Accessible & Barrier Free

Executive Summary

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 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)

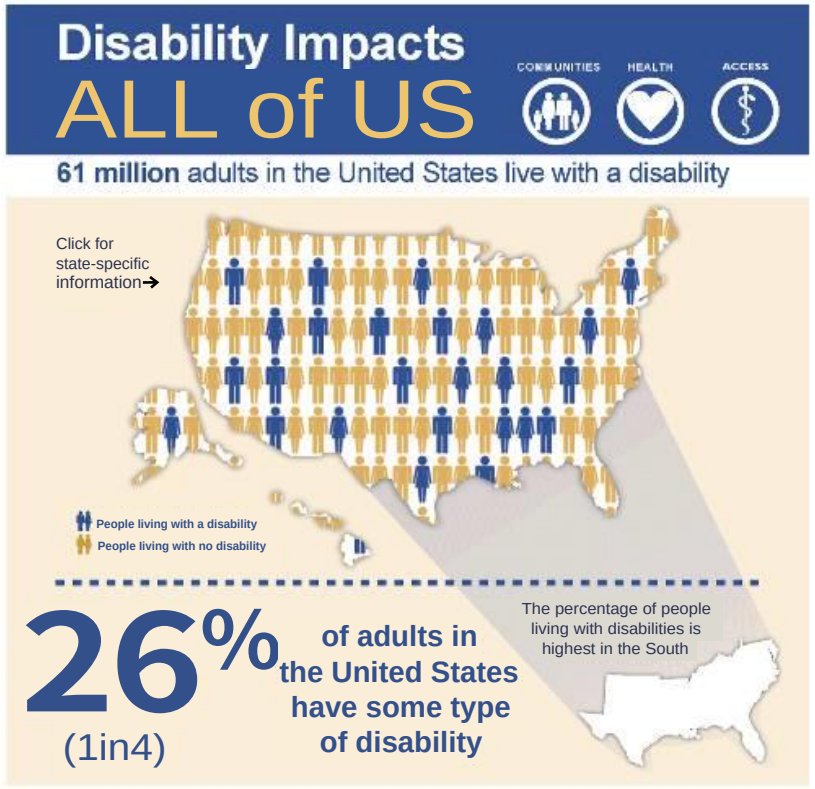
Safety/Security (Physical well being, data privacy, etc.)

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).

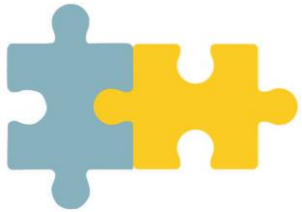
Identified Opportunities

Section 1:
Merging the Physical World with Digital Wayfinding Tools and Backend Enablement

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

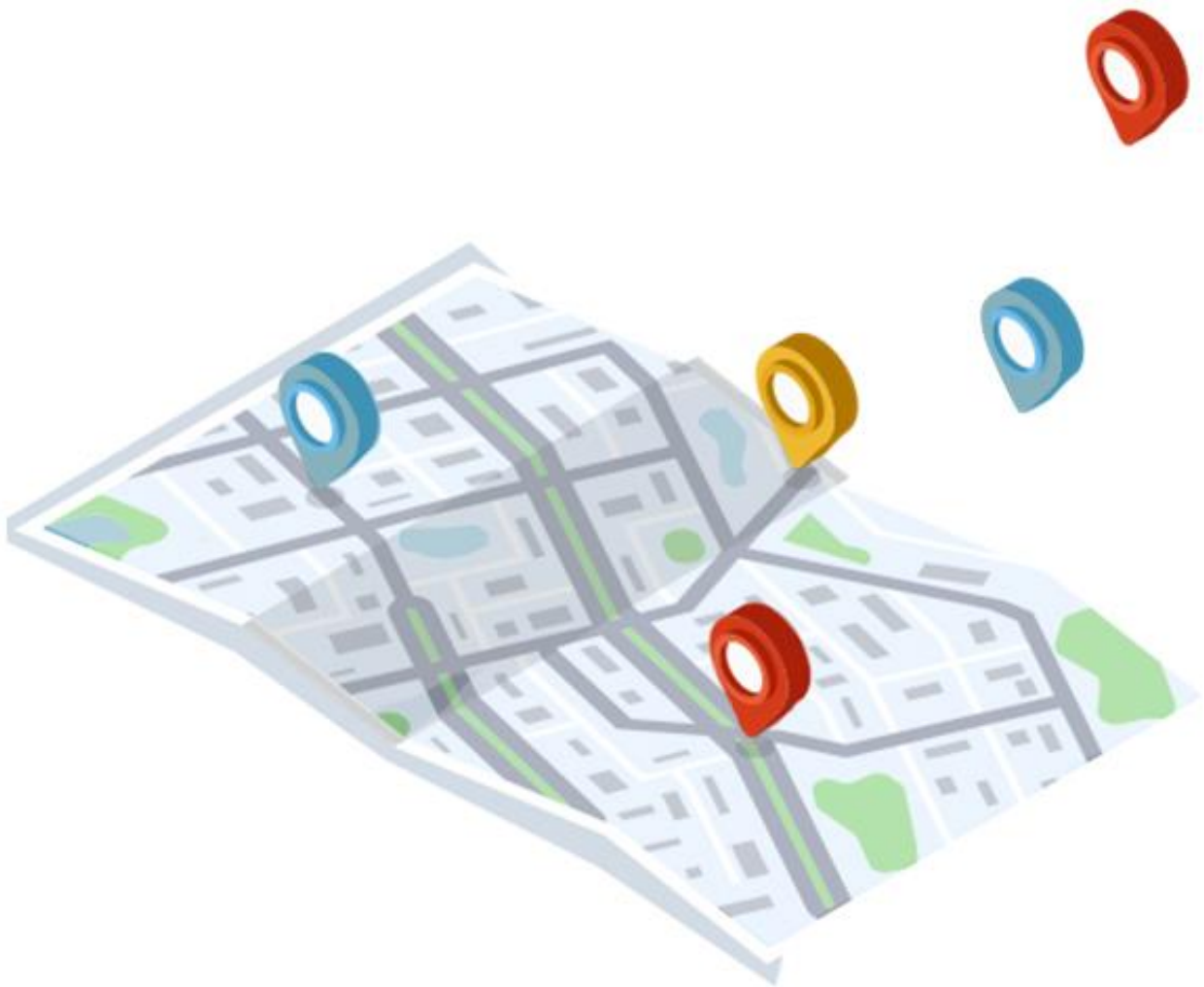
Section 2:
Understanding How Universal Design Language Could Impact AVs

- 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

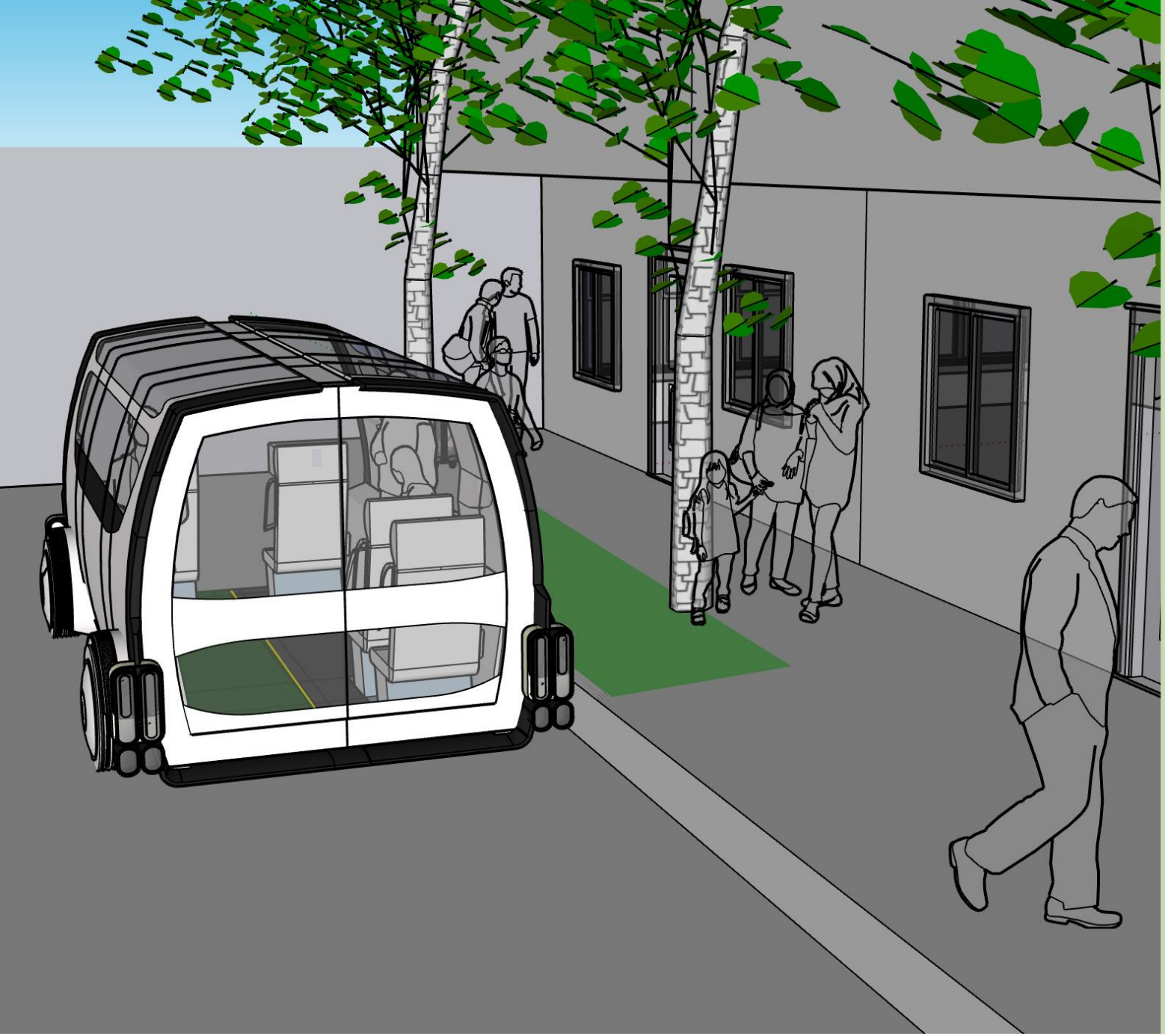
With the ability to enable spontaneity while still maintaining reliability for all riders, on-demand mobility is the optimal scenario.

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:

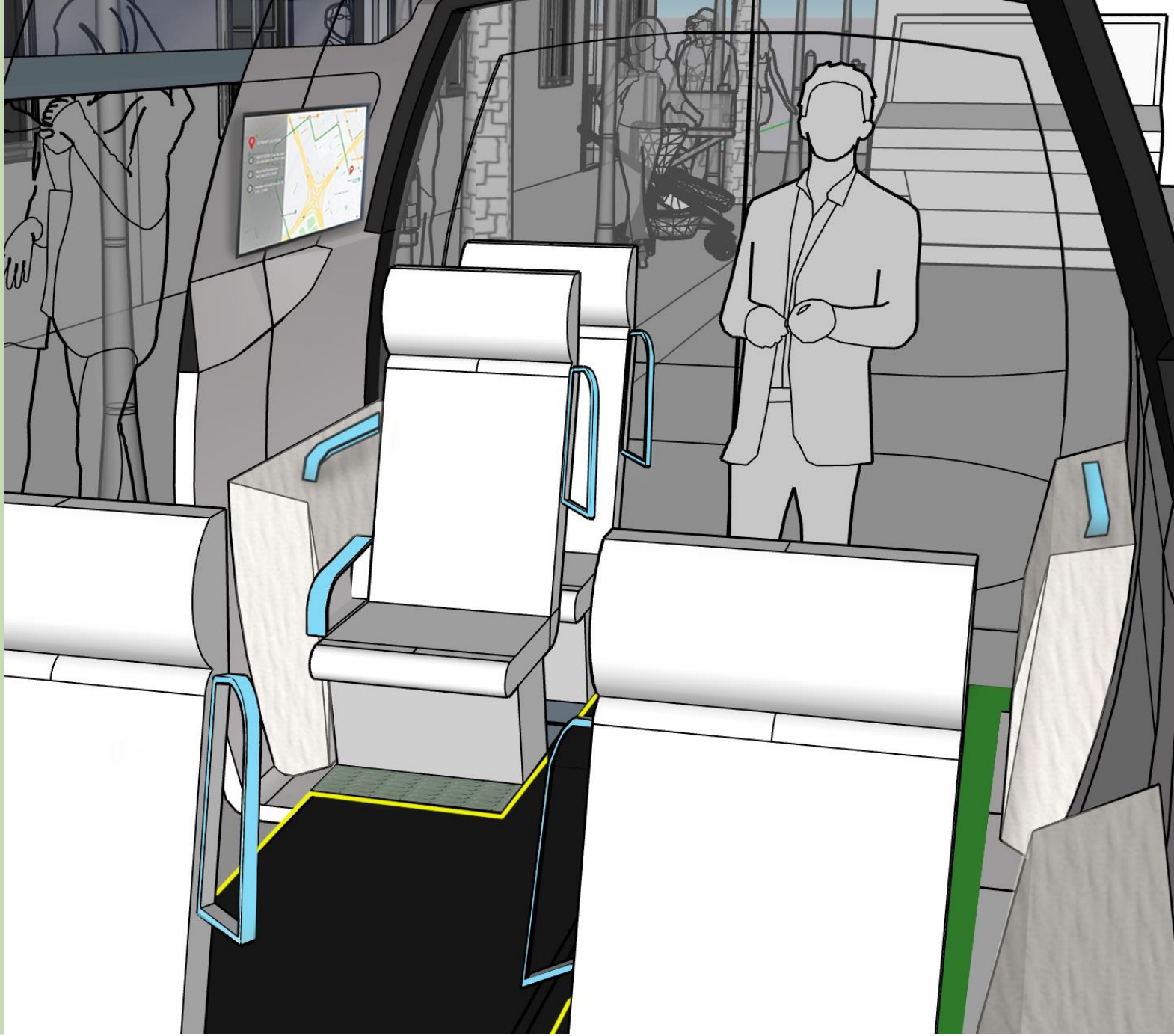
- flexible seating to keep riders from feeling excluded from their group and others (if the vehicle can not accommodate the rider and their group, it should not arrive as an option).
- grab bars for easy maneuverability.

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

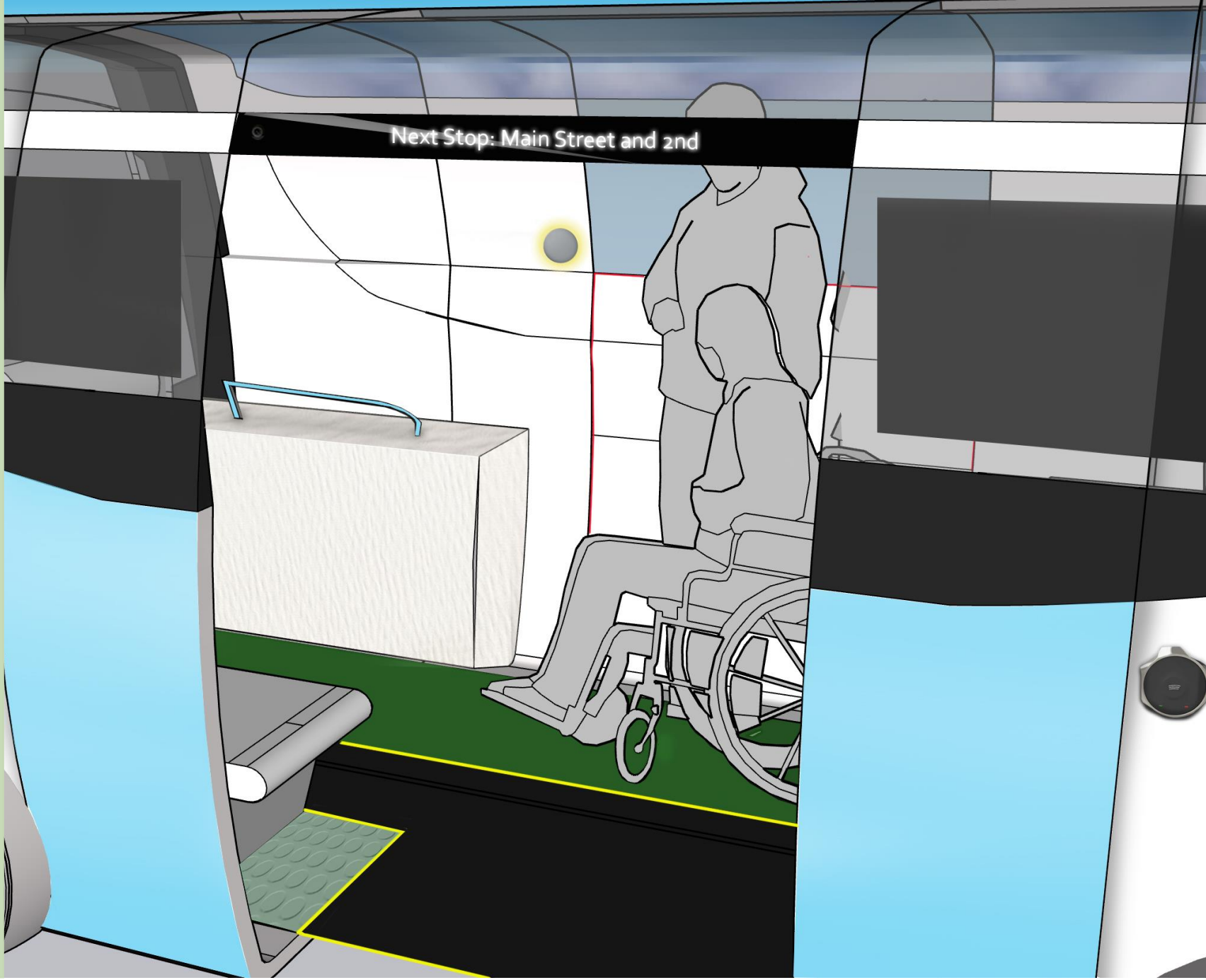
Having a standardized design language for the vehicle interior could be intuitive and informational for riders.

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/

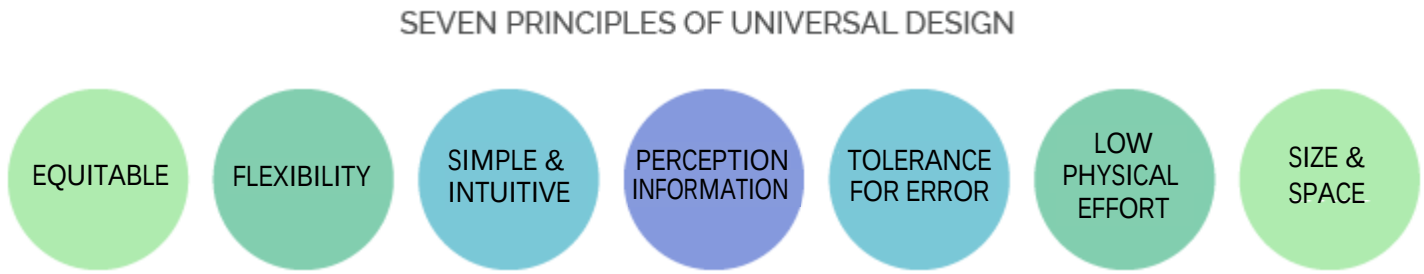


Designing for Usability by 85% of the Public

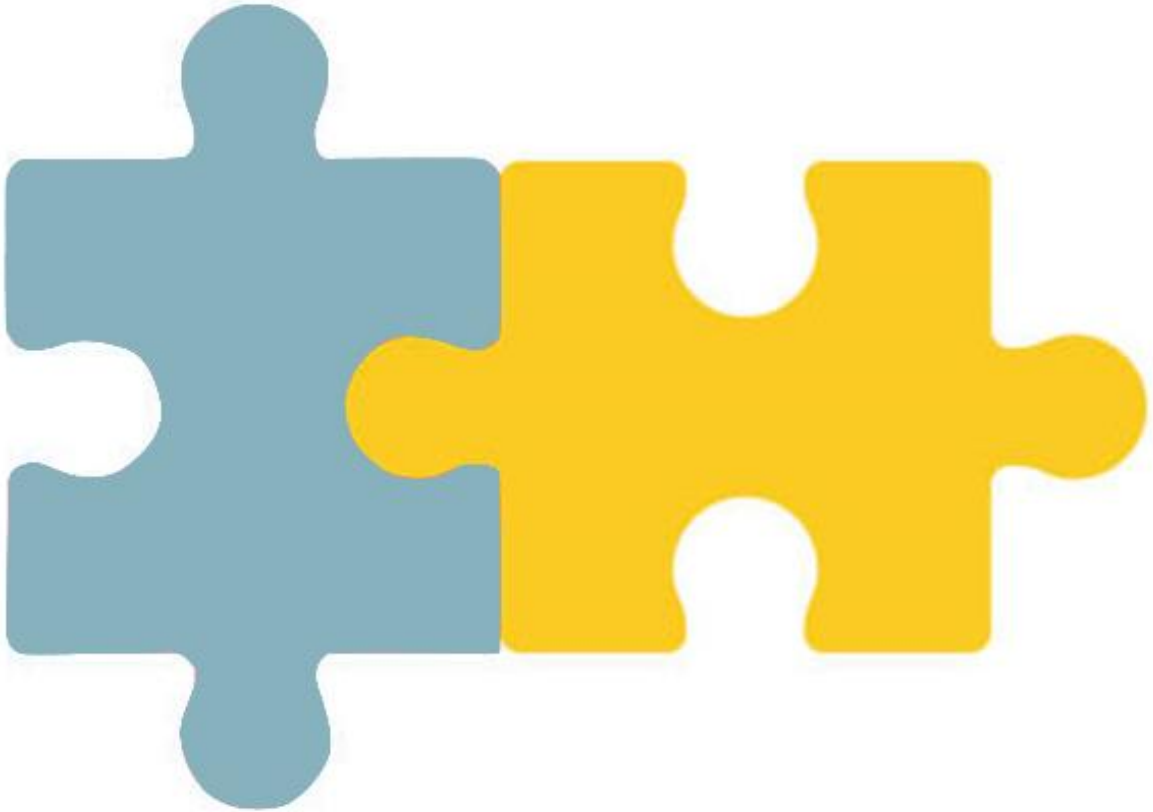
Universal design is the design of buildings, products or environments to make them accessible to more people, regardless of age, disability or other factors.

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

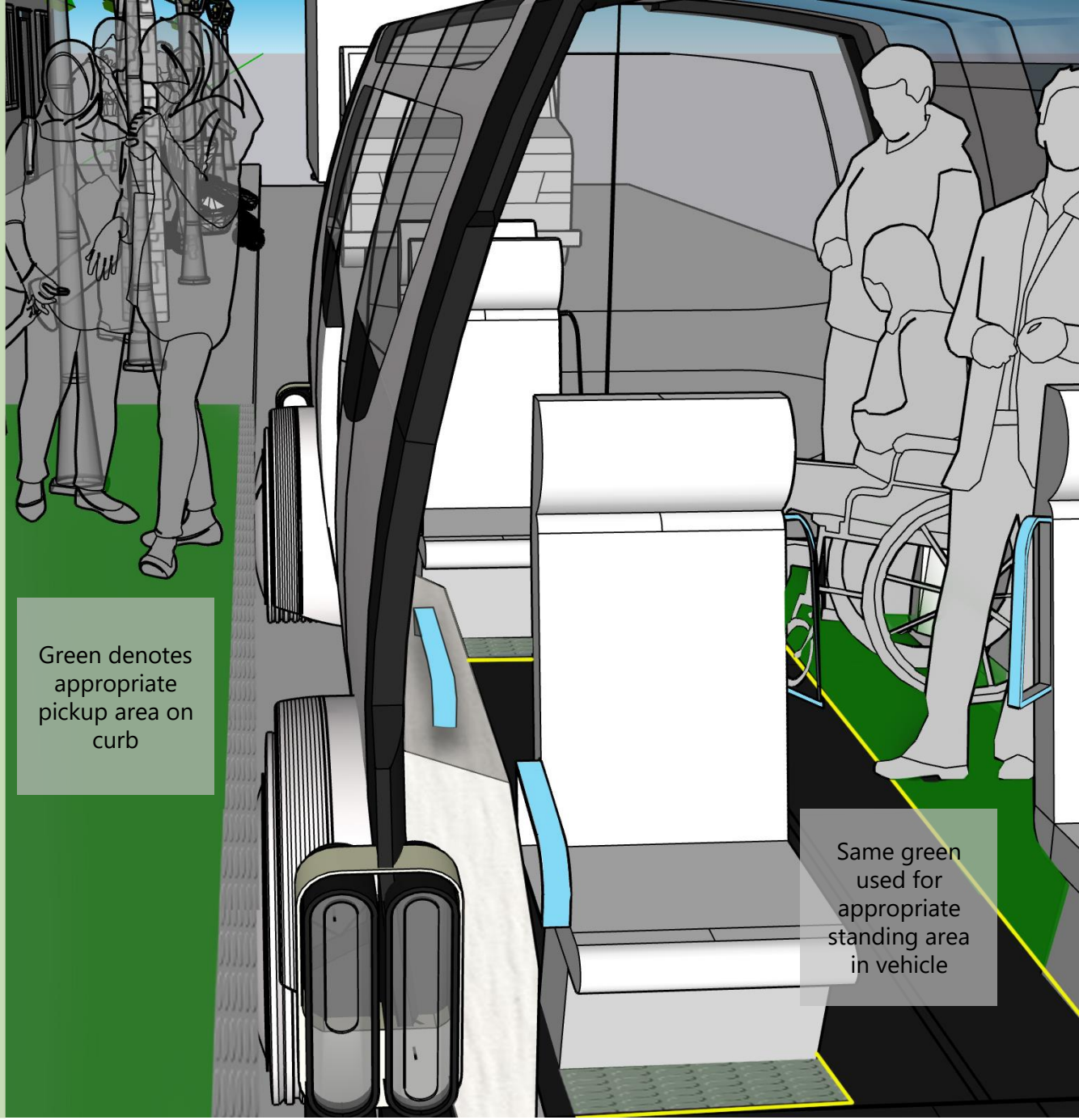
There is an opportunity for vehicles and infrastructure to work together as one unified design language. One way this could be accomplished is using the same design cues from the vehicle interior (such as color, texture or lights) at the onboarding areas as well.

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.

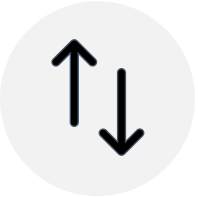
The use of interior passive messaging to riders (a light or something in a preferred seating area, etc.) would be helpful. Using tech to help people navigate, something to let them know where the bus stop is and where to stand, etc. -Elliott



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

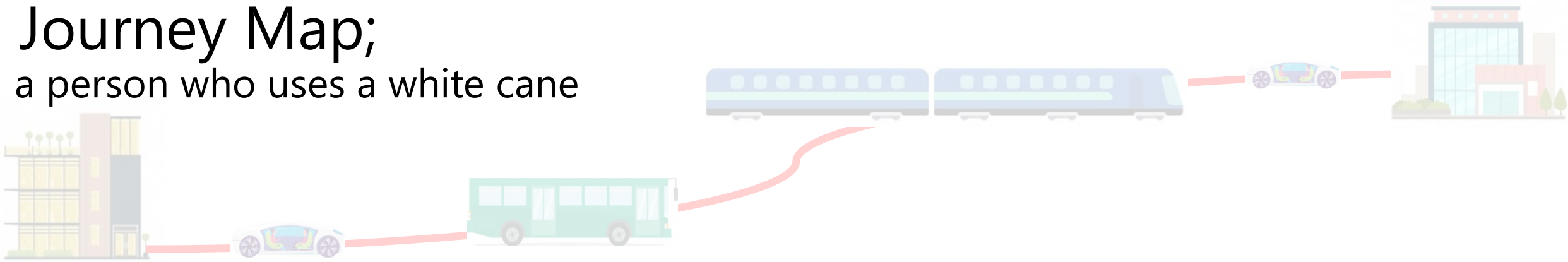
Limited sidewalk availability

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

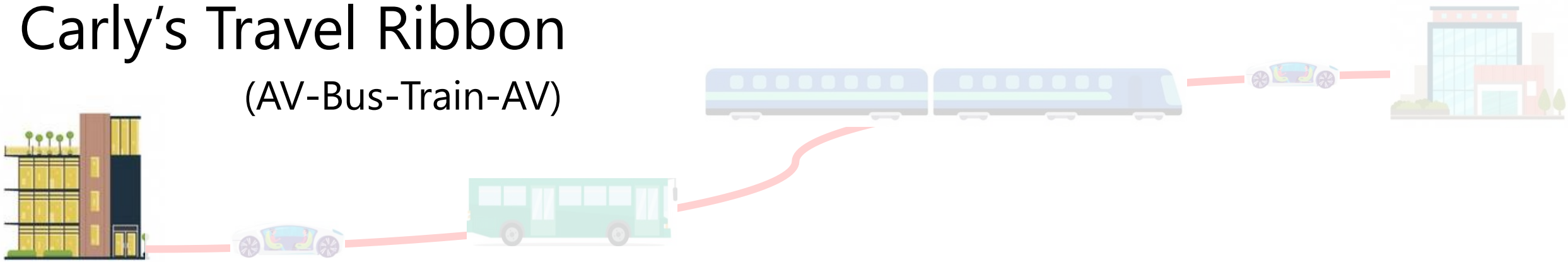


Carly is a 32 Years old African-American woman with a vision impairment. She lives on the south side of Chicago in the Douglas neighborhood. Carly is a Customer Service Consultant. She can recognize primary colors but is considered legally blind which results in Carly using a cane to navigate her way 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.

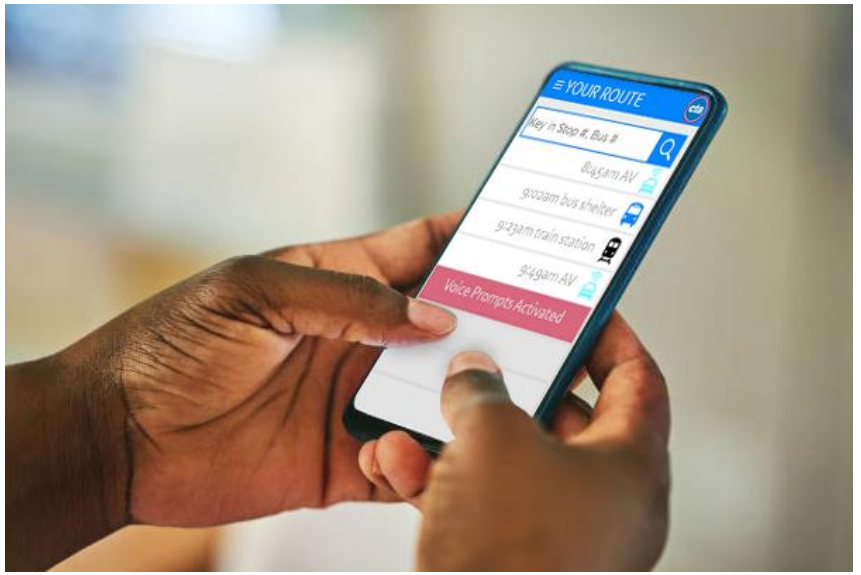
Carly's Travel Ribbon

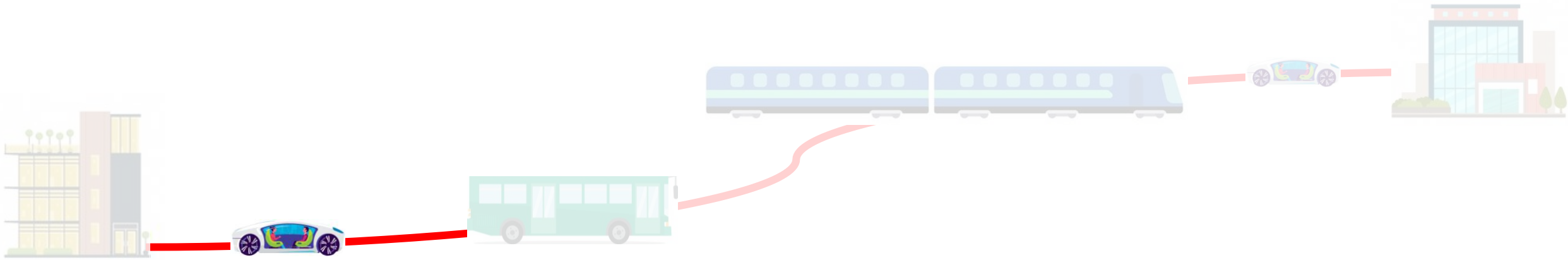
(AV-Bus-Train-AV)



7:30 AM

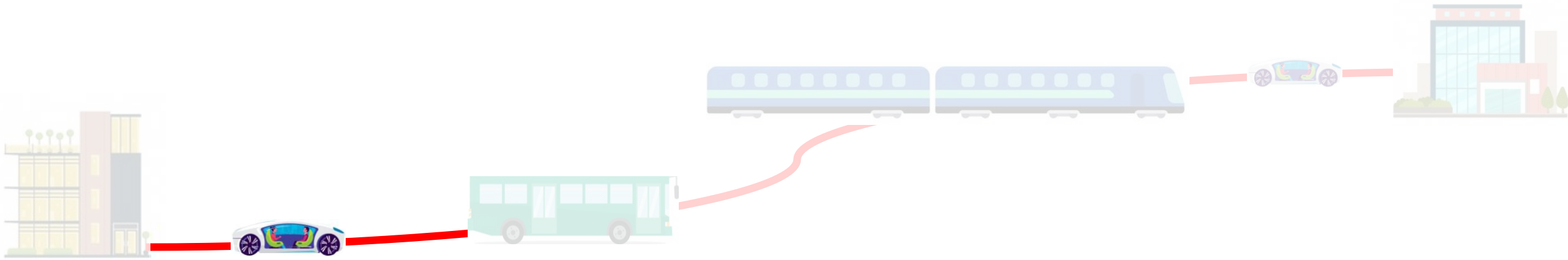
Carly opens her CTA App which allows her to plan her trip with audio prompts. The CTA app is a fully integrated mobility platform and considers all forms of private and public transportation options. The CTA app will aggregate those options to maximize the efficiency of her trip. The app asks, "what 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.

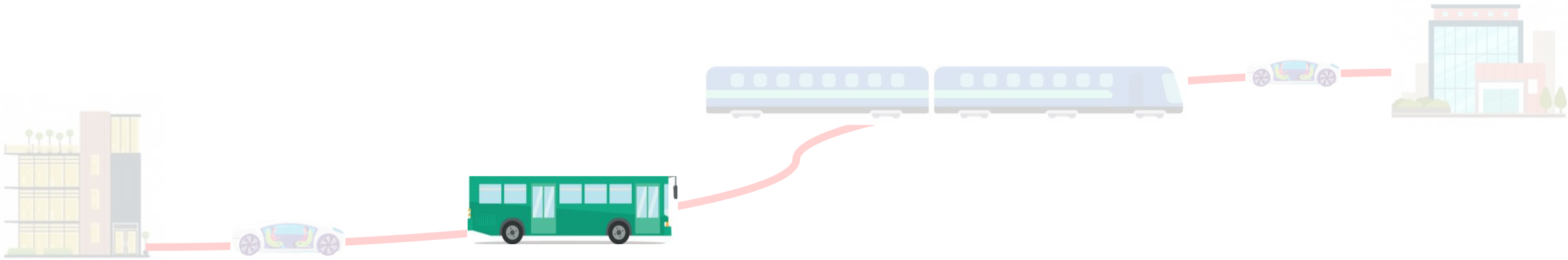


8:50 AM

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.

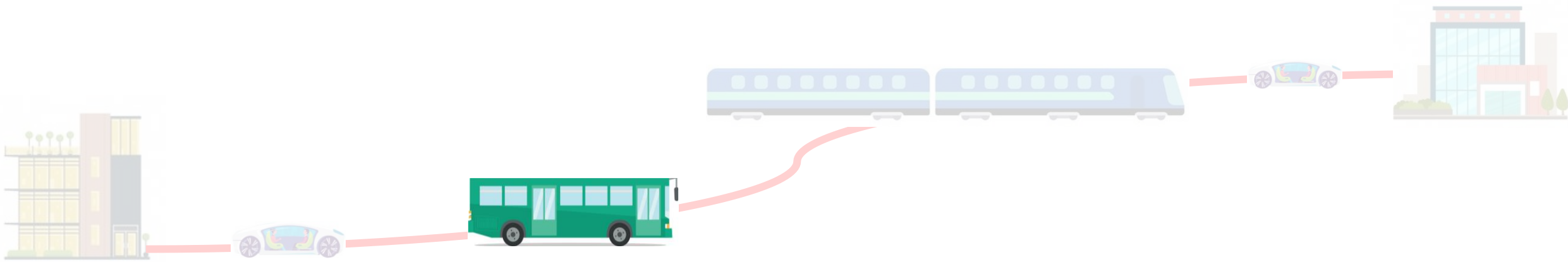


9:02 AM

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.

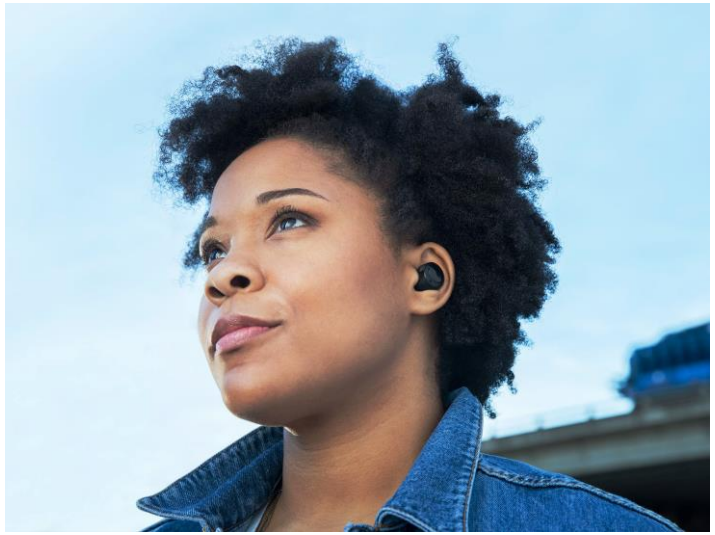


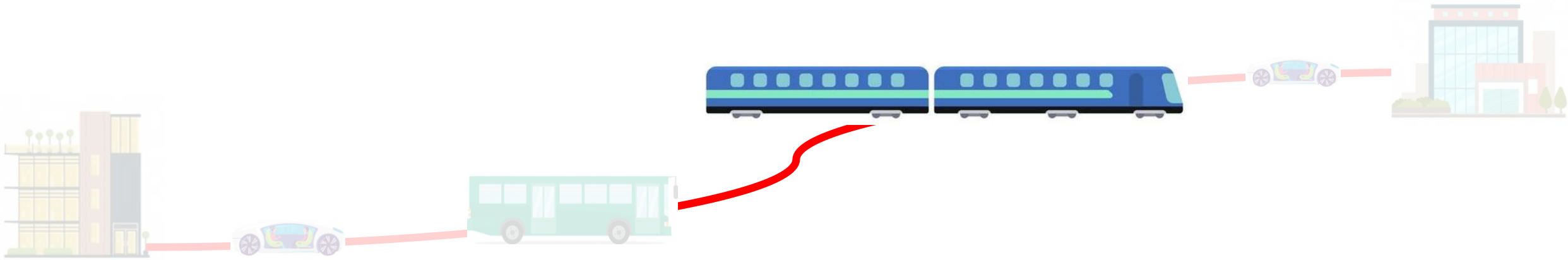
9:08 AM

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.



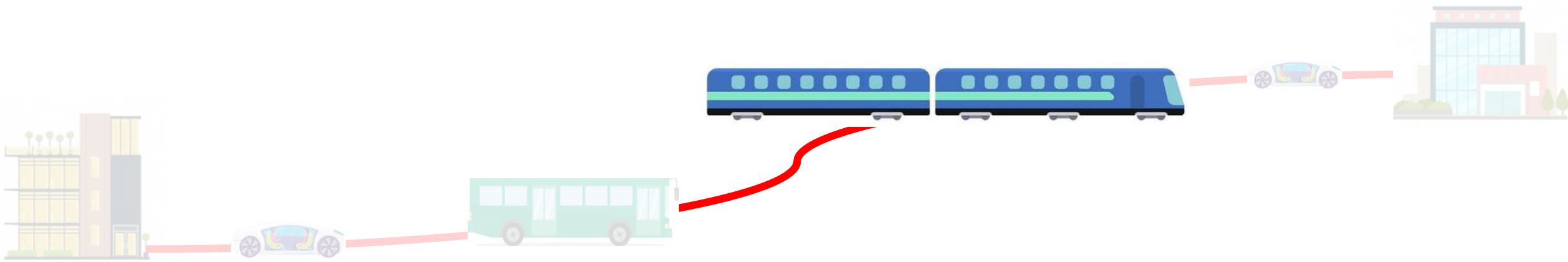


9:23 AM

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.

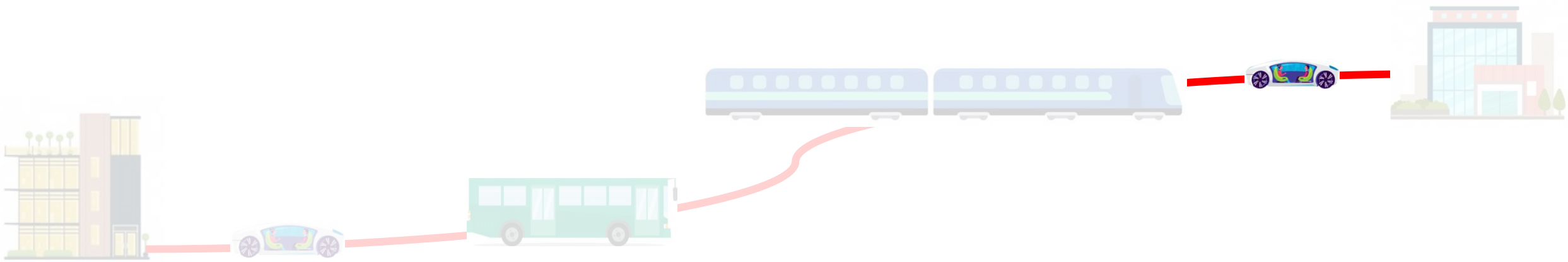


9:26 AM

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.

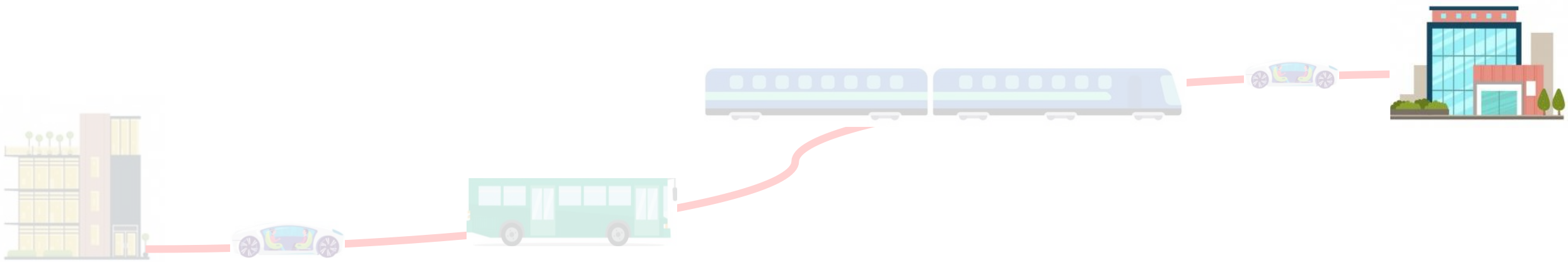


9:47 AM

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.



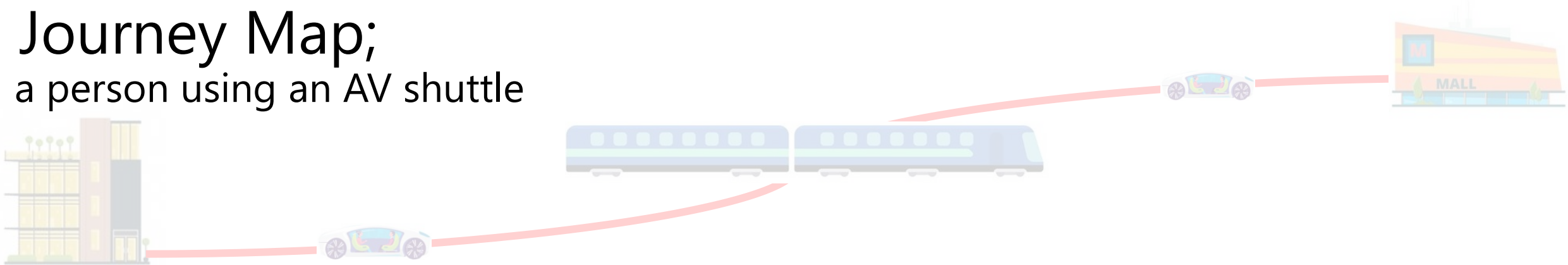
9:58 AM

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.

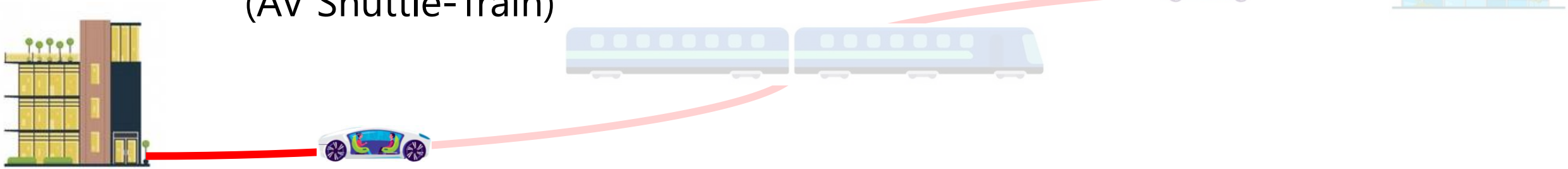
Journey Map;
a person using an AV shuttle



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.

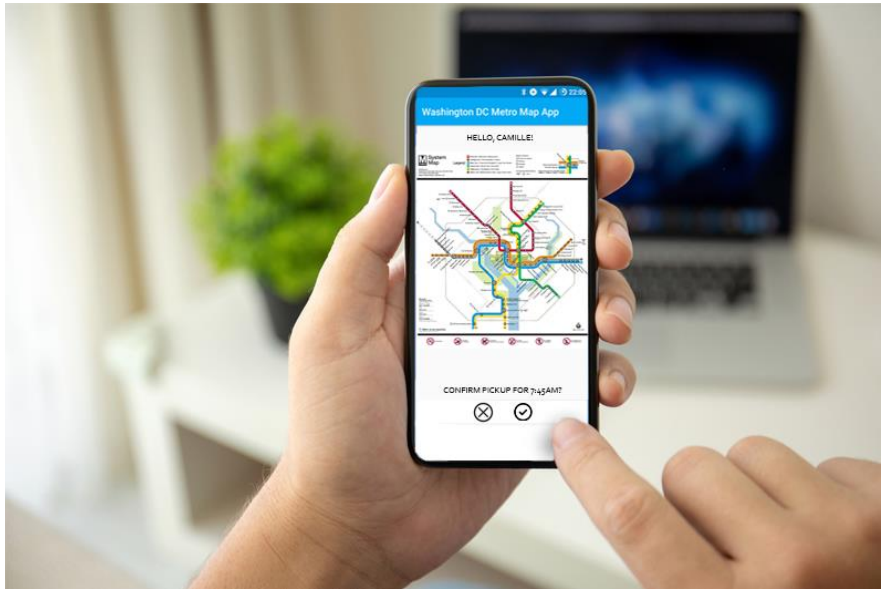
Camille’s Travel Ribbon

(AV Shuttle-Train)



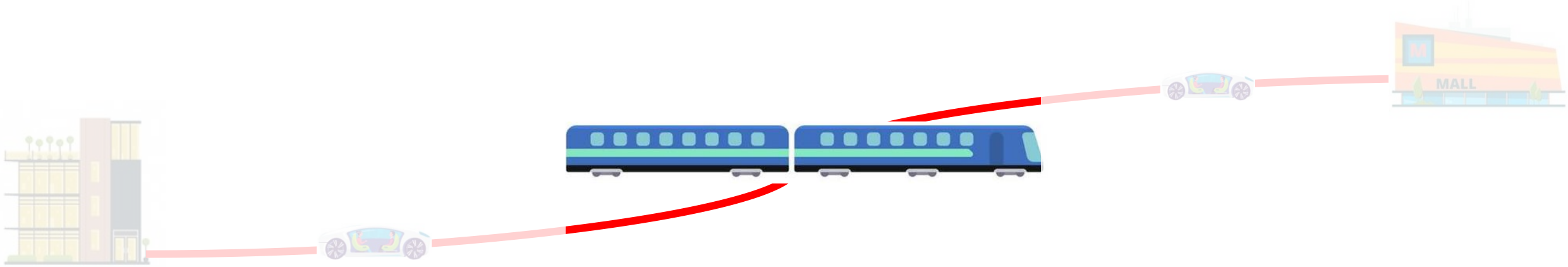
7:00 AM

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.

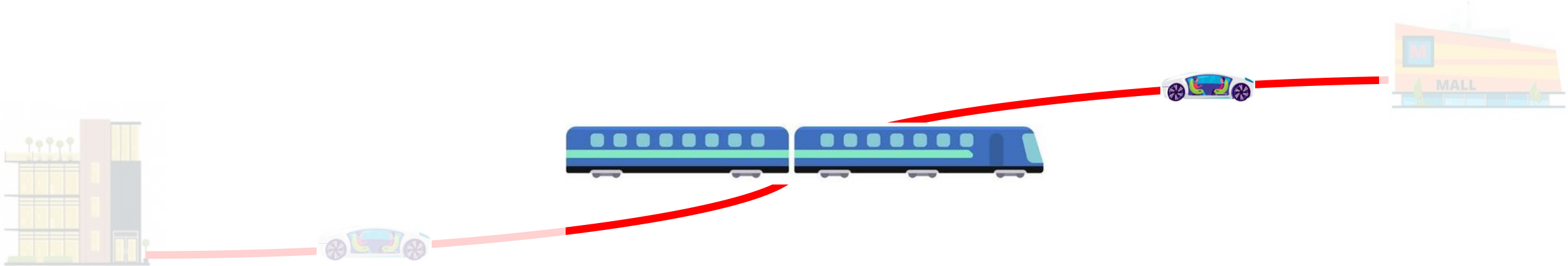


7:55 AM

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.

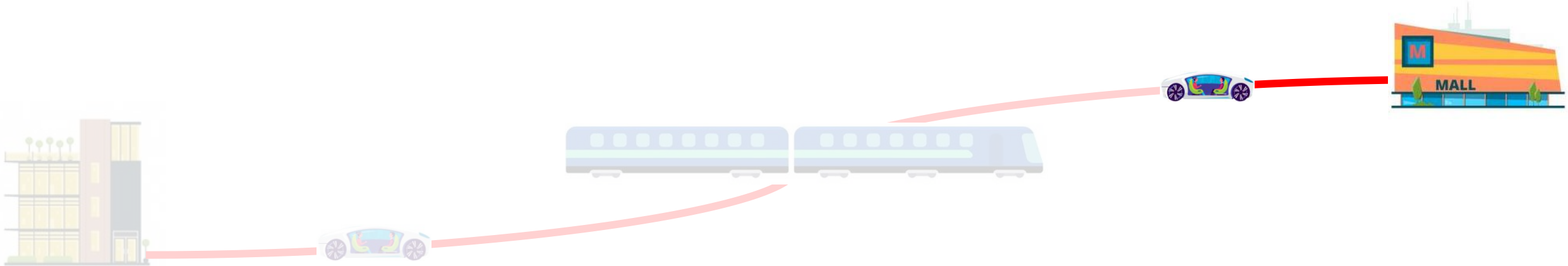


8:00 – 8:43 AM

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

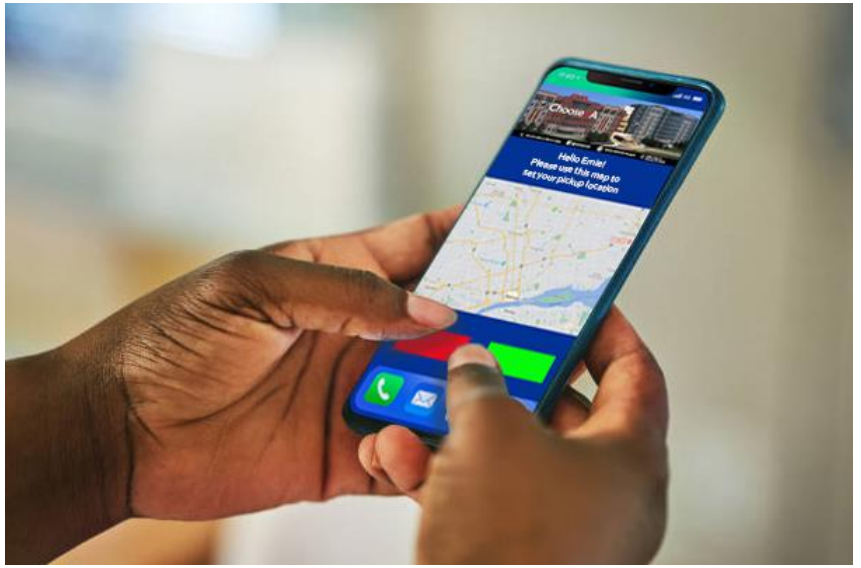
Ernie is a 46-year-old Iraq War Vet; he is living with a below the knee amputation and uses a prosthetic limb. Ernie lives in Detroit, MI to be close to his extended family and friends and recently had surgery at the VA hospital downtown to put in a stent for a blockage in his arteries. Today, he will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

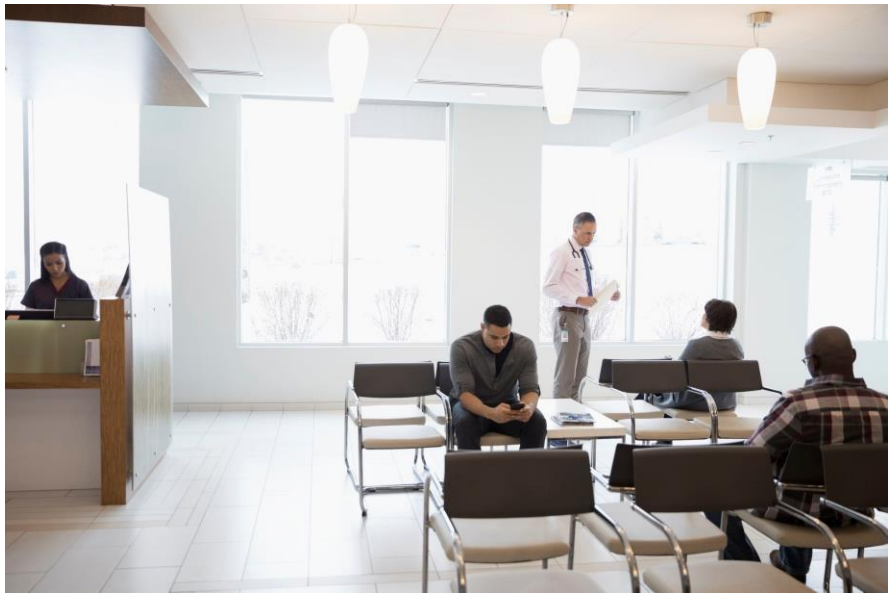
Ernie's Healthcare AV and a medical assistant named Sarah arrive. Sarah exits the AV and introduces herself and confirms Ernie's identity, she then motions Ernie into the vehicle. Sarah explains she will be taking Ernie's vitals prior to their arrival at the VA hospital to help expedite the check in 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

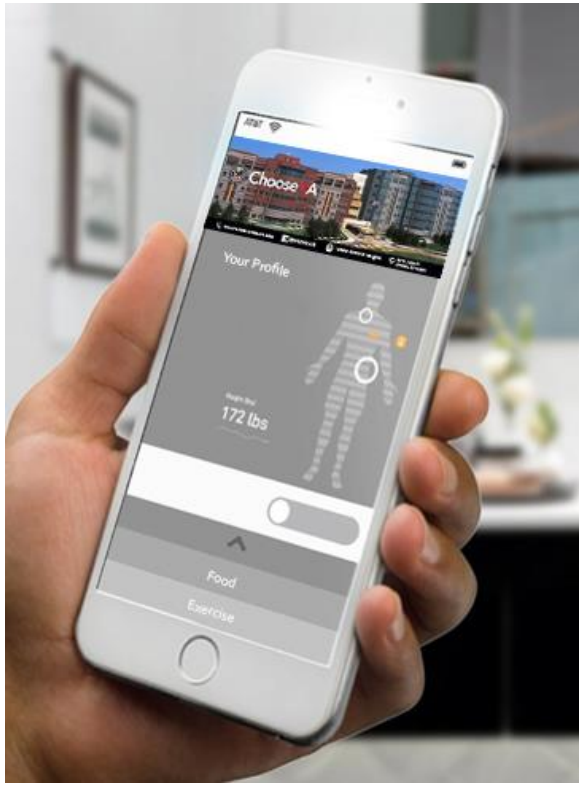
Ernie arrives at the main entrance to find his AV, which is displaying a 4-digit code on the outside. Once near the vehicle Ernie gets a confirmation text with the same 4-digit code confirming that his vehicle has arrived, he then enters the vehicle.

10:30 AM

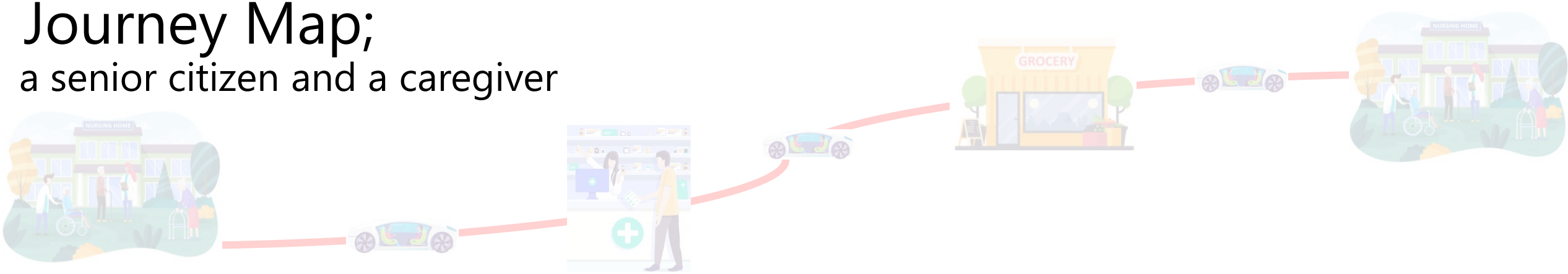
This time Sarah, the medical assistant, is not physically present but virtually present on a video screen inside the vehicle. While on the way to Ernie's home, Sarah confirms with Ernie the new blood pressure medication he was prescribed today and the proper dosage for it, as well as importance of the 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.



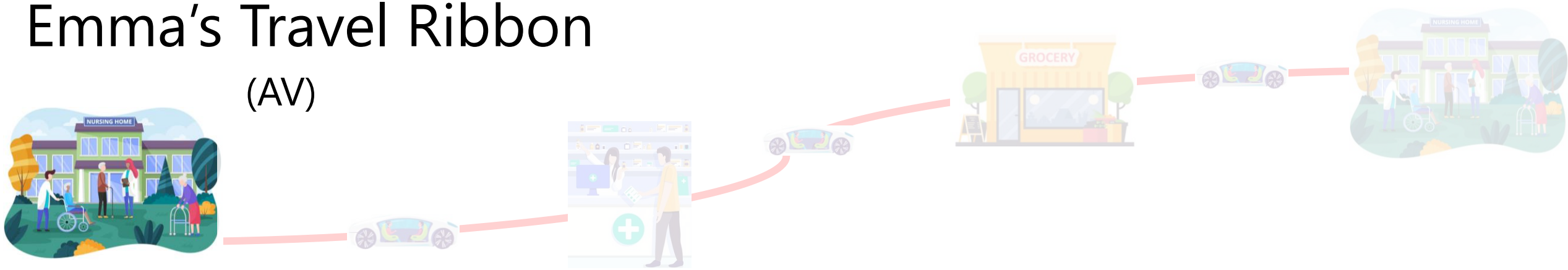
Journey Map;
a senior citizen and a caregiver



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)

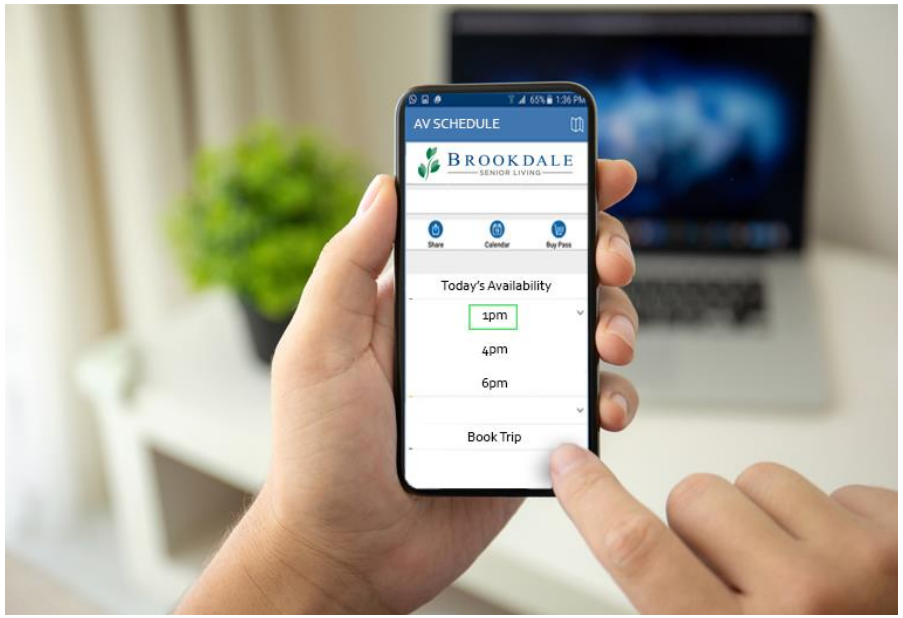


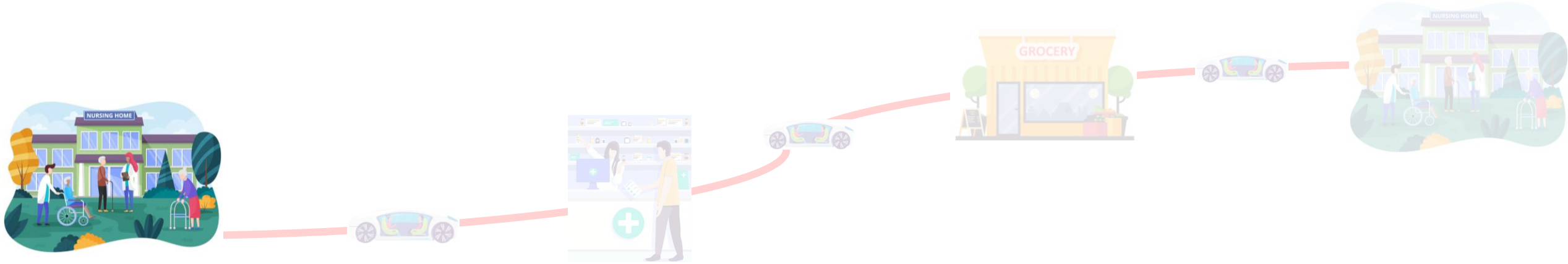
10:00 AM

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.



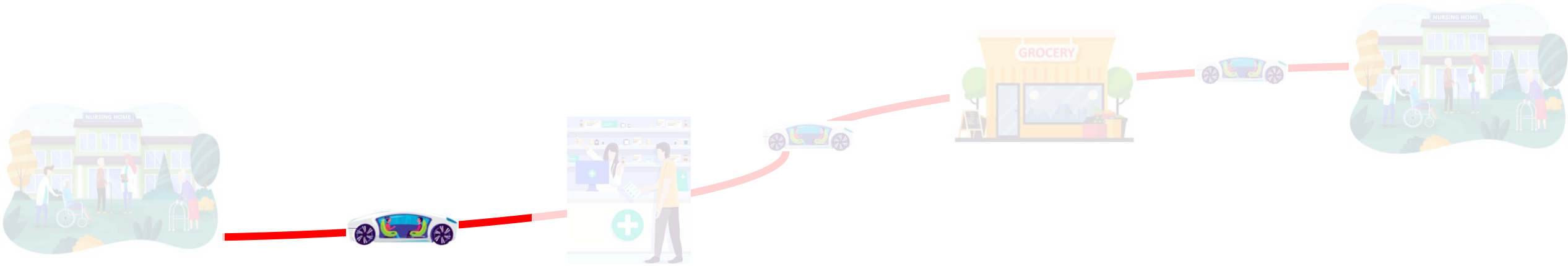


10:10 AM

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.

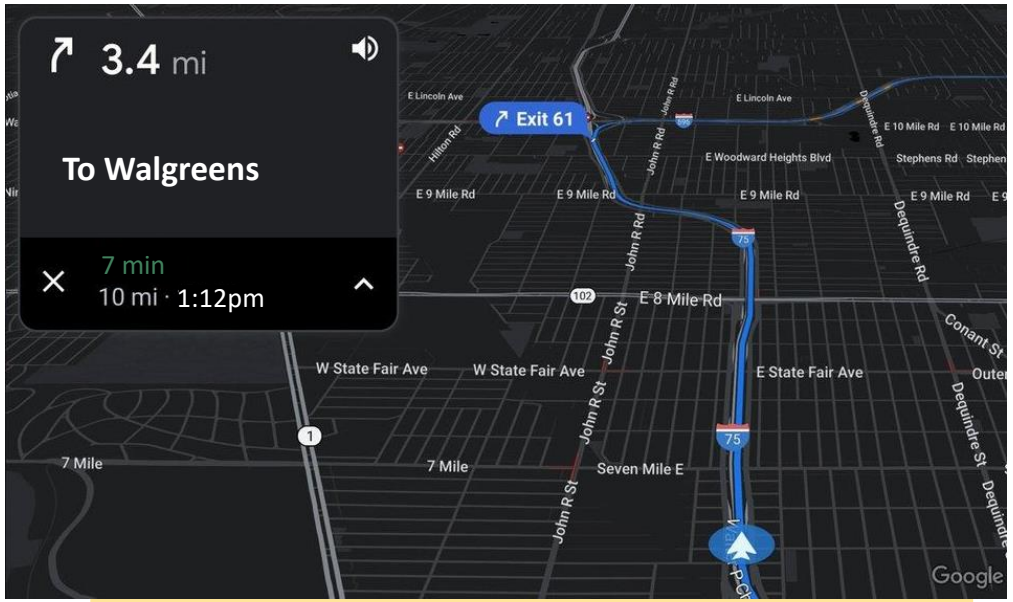
1:00 PM

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.



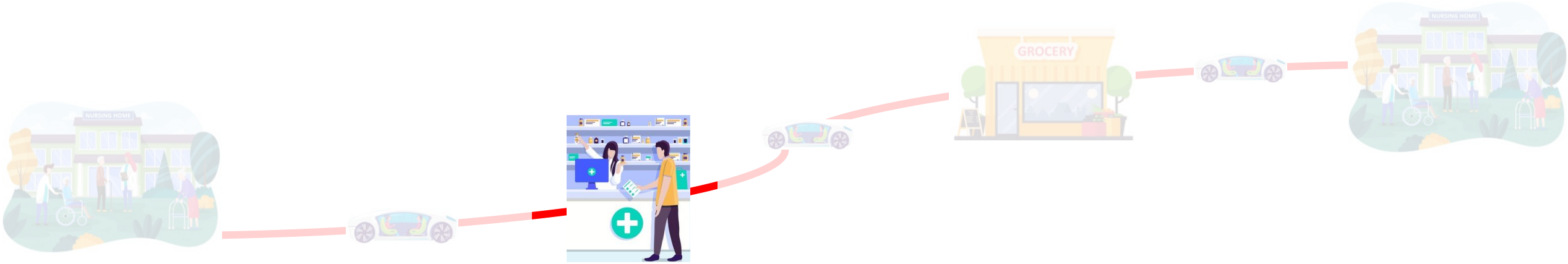
1:05 PM

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.



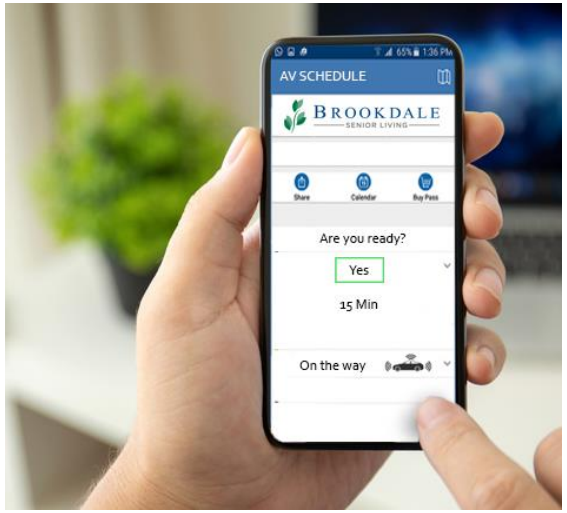
1:06 PM

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.

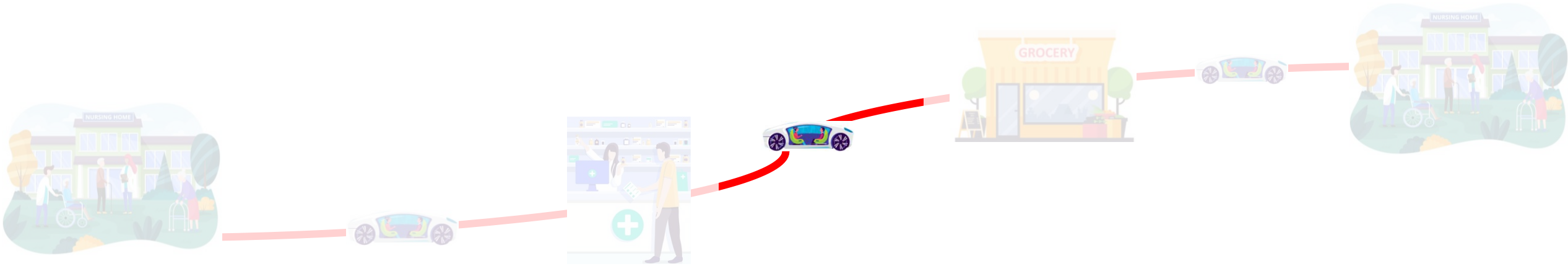


1:14 PM

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.

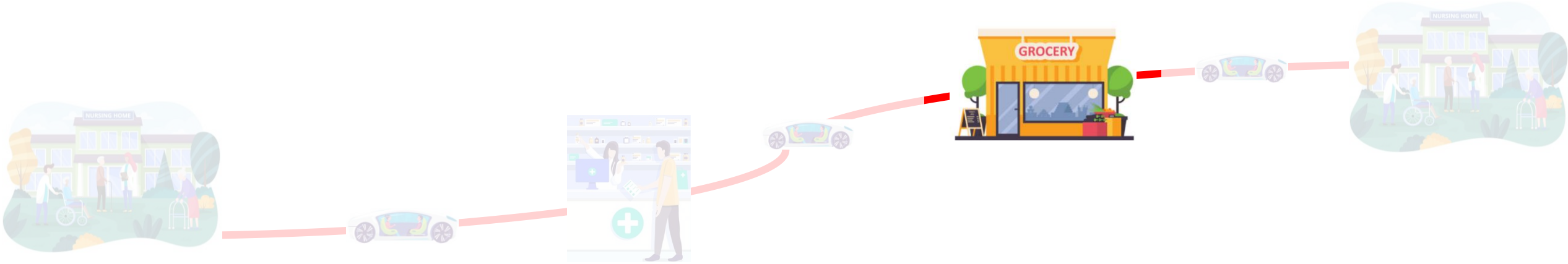


1:37 PM

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.

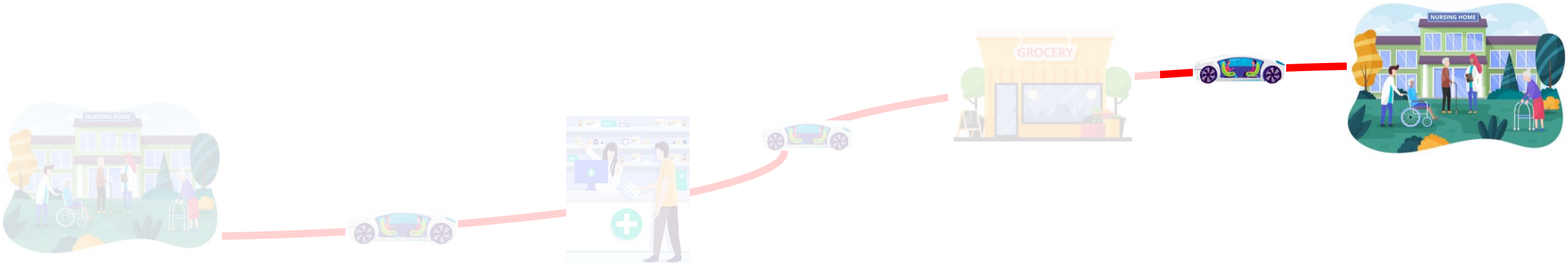


1:47 PM

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.

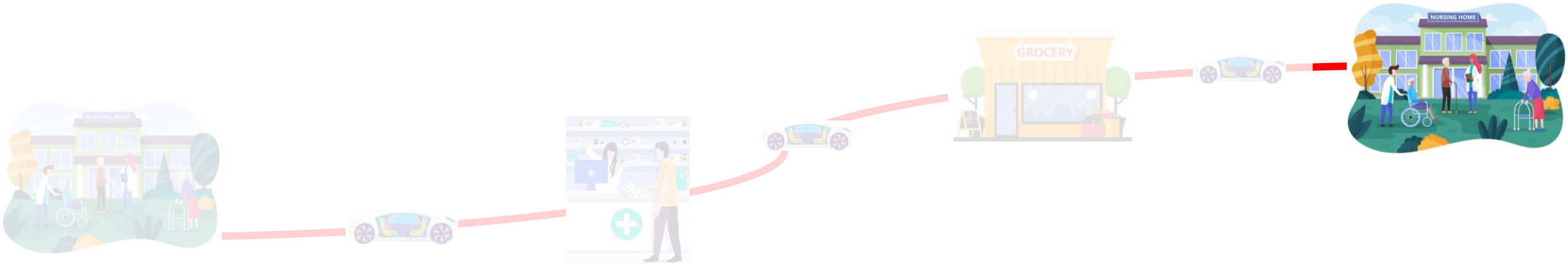


2:23 PM

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.

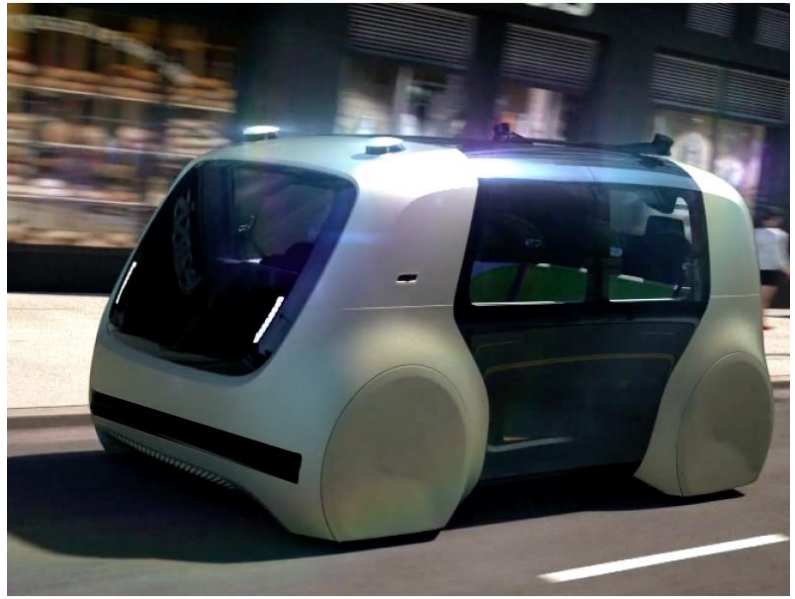
2:45 PM

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.

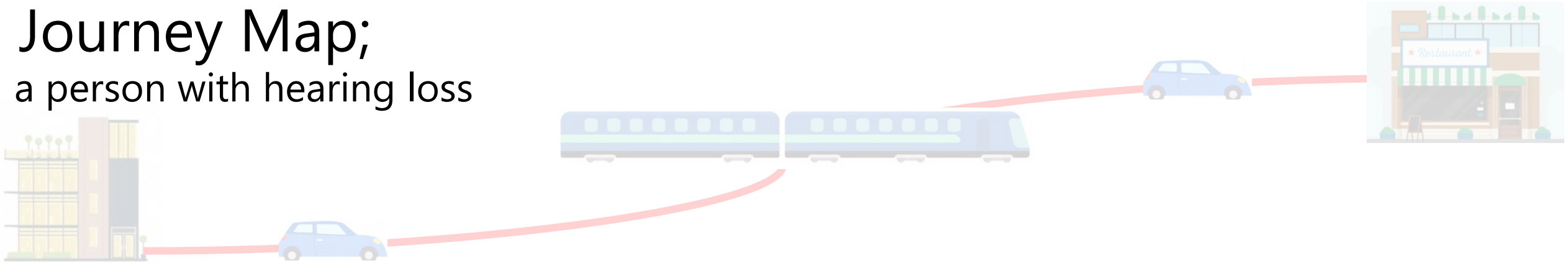


2:49 PM

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

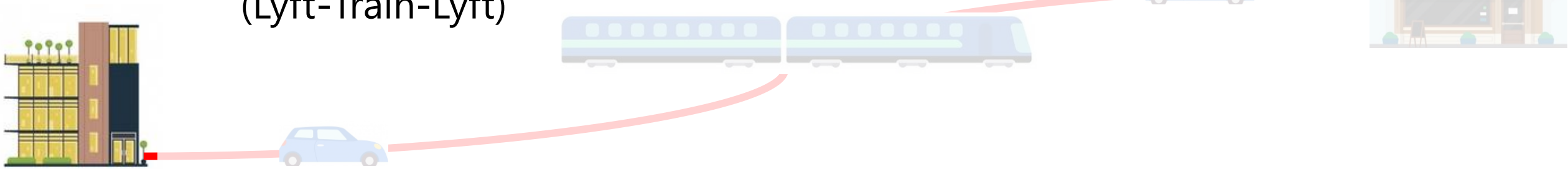


Carl Young is a 25-year-old recent college graduate that works for Dell in Austin Texas. Carl has hearing loss in both ears and can only hear 25% in his right ear and 30% in his left ear. He is saving his money for cochlear implants but having just started his new job as a project manager he is a couple 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.

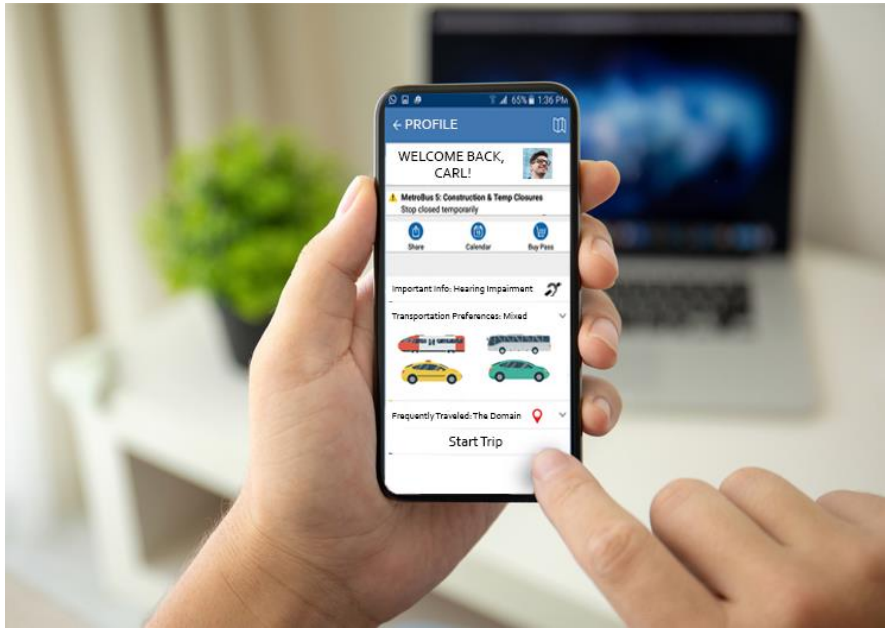
Carl’s Travel Ribbon

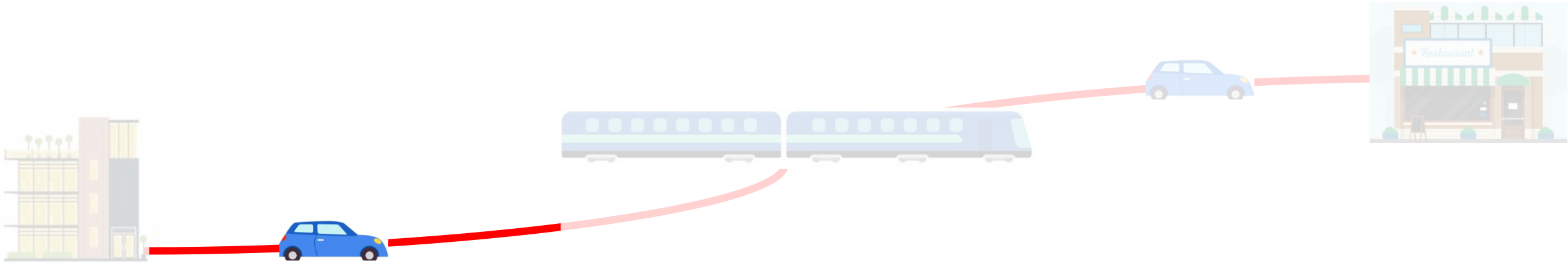
(Lyft-Train-Lyft)



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.



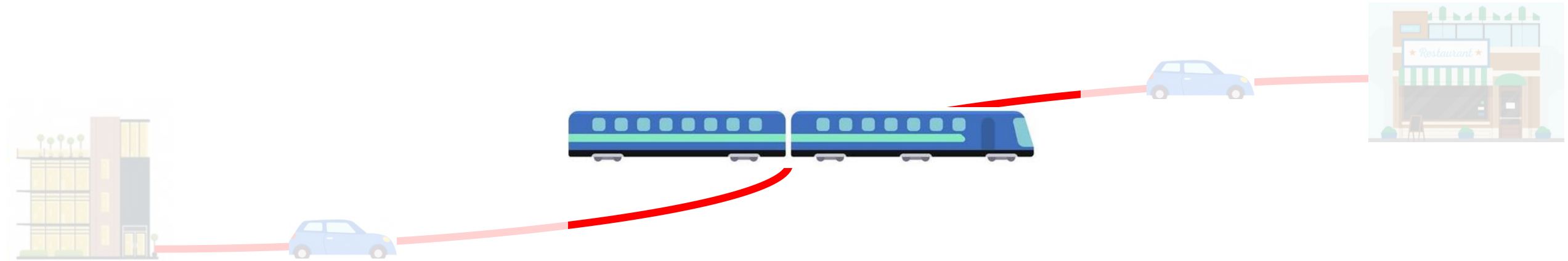


7:30 PM

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.



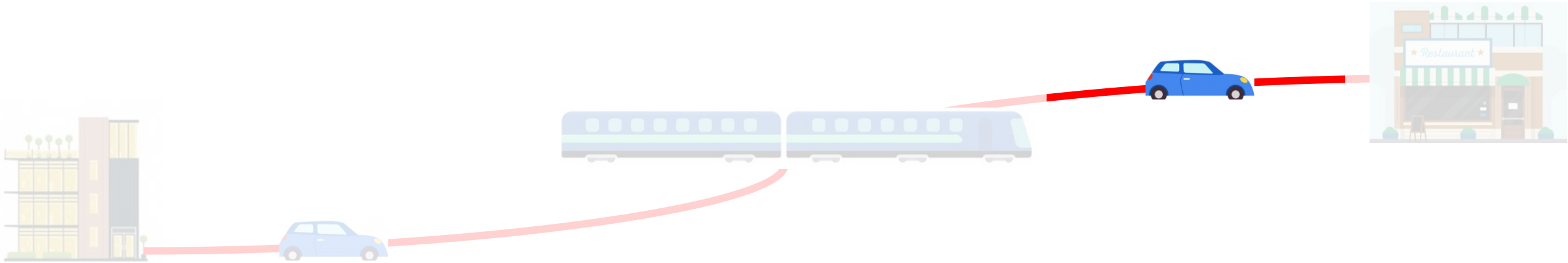
7:45 PM

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.

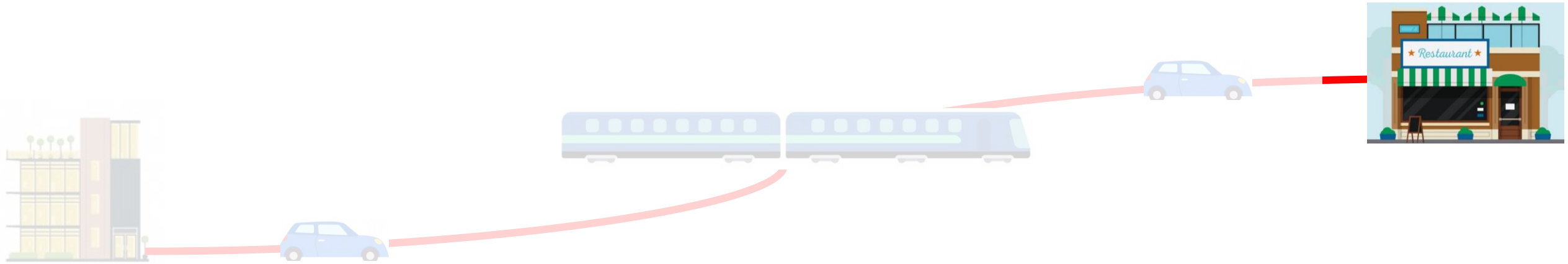


8:17 PM

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

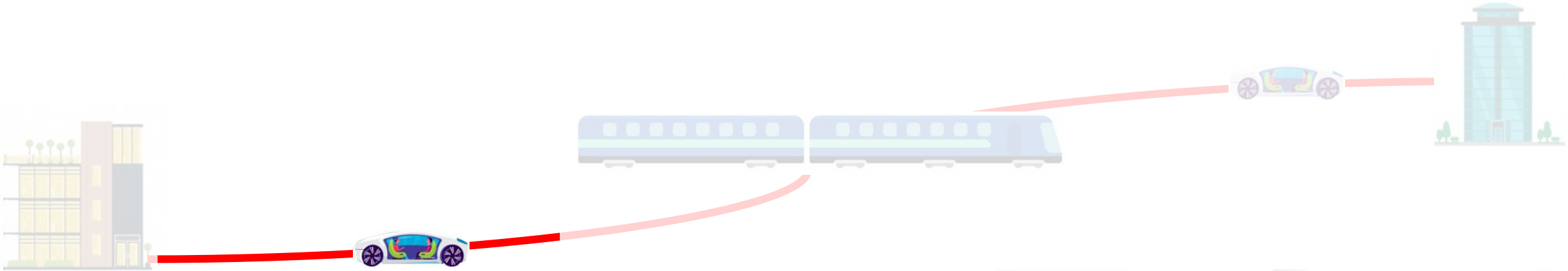
Marcus Pennington is the Director of Inclusion and Diversity at NCR Corporation located in Midtown Atlanta. Marcus navigates the world with his manual wheelchair which he typically breaks down and places into his own car to go places. Marcus however does not drive into the city for his job. Instead, 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

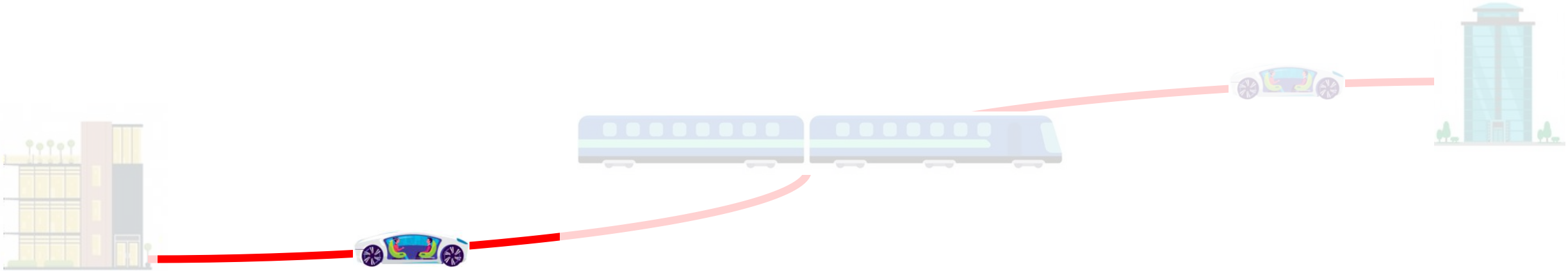
Marcus is having his first cup of coffee of the morning and gets a text notification from his MARTA app. The text is to confirm his morning pickup outside his townhouse at 7:30 AM. Marcus hits the ACCEPT button and his trip is confirmed. MARTA's mobility application allows Marcus to set up everyday trips (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.

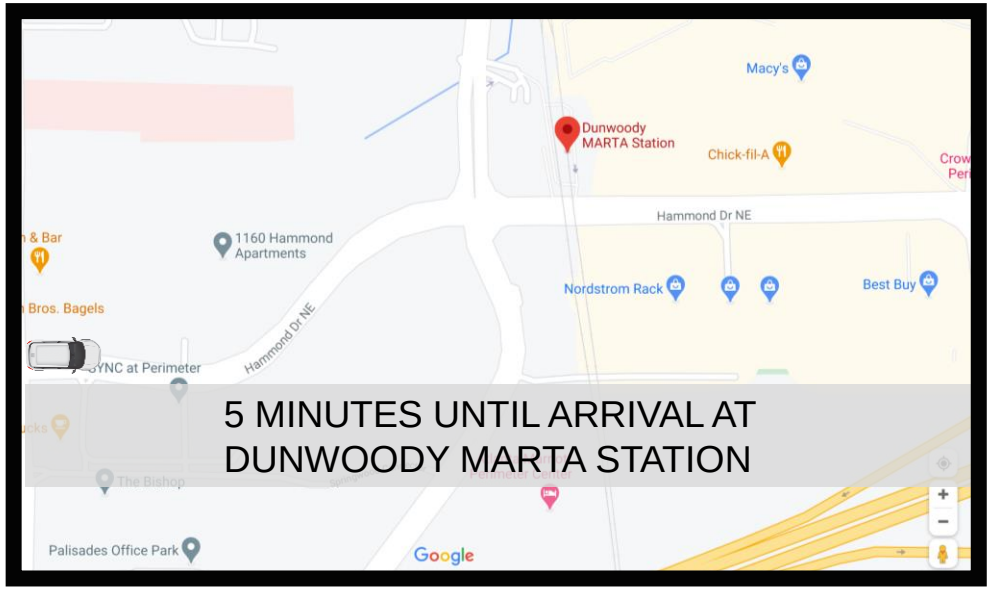


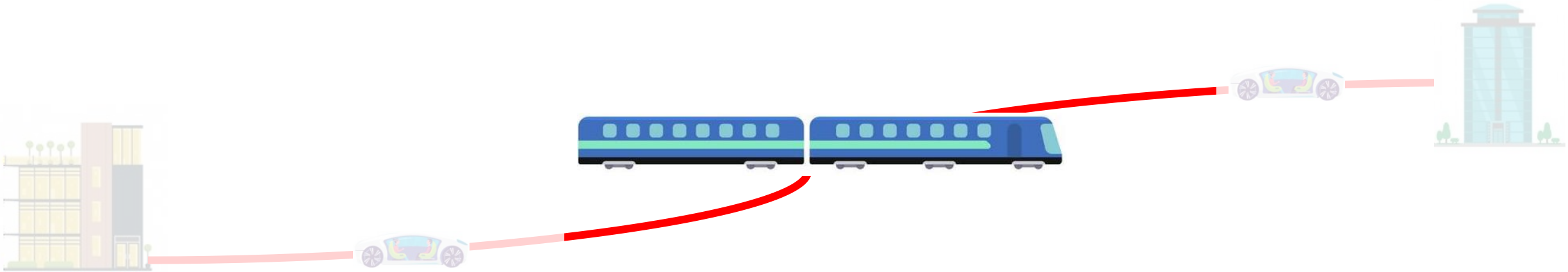
7:35 AM

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.



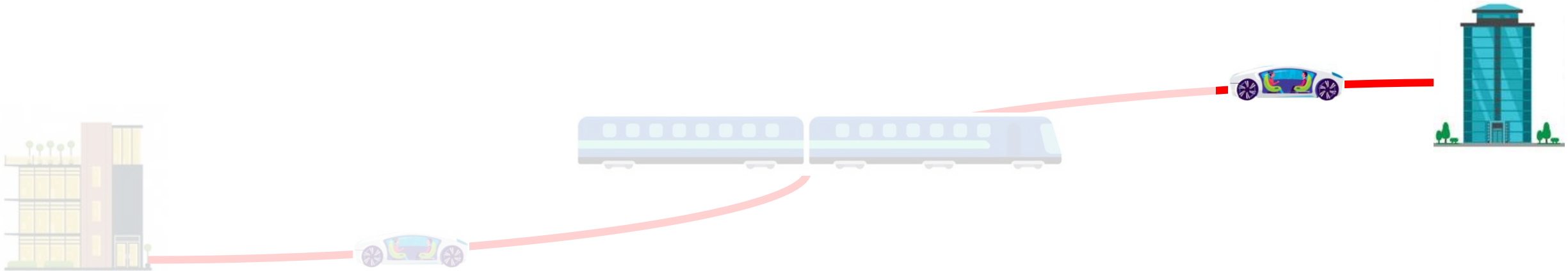


7:45 AM

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.

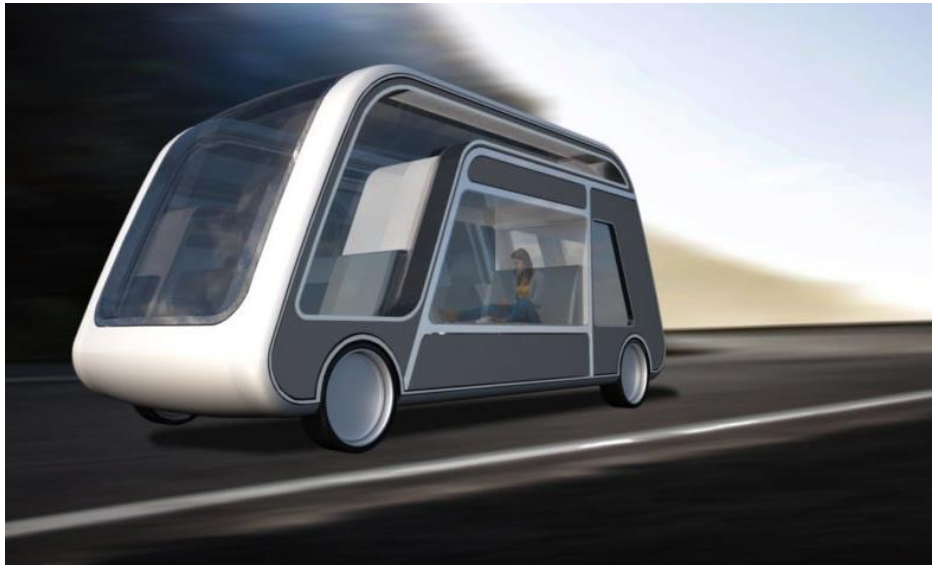


8:07 AM

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.



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

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