

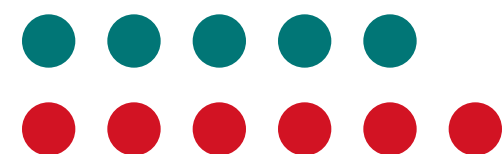
Commute with Ease

**Real Time Parking Availability and Permit Purchasing
Application and Data Standard**

MSIM Practicum Project Report

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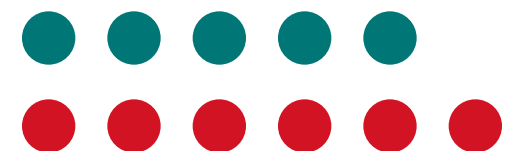
Prachi Sablani, Betty Zegeye



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Executive Summary

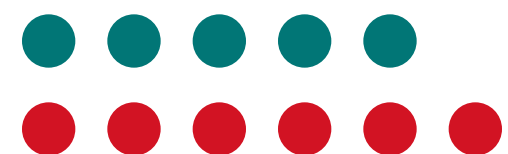


Source: <https://www.seattletimes.com/seattle-news/transportation/metro-expected-to-sell-monthly-parking-permits-at-crowded-park-and-ride-lots/>

Our group has partnered with the Mobility Innovation Center, King County Metro Transit Department, Seattle Department of Transportation, and Central Puget Sound Regional Transit Authority to form a solution to a common problem for commuters in King County. As drivers attempt to utilize Park & Ride facilities, they are often met with full parking lots which may cause them to drive to their final destination -- increasing traffic, increasing negative environmental impacts, and decreasing funds going towards public transportation.

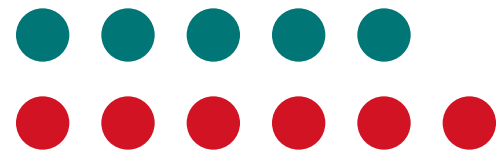
The previous group, Team EveREST, “aimed to use cutting edge technology (such as IoT, cloud computing, machine learning) to provide enhanced user experience for the commuters, analytical and decision-making capabilities to our sponsors, the democratization of data, reduce traffic congestion and carbon footprint; all of which would lead to a better environment and help convert the Puget Sound area into a smart city” (EZPark&Ride, 2020). They were able to successfully understand the technical details regarding how parking lot data could be used by commuters.

Picking up from where they left off, our team has focused even more on the representation of this information to users. Through the creation of a usability tested high fidelity prototype application and a data standard, our work will allow the sponsors and future teams to build a user facing application with integration to third parties that will effectively deliver key information about parking availability.



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Background



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Sponsoring Organizations

Each of our sponsors work towards creating a sustainable future for transportation by capitalizing on technology across the Greater Seattle area. By working closely together, they are able to provide a seamless transportation system throughout the area, as well as continue to develop technologies that allow for sustainable growth.

Mobility Innovation Center (MIC)

“Helping to build the transportation system of the future.”

The University of Washington and Challenge Seattle came together to form the MIC, which works to capitalize on data and technology to tackle the largest transportation challenges across Seattle. MIC leverages applied research and experimentation across various sectors to solve regional mobility problems, develop new technologies, apply system-level thinking, and bring new innovations to our regional transportation system (“Mobility Innovation Center | University of Washington”, 2020).

King County Metro Transit Department

King County Metro is the public transportation agency for King County. The transit department features many transportation services, including bus services, bicycle transit, rideshare services/vanpool, rail travel, water taxis, and paratransit options. Metro employs 2,716 full-time and part-time operators and operates 1,540 buses” (“King County Metro”, 2020). In 2017, “the greater Seattle-area led the country with the highest growth in people choosing transit, adding 4.7 million trips... to reach an all-time record high of 191.7 million” (Constantine, 2020).

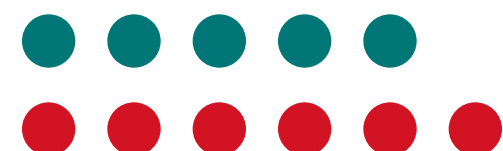


MOBILITY
INNOVATION
CENTER
at the
UNIVERSITY of WASHINGTON

Source: <https://mic.comotion.uw.edu/>



Source: <https://www.kingcounty.gov/elected/executive/constantine/news/release/2019/March/14-metro-all-boarding.aspx>



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Sponsoring Organizations

Seattle Department of Transportation (SDOT)

By prioritizing equity, safety, mobility, sustainability, livability, and excellence, SDOT works to deliver a transportation system that provides safe and affordable access to places and opportunities (“Seattle Department of Transportation”, 2020). SDOT directly runs the streetcar services in Seattle, and works closely with other transportation agencies in the area to provide access to transportation services throughout the city.



Seattle
Department of
Transportation

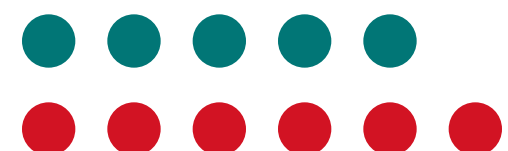
Source: <https://www.kingcounty.gov/elected/executive/constantine/news/release/2019/March/14-metro-all-boarding.aspx>

Central Puget Sound Regional Transit Authority

Central Puget Sound Regional Transit Authority is the public transit authority that directly serves the Seattle area. This agency works in parallel with the King County Metro Transit Department, and is responsible for construction of and operational assistance for large scale public transportation services in the area. This includes operational assistance for light rail service in Seattle and Tacoma, regional Sounder commuter rail, and Sound Transit Express bus service, as well as management for the ORCA fare card system (Sound Transit, 2015). Through these services, Sound Transit helps thousands of riders through their commute each day. In fact, “in 2017 Sound Transit services carried a total of 47 million passengers, which translates to an average of 157,000 riders on weekdays” (Sound Transit, 2020).



Source: <https://www.soundtransit.org/get-to-know-us/our-brand/logos>



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Information Problem

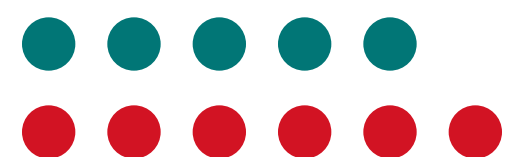
Drivers that currently use Park & Ride facilities often encounter one key problem: lack of available parking spots. This problem often causes drivers to not use the buses and instead, drive to their final destination. Whenever a commuter drives to their final location, that means more vehicles on the road and in congested areas, more emissions, and less money going into public transportation. Therefore, it is not only a problem for riders but also for other drivers and for the public transportation sector as a whole. The capstone team, Team EverEST was able to identify how real-time information about the availability of parking spots in Park & Ride facilities would benefit commuters. This solved the issue of what could be done to help, but did not fully address how this data would be utilized.

Our goal within this project scope was to understand what information related to parking would be valuable to share with users, how that information would be displayed, and how it would be integrated with preexisting GTFS standards.

To accomplish these goals, we designed a prototype application which acted as a visual representation of how parking availability information would be displayed to users. We also created a data standard with an example data set to demonstrate what data would be used and how it would be integrated with preexisting GTFS standards.

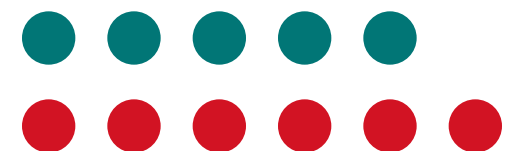


Source: <https://www.northcharlestoncoliseum.com/events/detail/sc-stingrays-vs-jacksonville-icemen-7>



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Application UX Design & Research

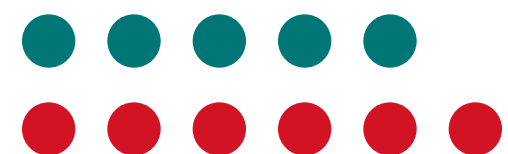
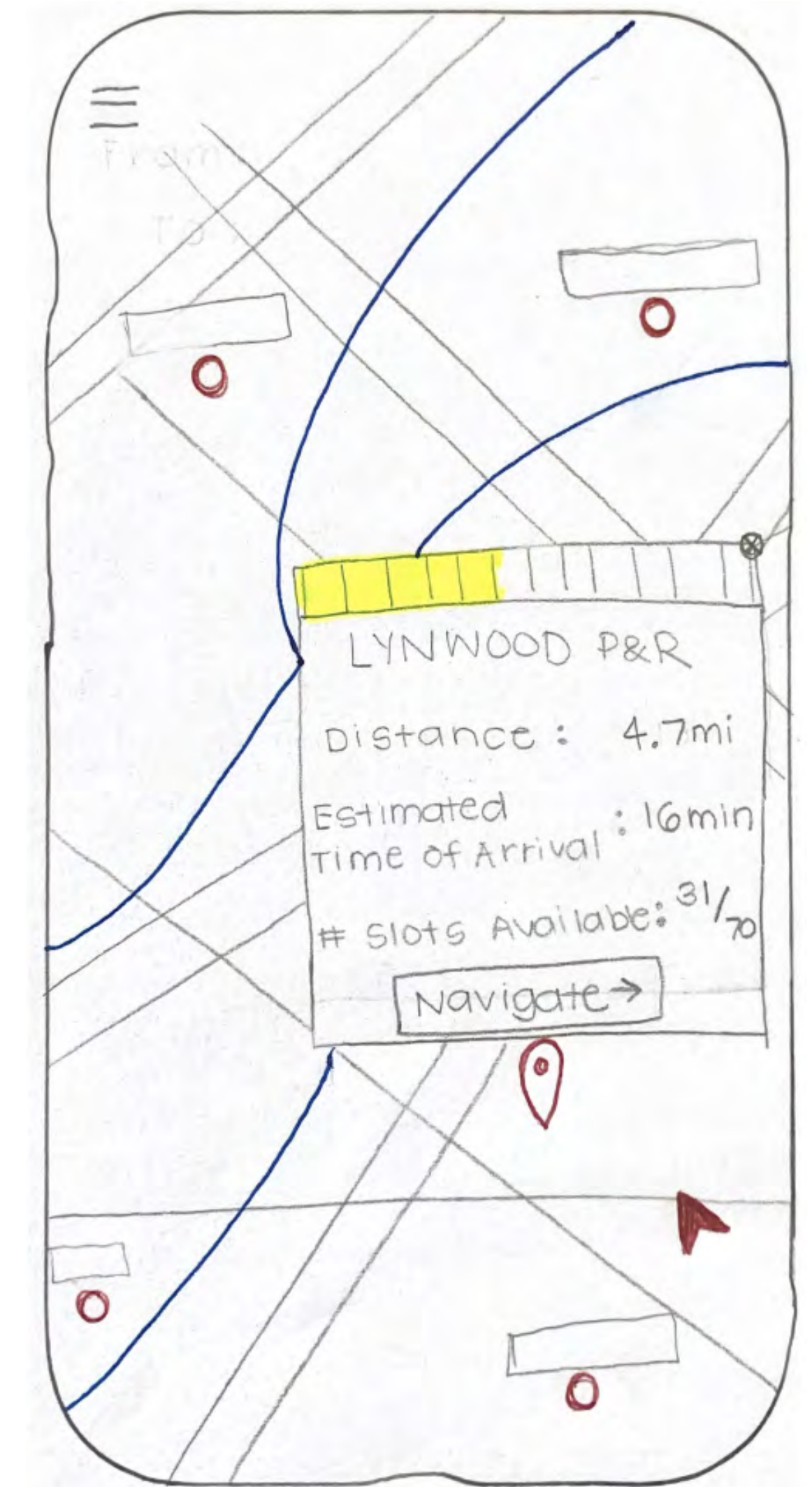


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UX Research and Design

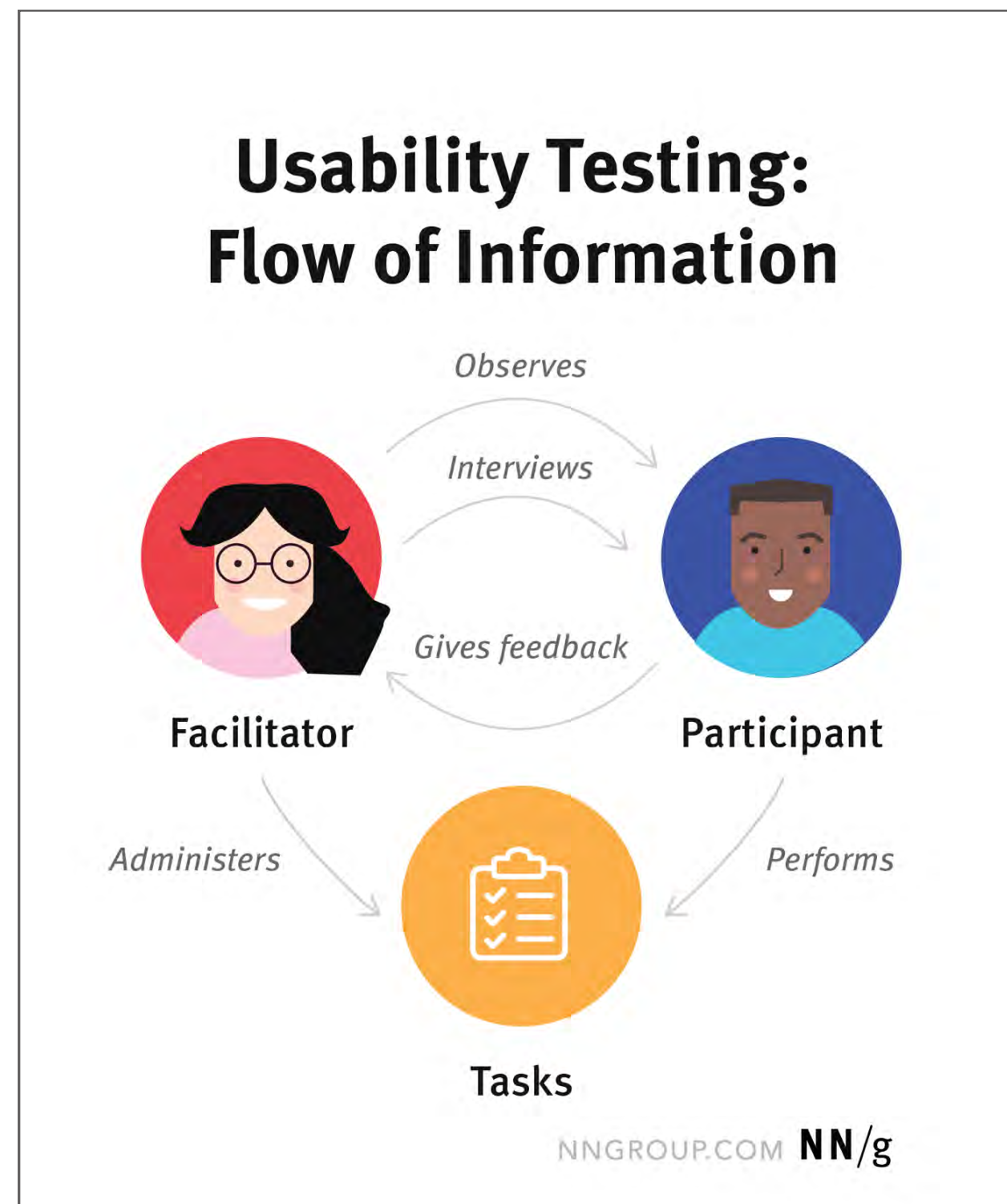
Early Design Stages

The UX team began the design process by clearly defining the scope of the application with the sponsoring organizations. After a scope was defined, the team utilized some initial design methods (user personas and a user flow) to better understand the potential users and their needs for this application. The team then began brainstorming the layout of the application by creating wireframes and eventually translating those sketches into a first draft, high fidelity prototype in Figma. Throughout this design process, the team looked towards stakeholders and sponsors for feedback. At this stage, they shifted to examine how potential users may experience the application. This high fidelity prototype was used in usability tests in order to identify the effectiveness of the application in delivering real-time information about parking availability in Park & Ride facilities. The application was also designed to allow users to purchase and manage their own parking permits, so the flow of this process was also a point of observation during the study.



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UX Research and Design



Source: <https://www.nngroup.com/articles/usability-testing-101/>

Usability Study Recruitment

Eight participants were recruited from the team's social networks. Participants included people who have been users of Park & Ride facilities on at least a weekly basis for transportation to either school or work. Though eight participants were recruited for the study, due to time constraints, only four users were able to participate in the study. These four participants also completed a demographic survey.

Evaluation

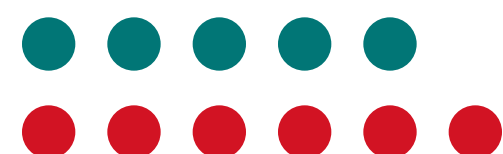
In order to observe and understand users' thoughts and reactions to the prototype, they were asked to complete the following three tasks:

1. Create an account and identify the number of available parking spots at the Redmond Park & Ride.
2. Purchase a parking permit for an individual commuter.
3. Check to see when your previously purchased permit expires.

While completing these tasks, the participants were asked to think aloud and share any reactions to the prototype. They were also asked supplemental questions about the information on the screen and their understanding. At the end of the test they were also asked to provide additional feedback about the process as a whole.

Analysis

Once the data was collected from the four usability studies, the research team utilized the method of affinity mapping to cluster interview data and form insights. These insights and the data from the study were used to modify the application and create the final prototype.



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UX Research and Design

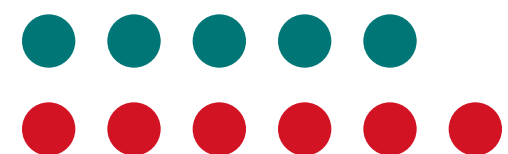
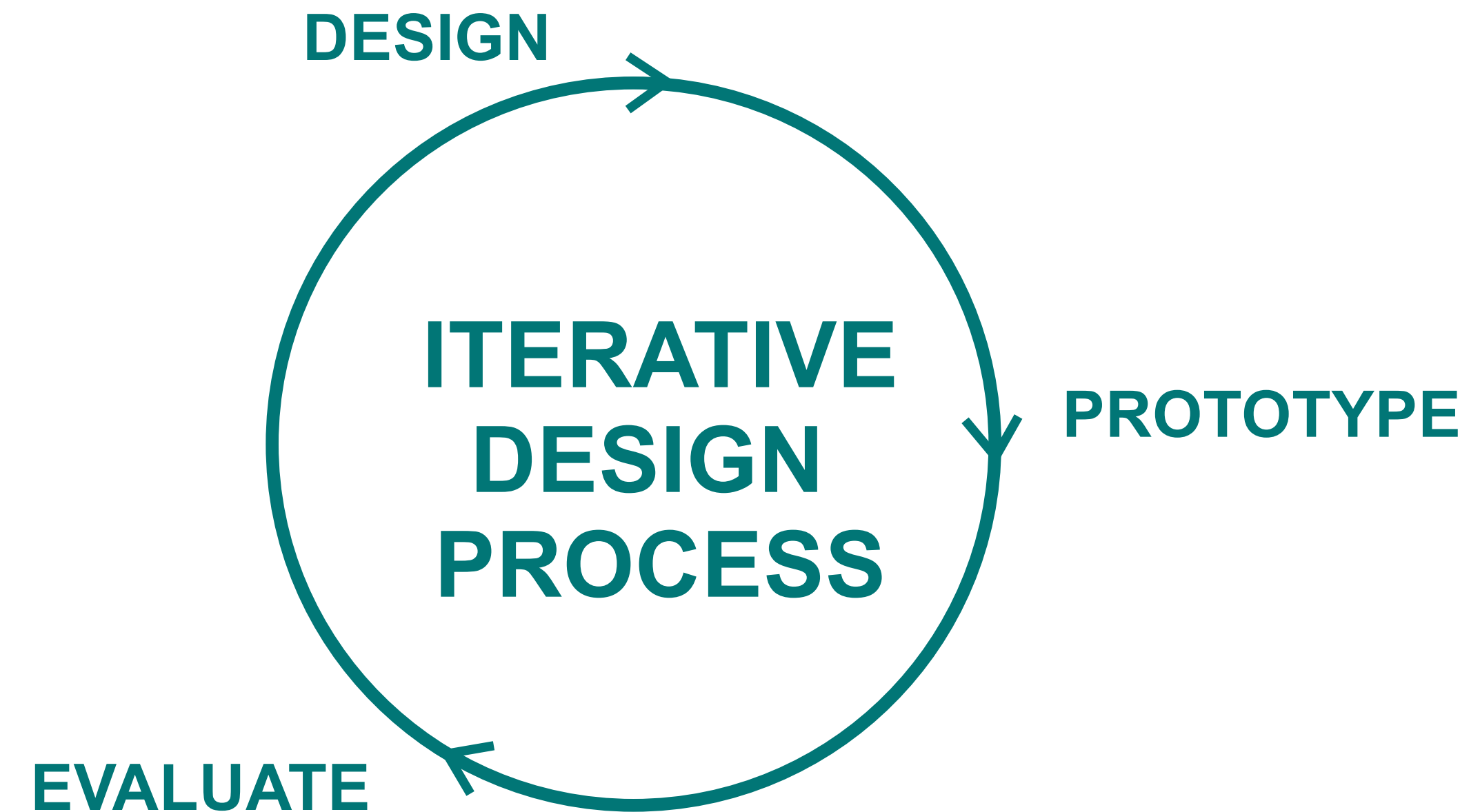
Usability Study Insights

Aside from small design changes, the team came up with four key insights that summarized the findings from the usability tests:

1. Users were able to navigate throughout the app but sometimes had difficulty understanding the information that was provided.
2. Permit purchasing was difficult for inexperienced P&R users because there wasn't enough information about how to use the permits.
3. All users found parking spot availability and the availability estimation graph to be helpful whereas some of the other information was deemed less valuable such as reviews
4. Some users had difficulty reading the lighter and smaller text. (Remote testing could be a factor in causing this issue.)

Final Prototype

After several iterations, the UX team created a final prototype of the application. The final prototype has three main functionalities: (1) view Park & Ride locations, details, and availability, (2) purchase Park & Ride permits, and (3) creating a personalized profile.

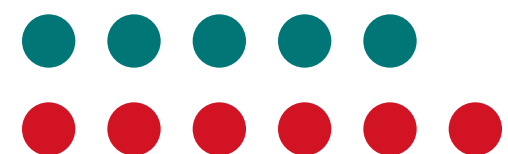
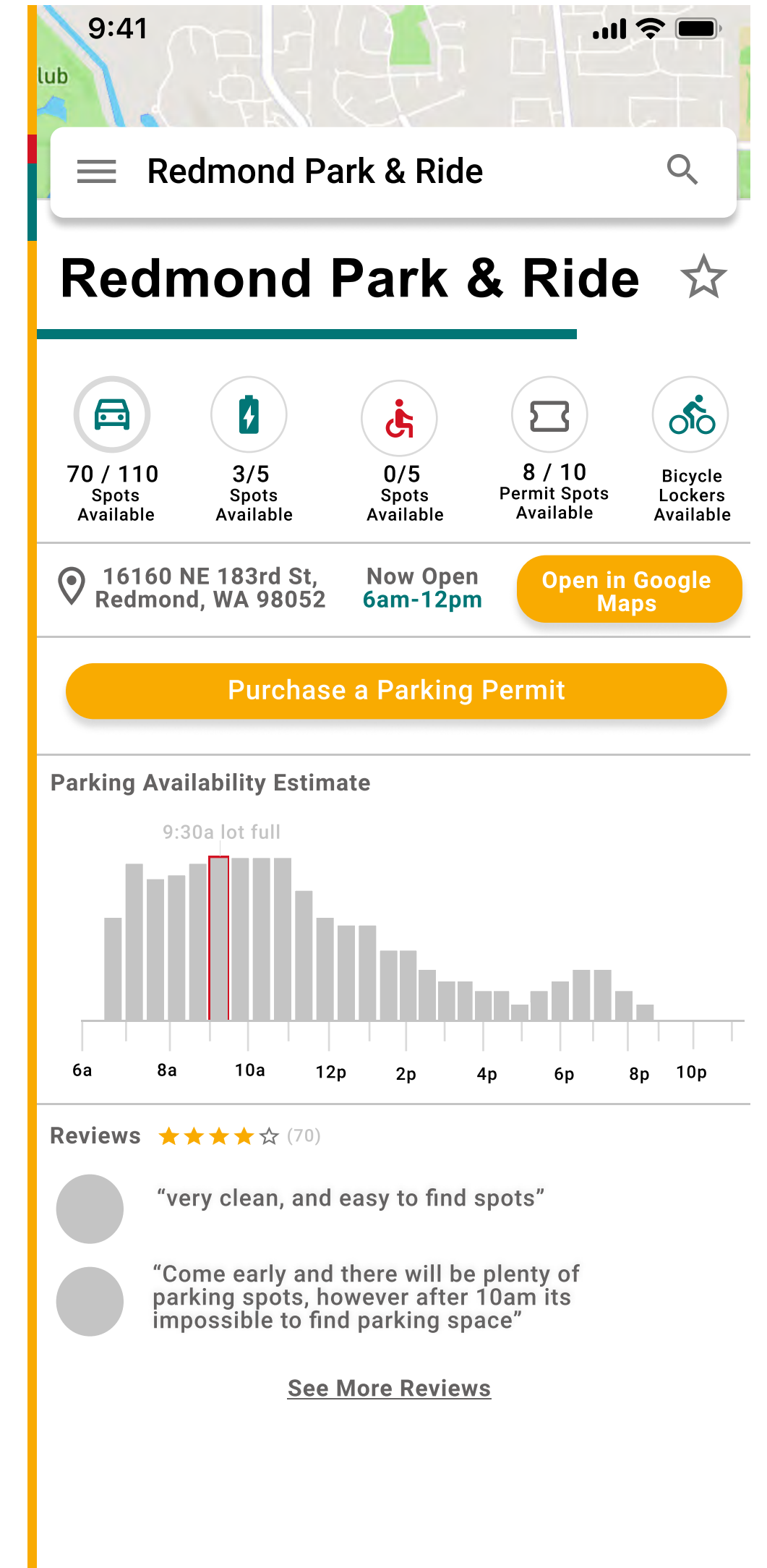
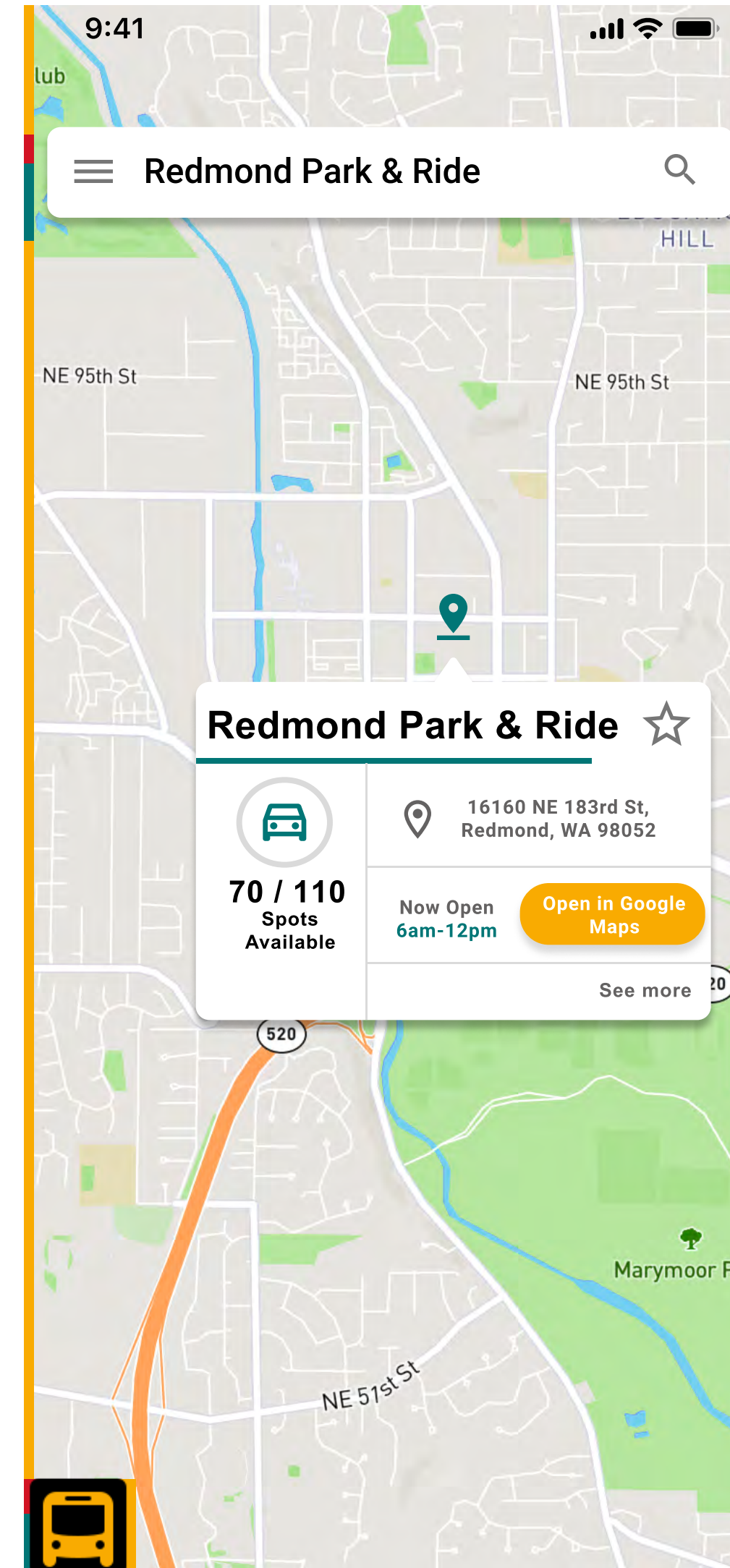
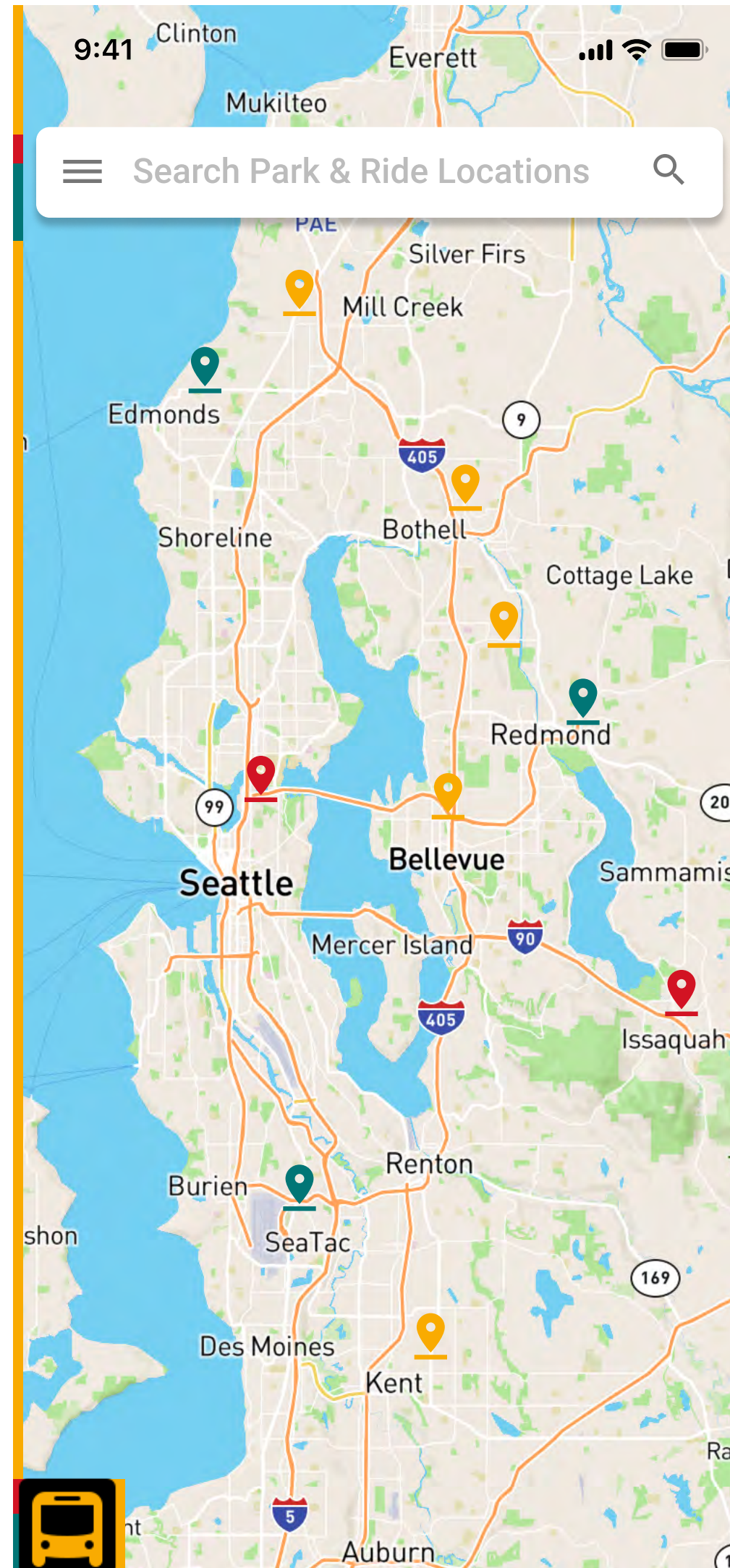


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Final High-Fidelity Prototype

Viewing Park & Rides

The home page of the application allows users to view Park & Ride locations and availability at a quick glance. Each Park&Ride location pin is color-coded according to real-time availability. After a user clicks on an individual pin, they are prompted with a pop up window that provides more details about the location, including current availability, hours, and reviews. Users can also choose to purchase a parking permit here.

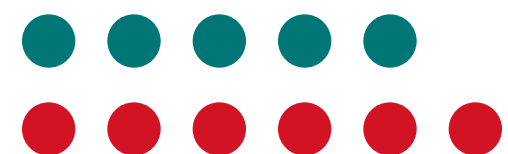
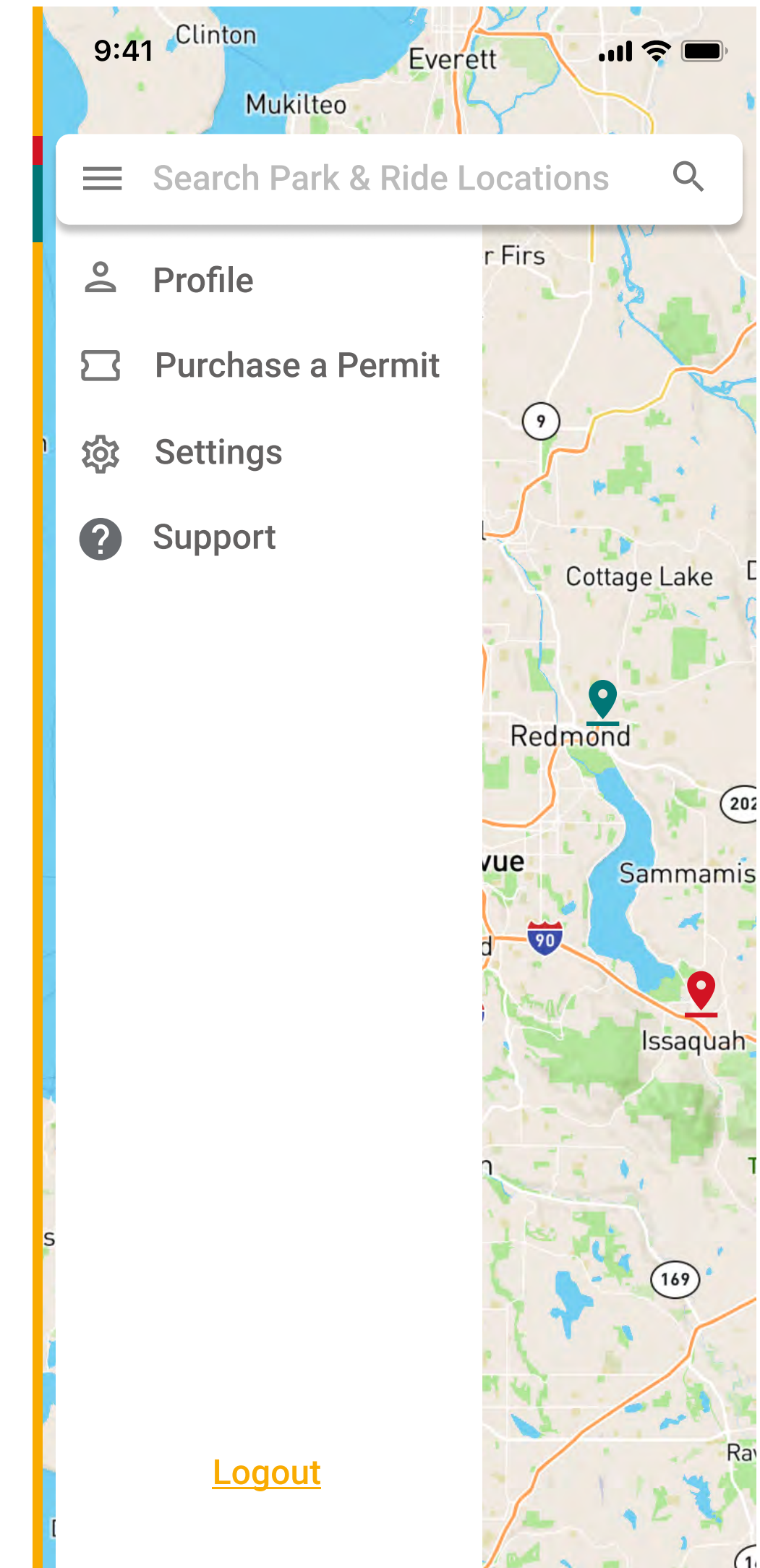
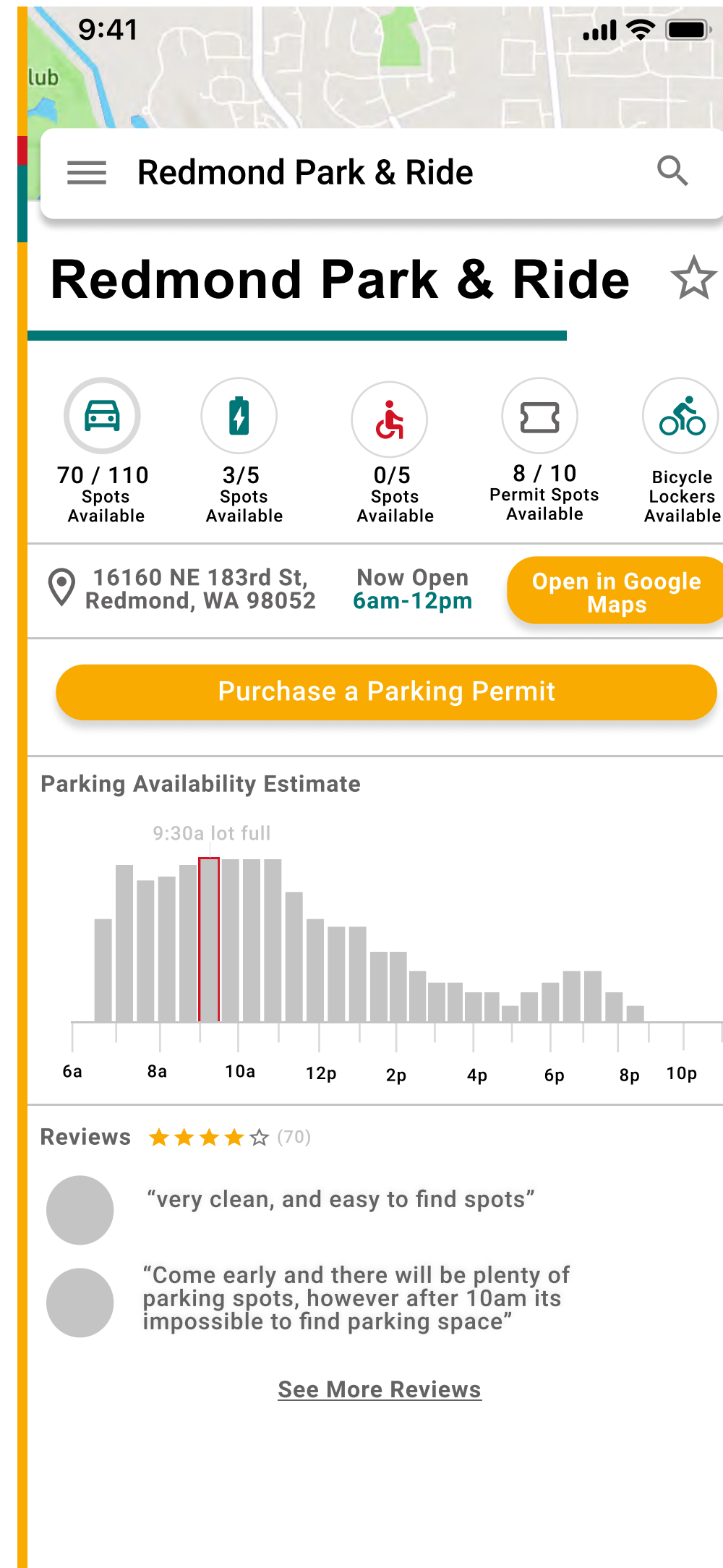


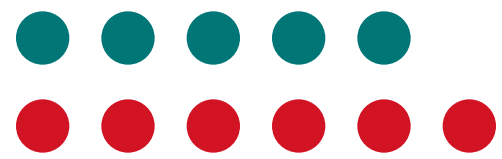
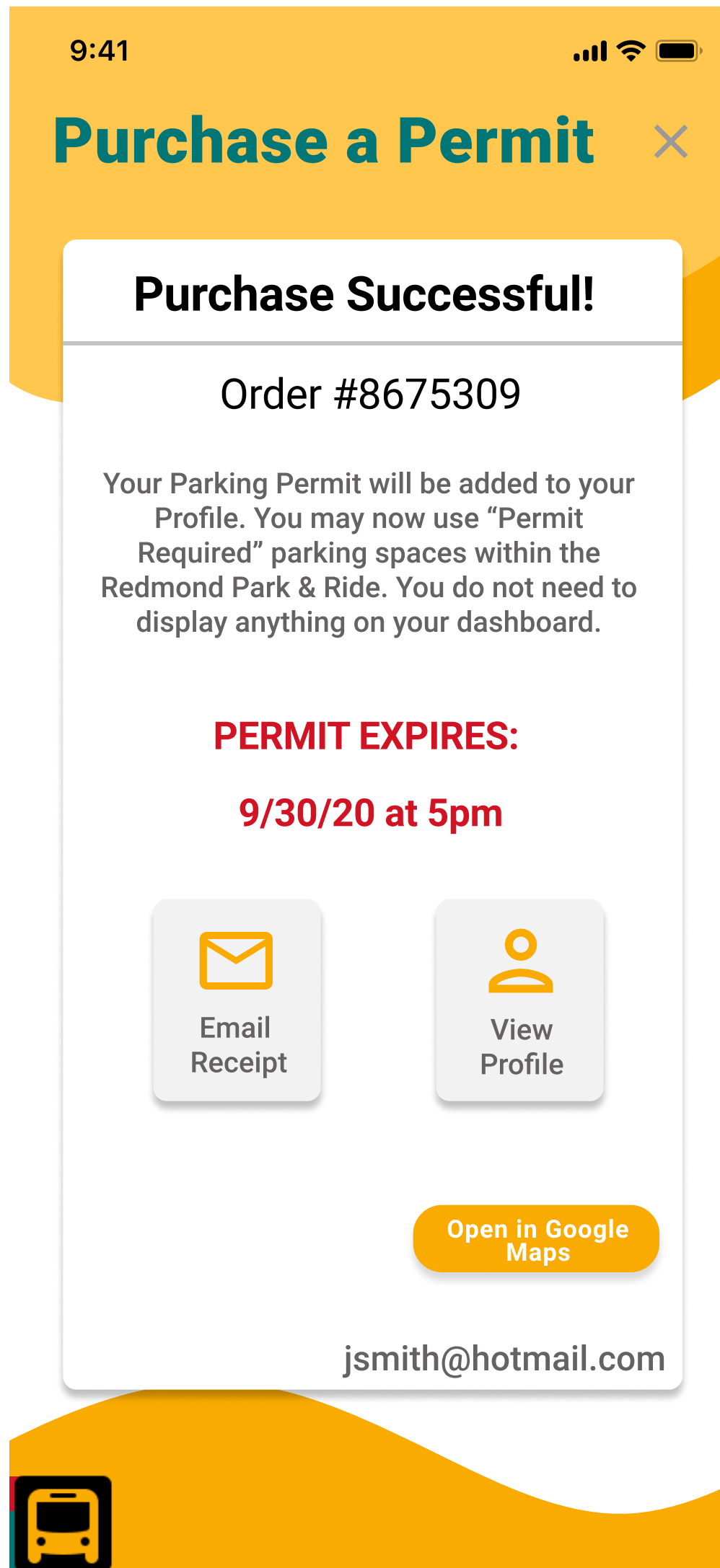
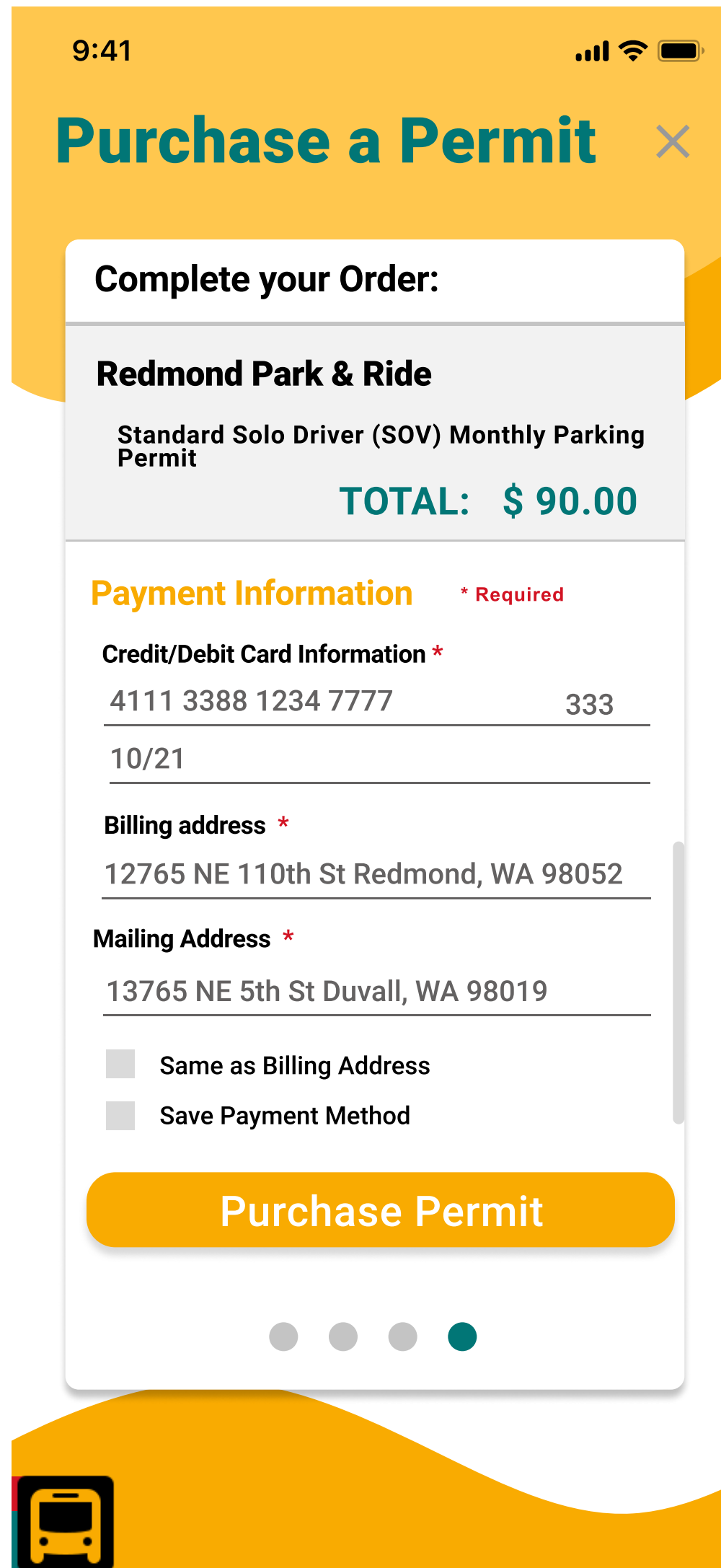
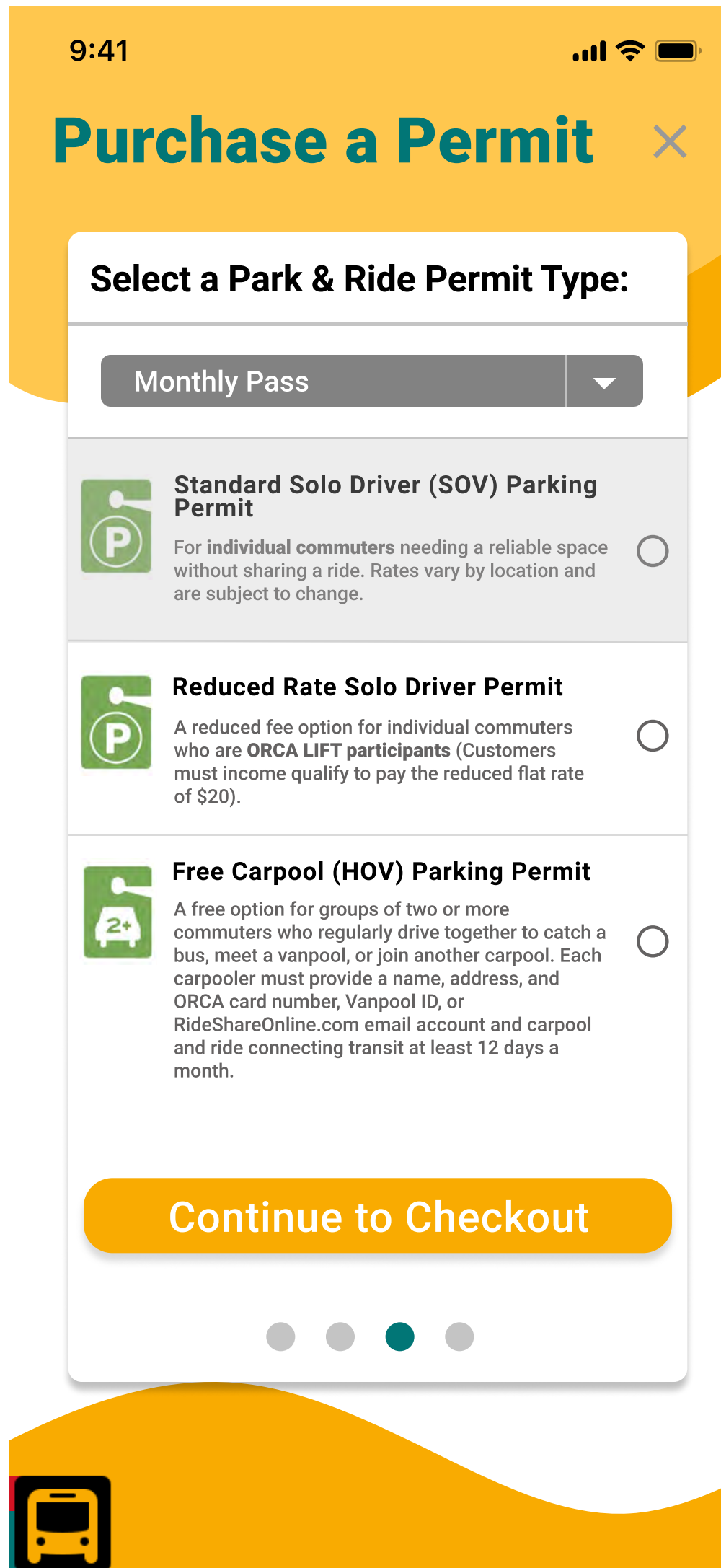
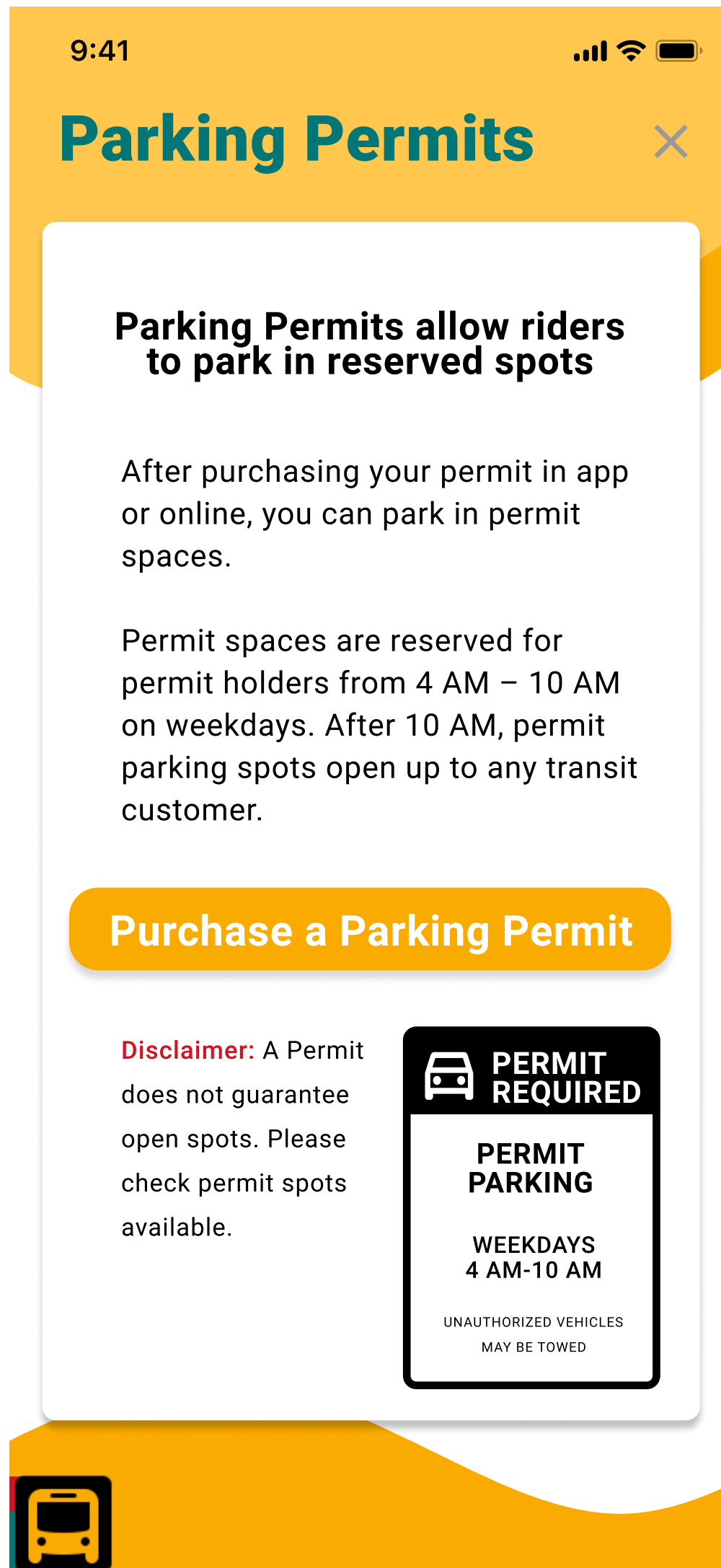
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Final High-Fidelity Prototype

Purchasing a Permit

Users can purchase a permit through the main menu or through a location pin. After specifying location and type of permit, users are prompted to a payment screen and are guided with information for how to use each permit.



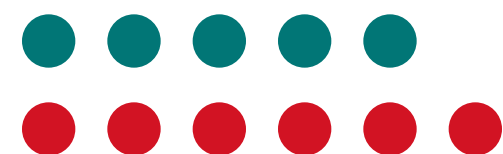
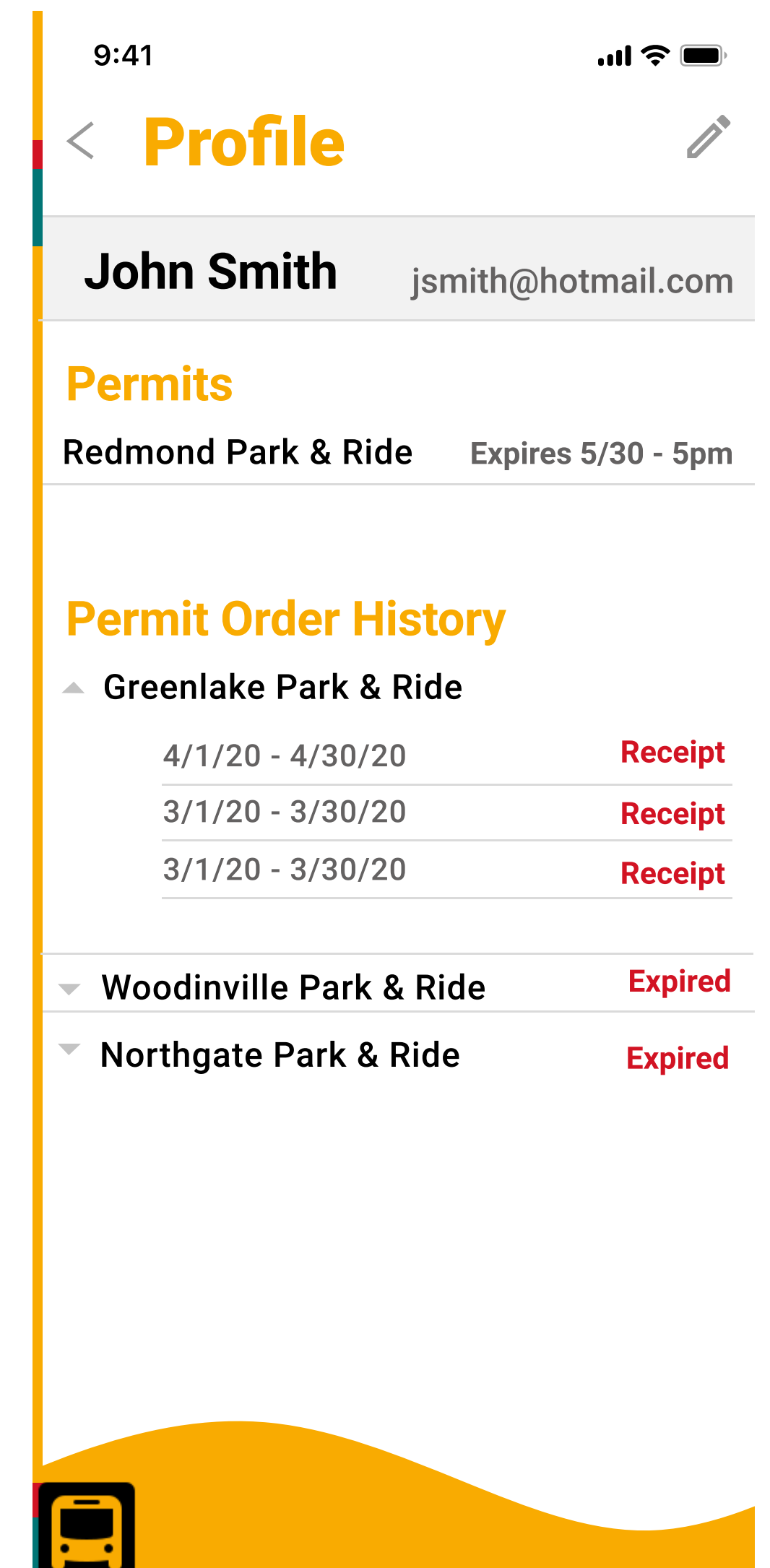
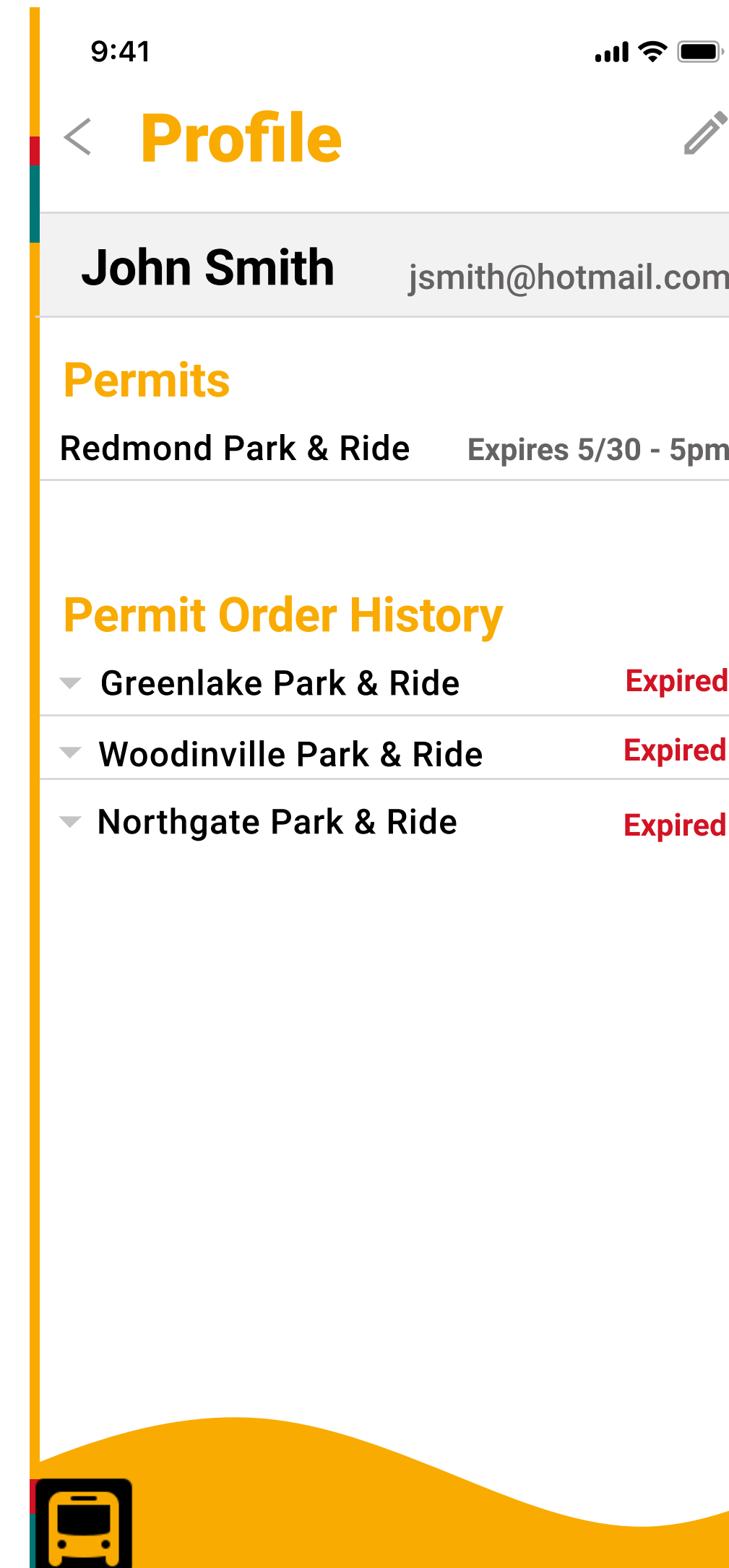
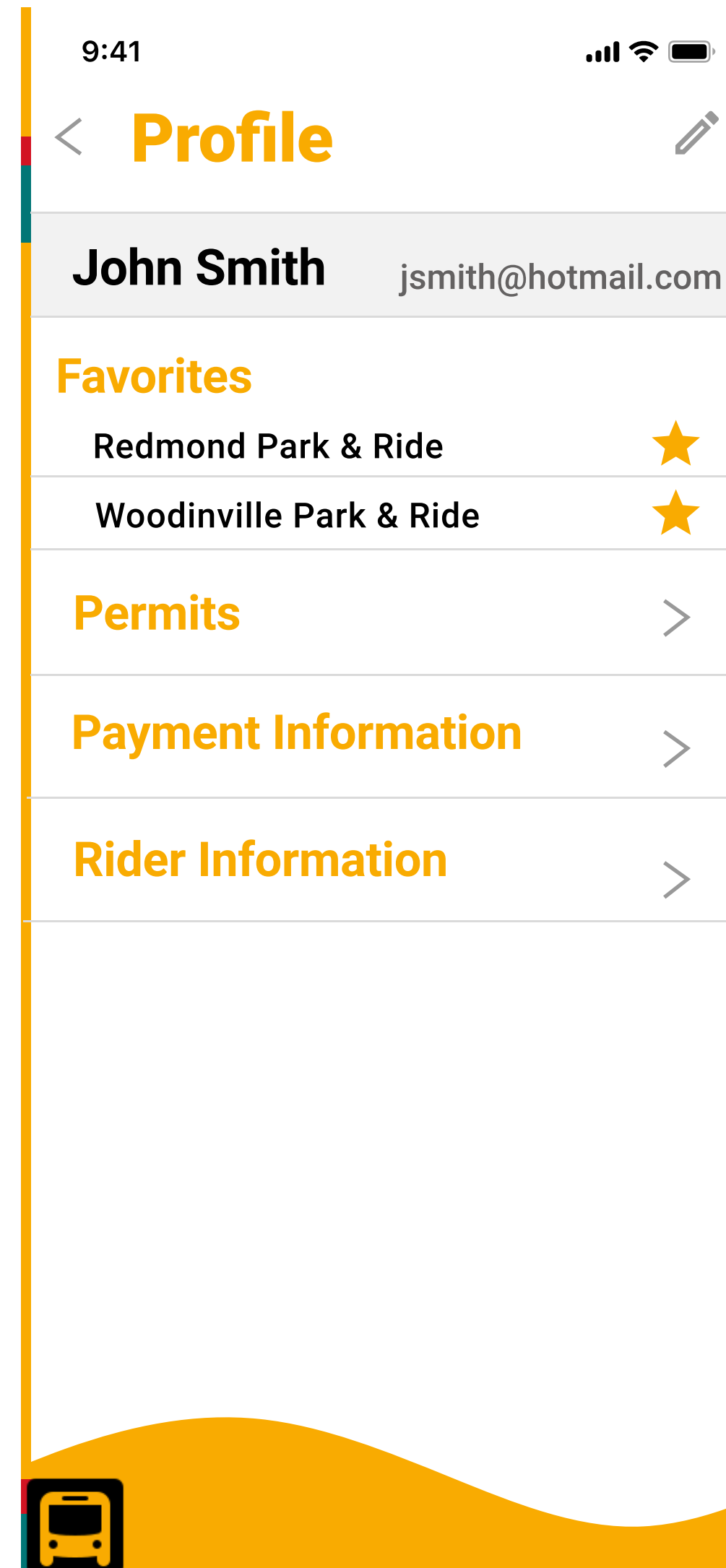


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Final High-Fidelity Prototype

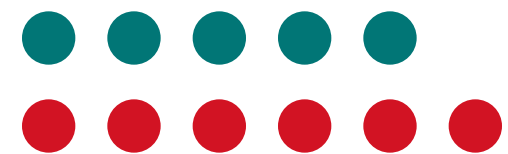
Personalization

Users have the ability to add/view personal information embedded into their profile including saved payment information, ORCA card numbers, and previously used permits. They also have the option to favorite their preferred Park & Ride locations to quickly and easily check for available spots. Permit holders are also able to access and renew permits through the profile page.



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GTFS Data Standard



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GTFS Data Standard Approach

Since the General Transit Feed Specification (GTFS) is used to provide data on public transit for use in multi-modal journey planner applications, parking information has to follow the similar data standards. Because creating a GTFS standard data was new to the team, the team had to be extremely open to new discoveries, meetings, different approaches, and different methods.

Understanding GTFS Data

The GTFS team undertook much secondary research to get a good understanding of the task at hand. Using research findings the team was able to identify organizations who might utilize the standard data. For example, Google Transit applications (as well as many bus and trip planning applications) have a high use for this type of standardized data.

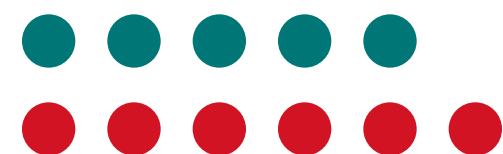
Because GTFS has rules and guidelines when creating standard data, the team looked at multiple GTFS data as references and examples. In addition, the team also incorporated other GTFS data files that had already been developed.

Standard Data for a Park & Ride

The team started by exploring different fields that are essential for showing space availability at Park & Rides. Using this information, they created a rough draft standard data which included key fields like space-availability, permit cost, and lot description.



Source: <https://blog.transloc.com/blog/what-is-gtfs-why-does-it-matter-public-transit>



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GTFS Data Standard Approach

Collaborating with multiple teams

To adhere to the needs of the sponsors and creating the best standard data for Park & Rides, the GTFS team collaborated with different teams each week:

The team met weekly with **sponsors** who provided support by connecting the team to multiple resources that work with GTFS data.

The GTFS team was then connected with **MobilityData** who gave examples of how to transform the initial rough draft into an acceptable standard data for GTFS. For example, they informed the team that because GTFS is a global platform, the GTFS team needed to make sure data names apply in a global sense. This is similar to changing the ADA field to Accessibility.

Metro/Sound Transit GTFS teams helped the team stay focused on the needs and requirements of our sponsors and the organization they represent. The King County Metro team provided a wide range of possibilities that helped the team widen the data standard. The initial draft was transformed from having one file with a few fields, to multiple files with specific special fields allocated to the file. In addition, the Sound Transit team helped to focus on the main issues within the scope of the project -- ensuring that the data standard included fields that mainly supported Park & Ride parking spaces.

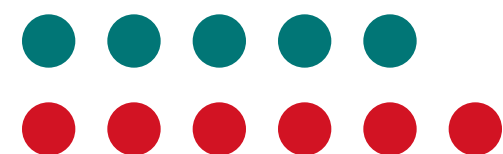
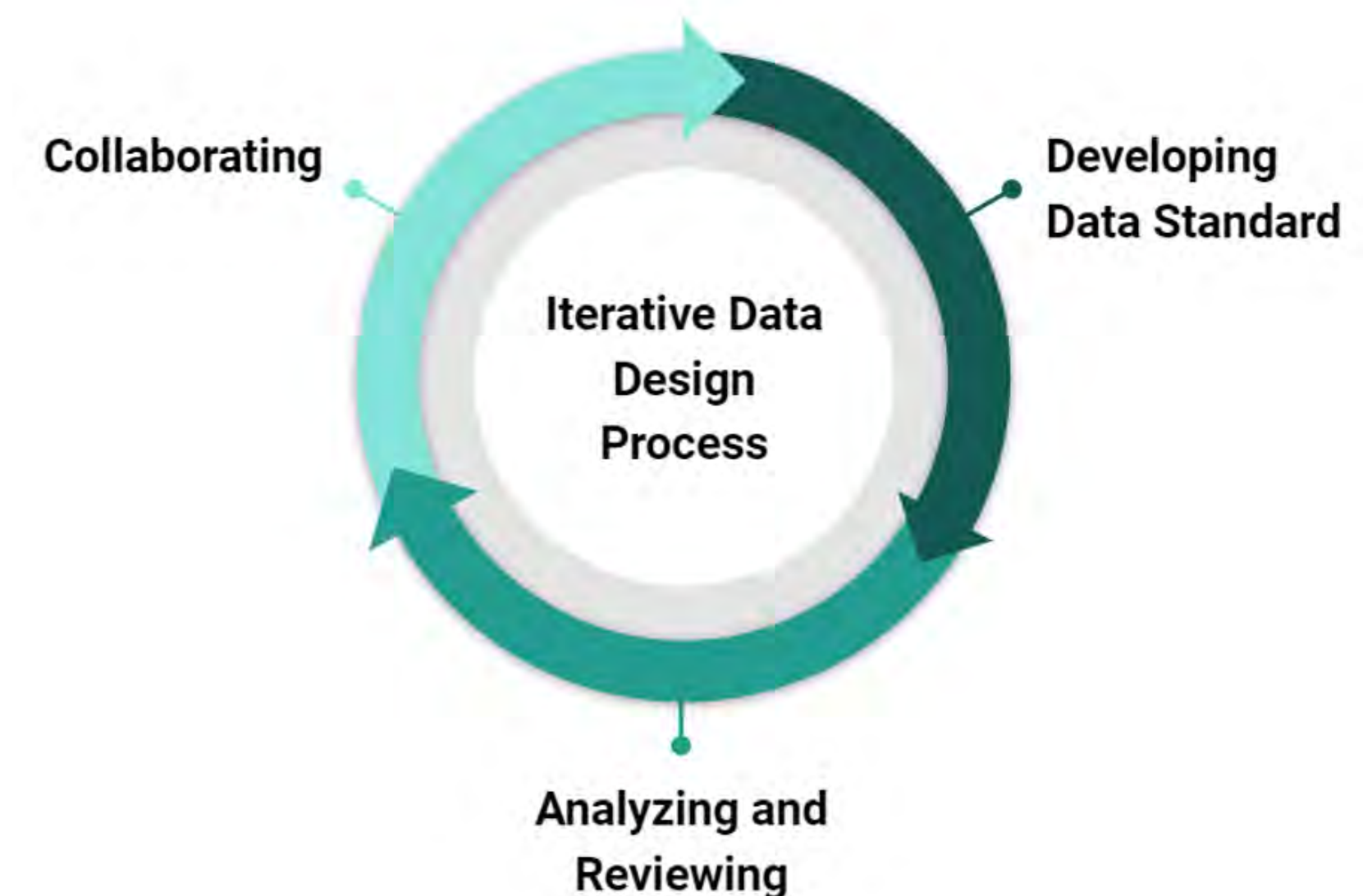
Refining Standard Data

All the meetings with the teams mentioned above helped the GTFS team to refine the initial draft of the standard data into a final draft.

Creating an Example Data Set

The final deliverable for the GTFS team was to create an example data set that will mimic information collected from the applications that use the data (Park and Rides, 2020) (King County, 2020).

Process of Creating the GTFS Data Standard



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GTFS Data Standard

This GTFS data standard consists of all the necessary information about Park & Rides that are necessary to create a positive experience for end-users. Specifically, the data standard contains five different files which has information about Park & Rides, parking availability, parking permits, and schedules. Each of these files contains information as follows:

Park & Ride

This file consists of general information about Park and Rides, such as -- name of Park & Ride facility, city, location, total parking spaces, owner, additional notes, and information about amenities. The amenities include information about elevators, escalators, handicap ramps, bike locks, ticket vending machines, phone chargers, and payphones. As mentioned in the future work, amenities can have further the information regarding floor level restrictions if applicable.

Parking

This file contains information about the start and end times of the Park & Ride facility, real-time information about number of parking spaces available, types of parking spaces like - car, bike, motorbike, availability of charging stations, availability of ADA (Americans with Disabilities Act) parking spaces, and time when information was last updated.

Permit

This file consists of information regarding permit costs (if applicable) at Park and Rides, mode of payment, and currency type (Google Developers, 2020).

Calendar

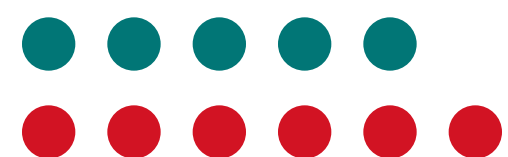
This file contains the daily Park & Ride facility schedules. This file was directly referred from the GTFS standard that google follows (Google Developers, 2020).

Calendar_dates

This file consists of expectations in the default service patterns, such as holidays or reduced service during festivals. This file was also directly referred from the GTFS standard that Google follows (Google Developers, 2020).

All main files within the data standard

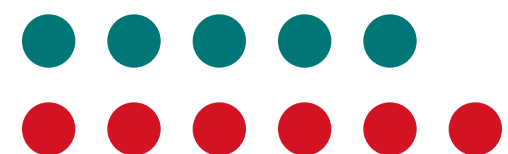
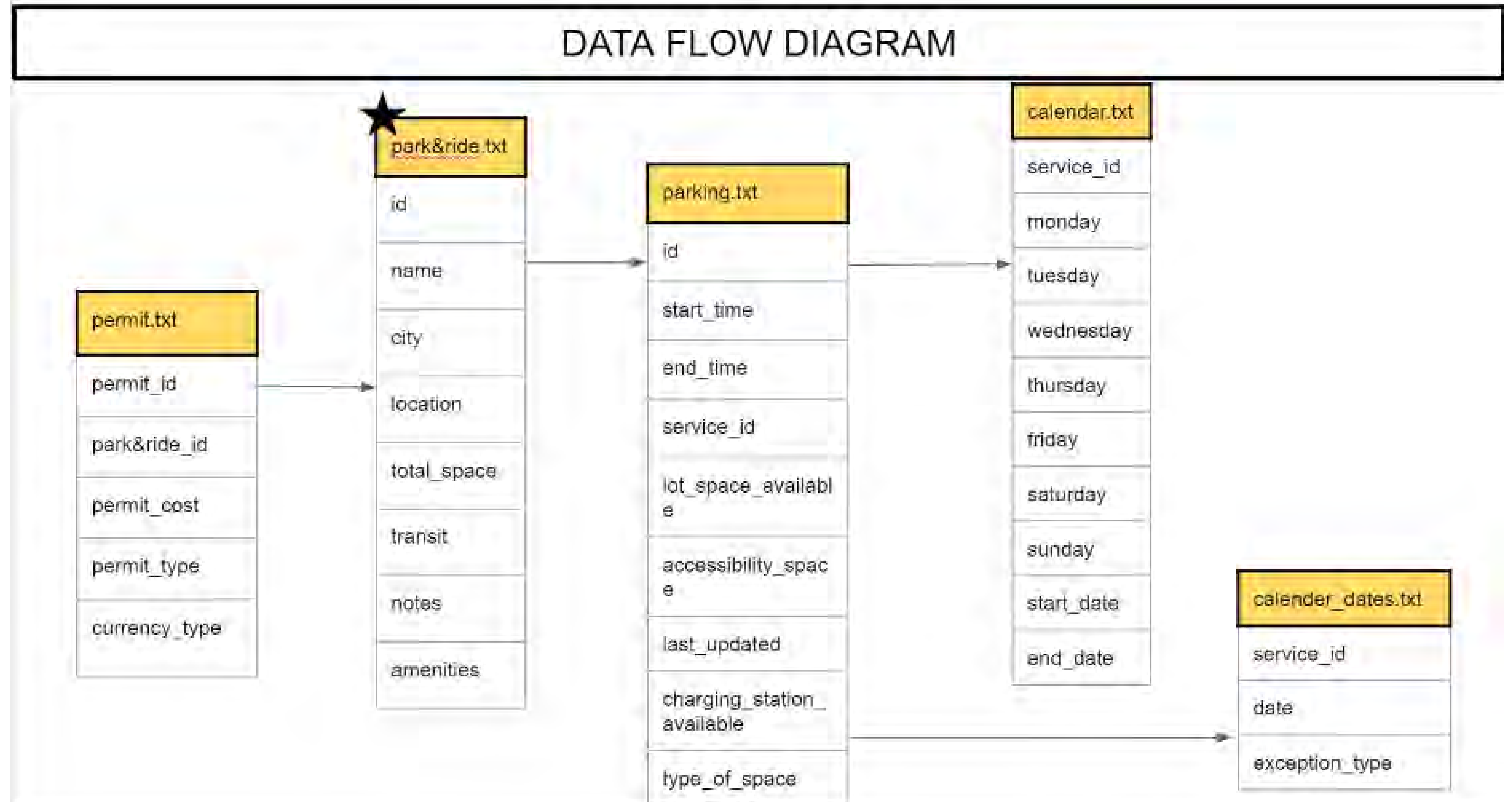
File Name	State	Defines
<code>park&ride.txt</code>	Added	Provides general information about Park and Ride. It contains the static information.
<code>parking.txt</code>	Added	Provides information associated with parking and space availability
<code>permit.txt</code>	Added	Defines information associated with cost
<code>calendar.txt</code>	Extended	Uniquely identifies a set of dates when service is available for one or more routes.
<code>calendar_dates.txt</code>	Extended	Identifies a set of dates when a service exception occurs for one or more routes.



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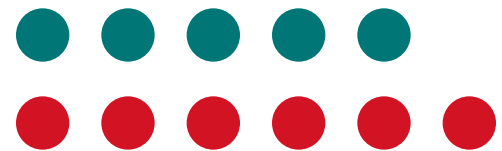
This diagram shows the connection between each of the files in the data standard.

Apart from the information included in the parking data standard, there were some other suggestions by sponsors which were out of our project scope but would add value if included in the parking data standard. These suggestions are mentioned in the 'Future Work' section below.



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Discussion



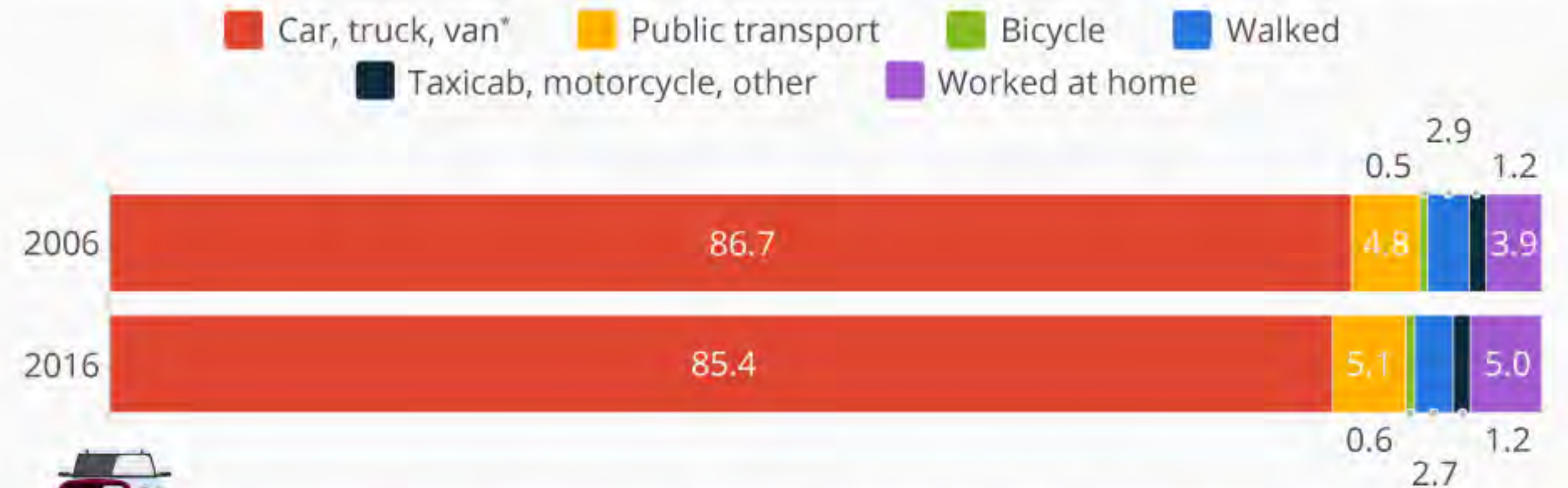
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Project Impact

According to the Washington State Department of Transportation, Park & Rides are an excellent option for people who have a long commute, don't live near the transit route, or need a convenient place to meet their vanpool, public transportations, or carpool Park & Rides (Park and Rides, 2019). They are also essential in reducing greenhouse gas emissions that are caused by traffic because they allow commuters to have the option to switch from personal cars to existing public transportation (U, 2015). However, as mentioned in the information problem section, there is often one key problem with the experience - full Park & Ride lots. By being able to collect and display real time information about the available parking at a particular location, commuters can more effectively plan their rides. By having the ability to make a fully informed decision about which Park & Ride to use, we also expect that commuters will utilize less popular lots when their normal lot is full, thus increasing the use of Park & Rides and decreasing the environmental impact of individual commuters.

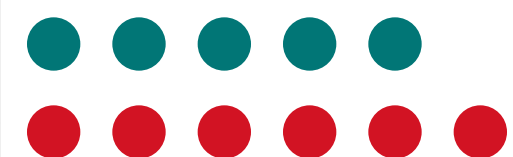
How Americans Commute to Work

Share of commuters by means of transport used and people working from home (in percent)



* includes carpooled
Considers all workers 16 years and over;
Source: US Census Bureau
@StatistaCharts
statista

Source: <https://www.statista.com/chart/11355/how-americans-commute-to-work/>



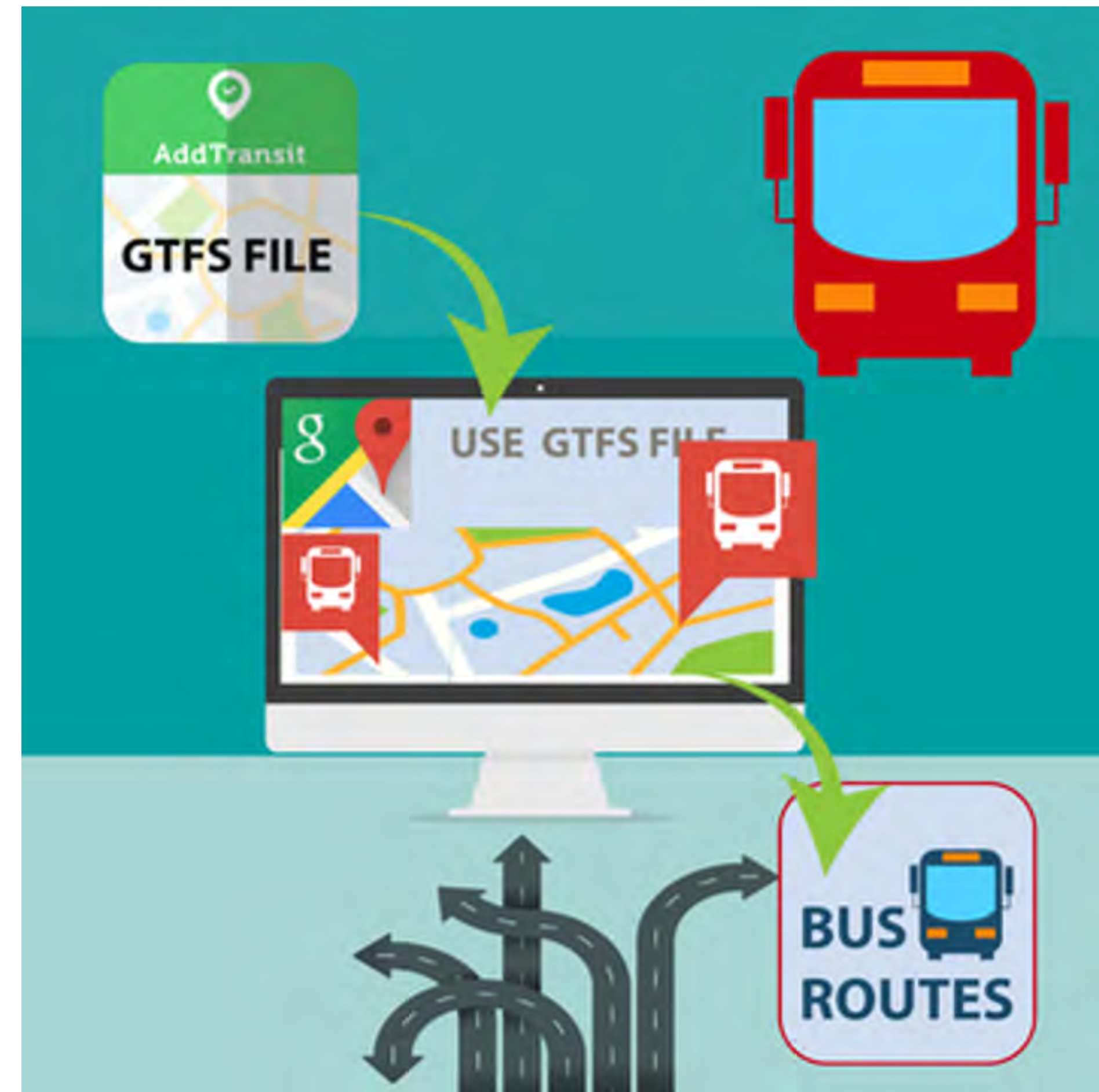
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Project Impact

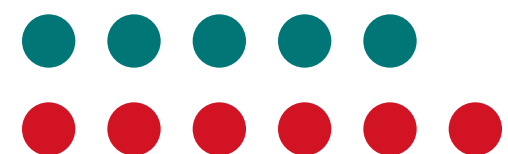
The data standard that was created will be utilized by future teams who will be able to collect the parking lot data using sensors. With this standard, the parking data will be integrated with third party platforms like Google. It will also resonate with the common format for public transportation schedules and associated geographic information.

As the sponsors proceed with the decision to develop an application or integrate parking data with a third party platform, the high fidelity prototype that the UX team created can be used as a reference for how this real time information can be displayed and most effectively used by commuters. By creating and testing an application design, the sponsors will easily be able to make decisions with the users in mind.

Source: <https://addtransit.com/blog/2015/09/google-maps-bus-routes/>



The above diagram shows the connection between the data and the use of a data standard and application to create an improved Park & Ride experience for commuters.



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Next Steps

Transition to Next Team and Sponsors

This report will act as a summary and overall description of the work done by the team during the Practicum. It will be shared with sponsors and other stakeholders and will be stored in a shared drive containing all work and deliverables from the team. The team has created a video to share the high fidelity prototype and its features. There will also be a Figma file in the shared drive which contains the designs created by the team. The final data standard will also be available in the shared drive as well as all work leading to its completion. A project presentation on August 26th, 2020 will share all of the details of the project and will also be included as a recording and slide deck in the shared drive.

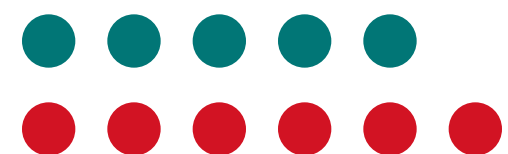


Source: <https://www.bosch-connectivity.com/products/connected-mobility/parking-lot-sensor/downloads/>

Future Work

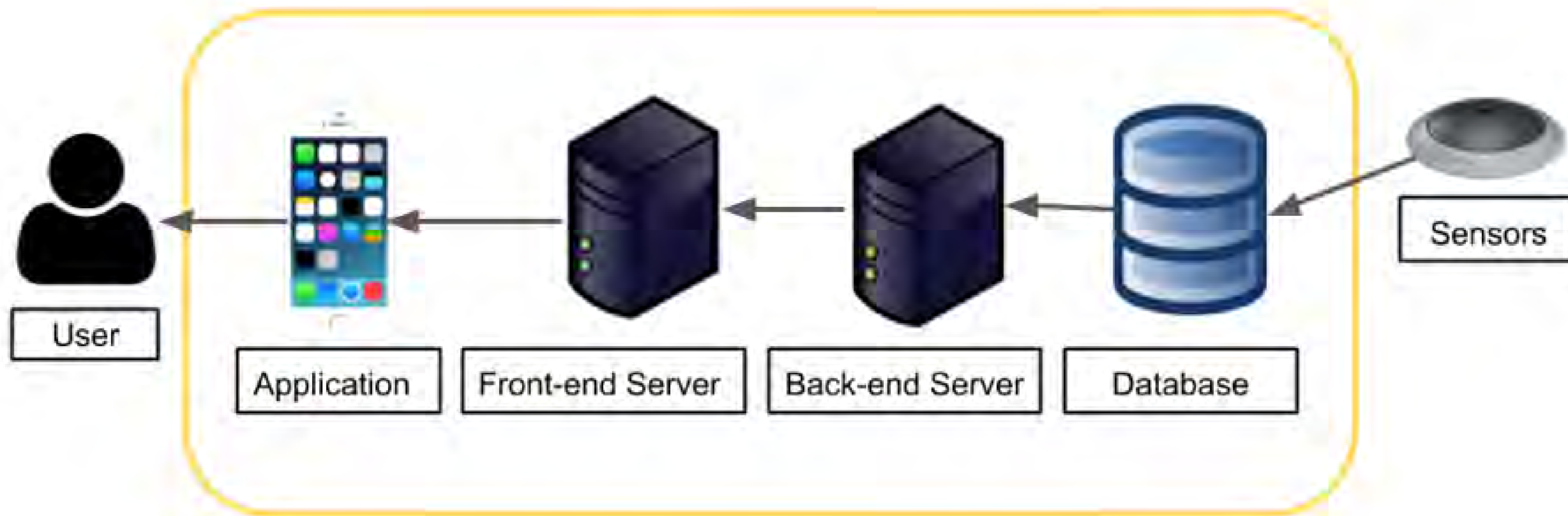
The team has completed all final deliverables including a high fidelity prototype, an application features video, a data standard, example data, and a user-flow demo of how the data will eventually connect with the UX team's front-end application. The next steps that the team recommends for future work includes:

1. Implement and test sensors.
2. Create a code that will not only connect the sensors but connect all data for a real-time active data. The team who took this project before us created dummy sensors to detect available spaces at a Park & Ride. This will need to be connected to the parking data in real-time with a time-stamp of when the data was last recorded.
3. Create a backend code that will connect the data collected in real time to the front-end user application.
4. Develop an application from the high fidelity prototype.
5. Make any changes to the application regarding daily permits or any additional information to be implemented by sponsors.

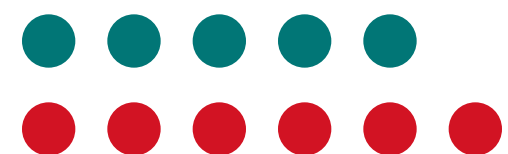


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SYSTEM DESIGN BLOCK DIAGRAM



The above diagram shows the flow of the data in accordance to the sensors and the third part application that would use the standard data.



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Standard Data Next Steps

The team had many suggestions on ways to expand the standard data. However, due to a limited time period and scope, the team was unable to pursue all suggestions. The list below shows GTFS data fields for future study.

Measurements of Parking Entrance

As suggested by Metro, it will be valuable to include the information about height and width of the Park & Ride entrance so that people are aware about the restrictions on the entrance. This information could be used for freight or large trucks.

Private Spots (shopping spaces, hospitals, churches)

After integrating the first proposal, the park and ride data has the ability to expand from just Park & Rides to private parking stations. This would provide alternative parking locations nearby if the lot had filled.

Floor Level Restrictions

Similar to school parking spaces, some floors are restricted to types of space and permit-only parking.

Multiple Stops

Since there can be multiple stops near a particular Park & Ride, it might be useful to include all stops in the data.

Information about Discounted Transit Pass

Sometimes users can have the option of getting a discount on Sound Transit and other regional agencies' services by availing a permit at Park & Ride.

Crowded Busses

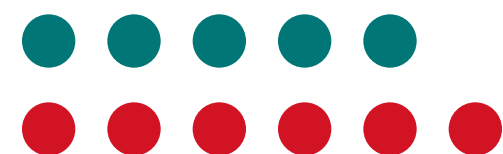
As a part of a future work by Metro, it will be useful to show the traffic inside the bus or information about the probability of getting a seat in the bus after parking at Park and Ride.

Additional Fare Information

From our research we found a GTFS fare file(fare_attributes.txt) that shows multiple fields that can be used in a permit data.

Permit

Having daily permit for Park & Ride users available.



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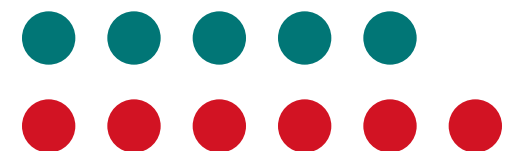
Conclusion

The primary goal for this project was to understand what parking-related information would be valuable to share with users, how that information would be displayed, and how it would be integrated with preexisting GTFS standards. Thanks to our supportive sponsors and professor, we were able to accomplish these goals. Though we had some limitations, including a short time frame, Coronavirus social distancing guidelines, and non-technical expertise, we excelled beyond our own expectations.

Additional Information

For additional project information, please contact Team Rainier through Trisha Asar - trishaasar@gmail.com.

Thanks!



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References

Basu, M. (2015, November 29). Singapore transport lab develops smart parking app. Retrieved June 11, 2020, from <https://govinsider.asia/smart-gov/singapore-transport-lab-develops-smart-parking-app/>

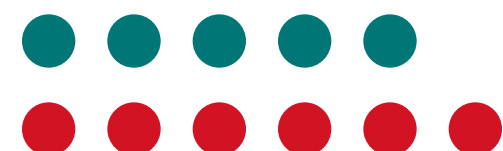
Constantine, D. (2020). Greater Seattle area leads the nation in transit ridership growth - King County. Retrieved 12 June 2020, from <https://kingcounty.gov/elected/executive/constantine/news/release/2018/February/21-metro-ridership.aspx#:~:text=In%202017%2C%20riders%20saw%20major,expansion%20by%20King%20County%20Metro.&text=There%20are%20now%201%2C600%20active,riders%20across%20King%20County%20annually.>

Continental Automotive Singapore Pte. Ltd.(2015). Park&Go @SG. Google play. from, https://play.google.com/store/apps/details?id=com.conti.parkandgo 2&hl=en_SG

Eadicicco, L. (2020, May 27). 19 incredibly useful Google Maps features everyone should know about. Retrieved June 11, 2020, from <https://www.businessinsider.com/google-maps-best-features-tips-tricks-2019-5#change-the-time-to-see-the-most-accurate-results-1>

Example GTFS Feed | Static Transit |. (n.d.). Google Developers. https://developers.google.com/transit/gtfs/examples/gtfs-feed#fare_attribute_text

Lee, Jessica. "A Parking Headache: What's the Fix for Crowded Park-and-Ride Lots?" The Seattle Times, The Seattle Times Company, 12 Feb. 2018, www.seattletimes.com/seattle-news/transportation/a-parking-headache-whats-the-fix-for-crowded-park-and-ride-lots/.



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References

Mobility innovation center | University of Washington. (2020). Retrieved 12 June 2020, from <https://mic.comotion.uw.edu/>

Park and Rides. (2019, December 18). Retrieved August 15, 2020, from <https://www.wsdot.wa.gov/travel/highways-bridges/park-and-ride>

Park & Ride and Transit Center Information - King County Metro Transit - King County. (2020). Kingcounty.Gov. <https://kingcounty.gov/depts/transportation/metro/travel-options/parking.aspx>

Public Transportation's Role in Responding to Climate Change. U. (2015, January). Retrieved August 15, 2020, from <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf>

Reference | Static Transit | Google Developers. (n.d.). Retrieved August 19, 2020, from <https://developers.google.com/transit/gtfs/reference>

Sound Transit (2020). Retrieved 9 June 2020, from https://www.soundtransit.org/sites/default/files/20150624_2015_FinancialPlan.pdf

Sound Transit (2020). Retrieved 9 June 2020, from <https://www.soundtransit.org/sites/default/files/documents/deputy-executive-director-facilities-systems-maintenance.pdf>

