needs and disabilities, very broad for everyone. People with a wheelchair definitely need an assist with boarding a vehicle. Older adults may just need help with packages but don't need help getting into and out of a vehicle.
- Typical situation for aging- need help figuring out a payment situation (help with any on board payment situation), everyone being properly seated before vehicle moves, help with packages.

Vehicle Recommendations:

- Having a standard interior in every vehicle makes sense.
- Going forward the dream is the vehicle services multiple purposes (using some vehicles right now to do meals on wheels, 3 drivers inside- only 1 driving and 2 packages food, etc.)
- **Seeing a new mode of transportation with how we live life (TNCs), not one was accessible in the beginning and didn't serve people with disabilities. Nobody tried to have something that was for everybody. So many people are shut out. "Unforgivable."** Thought AVs will come along and act the same and only serve able body people, happy to hear there could potentially be better options in the future.
- BRT has new cars that are very nice, open and have the "right materials" and the sound quality is excellent, different displays on board, different ways of messaging the same information "such a great improvement, but it's not perfect." Anything that has redundancies are important, if there is only 1 way for a wheelchair to get on board and that breaks…there needs to be another way. Destinations- show a map but also have a more linear way to explain the information.

Infrastructure Pain Points:

Very lightly involved in infrastructure. Few curb managements with curb policies. For long term planning projects going on, if they're trying to figure out if they need BRT lanes and get older people together for a focus group etc., she will get pulled into that.

Infrastructure Recommendations:

- For curb management, same raised squares where you board on the sidewalk and the same material in the vehicle where you would exit. "I think that makes sense for everybody." Matching exterior and interior makes sense for everybody. Keeping it simple, not over complicating things. Very rural and very urban, ability to get same materials in both areas may be difficult. "simplifying." Ex: "Bright colors but not chartreuse." COVID Ex: "some vehicles have nice plexiglass, and some are using shower curtains."

Planning Paint Points:

- #1- Jurisdictional lines (Federal funding by urbanized areas).
- Accessible vehicles.
- Costs.

Elliott Doza

Project Manager of Service Planning at COTA

COTA
CENTRAL OHIO TRANSIT AUTHORITY

General Notes:

- Started as a graduate intern. COTA provides 19million rides a year, operate 7 days a week mon-sat, sun reduced frequency, express lines operate Mon-Fri. 41 different lines.
- Network of 15 high frequency line (15min or better). Ridership growth over last few years or levelling of ridership which is a good sign because nationally ridership has been declining.
- In 2018 started C-Max on Cleveland Ave BRT through northeast Columbus in a low-income community.
- System redesign completed in 2019. New cross-town lines where service wasn't before. Higher quality service in neighborhoods that had 30min service and is now 15min service. Communities who traditional who rely on the bus CODA tried to make the service straighter and easier to understand with more frequency service 7 days a week. 'Allow the people to live a transit lifestyle'- reliable, standardized frequency.
- C-Pass program, which is downtown- 1 pass program connected to special improvement district. Building owners pay for part of the all for one program and got grant funding to pay for the rest.
- More initiatives- a mobile app that has limited ability to pay fairs. On demand service, plan to expand to 20 square miles on June 1 with an additional zone planned in August and a 3rd zone later this year.
- Also offers ADA paratransit service. ¾ mile buffer.
- For fixed route, 30, 35 and 40 ft busses. Next year testing electric busses. 2020 busses are more pleasing to the eye (rounded in the front, rather than 'butter stick' busses, more lighting & windows inside). 1/12 of fleet is replaced every year.
- For on demand service (CODA +) uses full sized vans, Ford transits. Passenger & also ADA.
- For paratransit- looking at a new models.
- For A&BF, who comes to mind? ADA riders (also used fixed route because it's free), seniors next.
- On full sized busses, they lean to curb height and they can also deploy ramps. Preferred seating up front for seniors and those with mobility challenges (which is enforced).

General Notes (cont.):

- On demand vehicles (CODA +), they don't lean but the operator can assist opening vehicle door, also has a ramp. In the app or when you call in you can specify mobility assistance and the vehicle will pick you up as close as it can. Currently corner to corner service (not at a cul-de-sac for example), have people walk to the corner for pick up unless specified otherwise.
- There's some ridership info on the website for training and guides or they can call customer service and get mailed materials.
- On demand has a max 15min wait time. Vehicle will be there as soon as possible, like Uber or Lyft. Deploy 2-3 vehicle at a time, fleet has 5 in it- only 5 square miles of service. Average cost is $30 an hour to run the service. Ridership was growing until COVID. June 1 the area will expand to 4 times it's size and will deploy 5-6 vehicles to operate in the zone. Also planning to provide an essential east-west connection. Currently service 16k jobs but the connectivity between routes right now is not good. Contracted out the technology platform. Goal is 4-6 riders an hour. Partnered with Gross City and they're paying a lot for the service (grants from the state) to launch and maintain the program.
- Once boarding the vehicle, its up to the driver's discretion if they help someone or not unless a mobility device needs to be secured (union drivers). If someone can't get on the bus by themselves paratransit is recommended.
- Personal care attendants can ride for free on all mobility options.
- Rural, suburban and urban. Urbanized downtown, urban neighborhoods then more suburban style (cul-de-sacs etc.). Columbus is the largest city in the U.S in terms of land area and not very dense, posing a challenge. Rural communities are in service area but not a lot, usually large plot housing or odd housing development off the highway somewhere.
- All stops have a pole with a signage at a minimum, prefer to have a cement bus waiting area (somewhere for passengers to stand), there are some shelters (increasing every year), minimum of 35 riders every day or be a high transfer stop to qualify for a shelter. Sidewalk coverage is also a consideration for these locations.
- All CODA bus stops are square so when you grab the pole you can tell it's a bus stop, helping sight impaired passengers navigate. CODA would consider other options, but there isn't a comprehensive system.
- When starting to modify their current network they switched systems within a day and they heard from riders that it was difficult to understand, navigate, etc. If there is any change, the riders call immediately. Not a lot of people just calling to confirm something they're already expecting, only in regard to new things/changes.
- Operators have specialized training to assist all types of riders.
- Amenities in current CODA + vehicle- Wi-Fi, USB charging ports, captain's chairs with lots of padding.
- Currently has some variation of interior configurability on fixed route busses and CODA +, not ideal for other riders when configurations are made though (fit a wheelchair, people have to move).

Overall Pain Points:

- For On-Demand- providing an easy way to schedule and pay for a trip. Many riders have phones (seniors or someone with a mobility challenge) but not all of them have a smart phone and not all of them have access to a payment option they accept (doesn't accept cash), they have to use a cash card etc. They have a policy of never leaving anyone stranded or behind, if someone doesn't have a payment option, they'll give them a ride and help walk them through finding a way to pay.
- For fixed route service- biggest challenge is physically riding the bus. If a line gets overcrowded or jammed its difficult to board or talk to the operator, etc.

Vehicle Recommendations:

- If the vehicle was fully universal there wouldn't have to be various models (for on demand). They have wheelchair accessible vehicles now and are about the deploy non wheelchair accessible vehicles because there is more seating.
- Fixed route fleet composition would likely stay the same, all busses have wheelchair ramps etc. Wouldn't really change the mix of vehicles, all have preferred seating and ramps.
- Paratransit typically fills trips that fixed route can't make, if someone has to travel a mile after they get off a line, the vehicle type won't matter…that's where paratransit comes in.
- Maybe the change would be how you interface with the built environment (sidewalk/bus stop shelter). Technology will be a key factor with helping make universal design. If there's sensors or use IoT, a connected vehicle could know a person's impairment while pulling up and the vehicle can adjust. Interior passive messaging to riders (a light or something in a preferred seating area, etc.). Using tech to help people navigate, something to let them know where the bus stop is and where to stand, etc.
- Being able to communicate with the passengers and know what their needs are. Help with navigation (if a blind person gets on maybe the bus starts to talk to them). Needs to be connected and intelligent to an extent.
- Boarding is most important- no stairs, level boarding, no ramp.

Infrastructure Pain Points:

- Suburban is most difficult to serve because it has a lack of aggregated density and the site planning is auto oriented (lack of sidewalks) and has deep neighborhoods which means they have to walk quite a while to reach transportation.
- Sidewalk coverage is a large challenge in Columbus.

Infrastructure Recommendations:

- Standardization throughout the industry would be helpful, it's necessary.
- Having sidewalks and a curb are critical, level boarding won't work without it.

Amy Hockman

Director of Mobility Services at COTA

COTA
CENTRAL OHIO TRANSIT AUTHORITY

General Notes:

- Director of mobility services for COTA. Public transportation experience for 10 years, at COTA for 5 years. Oversees and manages paratransit system for COTA. All her experience is with paratransit, ADA, public trans.
- Complementary ADA service- **core service** (ADA mandated public trans) booked 7-10 days in advance, additional ADA service (non-ada trips) anybody who is eligible for paratransit service through COTA can also do same day **on demand service** (started 1 year ago). They're able to travel a little further outside the ADA zone, opportunity to take more trips within central Ohio. Modelled off Uber and Lyft. Brought on various contractors and for the ambulatory trips the drivers use their own personal vehicles to transport them and if someone needs an accessible trip, they have 2 other non-emergency contractors for that. Started as a pilot and went so well they made it a program for COTA. Single trip- point to point. Scheduling as short as 1 hour before their ride.
- Core service has remained flat in term of ridership growth. On demand has grown. Riders using on demand love it and ridership has grown month over month. 13% of total ride is using the on-demand service, it is a little more costly but getting more of a premium service.
- Majority for on demand trips as essential (work, school and medical) but you could use on demand for anything you wanted (entertainment, shopping, etc.).
- Best features of on demand: single trips- no shared rides, point to point, more flexible and more reliable.
- On demand- there is a certain checklist for vehicle use (age of vehicle, 4 doors etc.)
- When looking to get vehicles they're looking at the kind of service they have to provide and then they also have to look at operator feedback as well because they're out there everyday and see what works and what doesn't for the vehicle. The cutaway fleet, bigger and bulky, too big and too much space for the service COTA provides. Transits are almost too small. Need something in between. They have to look at what's out there, what's the fuel type, are there electric options (not many available for paratransit). There isn't a perfect vehicle out right now.
- Drivers are very interactive with each passenger during the trips.

General Notes (cont.):

- For AVs- based on this particular industry there would need to be somebody in the vehicle at all times for boarding, securing, etc. They are using the service because they can use the fixed route, they need assistance from someone else. They are often not comfortable with technology, they prefer to have human interaction (call trips in and speak to someone), they use the service because they get more assistance from somebody. It also gives COTA the opportunity to provide quality customer service, sometimes they're the only people the rider sees for a couple days.
- Currently struggling with payments. No more passing of cash because of COVID, want to go to contactless or cashless, it's a challenge and they don't have a good solution for it right now. A large % of individuals don't have the capability to go cashless.
- For on demand you can't use a monthly pass or cash, you have to pay when you book with credit or debit card but if that wasn't an option you could go to a store and purchase a visa card and that form of payment works as well.
- How do we get ridership comfortable with public transportation again after COVID?
- Next pilots- evaluating making all paratransit on demand. What vehicles do we need? What tech do we need to operate scheduling?
- Look to get new vehicles in the fleet annually.

Vehicle Pain Points:

- Main challenges is looking what's being produced within the market and how it would work within the fleet. Inside, spatially, even the width is challenging.
- Have looked at cut away vehicles, spatially inside they have maneuverability but they're almost too big, more space than you need.
- Have Ford Transits, they're a little sleeker and spatially easier to maneuver for the drivers, but for the passengers it's hard to move around and secure wheelchairs.
- Also had NV1s, seemed like a good in between but it was hard for people to board even with the lift, clearance issues and people hitting their heads.
- It's never been a perfect vehicle. "They've been designed with disabilities in mind but in the design process I don't know if people with disabilities are even part of the design process." It seems like all after market things, the vehicle has to be redesigned or a lift has to be added, etc.
- It becomes overwhelming and frustrating, not really getting what you need but it's what's out there then have to make their own modifications.

Vehicle Recommendations:

- *ALL GROUPS* (seniors, disabled, etc.) They want vehicles and transportation that's easy to use but comfortable. In terms of comfort it is boarding the vehicle, it's inside the vehicle- the seating, it's not always comfortable, doesn't always have arm rests etc. Arm rests are an assistant to get up and down and give a level of comfort in the ride. In the Ford Transits, they came with cupholders next to some of the seats and the majority of the riders who get those vehicles rave over that features, so simple. Making the ride comfortable and easier.
- Currently evaluating if they can do most of their service on the on-demand model with single rider because of COVID. Not sure what the future is going to look like. The kind of vehicle they would need may possibly change (not big cutaway vehicles any longer).
- Sanitization after every trip will be important going forward. Being able to address this would be a good idea.
- What does the transit system look like coming out of this? What does the mobility options look like now? What kind of mobility do we now need to provide within out region, may not be big 40 foot busses with specific routes every day, that may not be what's needed or most efficient. At a crossroads.
- Not making a vehicle that the driver has to have a special license to operate, don't want to be pigeonholed into a certain classification. The fleet could be universal, flexible and accessible and you could then hire employees that could fit the universal need without having to hire a specific certification.

Infrastructure Pain Points:

- Partners with age friendly Columbus, works with different groups to give valuable info and figure out infrastructure issues.
- Lack of sidewalks, trying to identify those areas.
- Lack of seating at bus locations. A lot of stops don't have a bench or seat while waiting for transportation.
- Clearly marked signage and signage that offers opportunity for info or different ways to read the sign.

Infrastructure Recommendations:

- Mimic same design language from vehicle to the infrastructure and work together. It would be extremely helpful, even if it's a "recommended" design language. Making it easier on the population using the service.

Patrick Parkes

Business Development Coordinator at Disability Advocates of Kent County

DisabilityAdvocates

General Notes:

- 4 weeks at job. Going into the community and networking with businesses, architects, interior designers and people involved in design and helping them understand universal design. “You can do well by doing good.”
- Universal design is good for society as a whole and businesses as well, still a lot of work to be done and getting awareness out there. Patrick will talk to both locals and large companies about more diversity hiring initiatives. Companies need to make infrastructural changes to handle that as well. More financial burdens for smaller companies than larger ones (local bakery vs Microsoft)
- Patrick uses a motorized wheelchair (20 mi limit), has an accessible van with side ramp but can’t drive it, he has hired aides that help with tasks morning and nights including pickup and drop off in the van. Has used public transportation depending on the area, went to school in Illinois which was very accessible. He was in Nashville for a little bit but wasn’t able to try public transportation because of COVID but the infrastructure hasn’t caught up to capacity.
- Steelcase/Haworth/Herman Miller, bigger companies serving broader population, helping with their environments and ability to hire new individuals. Look at universal design from a product lens what are you incorporating to be universally designed? Regardless on company size, it will be about physical spaces that people visit and occupy. Are you reaching customers from a product standpoint as best you can?

Vehicle Pain Points:

- Paratransit and elderly share similar frustrations but a lot of the time windows for paratransit are set up for the elderly (ends at 6pm on Friday but not ideal for college students). If you don't reach core people who want to use it at a different time, then you're not really reaching a lot of potential users.
- Head clearance is a big thing for people in wheelchairs on ramps.

Vehicle Recommendations:

- Champaign Illinois has wheelchair cut outs as part of the fleet and paratransit options as well but all the busses had ramps and at least 2 wheelchair cutouts in front of the bus- nothing had to be pre scheduled and he could be spontaneous. "Being able to preserve spontaneity."
- Liked MOD friendly experiences in D.C they gave accessible cabs and you can hail cabs regularly with a little wait.
- An easy lock system that attaches pin to bottom of wheelchair then into the easy lock device (safety restraint without a tie down), not custom made pins but certain ones fit certain chairs so designing some kind of hands free tie down restraint system that fits most chairs easily and quickly.
- A lot of the vans have rear entry ramps that create a well within the truck and your essentially in the trunk and sometimes that gets a little odd in a group, you're thankful to use a taxi system that works well with people but it's not ideal. Find a way to incorporate seating so that you're more immersed in the vehicle itself and not isolated by yourself. When he got his van knowing he couldn't drive it he got the option where you can park your chair in the back where the advantage is not having to park in a ramp parking spot but he got the ramp option that you can get in on the side and some seating is taken out so he can be in the front seat of the van (loses seating for any other passengers besides rear of the van and they cant hear that well because it's a loud ride).
- An AV would be a winner in itself but, if you could design it universally that allow wheelchairs to integrate with others rather than isolate them by themselves.
- Would be good to have an easier and expedited process of getting on public transportation. Bus driver has to clear people out of the fold out seats to put up to fit the wheelchair and are calling someone out essentially and making it a spectacle. It also happens on airplanes as well. Has had a pilot say over the loud speaker saying they can't take off until they handle the mobility equipment and everyone knows it's him. ***SEAMLESSNESS is important***.
- Appreciates available features but best case, wish list items would be needing a more seamless option.

Infrastructure Pain Points:

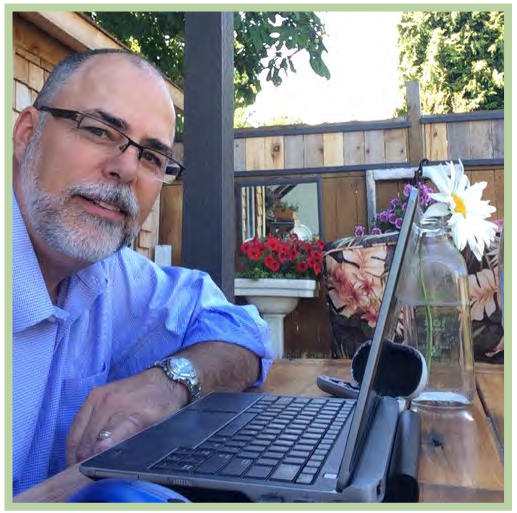
- Accessibility is misperceived as an afterthought or costly change but it's an investment in the companies future.
- 3rd largest segment in the US and ADA is the bare minimum from an accessibility standpoint, arbitrary measurements that can be met but not easy to use.
- Test pilot group volunteers time and life experiences to go into the community and help any organizations that request it to give live feedback or accessibility. Not as many direct product tests, more physical environment surveys so far.
- Tie downs restrict where you can go and there's always that uncertainty.
- There's not always uniformity, if someone says something is accessible does that mean the same thing in all places? All apartments may say they are accessible, but it doesn't always mean the same thing (roll in, barrier free shower vs bathtub with grab bars).
- People already think they are compliant so why would they do more? Money is a big factor, hard to get them to change if they are technically compliant. Governments are hopefully seeing the benefits of universal design, if you start to address the biggest barriers is the costs because they are budget constraints but if you can show them the investments in lowering their costs in other areas (getting people to appointments or to employment and get off government assistance, etc.). The investment offsets rising future costs.

Infrastructure Recommendations:

- Small nuances such as knowing what side of the street the bus was coming from. Could see uses for standard design cues inside of the vehicle that corelate with infrastructure. Maybe if the bus has this color it picks up on the left side of the street, etc. "pre-advertised" on a transportation website e.g. this amount of room on the left side of the bus, etc. Having a broader, understood language standard would be helpful and having that correlate with a specific bus stop or side of the street.
- Design element on the side of the vehicles to show where you should be standing, the exterior look of the vehicle, shown on an app. Usually doesn't know if he should be at the back of the bus stop or front of the bus stop to easier get to an accessible spot. ***When you design for individuals with the most needs you meet everyone's needs in a better way.***

Graeme Masterson

Global planning transit lead at Stantec



Stantec

General Notes:

- Graeme works for Stantec Consulting in Vancouver Canada- he is a global planning transit lead. In charge of transit planning (studies and plans).
- “When you think about economics of the city, they can only solve for what is best for the majority.”
- The transit industry as a whole is very individualized, each agency does what it thinks is right, but no one wants to create a design guideline. Everyone has created their own, there are hundreds of guidelines that say almost the same thing.
- It’s all about money, to change the NY subway to be fully compliant would be a big deal.
- It’s not that people don’t have phones, almost everyone has a phone, but they don’t have a plan that has data. If you made every vehicle into a hotspot where you can connect whether you have a data plan or not it reaches more people. Free wireless area could be at pickup areas (e.g. like a coffee shop).
- “Biggest issue overall is getting away from thinking about accessibility as being something targeted to a specific group (cognitive or physical disabilities) and getting to solve it as more of a universal application. If you made it easier for everyone to use, would it solve 80-85% of the problem? The last 15% is going to take double the effort of the first 85%”

Vehicle Pain Points:

- Busses degrade overtime differently; average height of the doorframe depends on the suspension itself. There is going to be some variability in the vehicle.
- Height of the vehicle is important, SUV hybrid style of easier to get into and out of because it's not as high off the ground as a full SUV or truck and not as low as a sedan.

Vehicle Recommendations:

- Level door boarding- a smooth transition with a lateral gap of up to 2" (door edge to whatever you step off of).
- Door height (shoot for the 80th percentile)
- On board annunciation- it's come about because of lawsuits. With a multicultural society, English isn't always users first language or accents make it difficult. Automation can visually and verbally call out next stops. What's the right level of information? Call out the stop or the cross streets for the stops or the street you are currently on?

Infrastructure Pain Points:

- There are no guidelines from a city perspective that show how to marry two things together (vehicle & infrastructure)
- Curb cuts are best practice where you can do it, but you have to have a sidewalk to do that.

Infrastructure Recommendations:

- Vehicles needs to be accessible on a gravel street with no sidewalk up to an area with an 18” curb.
- Currently there is a second tactile strip that denotes where the door is at the edge of a platform so it’s not just “here the edge of the platform don’t fall off”, it’s “stay here” because that where the wheelchair position might be.

Carol Wright

Assistant VP of Transportation and Mobility at Easterseals

easterseals
all abilities. limitless possibilities.

General Notes:

- Asst VP for transportation and mobility at Easterseals. Leads transportation group (co-director of national aging and disability center, funded by federal transit administration). Training and tech assistant to transportation providers across us. Executive director of Easterseals project action consulting- nonprofit, provides services above and beyond what national assistance can do and as economically as possible. ADA, human resources, transportation programs, strategic planning at an affordable cost. Oversees center for mobility management technical assistance center.
- Has been involved in universal design and AVs for the past 4-5 years and is interested in the opportunity to work on the design of vehicles from the original equipment stage and make universal design one of the key elements that is practiced. She is involved in the grant processes at Easterseals because of their expertise in accessibility and also works with engineering partners to explain concepts and why they would want to do them.
- Worked with Pratt & Miller engineering (race cars) with an AV project. Started with group of people that didn't see any reason for doing accessibility and by the time they were done they could see where it would apply and wanted to do more similar projects.
- Using universal design concepts, not just for disabilities or elderly, is designing for everyone. and serves people better than they are being served right now.
- ***"Shoot for the average but spread the average out over more of the population."*** Not everyone single person on the planet can be a use case, that's not true about anything but we want to improve quality of life.
- Universal design push back is usually because of cost and the universally design vehicle when it's done (EX: including a ramp), not a real flashy, luxury vehicle and doesn't have mass appeal.
- It's a large-scale opportunity, but not the same opportunity as buying a car today (EX: walking on the lot and picking out a car).
- 61M people in US that have disabilities.

General Notes (cont.):

- Personally owned AVs will be out of reach for majority of people, especially people with disabilities and the elderly.
- What is convenient for all of us is good for all of us, they make all our lives better.
- Regarding Elderly: Vision- what can we do to accommodate different peoples needs for lighting, magnification? Hearing- is there a way to increase the volume, audible signals? Cognitive ques, reminders, things that say next steps. All of these would work well for older adults but could also help everyone else as well.
- Unbanked is a big equity issue but there are ways around it (plastic card that acts as a credit card that can be bought with cash). Unbanked is a critical element, can't assume everyone has a credit card. Same with cell phones, people sometimes have track phones and not smart phones.
- Most important to focus on: do not segment society into the haves and have nots. Try to look at concept of design that service all (not every single person, but 80-90%), concepts that make things better and easier for everyone because those are selling features. Create a vehicle that is marketable and scalable that helps all, if it's a fleet vehicle then it can serve a large population of people, ease congestion, dispatched economically, operated economically, etc. Are there multiple scenarios for these vehicles? The vehicle could never be sitting idle, it could transport employees, general public, transport meals, all at different times so it's in constant use.

Journey map personas request:

- Not reinventing the wheel just calling out what the needs are and what the future opportunities are.
- Specialized subgroups have more steps involved because of specific needs, what are the steps? How can it interact with a smart vehicle that can help contribute to a successful wayfinding experience based on what's available in the vehicle itself? How can the vehicle work with other tech that might exist in the infrastructure?
- Follow up soon.

Vehicle Pain Points:

- Vehicles are designed first before considering accessibility, which now must be retrofitted to accommodate people with varying abilities (wheelchair, scooter, walker, etc.).

Vehicle Recommendations:

- From the beginning, design the vehicle that is usable by everyone, on day 1. At least 1 set of vehicles, understands not all vehicles will be. Not every single person on the planet, but having elements in the vehicle that make it more accessible than a traditional vehicle.
- Level surface loading.
- Cognitive cues.
- Varying amounts of light.
- Audio Enhancements.
- More fleet operations like Uber or Lyft. Covering the widest range of potential user but not exclusively people with disabilities or older adults. All vehicles could pick up anyone who needs a ride. Scale up.
- Wayfinding makes a big difference. Allowing there to be symbols (a lot already exist), opportunities for people to be able to anticipate what might be there for them that will give them the direction that they need in order to navigate the environment. Physical ques, audible ques, touchable ques. Adaptable ques exist now that don't have to be created from scratch and people would already recognize. This could make the cost of development low as it could be worked into design and are already universal.
- AVs currently have safety operators, eventually when there is no driver there could be another type of concierge and it could respond to riders' questions etc.
- Making connections is nice for everyone, if the vehicle told you which way to turn and how many feet until your destination…. ***"we call that a VALUE ADD."***

Infrastructure Pain Points:

- N/A

Infrastructure Recommendations:

- Wayfinding could be extended into the infrastructure and be helpful. Thinking about the destination from wherever you start out (at actual final place, not when leaving the vehicle), the journey isn't the trip in the vehicle- it's door to door, point to point.

Eric Sinagra

CEO of PathVu

pathVu

General Notes:

- PathVu mission- map the worlds sidewalks to improve accessibility/walkability.
- Typically, sidewalks are not mapped- google just starting to look into it.
- Did research at the University of Pittsburg to understand how sidewalks affect people with disabilities (wheelchair users specifically). Developed research for sidewalk roughness and how to measure that. Roughness can cause negative vibrations (neck and back pain ensue).
- PathMet- Stoller type device with sensors and goes down sidewalk (roughness, tripping hazards, slope etc.), get imagery with that device.
- 2014 completed master's degree and started the company PathVu (6 years).
- 1 part of company- navigation/accessibility 2nd part- projects/working with cities (main revenue).
- Help cities/civil engineering companies collect data for sidewalk conditions (ADA improvements, etc.), uses PathMet, CurbMet (curb ramps for ADA, making sure they are compliant).
- Passion for accessibility, helping people understand safe routes to travel.
- Worked with USDOT through Attri program (complete trip)- any pedestrian going from a to b using all different transportations (pedestrian navigation & wayfinding). Developed an App and APIs to provide real time navigation based on sidewalk conditions and the users abilities to navigate those routes. EX: Wheelchair user needs curb ramps and the app takes them a way with curb ramps.
- Added accessible entrances, accessible bathrooms, favorite locations and are continuing looking to add better directions and nav capabilities. EX: blind pedestrian to walk on right side of the road instead of the left due to construction.
- Snow & ice navigation are part of the bigger idea going forward.
- Accessibility from a universal design perspective.
- Attri = complete trip. PathVu is individual steps in the complete trip.

General Notes (cont.):

- App could tell you once you have completed a mobile trip the pedestrian directions after that.
- Want to provide best directions for pedestrians that fits in to existing technology.
- We are pedestrians 99.9% of the time.
- If vehicle drops off on right side of the road, they can tell them to turn right or left but as far as utilizing vehicle and infrastructure textures/colors etc. he could see adding that into directions in some way. EX: Exit vehicle from the green exit (vs yellow) then turn right to go down the sidewalk.
- It's all about having the data itself and understanding the format (standardization/universal) etc. then it could be taken from whoever's database and included into PathVu otherwise it's not possible.
- Some cities look at it purely from infrastructure and other cities look at it as ADA compliance (sometimes forced through litigation, or just because they are being proactive etc.)
- Future being API sales of routing tool and being proactive and collecting the data themselves so they can sell the data.
- Talking to cities- typically talks to public works of some sorts (public works, city planning) but a lot of times they work with civil engineering companies themselves and already work with the city who are responding to an RFP. They help address the sidewalk piece.
- Conversations with AECOM and Stantec a couple years ago but it wasn't a right fit but those are the types of organizations that they talk to.
- Ultimate goal- be able to provide ped directions in any major city with providing each user with confidence going from a to b in any city in a safe and accessible way. Part of that is making sure data is widespread and available anywhere, the other piece is making sure the user themselves have the confidence that the data provided is reliable. Making sure data is accurate and reliable as well. Be known as a trusted pedestrian app (like Google or Waze for driving directions). Goal is to merger have an acquisition with Google or another company similar.
- Travel ribbon-EX: Providing the airline with API and monetizing on the API in the airline app

Important Factors:

- PathVu tries to address the individual's abilities. (manual wheelchair vs power wheelchair). Narrow widths are hard for wheelchair users/visual impairments, unexpected obstructions, steep hills, heaving sidewalk (tripping hazards- tree root etc.), any obstructions that block a route (construction, menu sandwich boards, etc.).
- The app currently asking 4-5 questions, what type of users are you (blind, wheelchair, etc.), then understanding comfort navigating- tripping hazards, rough sidewalks, slopes, etc. then app determines optimized route.
- There is no perfect answer for widths. ADA is 4ft but each user varies. 2ft or less is impassable or almost impassable. 3ft is the next level. 4ft or more is essentially barrier free. ADA is used as a guideline but also realistic expectations from a user to understand what they really want. Things to keep in mind- how comfortable is it in a crowd?
- Not currently looking at indoor navigation but that is another piece of complete trip puzzle. Ex: After getting out of a vehicle PathVu could get you to the entrance of where you are going, and another company could get you where you need to be inside.

Sarah Green

ADA Admin and Travel Trainer

General Notes:

- Shows people with disabilities how to use fixed route transit. Engaging and showing how safe it is, basically "sells" it to them. People can use paratransit and still used fix route (although paratransit is expensive).
- **"Enhancing people with disabilities independence."**
- Knows of "Looking Bus"- a bus that looks for individuals as they are out on transit, it can tell the driver there is a person with visual impairment coming up. Beacon technology in Lansing.
- 26 fixed route busses in GR (6 city area), cost neutral. First mile last mile options for places that are under served by fixed route- rideshare. Pandemic makes everything different.
- She's also on dementia coalition and age friendly grand rapids committee.
- All they look at for paratransit is how the disability prevents people from using a fixed route bus.
- If someone uses a walker and there is 6'" of snow they would be conditionally eligible for paratransit but there are no attendants with that.
- She shows people the route they want to take to job for example if someone moves, they'll train again.
- 2 pilot programs in GR if your paratransit eligible apps- kaizen health – but had various issues with people and visual impairments and wasn't very user friendly.
- Doesn't typically work with people with visual impairments.

Important Factors:

- People in senior living are feeling very isolated right now because their van drivers refuse to drive during pandemic so seniors are going out with Sarah on fixed routes because they need to get out even though they're the most vulnerable population.
- May Mobility- “Dash”- Outside parking lots to inside parking lots (free). Plexiglass and sanitation in place since pandemic. Short route that goes downtown. Because it’s free people who are homeless tend to ride it a lot. “When you don’t pay for transportation people don’t really realize the implications of it.”
- People on dialysis are most vulnerable and transportation hours are reduced right now and can’t get everyone to their dialysis appointments. Drive assistance is important (if someone falls out of the vehicle…etc.). How does an AV know if someone has fallen?
- People are more anxious now during the pandemic, people are not able to get the rides they used to get.
- Different size of mobility devices (wheelchair, scooter, etc.) are not unform sizes and are not always able to be secured in a vehicle.
- Getting all the entities to talk to each other (infrastructure & vehicle) would be revolutionary.
- Suggests talking to epilepsy foundation (big market).
- Thinks some people would really like the journey map but some people do not like transferring between modes of transportation and just will not do it.
- Likes that someone could put what colors they could see in the app and the transportation vehicle could project it for her.
- “It would be magic if it all worked out.” – the journey map
- Likes the standardization of colors in and out of the vehicle and thinks it would be good if thinks looked the same and orderly, especially for people on the spectrum.

End User Interviews

Pat Besta

Using a Manual Wheelchair

General Notes:

- Pat has a degree in automated engineering and worked as a design engineer for 13 years. Pat also owns his own medical supply business.
- Car industry is moving to higher off ground and SUVs are an issue. Lower/zero entry vehicles more ideal for people with manual wheelchairs.
- The Dodge Challenger- It's Pats toy. He loves the style, and power. The vehicle sits low and is easy to transfer into (slide from wheelchair to drivers seat easily)
- His wheelchair wheels pop off. His chair is lightweight and is only 24lbs. The chair stores nicely behind driver's seat. Pat wants more durable materials he doesn't want to mark up seats with his chair.
- He plays semi-professional wheelchair basketball and travels with his team.
- A car accident at 22 put him into the wheelchair. He is married, and has twin boys who are 21 years of age.
- Pat has always had his own car and considers his Challenger the best yet.
- He likes that its unique (electric blue), not everyone has it, fun style, good functionality. "people know it's me."
- It's nice to not drive sometimes (if drinking or just want to save money). An AV would help solve for that.
- Has used Uber in different cities or will rent a car- have to do special hand controls and can only put them on certain cars.
- Pat has confidence to figure things out for himself- no anxiety, very independent.
- Replaces wheelchair every 4-6 years.
- Relies a lot on upper body strength.
- His Ford Edge is good vehicle option because it has a lift gate and cargo floor that is at his chair height.

Transportation Preferences:

- Zero entry into a vehicle has benefits for all.
- Vehicles with wide opening doors or sliding automatic doors are ideal.
- All vehicles need durable/easy to clean seats. Getting in to the vehicle and swinging the wheelchair (Broken down parts) over him to place inside and behind the front passenger seat.
- Preference would be to have no deep storage wells. It's difficult to lift things out of the well and can cause injury.
- Possibly fold flat for passenger seat.
- Saw a pickup truck where the bed "leaned down."
- Needs a gate or lock for wheelchair when in shuttle/bus.
- Power seats are very slow- prefer manual seats (pull a lever to fold)
- Likes to keep wheelchair in back- easier/quicker, keeps front passenger seat for others and doesn't scuff up front seats.
- Pulling the wheelchair up and down is hard to do, needs it to be flat and smooth- not in a well.
- Maneuvering wheelchair in/out is a big element.

Important Factors:

- Dignity/Independence is key. Pat doesn't want to stand out as "in need" or have to ask for help. Allow him to be independent.
- Being able to pull up with wheelchair, enter and put the chair in without hassle.
- Chairs wear out the interior- doors get banged up and the fabric wears- need flat entry and durable materials.
- Tried local shuttle service (future AV pilot)- easy to get in staying in wheelchair, not enough seats to bring someone with him, ramp that came out was too steep.
- A lot of shuttles are not designed for him to travel with his family.
- He would prefer an accessible path to enter the vehicle. Sometimes he has to go over curb or no ramp is available or no path—need pathways to the vehicle.
- Often looking down in his chair to make sure the path is clear for him, no rocks, nothing to stop him or get in the way, anything that isn't smooth. Sudden movement could knock him out of his chair.
- Doesn't like to have his wheelchair- feels like he's holding people up, doesn't want to stick out and just wants to blend in with everyone else, doesn't want to be called out- "this is for handicapped", doesn't want to slow anyone down (family, passengers on public transit)
- Where the gas tank is located on a vehicle can be an issue in relationship to the door and accessibility.
- His friend has a Mazda 5 Grand Touring and he noticed how very easy it was to get the wheelchair in and out. The vehicle has a sliding door for rear passengers.
- Considered hybris/electric.
- Flexible/configurable seating is expensive (Fold flat seats, tow and go seats in minivans).

Gerid Adams

Hearing Impaired, Cochlear Implants

General Notes:

- Gerid is deaf and is a hearing loss advocate for Grand Raids and the State of Michigan. Gerid has had his Cochlea Implants for approximately 4 years.
- Gerid lost his hearing at 2 years old due to a virus. He lived 34 years with hearing aids.
- Emergency vehicles are a big issue, he can't hear them and they cause anxiety when driving.
- Not as many issues with planning ahead for a journey or going to a new place. Gerid usually looks to see if they have assistive technology like at movies, exhibits, museums, etc.
- Gerid uses adaptive cruise a lot when driving his own vehicle.
- Visual displays are key for hearing loss consumers.
- He welcomes AVs entering the market, especially for the majority of what he uses his vehicle for (he is a road warrior)
- Arizona DMV has something where you can have a designation on your drivers license that you are hearing impaired or have cognitive issues. So, if you get pulled over police understand this up front. AVs should have this ability. Create a personal mobility profile regarding any issues to know.
- How can we quickly solve for these issues-spotlight effect?
- Making these enhancements would build self-confidence.
- OEM's would get a tremendously positive brand impact of being proactive. Not just making these things happen because regulation.
- ADA should be more the bare minimum- if you only do ADA then you only did it because you were told to.

Transportation Preferences:

- Moving geofence systems need more solutions where the emergency vehicles gets/emits a signal.
- Regarding Vehicle Displays (Private and Public). Hearing impaired need to get information visually. Understand when someone is honking at you or if an emergency vehicle is approaching your vehicle or you. It would be great to get repair cues in your vehicle on the display (in vehicle).
- Smart speaker for beta testing- train it to “hear” for you, e.g. ‘your microwave is going off.’
- What type of notifications could apply to vehicles? Railroad crossing, green lights… not going (someone honking at you), etc.
- Knowing you had these types of notifications would help you concentrate more on driving/riding. Creating an environment with less anxiety for driving or riding.
- In-vehicle: The more info you can get without looking down the better- heads up displays.
- Navigation system- use phone more and will put it on the dash to see/not look down.
- Ambient noise and vibration are a big issue. It can cause confusion. A vehicle with sound deadening is important. (Note: This is also important to individuals with Autism)
- The volume is not the biggest issue, but clarity is an even bigger issue- sound deadening material so that clarity is clear.
- Personal displays- info displayed on your phone seamlessly auto connects v2x to displays around you and gives you in the moment (real time) information.
- Better infotainment system- integrate with systems that are more advanced e.g. nav used a lot during walks.
- Bigger information displays would be preferable.

Important Factors:

- Busses have issues with not enough sound deadening.
- Electric vehicle is a positive- less noise (But is an issue to visually impaired individuals)
- *Sound management and visual displays important*
- Scrolling information in a vehicle is a problem. If you miss info you have to wait for it to come back again, better to be static information displays.
- Sound deadening materials are not easy to clean- issue during COVID.
- Are there natural materials that are sound deadening (plants?)
- Where is the sound coming from? The potential for haptic feedback for where the sound is coming from.

Vicky Schmidt

Incomplete Paraplegic Using a Manual Wheelchair

General Notes:

- The lack of uniformity in cities is hard (with sidewalks and crosswalks). Why not make it all the same and predictable and it "would be more relaxing for everyone." If you're in a group and trying to talk and also having to constantly survey the area you can never go more than a few feet without looking down and looking for obstacles.
- Doesn't want someone to be "condescending, coddling or overprotective" of her like she experienced in DC on a tour that she felt wasted everyone's time with all the procedures and humiliated her.
- Flies a lot by herself (plays wheelchair tennis). She prefers to fly alone because it's easier for her to not have the extra help or have to worry about anyone else. Has also driven cross country by herself.
- When on an airplane she forces herself to step-walk if necessary so nobody can tell her she can't do go down the aisle.
- Stairs stop her, if she has to get too much help she just won't go because she doesn't want all the help. Pride. She wants to remain independent.
- **"I don't want to look diminished or weak or disabled so greatly…let me do everything I can."**
- Travelling alone gives her more confidence "I was much stronger alone, and more confident."
- Thinks people who were born with disabilities are coddled and expect a lot more help than people who have had accidents later in life.
- **"I'm very demanding, assertive for myself."**
- Doesn't like things being "too adapted" to her.

Transportation Preferences:

- Loves the dash- mostly accessible but went with her friend who was also in a chair and the ramp came out of the bus and went to the road instead of the curb because of construction and the grade was too steep and they needed help to get in. **"I hate that, it's humiliating to me…I just want to be a person."** When in a non-construction area the ramp went to the curb and she could do it herself. She has a bigger hesitation when thinking about using the Dash because of the current construction and her experience with that.
- Does not like to sit in her chair while on transportation because "it's unsafe" to her. Prefers to transfer herself to a seat. Doesn't like that the wheelchair has to be strapped down even if she's not in it, she wants to get on the road and not be embarrassed or humiliated by being singled out. (the wheelchair was locked by her already).
- She liked being able to get on and off with everyone else and the more experience they had with it the more "assertive" they were with handling it themselves and no longer felt anxious.
- When in DC: "Calm down, it's just a wheelchair…I'm just a person…they overly help you, very condescending and have to completely lock you down."
- Wants to be able to transfer to a seat that's part of the transportation like everyone else and have the wheelchair close to her so she can do everything herself and have her belongings near her. Comfortable with the chair being removed from her but not ideal.
- "This piece of metal isn't any different than a walker or a stroller…there's a stroller right there, why isn't it locked down?" –re: wheelchair having to be strapped down.
- Feels like she's always trying to put the Uber driver at ease by saying it will fit fine, she can take it apart for them to adapt, etc.
- She feels like Uber is predictable to a certain degree.
- Likes when public transportation seems "open" inside.
- Most ideal way to use transportation would be being able to sit in a standard seat like everyone else and have a universal, easy to understand strapping for the wheelchair so she could do it herself like some kind of elastic band that could strap around the chair but when not in use would be retracted back into something. Or if the chair could be backed up to a wall and something could come down to secure it.
- **"You can't single out me."** There is no difference between luggage or baggage and a wheelchair…why isn't everything strapped down?

<u>In her Chrysler Pacific:</u>

- Stows seats and picks up her wheelchair to put it in (without strapping it down but locks the wheels) once she has ahold of the door frame/handlebar grips to keep her balance.
- Important to have hand grips at entry points.
- Can't use the appropriate hand controls if there is no steering wheel knob because she would be hitting her hand while turning.

Important Factors:

- Likes the idea of standardized infrastructure/vehicle coordination. It would cut out anxiety.
- Likes the idea of being able to set up preferences in an app EX: I'd like to sit in a seat, etc. and that the shuttle would know who was being picked up, the idea of zero entry and that the vehicle could react to her needs without making a big scene.
- Doesn't want to inconvenience anyone on the bus, goes as fast as she can. If she needed help, she would ask for it.
- Says she very sensitive to people's expression and their vibe when she feels like she's holding them up on their ride.

Kristen Kelling

Completely blind- uses a cane

General Notes:

- Mostly uses transportation to go to volunteer at disability advocates of Kent county twice a week then association for the blind and visually impaired once a week if not more.
- Piloting go bus plus (app) and have to be paratransit user. Can take either go bus, uber, lyft or another wheelchair service and the app/website can schedule it. You get $145 of free money to use but is ending soon. She has been testing for accessibility. She thinks it's a nightmare (tech issues), had ups and downs but thinks it's nice to have the option. There is a combination of on demand and prescheduled. The website looks much different than the apps and has more issues with that than the app.
- Taps her phone for audio prompts to use apps.
- Works with absolutely accessible kent – has done charrettes regarding sidewalks
- **"If it's accessible for me, then it's accessible for you."**
- Most difficult form of transportation for her depends on where she's going, going somewhere not on bus route like uber and Lyft are hard because you can't always guarantee a ride both ways.
- Difficult with fixed route is dealing with transferring, the more details the better to make it easier (like journey map has).
- Paratransit works fine for her.
- Uses stairs multiple times a day.
- Doesn't often have to use a transportation center.
- Has used rapid stations near her occasionally.
- She is on several transportation committees.
- "One of the first steps in advocacy is educating yourself first, be willing to do the research and do the work."

Transportation Preferences:

- Uses paratransit at least 3 days a week- schedules a day in advanced at least, no later. Scheduling 3 days out now because of the pandemic, used to be able to schedule up to two weeks out but not now because ridership is down.
- Doesn't used fix route bus because transferring is cumbersome for her. Could do it if she had to but doesn't.
- Uber/Lyft used on occasion, but they are costly and doesn't always work with her income.
- The standard go bus (current paratransit option) has to be scheduled 48 hours in advance and requires more time to plan.
- Go bus plus- uses voice prompts in the app as well. App doesn't ask about specific impairments but would have had to be go bus eligible (paratransit) to use go bus plus. Just asks if you have a wheelchair/walker yes or no.
- Would like to schedule return trip with first trip (with the pickup address being the end destination so you don't have to change everything).
- Journey map seemed very thorough to her but wondering how it would work if you can't see the colors. What would be better for her would be sounds. "Having a little bit of sound is key."
- If there were audio signals for the user when it's close by it would be good. If there was some kind of ping or audible announcement of the user approaching the vehicle. Different types of beeps, red could be a difference tone than yellow.
- Texture helps her navigate.
- Have visuals and closed captioning for other users.
- **"I only live in the city because that's where I can get transportation. I should have the right to live and to go wherever I want, whenever I want, and transportation should not be a barrier."**

Important Factors:

- Could work with big tech companies that have GPS and it could tell you where the bus stop is, etc.
- Likes the detail and options included in the journey map.
- Would want it to incorporate walking portion and points of interest or reference to orientate where she is.
- Especially for wheelchair users, they want to know if it's wheelchair accessible and that they'll be able to navigate successfully.

American Counsel for the Blind Survey

Key Contact:

Claire Stanley, Advocacy and Outreach Specialist

American Council of the Blind

The American Counsel of the Blind was kind enough to respond to the thought starter questions we have sent to stakeholders and end users who we have interviewed so far. Their Infrastructure and Vehicle Committees reviewed the questions and forwarded the following answers to us. Their feedback has aligned nicely with our interviews so far.

In addition, we will be receiving answers to the same questions from the National Council on Disability. Lisa Grubb, the Executive Director, is currently helping us to coordinate this.

American Council of the Blind Survey

Infrastructure Questions

Infrastructure Questions

Q: What environments/infrastructure pose the most difficulty? Why?

A: Unfamiliar subway stations for navigational reasons, open plazas without landmarks for cane use, cluttered sidewalks in urban settings, sidewalks in need of repair

Q: How do you navigate through them if at all? Do you use any special tools to do so? (please specify analog i.e. notes, or digital like an app)

A: Red-and-white cane, guide dog, AIRA for navigational needs, assistance of public, GPS apps on smart phone, notes

Q: What are the best environments (infrastructure) that cause you the least issues? What makes them the best?

A: Uncluttered sidewalks in good repair, with hybrid/EV vehicles that emit sound, drivers who observe White Cane law, plentiful and functioning accessible pedestrian signals, commuter, bus and rideshare apps and transportation sites that are ***WCAG-compliant**, drop-off and pickup points for rideshare drivers at the place where I'm located and not at a distance, freshly-painted crosswalks with good contrast to street, absence of scooters and micromobility devices blocking path, good lighting, trash barrels for pedestrians with guide dogs. https://www.interactiveaccessibility.com/services/wcag-20-compliance

Q: What are the pain points in navigating different environments (streets, arranging transportation etc.)?

A: Streets: faded crosswalks, broken or absent accessible pedestrian signals, drivers not observing White Cane law, cyclists in bicycle lanes

A: Arranging transportation: inaccessible websites and apps, necessity of sometimes needing to depend on someone to drive, not everyone has a cell phone or is comfortable using internet, some transportation must be booked in advance

A: Sidewalks: snow not shoveled, landscaping elements protruding on path of travel, public interactions with guide dog

Q: How do the pain points differ between a familiar route and unfamiliar or a new route you are navigating for the first time?

A: Mostly the same, though unfamiliar routes makes it harder and takes more time to plan for.

American Council of the Blind Survey

Infrastructure Questions

Q: What are the top 3 pain points when navigating your journey:

A:Streets : drivers texting or not paying attention to pedestrians, challenges related to mapping a personal travel route between 2 points and staying on route, traffic signals not accessible

A: Sidewalks : cluttered, poor repair, snow not shoveled in winter

A: Arranging or planning for transportation: inaccessible websites, communication difficulties with drivers, connecting with drivers when I can't see them

A: Pick up and Drop off : Connecting with drivers at pickup (rideshare apps have a map that sighted people use to pinpoint location, but it's inaccessible, and since I'm unable to see driver, I must rely on them to read my notes, understand the message, locate me), getting dropped off in unsafe or unfamiliar location.

Q: What are the top three opportunities for infrastructure planning that would positively impact your experience?

A: Accessible websites and apps that permit easy reporting of specific problems that local authorities can address and which are designed to incorporate the unique feedback of people with disabilities who interact with the built environment differently, allowance in high traffic areas such as airports for drop offs at door by rideshare companies for people with disabilities, sidewalks that are free of clutter

Q: Is there a better way for vehicles to interact with infrastructure (sidewalks, roads, pick up and drop off, etc.?

A: Don't favor pickup points, as they can be difficult to locate, particularly in an unfamiliar area. Infrastructure that supports easy and safe drop off and pick up, as well as pedestrian safety is good

Q: How does transferring from different mobility modes (e.g., public transit to AV to walking) impact your journey?

A: More information is usually needed about my surroundings during a transfer from one mode to another. Some stress around each transition, as these are the places where things can get complicated.

American Council of the Blind Survey

Infrastructure Questions

Q: How do you think technology could be leveraged to create a better and safer environment/infrastructure experience?

A: Apps with detailed information about surroundings, perhaps with greater accuracy to find street corners and entrances, a way to connect with vehicles when passenger isn't able to see vehicle, added emphasis on safety of corners because if autonomous vehicles stop for all pedestrians, they'd stop in the middle of the street for jaywalking pedestrians, so pedestrians will probably need to use corners more for proper crossing in the future than is done today.

Q: Currently what is the easiest transportation vehicle (type or mode) to use/navigate? Why?

A: Uber or Lyft for curb-to-curb experience with few transitions or planning. The apps are accessible (though not without some room for improvement,) cashless transaction with good transparency about driver and route, available on demand. Ridesharing services have transformed my morning commute!

Q: What are the pain points when using different vehicles? (Cars, Buses, Trains, Shuttles, Ride Share, Etc…)

A: Cars: need to find a sighted driver and work with their schedule

A: Buses: bus stops not announced, routes change, can be challenging to locate stop in unfamiliar place

A: Trains: inaccessible commuter rail websites for schedules, stations challenging to navigate, some dangerous platforms

A: Shuttles: Have to plan a day ahead for paratransit, arrive at destination very early, lack of spontanaity

A: Rideshare: Connecting with driver, reporting negative experiences in a way that generates policy change rather than a refund, drivers that don't pick up guide dogs, expense, not all people use technology

Q: What do you wish certain vehicles could do that they currently cannot? Can you specify by vehicle type?

A: More wheelchair-accessible vehicles needed for passengers, autonomous vehicles that would permit a blind passenger to hail car, connect easily, and drive alone to destination, with a safe drop off and a way to provide meaningful feedback on experience

Q: What is the best-case scenario for a vehicle interacting with infrastructure? (sidewalks, roads etc…)

A: Thoughtfully designed created by getting feedback from people with disabilities, like the AVA is doing

American Council of the Blind Survey

Infrastructure Questions

Q: What barriers exist to utilize a vehicle that go beyond the physical design of the vehicle itself (locating, hailing, arranging for, payment, etc…)

A: Apps and websites that aren't fully accessible or which complicate independent use for hailing

A: Difficulty specifying exact pickup point when blind user can't see map

A: Difficulty locating rideshare vehicle that's arrived

A: Short wait times that sometimes don't facilitate connections for passengers with disabilities

A: Pickup at an unknown point at a distance

A: Unsafe drop offs

A: Not enough wheelchair-accessible vehicles

Accessibility Working Group

Accessible AV Scorecard Background Info

Prepared by Sarah Cicotte

Goals and Vision

- Tool for evaluating AV service providers
- Scoring limited to transportation of people, not goods or services
- Encourage designs that meet diverse range of personal challenges
  - Incentivize vendors to push the limits
  - Do more than the bare minimum
  - Equitable service
  - Meet the needs of as many people as possible
- Vendor agility
  - Leave room for vendor interpretation of implementation options
  - Can user complete task
    - Scoring system of 1-4 based on usability
      - 1: Hard to use to 4: Easy to use
  - Clarify that it is not an absolute judgment
    - Measure “How good is your system for this project?”

Assumptions

- User
  - Not a licensed driver
  - Challenged by at least one aspect of functioning
    - Could be challenged by multiple aspects of functioning
- Vehicles
  - One vehicle does not need to address all aspects of functioning
    - Multi-vehicle fleet should strive to address all aspects of functioning

Considerations

- Not everyone with the same challenge has the same issues
  - Testing should include multiple individuals within each aspect of function to cover the spectrum
- Solutions for some may be detriment to others
- Opportunity to identify where solutions are lacking

6 Aspects of Functioning

- Mobility Impairment
  - Ambulatory
  - Non-ambulatory (wheelchair)
- Sensory
  - Vision Impairment
  - Auditory Impairment
- Age
  - Children
  - Elderly
- Size
  - Children
  - Bariatric
- Cognitive Impairment
  - Intellectual - Developmental
  - Functional - Medical
  - Communicative
- Other
  - e.g. Communication barrier
    - Accents, non-English speaking

Note: A spectrum exists within each category

Scorecard Details

- Spreadsheet
  - Organized by task
  - Evaluated across all aspects of functioning
    - Task completed?
      - Yes
        - Slide scale, 1-4 points, based on usability (1=hard to use, 4=easy to use)
      - No
        - 0 points
  - Determine weighting strategy
    - Weighting is based on target population
      - Project dependent
  - Overall score
    - Show points earned for each aspect of function
    - Final Score
      - Calculated, weighted score, in percentage

Suggested Initiatives for Scoring

- Tasks are demonstrable by user population
- Scorecard is completed by users
  - Random, diverse selection of users chosen from project population
- Vendor selection team compiles results and ranks vendors

Next Steps

- Add questionnaire
  - Opportunity to provide other valuable information for vendor consideration
    - Dual purpose fleet for transportation of both people, and goods and services
    - Ability to sanitize vehicle between uses
    - Ability to incorporate social distancing and virus management protocols if necessary
    - Ability to implement eco-routing
- Work on aesthetics of the scorecard
- Begin writing a users manual

Scorecard

	Sensory				Mobility				Age				Cognitive						Size				Other	
Executable Task	**Vision**		**Auditory**		**Ambulatory**		**Non-Ambulatory**		**Children**		**Elderly**		**Developmental**		**Medical**		**Communicative**		**Small**		**Bariatric**		**Communication**	
Slide scale: 1=Hard to use, 4=Easy to use	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No	1-4	No
Plan Route																								
Identify Correct Vehicle Station																								
Identify Correct Vehicle to Board																								
Board Vehicle																								
Pay Fare																								
Move to Seat or Securement																								
Secure and/or Retrieve Belongings																								
Secure Passenger																								
Maneuver from Securement																								
Ride Vehicle																								
Indicate Stop																								
Identify Correct Stop for Alighting																								
Exit Vehicle																								
Emergency Situations																								
Total Points Earned	0		0		0		0		0		0		0		0		0		0		0		0	
Itemized Score	**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**		**0.00%**	
Equal Weighting Overall Score	**0.00%**																							
Custom Weighting (Must = 100%)	5.00%		5.00%		30.00%		30.00%		0.00%		10.00%		0.00%		10.00%		0.00%		0.00%		10.00%		0.00%	
Custom Weighting Percentage Sum	**100.00%**																							
Custom Weighting Overall Score	**0.00%**																							

(photo source: Cities Today)

Accessible, Barrier-Free Mobility

(Literature Review conducted by ITS America, with the support of AARP and the Autonomous Vehicle Alliance)

ITS AMERICA

What does it mean to be barrier-free?

- Barriers to mobility may be associated with:

  - Physical limitation/disability
  - Cost
  - Coverage
  - Safety/Security
  - Awareness
  - Technical limitations
  - Design/Upkeep

(photo source: City and County of Denver)

Motivation: Barrier-free mobility for all

- Mobility is fundamental to accessing work, goods, community, etc.
- Many currently face transportation-related barriers
  - 61 million adults in the U.S. live with disability
  - About 1 in 5 adults >65 years old have lost their driving privileges
  - There are also a range of other types of needs & challenges that can limit one's ability to be mobile.
- New technologies, services, and updates to the transportation landscape can help to alleviate barriers and improve mobility for all
- A system that is more accessible for some will be more accessible overall to all users

Literature Review: Key Topics

(photo source: Transport Hub)

- **The "Complete Trip"**: accessible trips, from start to finish
- **Automation**: automated vehicles (AVs) and other technologies
- **Mobility on Demand (MOD)**: emerging shared services
- **Accessible streets**: maintaining and improving accessible paths
- **In-hand technology**: leveraging smart apps and accessible interfaces
- **Considerations moving forward**: lessons learned and recommendations for improved accessibility moving forward

The “Complete Trip”

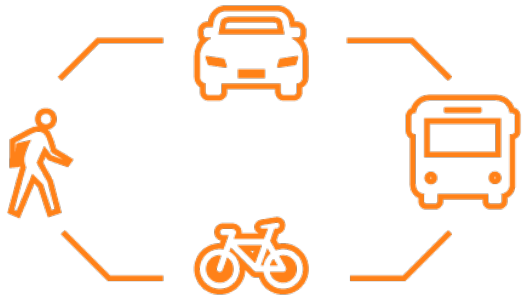
(photo source: Transit Protocol)

ITS AMERICA
poco Labs

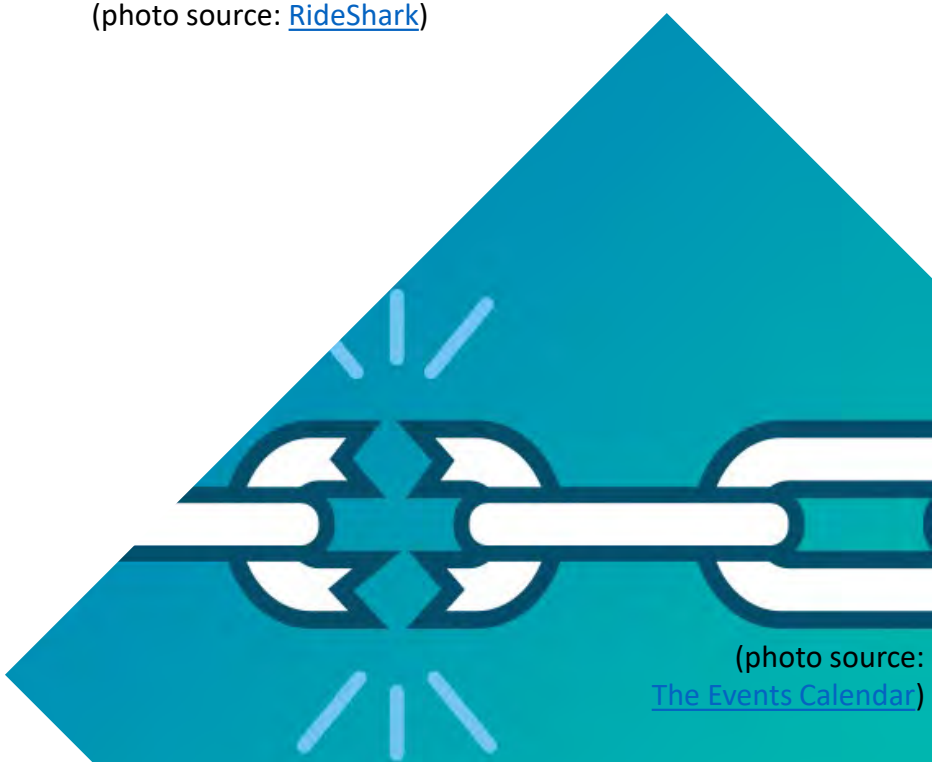
What is the “Complete Trip”?

- Accessibility from origin to destination
  - Trip planning
  - Travel to station
  - Station/stop use
  - Vehicle boarding and off-boarding
  - Stops or transfers
  - Travel to destination after leaving the station/stop

- If one link is inaccessible, then access to subsequent links is broken and the trip cannot be completed



(photo source: RideShark)



(photo source: The Events Calendar)

THE COMPLETE TRIP

After his doctor's appointment, Andy decides to take a spontaneous trip to meet a friend at a coffee shop in an unfamiliar part of town. Using ATTRI's **pre-trip concierge**, **wayfinding and navigation**, **robotics and automation**, and **safe intersection crossing** applications, Andy can travel with confidence throughout his trip.

1. Plan and Book a Trip

Andy uses a **pre-trip concierge application** to plan and book his trip from the doctor's office to the coffee shop.

2. Travel to Transit Station

An **automated shuttle** (rideshare service) is dispatched to take Andy to the transit station based on his booked trip. Once there, an **assistive robot** helps Andy to his bus platform.

3. Ride the Bus

While on the bus, Andy receives direction on when to pull the Stop Request cord from his **wayfinding and navigation application**. After he departs the bus, the application provides Andy with turn-by-turn walking directions to the coffee shop.

4. Cross the Street

As Andy approaches an intersection, his **safe intersection crossing application** communicates with the traffic signal to ensure sufficient time for him to safely cross the street, and notifies him when it is safe to begin crossing. The application also communicates with nearby cars to notify them of Andy's presence in the intersection.

5. Arrival at Destination

Andy safely arrives at his destination, while the **pre-trip concierge application** plans his return trip home.

(photo source: USDOT)

Complete Trip

- Persistent challenges within travel chain
  - Getting to/from destination
  - Distance traveled
- Goal of ATTRI:

  To work with system operators and the stakeholder community to address all parts of the travel chain, allowing individuals with disabilities – especially those with severe disabilities – to have independent access to work sites, educational programs, health facilities, and social and recreational activities

(photo source: USDOT)

ATTRI Projects

- AbleLink Smart Wayfinding Standard
- AbleLink Smart Travel Concierge System
- TRX Systems' Smart Wayfinding and Navigation

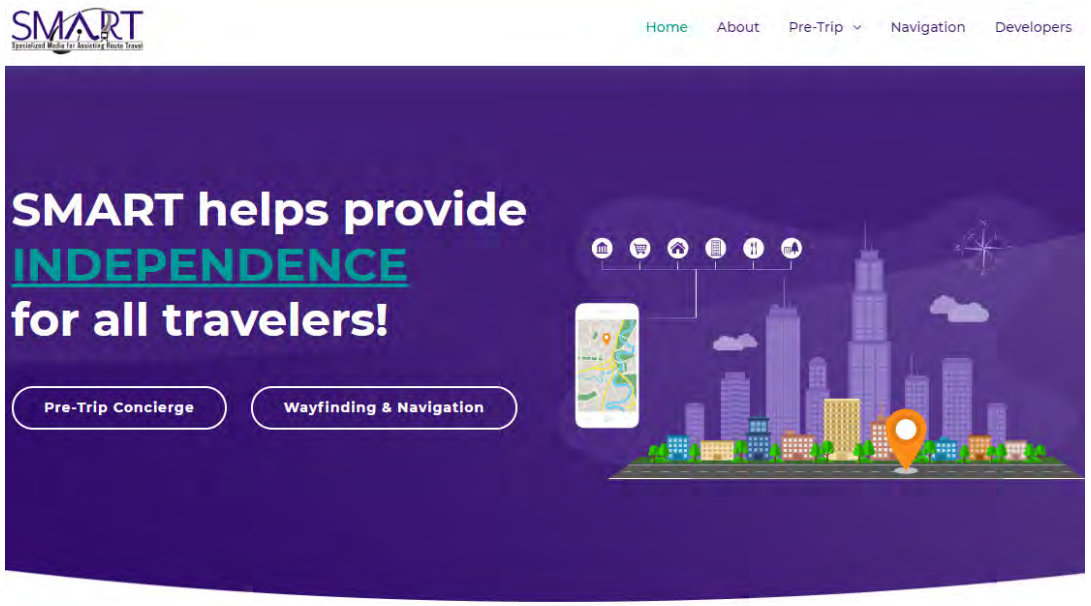
(photo source: USDOT)

AbleLink Smart Wayfinding Standard

Objectives:

- Develop a common format for travel instructions for individuals with cognitive disabilities
- Enable individuals to more independently use public transit

AbleLink Smart Travel Concierge System



(photo source: AbleLink Smart Living Technologies)

- Technology suite for individuals with cognitive disabilities
  - Transportation Readiness Assessment
  - Pre-trip Planning
  - Trip Virtualization
- Allow individuals to take fixed-route transportation more independently

Smart Wayfinding and Navigation (SWaN)

Indoor wayfinding and navigation system
for individuals with visual impairments

- Navigation and wayfinding mobile service
- Open APIs
- Tools for path planning and routing
- Support standardization efforts

Smart Parking

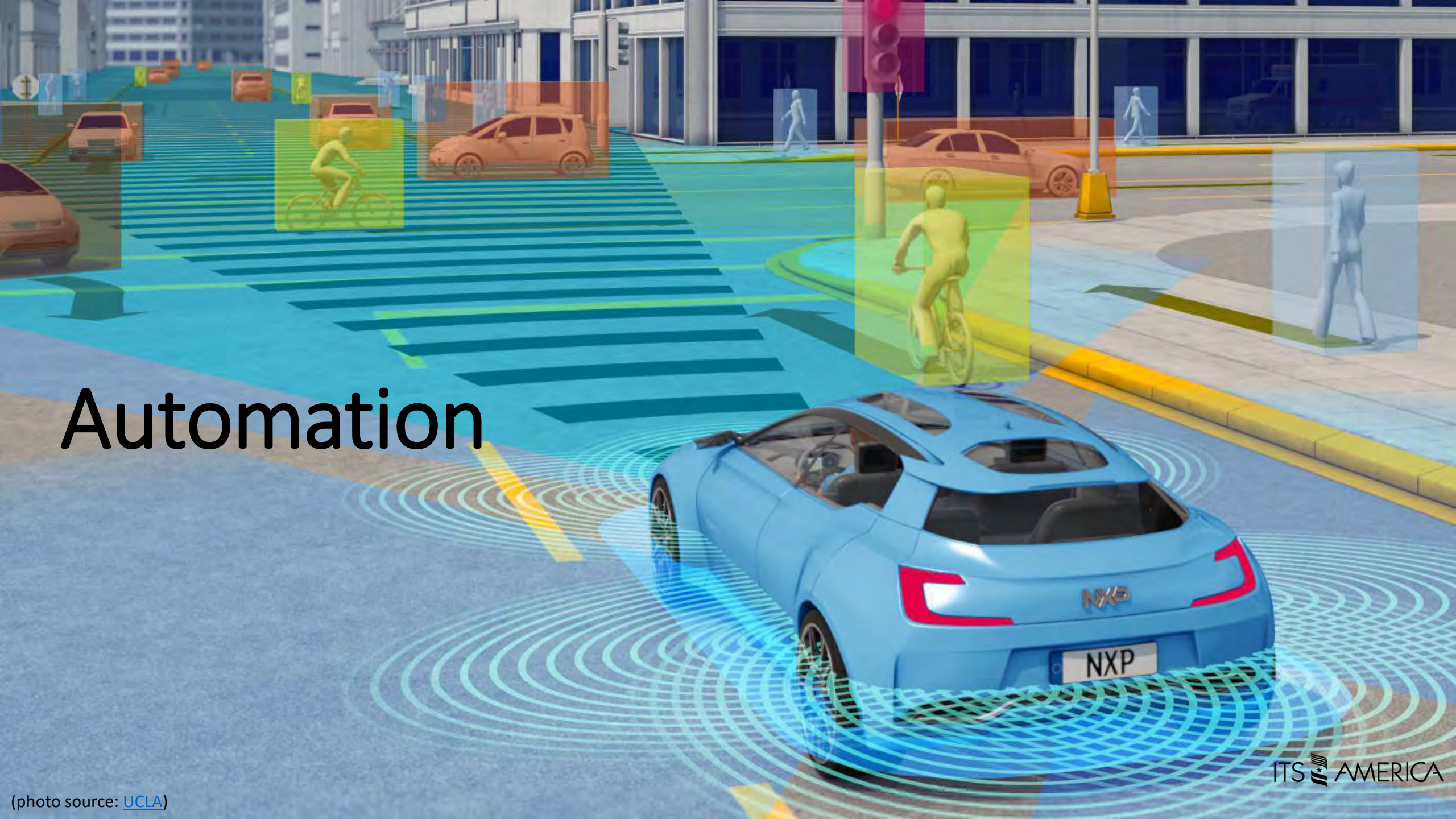
- Approximately 30% of city traffic consists of drivers searching for parking
  - ➢ Direct drivers to available inventory → reduce congestion

(photo source: Happiest Minds)

Examples:

- San Francisco MTA's pilot program
  - ➢ Street parking and city-owned lots / garages
  - ➢ Demand-based cost + targeted occupancy rate
- Blue Badge Parking
  - ➢ Specifically locates handicapped parking spots
  - ➢ Crowd-sourced

(photo source: Blue Badge Parking)



Automation

(photo source: UCLA)

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Automated Vehicles

- AVs could remove some existing mobility barriers.
  For improved mobility for all, however, AVs should be:
  - Designed to accommodate wheelchairs
  - Designed for individuals with low vision
  - Designed for individuals with hearing impairment
  - Designed for users of all abilities, ages, etc.

- Examples: May Mobility
  Voyage
  e-Palette (Toyota) **see photo**

(photo source: Philippine News)

Autonomous Personal Electric Vehicles

Autonomous Wheelchairs

- Target markets / locations: large public areas
  - Conference Centers
  - Airports

- Potential benefit: increased mobility and independence

Example: Whill

(photo source: Inventiva)

Automated / Redesigned Features

- Jaguar's "Mobility Door"
  - Door opens and closes via proximity sensors, buttons on dash or door
  - Sensors ensure doors don't open into nearby obstacles, close on passengers
  - Off-the-shelf hardware

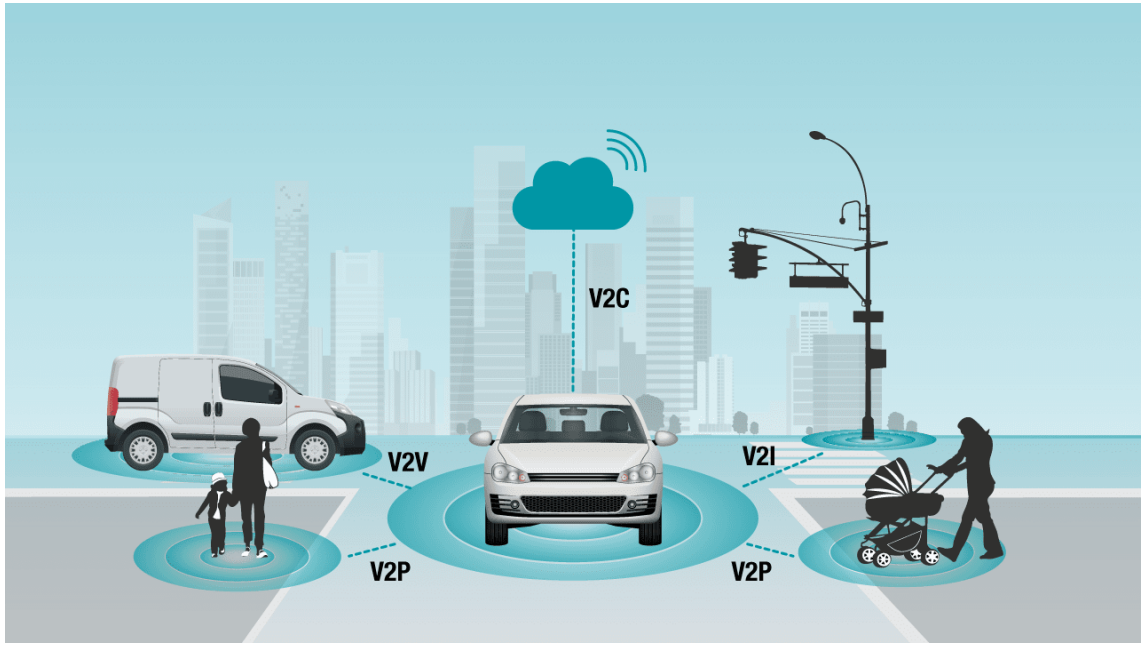
- Reimagining vehicle:
  - Design
  - Displays

(photo source: Jaguar)

Connected-Automated Technology

- Connected Automated Vehicles (CAVs)

- Safe Intersection Crossing
  - Carnegie Mellon University
  - V2X
  - Smartphone + antenna “sleeve” acts as a DSRC radio
  - Can transmit:
    - Warnings
    - Timing Info
    - Adjust signal timings



(photo source: Texas Instruments)

Considerations

- AVs should be designed to be accessible from the beginning
  - Developers should seek out feedback from diverse users
  - Design should accommodate riders or varying abilities, ages, etc.
- AV passengers may need training to understand how the AV will operate, its movements, and its communication with the passengers.
- The majority of AV development is occurring in more populated, urban areas, and due to the implementation of the current technologies, most of the focus of future deployments will likely continue to occur in more commercially viable areas.

Mobility on Demand (MOD)

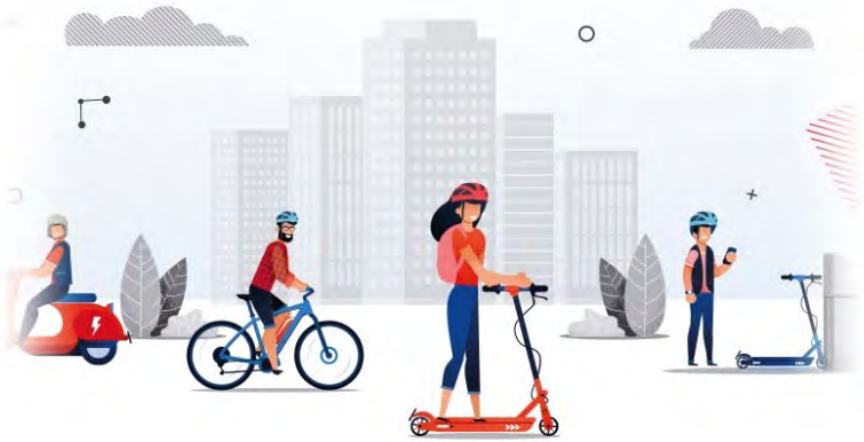
(photo source: Corporate Knights)

What is MOD?

- The "*integrated and connected multi-modal network of safe, affordable, and reliable transportation options that are available and accessible to all travelers*."
  -- Federal Transit Administration (FTA)

- May include not only traditional transit, but also the range of shared mobility services

- Aim: Improved efficiency, effectiveness, and customer experience



(photo source: Porsche)

MOD
MOBILITY ON DEMAND

(photo source: USDOT)

Modes include:

- **Ridesourcing** (ex: Uber, Lyft)
- **Ridesharing** (ex: Scoop, Hytch)
- **Microtransit** (ex: Via, TransLoc)
- **Carsharing** (ex: ZipCar, Turo)
- **Bikesharing** (ex: BCycle, Divvy)
- **Scooter sharing** (ex: Lime-S, Bird)

(Autonomous Vehicle Alliance - Accessible & Barrier Free Full Report

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poco Labs

MOD & Shared-mobility can *(potentially)* help to:

- Reduce congestion by offering dynamic alternatives to driving alone
- Bridge transportation gaps and connect riders with existing transit
- Offer more cost effective, timely paratransit service
- Improve options for non-emergency medical transportation
- Meet specific transportation needs (ex: rides for seniors, kids, etc.)
- Increase mobility on university campuses and in downtown areas
- Aid mobility during special events: (ex: emergencies, holidays, etc.)
- Connect those in need with rides to jobs, groceries, etc. via pilots
- Make the process of trip planning and traveling more simple/easy

Shared-mobility for congestion mitigation

Over 76% of Americans commute by driving alone; congestion is a pervasive barrier to mobility. Shared-mobility partnerships can potentially help reduce the number of vehicles on the road.

- Rideshare: Bay Area Council in San Francisco & Hytch partner to incentivize carpooling
- Microtransit: Montgomery County Department of Transportation & Via partner for "Ride On Flex" (dynamic bus service)
- Micromobility: Arlington County, VA launched a shared mobility pilot (including dockless electric scooters and bikes)

  - 32% of e-scooter riders reported that their scooter ride "replaced an automobile trip"

Growth/Impact of Micromobility

(photo source: NACTO)

- "In 2018, people took 36.5 million trips on station-based bike share systems and 38.5 million trips on shared e-scooters" and e-bikes "emerged as a popular option, accounting for 6.5 million trips in 2018."

  – Source: National Association of City Transportation Officials (NACTO)

- With 60% of trips in the U.S being less than 5 miles long, micromobility services offer a potentially efficient, healthy, and environmentally-friendly way for people to explore downtown areas and reach their destinations without a car and without contributing to traffic on the road.

MOD & first/last mile accessibility

(photo source: Transportist)

New, on-demand mobility options can help connect commuters with existing transit services. Public-private partnership are working to alleviate gaps in transportation coverage. For example:

- Microtransit: Tri Delta Transit & TransLoc partner for "Tri MyRide" in Contra Costa County, California (launched: June of 2019)
  - Offered $2, wheelchair accessible rides to local BART stations or other destination
- Ridesourcing: City of Phoenix & Lyft partner for “First Mile Last Mile” campaign (launched: October of 2017).
  - Offered commuters discounted rides to or from local bus stops

(photo source: ABC15)

MOD & accessible mobility for targeted needs

- Paratransit
- Non-emergency medical rides
- Rides for the elderly
- Mobility on campus
- Improved mobility programs for special events

  (e.g. holidays, elections, concerts, sporting events, natural disasters, …)

- Rides for children
- Grocery access
- Etc.

(photo source: TheTransitWire)

Paratransit (example: MBTA pilot program)

(photo source: MassGovenor)

The Massachusetts Bay Transportation Authority (MBTA) partnered with Uber, Lyft, and Curb to offer on-demand transit service to RIDE customers.

This pilot offers shorter wait times, same-day booking, and cheaper prices.

Service Comparison

Service	THE RIDE	Pilot Program
Price	$3.35 or $5.60 for premium trips	As low as $2.00
Booking Timeframe	At least 1 day in advance	On demand, instant request to dispatch
Day-of Wait Time	30-minute window	As low as 5 minutes in core service areas
Trip Reservations	By phone	Via smartphone app (Uber, Lyft, Curb) or phone call (Lyft and Curb only)

(Source: MBTA)

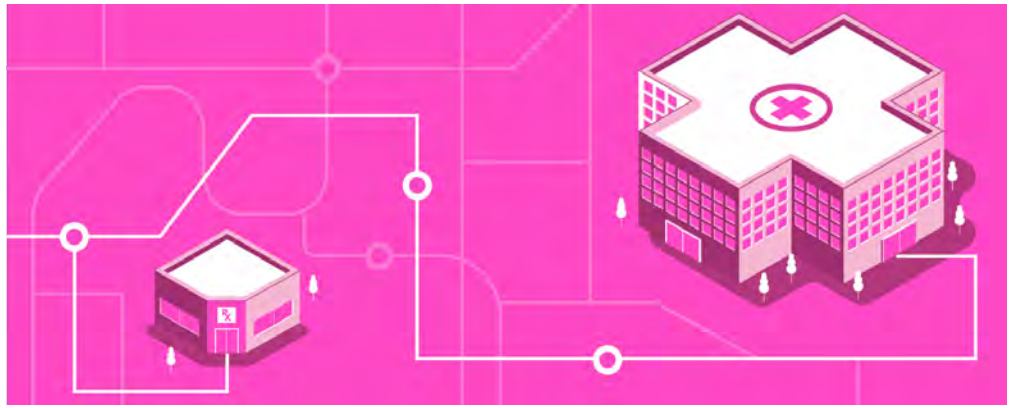
Non-emergency medical rides

"Each year, 3.6 million people in the United States do not obtain medical care due to transportation issues."

– Source: National Association of City Transportation Officials (NACTO)

Uber Health

(photo source: Uber)



(photo source: Lyft)

(photo source: Thinkstock)

MOD programs can help make it easier and more affordable to meet critical transportation needs, such as traveling to see a doctor.

Other specialized programs/services

(photo source: DailyCaring)

(photo source: Veterans Rideshare)

(photo source: Lyft)

(photo source: Washington Regional Alcohol Program)

(photo source: Jeff Bender)

RIDESHARE 2VOTE

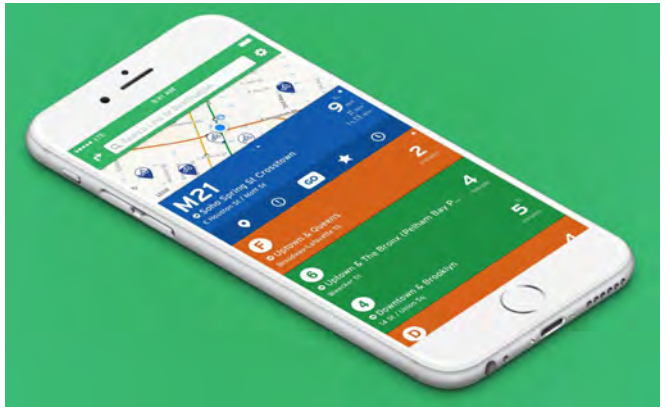
(photo source: Rideshare2Vote)

Integrated, multimodal trip planning/payment

The expansion of integrated trip planning and payment platforms for multimodal, shared-mobility services is a notable mobility trend that offers the potential to make it easier for travelers to understand their mobility options and make informed, personalized travel decisions.

Ex) Utah Transit Authority (UTA) & Transit app partner:

- Real-time information on nearby bus & rail options.
- Transit departure times
- Real-time tracking
- Route-specific push notifications
- Go feature: step-by-step navigation and information on other modes – including Lyft, Uber, GREENbike, and Spin – for their first/last mile travel needs. Lyft and Uber rides can be booked and paid for within the app



(photo source: Columbus Underground; Transit)

Key Considerations for Accessible MOD

- Affordability
- Flexible options for ride booking/payment
- Availability of accessible vehicles
- Safety

(+ more)

(photo source: SRF Consulting Group, Inc.)

Accessible Streets

(photo source: City of Fort Lauderdale)

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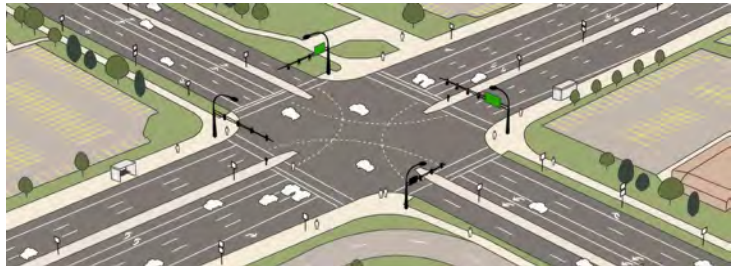
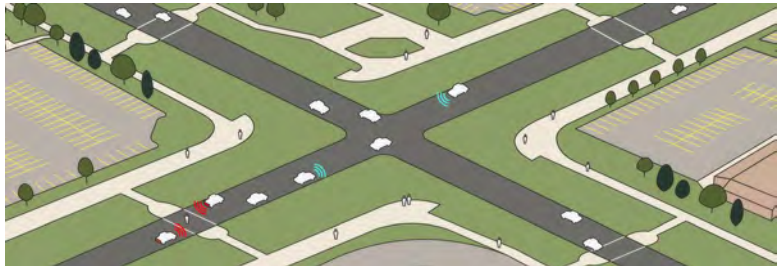
Road design





(photo source: Short Elliott Hendrickson Inc.)

- Street design has generally prioritized one thing above all: vehicle throughput. Volume/capacity ratio and intersection level of service are often the guiding metrics that determine the designs of roadways and intersections.

- Prioritizing the throughput of vehicles above alternative forms of transport, however, may create mobility barriers for pedestrians and other road users.

    - For instance, narrow sidewalks may discourage walking, lack of bike lanes may discourage bicycling, and limited access to bus stops may discourage transit use.

Complete Streets

- **Improved safety for all transport modes**
- **Societal health benefits.**
- **Environmental benefits.**
- **Improved utilization of the public right-of-way.**
- **Cost savings for individuals.**

(photo source: Town of Weymouth)

(photo source: Transportation for America)

Curb Management

- Curb space is premium real estate in urban areas – space managed by cities that is in demand for many disparate uses.
- Most curb space in urban areas is used for travel lanes or parking.
- Rise of online shopping puts additional demand on curb space. The ability to have everyday essentials, such as groceries, ordered and delivered without leaving home reduces the need for personal transport, including for individuals with disabilities.
- Further into the future, as vehicle connectivity and AV adoption continues to increase its share of the national vehicle fleet, there will likely be opportunities to offer dynamic curb use regulations.

Example: City of Houston, TX

- Partnership with app based TNCs to create rideshare parking zones
- The current zones include restaurants and nightclubs, businesses that are typically active during the evening and late-night hours.
- The curb space is used by delivery vehicles during the day, then converted to TNC pick-up and drop-off zones during evening hours.
- When users request a ride from within the zone, they are directed to the loading zones to retrieve their ride

(photo source: City of Houston)

Pedestrian Path Mapping

Examples:

- PathMeT

  Identifies conditions along sidewalks, paths, trails, etc.

- AccessPath

  Accessible turn-by-turn directions

Considerations

- Complete Streets encourages mobility and access for all, with accessibility and diversity of modes identified as priorities.
- Complete Streets can make communities healthier, help the environment, and improve the utilization of the public right-of-way.
- Effective curb management requires balancing existing demands for curb space, while adjusting for evolving modes and loading/unloading needs.
- The mapping of pedestrian paths to determine accessibility is important not just for the disability community, but important information for municipalities for determining maintenance needs.
- The safe intersection crossing application would offer significant benefits not only to pedestrians with disabilities, expanding the project to the broader public would benefit all pedestrians.

(photo source: PhoneArena)

In-hand technology

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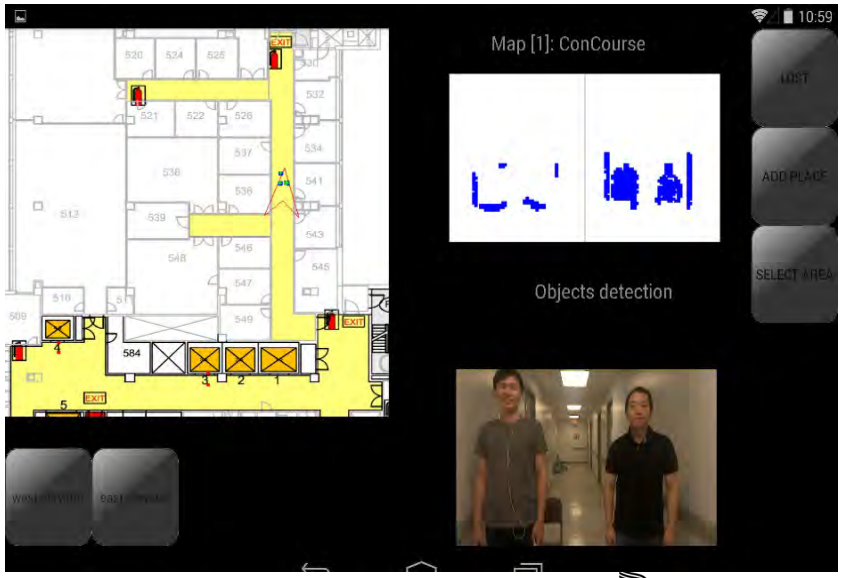
Smart Cane for Assistive Navigation

- ATTRI Project from City College of New York (CCNY)
- Specialized Cane + Smartphone interface
- Wearable system to assist with localized navigation



(photo source: USDOT)

Vehicle-to-Everything (V2X)

- Annual Collisions Decrease, but Pedestrian Fatalities Increase
- V2X Technology
  - Reduce unimpaired vehicle crashes by 80%
- USDOT Mobile Accessible Pedestrian Signal System
- Safe Intersection Crossing (CMU)

Smart Cities

(photo source: Center for Internet Security)

- Data collected, analyzed, and disseminated by city
- Concerns with accessibility of interfaces

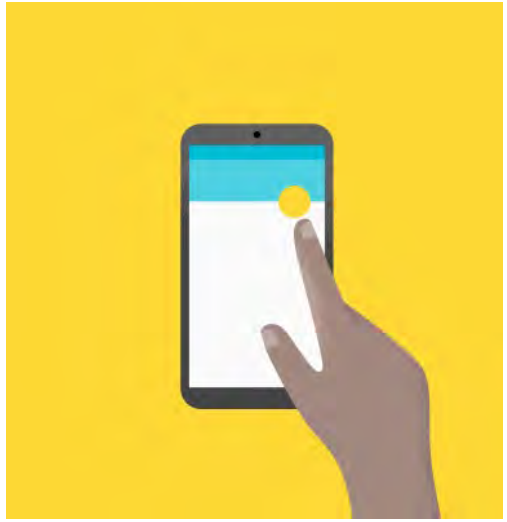
Crowdsourcing & Accessibility

- Perkins School for the Blind
  - Volunteers provide auditory directions for “last 50 feet”
- MoDE
  - Accessible bathroom locations
  - Breakdown by available facilities

HMI & Accessibility

- Human-Machine Interface
- Universal Design

Verizon



Material Design

UX Planet

Considerations moving forward

(photo source: QROWD)

- Design of vehicles, roads, HMI, etc.
  - ➢ **Accessible design is *critical* for mobility for all**
- Role of new platforms and services (ex: MOD) as tools to help address gaps in transportation
- Communication infrastructure, smartphone penetration, etc.
- Rethinking/adapting related standards and policies
- Need for diverse feedback, engagement, and collaboration

For more information, please contact Tim Woods at the Autonomous Vehicle Alliance

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