Final Report

Enhancements for General Population Incident Avoidance in the Seattle Area

Industry Capstone Team 5

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Executive Summary of Completed Work

The focus of this project was to find a way to better notify the general public of extraordinary incidents (three or four times per year) that would greatly impact their travel in the Puget Sound area. There is a secondary focus on how this notification system could be integrated with the daily utility through improved mobile ticketing.

To create an actionable solution plan, in our first quarter of work we completed research on mobile ticketing application best practices, surveyed general populations about their experience with major road incidents, and interviewed experts to learn more about fields we identified to be relevant to our problem space. We also learned of the capabilities of the Virtual Command Center (VCC) from CoSSAR, which will effectively solve the problem of fragmented interagency communication. We found that our solution should focus on the communication of incident information to the public and providing routing recommendations.

Focus Group

After deciding on a solution path, we spoke with users to hear their feelings on our solution. Our selection criteria for participants was that they must be a frequent driver which we defined as driving during at least four days per week. Luckily, we were able to find participants with geographically diverse commutes going to and from Kent, Mukilteo, Capitol Hill, Downtown, and University District. The limitation of our focus group was that the age of our participants was only between 21 and 28 years old, so they were all fairly familiar with social media and other avenues of getting information online.

The participants were asked about their decision to drive instead of taking a bus on a daily basis to give context to their later answers. The focus group was meant to be conversational and address the following topics in transportation:

- Availability of information from various sources, including incident notifications, and traffic reports
- Available transportation options and concerns about each (safety, cleanliness, personal space, etc.)
- Parking
    - How to deal with their parked car if they take public transit including their concerns about the safety of their vehicle and personal responsibilities that change their transportation behavior
    - What would help them make a decision on where to leave their car
- Concerns (besides parking) about leaving their car at work
- Situational questions to understand how they would react to an incident

The perspectives these drivers provided were valuable because they provided support for some aspects of our solution and helped us decide to cut aspects we were unsure about. Participants further confirmed data from our survey that it is very difficult to convince a driver to shift to public transit, even during a major incident. However, they were more motivated to mode-shift when presented with safe and cheap parking options, such as in a covered garage or lot. Almost all participants shared concern over the safety of their vehicles if they left it overnight in street parking. Time shift was by far the most popular option because the participants stated it would be a great inconvenience if they had to take public transit home and for their commute the next day. Their problems with current systems included the lack of information on bus capacity during peak times and not providing reasons for the delay were barriers in using public transit In some cases, it was not an option to take public transit for some portion of their commute. One of the participants chose to bus on some days and used the Google Travel Times widget to check how long their travel would take at a glance. When they mentioned this widget, the other participants all expressed interest in downloading this feature. This excitement informed us that at-a-glance information is desired, which inspired us to integrate a text notification system.

Refer to Appendix A1 for methods, questions, and notes from the focus group.

Expert Interviews

We had an expert interview with Brent Young who works for Impark, a nationwide company which manages more than 450 locations across the country. He was able to give some light to how parking can fit into the final solution we proposed. All of the parking garages which are operated by Impark are privately owned meaning Impark simply manages them and has no ownership. This makes it challenging to force garages to take certain people or cooperate with lower prices during an emergency. He gave the idea of working with the city to create a program which will allow traffic emergencies to be handled better. A key takeaway was working with Seattle to create some sort of gold star lots which could be used for a fixed price throughout the day. He gave us the idea to utilize SpotHero for our final solution because it has the information

people would need to make an informed decision on what the best solution is in an incident. There is always the ability to leave cars overnight it will just have a fee which is what we need to communicate to users in making recommendations.

Adiam from the Seattle Department of Transportation gave insight into what the VCC will be responsible for. She gave us a place where our solution fits as how we can take advantage of our infrastructure and depend on each other to reduce or mitigate the impact. This speaks to the overall structure of our solution where we give both a centralized source for information as well as recommendations to mitigate the impact. There are five types of incidents which the VCC is planning for; fatality, hazardous waste, fire, commercial vehicles, and rollover. There is also a limit of 90 minutes for a road closure to be present before it will cause ripple effects throughout the transportation system. There is a specific prioritization for modes as well. This is as follows, emergency responders, transit, walkability/bike, freight, and always last prioritized is single occupancy vehicles. The place for our solution was stressed to be focused on users and how to populate the information from the VCC.

Implementation Plan

System Design

We identified four systems that fulfill the needs for timely congestion information, routing recommendations, shifting transportation modes, and mobile ticketing following a major incident. Please refer to Appendix D for more system design details.

Notification System

Text notifications will be available to users and used primarily to provide updates for the current incident. Users will have the option to sign up for future incident notifications and regular transit updates through the same service. We recommend integrating this service with AlertSeattle to minimize cost.

1. Text notifications via AlertSeattle
    a. Subscribe to the current incident for 24-hour updates
    b. Subscribe to future incident notifications
2. Live incident information updates with inputs from VCC
    a. Easily identifiable road closures in bullet points
    b. Live updates in a timeline format
3. Display a live map using Google Maps API and VCC inputs
    a. Incident area visualizations
        i. Heavily congested area
        ii. Visualize traffic intuitively (e.g. red for the heavy delay, green for no delay)
        iii. Free parking area (if available)
    b. Estimated traffic delay time from VCC

Recommendation System

Inputs for route recommendations will be fetched from the VCC and will be displayed as options that prioritize time-efficiency and the use of transit instead of personal vehicles. Due to the potentially high volume of web traffic, our solution prioritizes redirecting users to other platforms to fill their needs. This will help split the server traffic and will enable the website owner to only activate the server when necessary, saving money for the agency.

1. Dynamically personalized transportation recommendations with inputs from VCC
    a. Mode shift/ Time shift/ Route shift
2. Navigation support from Google Maps
    a. Input real-time public transit data with General Transit Feed Specification Realtime (GTFS-realtime) into Google Maps
3. Specific transportation option support
    a. Public transit - redirects to Google Maps or OneBusAway
    b. Bikeshare - redirects to Migo app
    c. Walk - redirects to Google Maps
    d. Rideshare - redirects to Uber, Lyft, or Via
    e. Drive - redirects to Google Maps

Parking System

Our solution will provide parking extensions and personalized recommendations to support drivers if they shift to taking mass transit. In the case of a major incident, we recommend that the Seattle Department of Transportation (SDOT) provide 12- or 24-hour free parking in the affected area. Moreover, we advise public sector agencies to collaborate with large private sector employers (e.g. Amazon, Microsoft) to provide 24-hour free parking to their employees.

1. Free parking announcements from official agencies (with inputs from VCC)
2. Extend parking option - redirects to SpotHero
3. Locate and reserve a private parking spot - redirects to SpotHero
4. Locate street parking - redirects to PayByPhone app

Ticketing System

Mobile ticketing option is also recommended and included in our solution to support mode shift from single-occupancy vehicles (SOV) as well as first-time users who are unfamiliar with the local public transit system and/or do not have an ORCA card.

1. Show announcements from official agencies about free/reduced-price public transit
2. Guides user to mobile ticketing solution - redirects to Transit GO

Assumptions

Based on the previous claims, we assume the following will be available for our solution in 2021.

1. VCC will provide real-time incident information
2. VCC will provide text-based or machine-readable live incident updates
    a. Time estimation of delays

    b. Bus reroutes
    c. Lane and road closures
    d. Free parking / free public transit announcements
3. Google Maps' traffic layer will keep track of real-time traffic congestion
4. Partnership with Google Maps and share public transit information using GTFS-realtime specification (refer to Appendix C for more guidance)
5. SDOT and large-scale employers may provide free parking for incident-affected areas
6. Incident notification will be spread through software and non-software means
    a. Official websites, social media, local news (online and TV), radio, text alerts, electronic road signs, etc.
7. SDOT will develop a relationship with the PayByPhone App to allow extended parking (Further feasibility and user testing required)

Design and Technical Considerations

Why use a website rather than a mobile app?

We initially proposed our solution as a mobile application with push notifications rather than a webpage augmented by text notifications. There are four main reasons for choosing a website that were inspired by our research, and more specifically, our focus group.

1. Re-evaluated the problem scope and recognized it is unreasonable to expect users to download an app for rare (1-3x per year) traffic incidents.
2. People are less willing to enable push notifications for a rarely used app and would likely rather subscribe to an infrequent text notification.
3. Heavy website traffic could cause server overload and ensuing website crashes, so we have prioritized redirecting users to other platforms when appropriate and possible. Switching between websites would also be easier than switching between apps and websites.
4. Considering the operating cost of an application and necessary servers, we recommended activating the web server and website only during the case of a major incident. An app would need to have a server that is constantly running which would be costly.

How to deal with web crashes?

Due to heavy web traffic, the host server might be overloaded and cause the website to crash. We proposed the following three solutions for mitigating server traffic issues and reducing the possibility of a crash.

1. Use a content delivery network (CDN) to ensure that the website stays online. As a benefit, a CDN would also decrease the loading time for users.
2. Run a crash test and prepare for a massive influx of website traffic.
3. Make continual backups to ensure the site can be repaired and updated instantly without information loss.

Why do we include time shift and route shift besides mode shift?

According to our survey as well as focus group investigation, we learned that departure time shift and route shift are more convenient and preferred over mode shift. Based on this information, we will build in functionality to support users' decision making process with a visual comparison between the three shifts. Specifically, the comparison will include details such as estimated travel time and arrival time. Thus, users are empowered to make a decision with respect to their personal needs.

Design

Process

Based on the implementation plan, we began the design of our solution using Figma. Figma is an online collaborative design tool that allows multiple users to edit the same design file. We created a wireframe of our website and began to iterate on our design. Once we solidified the basic layout of the site including button locations and text sizing, we implemented the design using Webflow. Webflow is a tool that makes it easy to build a website without manual programming of HTML (content), CSS (styling), and Javascript (interaction). We rebuilt the Figma-based design inside Webflow and this allowed us to bring the static design to a real website that dynamically adjusts to different screen sizes and can react to user input. Our final design resulted in a website can mainly be broken down into three distinct tabs: *Information*, *Map*, and *Plan your route* (Figure 1).

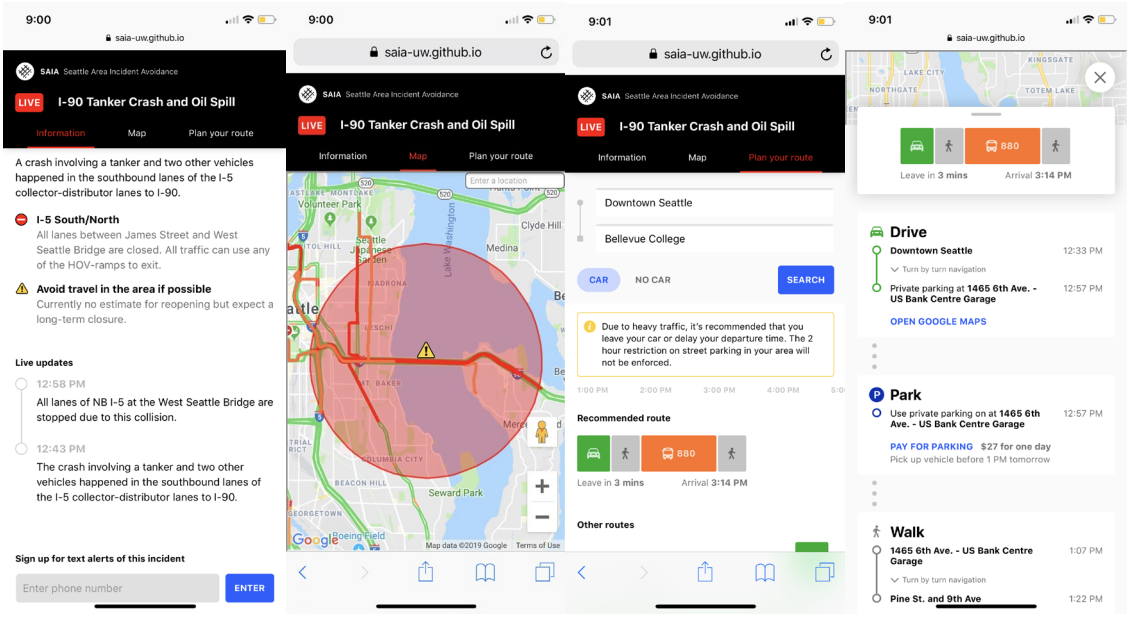

Figure 1: Final design of SAIA using Figma and Webflow

Information Tab

The *Information* tab is where all of the information about an incident lives. The top of the page includes a summary of the incident with glanceable notices about road closures and cautionary messages. If a user wants to learn more, they can scroll down to see live updates about the incident. Users can also input their phone number to sign up for text alerts of the incident. If a user decides to opt-in, it displays a modal that asks them if they would like to opt-in for all

future major incidents in the area. This ensures that future commuters receive instant information without having to seek it out during an incident.

Map Tab
The *Map* tab allows users to visually explore the incident which is marked by a yellow warning icon and a red circle that indicates the distribution of traffic around the incident area. If a user decides to zoom in to the map, either by using the +/- sign or pinch/zoom, they can also view heavily affected roads denoted by orange or red lines. Both street view and the Google Maps search function are enabled in the map view. In contrast to the *Information* tab, the live map provides a visual understanding of how the city has been affected by an incident.

Plan Your Route Tab
The *Plan your route* tab is a key functionality that aims to solve the unreliability of mapping software during major incident scenarios. Existing mapping applications – such as Google Maps and Apple Maps – fail to update incident information quickly enough which often results in users being routed through paths that are blocked or otherwise inaccessible. By using GTFS-realtime data from the VCC, our solution will update Google Maps with more accurate information. This tab will allow users to input their current and final destination and designate if they have a car to get recommendations for their journey.

If the city decides to make local street parking free during an incident, the first thing a user will see is a yellow announcement indicating about the city's decision. If a user's car is gridlocked on street parking, they may be worried about fines for not moving their car. This feature ensures that they can leave without worrying about the cost of parking or trying to move their car around the affected area which would lead to more traffic. Within the route options, users can see a variety of transportation methods that include public transit, car-sharing, bike-sharing, walking, and departure time shifting. Because the results are displayed on a linear time scale, it makes comparing arrival times across different options effortless. Once a user taps on one of the options, the map shows the route and gives step-by-step guidance to the user's destination. The integration of Google Maps is necessary for their granular mapping functionality. SpotHero for will be used for reserving a parking space, and Transit GO for purchasing a mobile ticket. This functionality aims to safely route users around the affected areas while reducing traffic within the entire network.

Technical Implementation

Software/APIs - Tech Stack

There were several iterations of both the design and map implementation which led to an optimal combination of the tech stack for our final demo (refer to Appendix F) for detailed evaluations). Here is the software stack we used for our clickable demo.

- Figma and Adobe Illustrator for creating wireframes, initial web design, and visual design
- Webflow for web design and development

- Google Maps Directions API, JS API, and Places API for map implementation
    - Directions API - mockup traffic & routing
    - Places API - search and autocomplete.
- HTML, CSS, JS, and jQuery for the final clickable demo
- Git for version control, GitHub for releasing the code to the stakeholders, and IntelliJ for merging and major demo development

Technical Challenges

Web development by itself is highly time-consuming and with the added challenge of understanding Google Maps APIs and traffic routing, implementing our solution was a challenge. There are many choices to be made in terms of software, frameworks, libraries, and APIs (that are all continuously updated) and we had to choose exactly which ones to use for our demo development. We spent much of our time during development going through tutorials and evaluating all kinds of existing software, testing APIs and frameworks, and web programming languages (refer to Appendix H for more detailed information on software and API choices). The following list recounts the challenges we faced in the technical implementation of our solution.

URL Redirection

Challenge 1: Redirect to a website with a specific action

- Solution: Both SpotHero and Google Maps have specific URL schemes for each action. For instance, to launch a map with bicycling directions from the Space Needle to Pike Place Market, in Seattle, WA., use the following URL scheme: "https://www.google.com/maps/dir/?api=1&origin=Space+Needle+Seattle+WA&destination=Pike+Place+Market+Seattle+WA&travelmode=bicycling"

Challenge 2: Launch correct app store based on what OS is being used

- Solution: Dynamically detect the operating system: Android(Google Play)/ ios(Apple iTunes)/ Windows (Microsoft); Match each operating system with the correct app store.

Merging Code with Webflow

Challenge 1: Merge Webflow's non-readable JS file with 10k+ lines of code

- Solution: IntelliJ IDEA has a comparison tool that allows for correct formatting comparison between two files.

Challenge 2: Webflow interaction events (click, hide, show, hover) are independent and not modifiable

- Solution: Rewrite the event rather than reverse engineer it. For future development, we would recommend keeping static design and interactive functionalities separate.

Challenge 3: When merging Webflow code packages, HTML elements and CSS Styles may conflict

- Solution: Webflow used the class name for CSS Style definitions, so we reformatted the code by adding an ID for the conflicting elements.

Live-Map

Challenge 1: Automatically show incident area when the map loads

- Solution: 1. Auto-center the incident area with the appropriate zoom level; 2. Add a search bar with autocomplete feature for easier re-center; 3. Zoom in/out button for easier manipulations; 4. Add Street view to learn where the place is.

Challenge 2: Default marker does not intuitively make sense?

- Solution: 1. Add a configuration for the marker and replace the default with a customized marker; 2. Add a popup info window to display the brief info about the incident.

Challenge 3: Mockup traffic visualizations?

- Solution: The current solution we used is to 1. use Directions API to find a route between two geolocation points; 2. use returned points along the road to draws the polyline with Direction Renderer. However, this is only a problem with the demo. Once Google Maps has lively updated traffic information, our live map will function correctly as we implemented based on the traffic layer from Google Maps.

Plan Your Route

Challenge 1: Make website responsive to browser size

- Solution: Dynamically find the width of the viewport and set element width as a ratio of the viewport. For instance, to keep the image always 60 percent as wide as the browser width, use “width: 60vw;”.

Challenge 2: Point B problem - Given origin A and destination C, if we want to avoid the incident area, how can we find the optimal midpoint B where it takes the least time to get from A to C?

- Solution: If we partner with Google Maps and input GTFS-realtime transit information, we can use their existing routing algorithm rather than creating our own.

Challenge 3: Using hide/show for switching between tabs and load the map with the correct zoom level

- Solution: Mock the onclick event of the “find path” button. However, this is not an optimal solution for real-world implementation. In further development, each tab should be its own webpage.

Traffic Analysis

While the website will serve as the public-facing side of our solution, traffic analytics will function as the backend. Analytics will inform decision-making for traffic agencies that will affect how the public will navigate major incidents. Traffic analysis was conducted with two goals in mind: find the lowest traffic volume reduction to eliminate the worst congestion and test possible road closures to use as public transit-only during an incident.

The transportation planning software Emme (made by INRO) was used to conduct the traffic analysis. The Puget Sound Regional Council gave us a sub-area network of Downtown Seattle model with 1,800 links that represent the arterials and Interstate 5. To ground our solution in reality, we chose to mock the propane truck incident from February 27th, 2017 and close I-5

southbound. We used volume divided by capacity (V/C) as a measure of effectiveness (MOE) from the Federal Highway Administration to determine the performance of each road segment. The overall network performance of the subarea of downtown can be seen in Figure 2. It is shown on the network that some roads have bad congestion – defined as V/C > 1 – which means that the affected road has reached its capacity. The majority of the roads in the downtown area are not congested with V/C < 0.5.

Figure 2: Model of Downtown Seattle Subarea traffic with I-5 closed

In order to reduce transit times, we tested the lowest traffic volume reduction necessary to lower V/C in the congested area. After testing out the reduction of both single occupant vehicles and high occupancy vehicles by 20 and 30 percent, we found out that 30 percent reduction is able to alleviate the congestion caused by the incident. In an active scenario, the responsible transit agency will be able to run a real-time dynamic simulation to determine how aggressive their efforts needs to be to reduce traffic volumes.

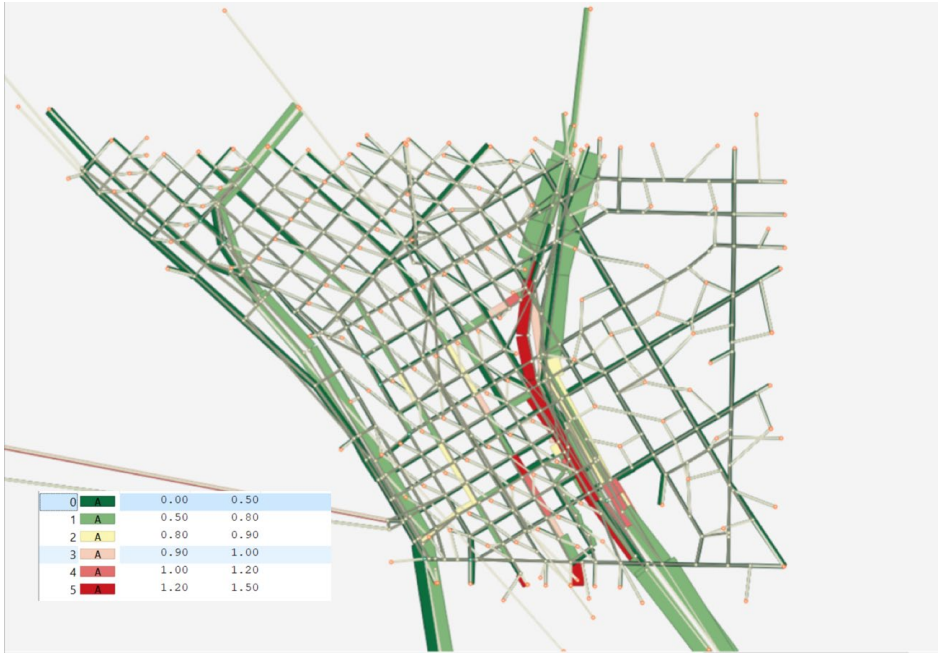

Figure 3: Network performance with 70 percent SOV and HOV volume

By giving roadway priority to public transit, the amount of buses can support an increased demand for public transit. For the propane truck incident, we tested different road and lane closures that could be used for transit-only during a major incident. Closing 2nd and 4th Ave to personal vehicles would be one of the best options to get buses out of the incident area quickly without major rerouting. The closure of 2nd and 4th Ave is supported by 3rd Ave already having the capability to be transit only, as it is from 6 am - 7 pm already. Many buses already have stops along 2nd and 4th Ave to pick up passengers, as Appendix Figure I1 illustrates. In Figure 2, the traffic analysis shows that closing 2nd and 4th Ave has caused the I-5 V/C to increase from 0.8 to greater than 1 and making SR 99 also over capacity. However, the majority of nearby arterials still have free flowing traffic. Alongside this transit-only arterial-closure plan, we tested which freeway would be best to close. In the case of an accident like the propane tanker incident, the majority of downtown arterials will be over capacity. Based on our analysis, we recommend delegating one lane to be transit-only going in each direction on I-5. This will be the fastest way to get both buses out of the accident area in a timely manner.

One of our goals is to provide routing recommendations to the general public in the case of an incident. In a low-impact incident, Google Maps would be able to provide sufficient real-time recommendations. However, in the case of a major incident, road congestion is much more dynamic and impactful, so a Google Maps suggestion may create congestion in more roads surrounding the incident area. Because of this, we decided to seek out the roads that would have the lowest congestion and use those to move people out of the incident area. Due to the limitations of our data, we only tested roads that have low V/C with one set of morning commute data to represent the roads that are most likely to not be congested in a comparative scenario. By comparing the closure of I-5 at 100 percent capacity, I-5 closure with 2nd and 4th Ave turned into a transit-only lanes, and opening just one lane to be transit-only on both I-5s,

we found that the roads highlighted in Appendix FigureAppendix I4 has V/C lower than 0.2. These roads can be used as the rerouting option to get people out of affected areas.

Marketing Plan

The marketing plan revolves around five key areas of awareness-building and user retention:

1. Social Media/Blog Posting
2. Earned Media
3. Digital Advertising
4. Out-of-Home Advertising
5. User Feedback

Social Media/Blog Posting
Over the course of a year-long timeline, social media would roll out first, with increased importance given to platforms like Twitter and LinkedIn. Twitter is most effective in getting information to users in a timely manner, while LinkedIn would be more effective in the long run. As blog posts and promotions go throughout transit agencies, employees at the agencies can share posts on LinkedIn and provide quick commentary that pitches the site to people in their professional network.

Earned Media
Earned media would come out next, with stories about the website being pitched to various Seattle media outlets across TV, radio, and print. These stories should aim to educate the general population about the service and how it differs from and improves on the other options available both privately and publicly.

Digital Advertising
Digital advertising would take place on popular websites with high amounts of unique users, like Yelp, Yahoo, Spotify, Reddit, ESPN, and Accuweather.

Out-of-Home Advertising
During the second half of the year-long timeline, out-of-home advertising should roll out across various mediums in the Seattle area. This would start with billboards and bus ads. Commuters will inevitably find themselves driving next to a bus, behind a bus, or on a road where billboards are easy to see for a few seconds. In these cases, it would be beneficial to provide the ad copy and a design that would quickly help people visualize how they can shift modes quickly with our website. Later on, ads would appear on pumps at gas stations and decals on grocery store entrances and drink fridges.

User Feedback
At the end of the timeline, we would release a brief survey to sign up for the website to field feedback from users on what they liked and what they could improve.

There's also the issue of marketing the day of an incident, especially if the website hasn't had time to be proliferated across platforms. In this case, it's best if pre-existing notification

channels with established user-bases like Twitter and agency text alerts (i.e. AlertSeattle) are taken advantage of. Using these channels would potentially further decrease roadway congestion. As another notification method, red banners should be placed at the top of each transit agency's website to alert commuters that there is an incident, and then direct them to the website to plan their routes through or around said incident.

Recommendations and Next Steps

To implement this platform in a real-world scenario, there is still much work to be done. In terms of design, the platform should support multiple languages starting with Spanish and Chinese – the second and third most used languages in King County according to King County Demographics. Accessibility should be further built out for visually impaired individuals, including support for assistive technologies such as screen readers and a call-in number that can be used in lieu of the visual interface. This work can be completed preceding the release of the VCC.

Collaboration with other Seattle entities will also be crucial to the success of this tool. For street parking, the City of Seattle should be negotiated with to provide free or reduced-price parking during major incidents. However, since our focus group participants noted that the safety of their vehicle was a major concern, covered or otherwise protected lots would need to be contacted as well. This will likely require some kind of incentive for the owners of private lots to convince them to open their lots for a free or reduced rate during an incident.

Mobile ticketing is a moving target in terms of next steps. With the creation of Orca Next Gen underway, our limited understanding of the platform will require us to provide recommendations only in consideration of the available mobile ticketing solution, Transit GO. To reduce the barriers to entry for mobile ticketing, we suggest that King County Metro provide an online ticket purchasing system that could be used from a mobile device without requiring the Transit GO app to be downloaded.

Following the implementation of the VCC, we recommend creating an API to be used for the output of GTFS data from the VCC. This data can be plugged into Google Maps and be used to provide more accurate routing recommendations without having to work directly with Google Maps, which has proven to be difficult for our industry mentors who have tried to do so.

Appendix

Appendix A. Focus Group

Blurb to participants
We are an engineering capstone team at the University of Washington working with WSDOT, King County Metro, and Sound Transit to build a solution around helping people navigate major traffic incidents on the road. We will be holding an hour-long focus group the afternoon of Sunday, April 14th to discuss our potential solutions with people who commute by car on a daily basis. This focus group will be held in Capitol Hill. Participants will receive a $15 Starbucks gift card for their participation.

Expectations and Ground Rules for discussion
- Participation in the focus group is voluntary.
- It's all right to abstain from discussing specific topics if you are not comfortable.
- All responses are valid—there are no right or wrong answers.
- Please respect the opinions of others even if you don't agree.
- Try to stay on topic; we may need to interrupt so that we can cover all the material.
- Speak as openly as you feel comfortable.
- Avoid revealing very detailed information about your personal health.
- Help protect others' privacy by not discussing details outside the group.

Motivation for Focus Group
To understand the reasons behind driving to and from home/work during an incident which severely affects the driver's commute. We are not gathering insight into a driver's commute we are purely seeking approval of our own ideas or solutions.

Gathering participants
Intending to source from personal connections. Participant must drive as a primary form of transportation (4/7 days per week on average). Diverse age, location of work and home desired. Sourced from personal connections and vetted in a Google Form application.

Topics
- Short question on their reasoning behind their decision to drive instead of the bus on a daily basis to give context to their later answers
- Information availability
    - Incident notifications
    - Transportation options
    - Traffic reports and estimates
- Concerns about transportation options
    - Safety, cleanliness, personal space, etc.
- Reasons for not taking public transit
    - Personal responsibilities, picking up kid, etc.
- How to deal with their parked car if they take public transit

    - What would help you in making a decision on where to leave your car?
- Concerns (besides parking) about leaving their car at work
    - Safety of vehicle, need a car for a task later in the day
- Situational questions
    - An incident happens on the roads you use to get home while you're at work. Roads are at a standstill around the parking garage you used while at work so it's going to take even longer to get moving. How do you plan on getting home?
- Travel behavior question
    - What is a traveler's preferred mode during an incident

Questions

1. Tell us more about your decision to take your daily commute by car rather than by bus or other modes of transport.
    - How long is your commute?
    - What routes do you normally take?
    - Comfort, the bus doesn't serve your needs, time constraints, etc.
2. What's your experience with public transit?
    - How often do you take it?
    - At what occasion do you use it?
    - Have your public transit habits changed over the years?
3. An incident happens on the roads you use to get home while you're at work. Roads are going to be gridlocked for hours around your work so taking a car is not an option. How do you plan on getting home?
    - Step 1: Find information on an incident
        - How would you find information about road closures and time estimates?
    - Step 2: Getting to the nearest public transit option
        - How would you find information about finding the nearest bus stop is quite a few blocks away, how do you get there?
    - Step 3: Getting home using the option
        - The closest bus stop is a mile from your house, how do you plan to get home? (shared bikes?)
4. If you wanted to wait out the accident and stay after work, what would your considerations be?
    - Where do you go? What do you do?
5. Question about recommendations

Notes

- Live in West Seattle but work in Kent so it would take way too long with bus
    - Would actually take
- 45/hour with a bus but 20 minutes with car
- Greenlake to SLU has no reliable bus line
    - 1.5 driving or 20 minutes driving with car
- Everyone takes the I-5

- Mostly takes Uber now
- Took a lot of bus in college
- Buses are gross
    - Has seen beer spill or acrobats
- If it is high traffic and there is a bus lane, I would take the bus
- No one knows how to drive
- Unreliability with busses had to wait 20 minutes
- For busy events, takes a rideshare
- Prefer to spend money on gas
- Would like to help the environment but it's more convenient
- Used to carpool but not anymore
- Used to take a bus but needed to make it to the 2nd job on time so used a car
    - After a while it became a habit it became easier to do
- There are times where you have to be late
- Scenario-based
    - If it would take a while, I would get dinner or study
    - First Google Maps, second twitter (fastest way), SDOT, Seattle PD, searching hashtags, seeing if any events around the area
    - Would probably walk to the nearest bus stop

    - I would wait it out in the area because there are
    - Parking would be difficult, next morning worried about ticket
        - Sometimes mom would come to pick me up in the morning
        - Use WSDOT site
    - Subscribed to community transit text alert for bus routes

    - I would probably just bus home by leaving the car in the garage
    - Would google something or transportation twitter

- Considerations for leaving the car
    - Theft
    - Getting Towed
    - Getting crashed
- Parking garage gives a sense of parking
- If you could leave the car for free + free bus ticket
- I would take a hotel where I live
- If I would wait out the accident
    - Go for a drink with coworkers
    - Study in a coffee shop
    - Go shopping
    - Ask friends if they want to eat
    - Sleep in Ode (desperate times)
    - Do more work
    - Go get dinner nearby restaurants
    - Watch Netflix in conference rooms

- If there is a carpool option from my last destination
    - A shuttle that my company coordinates would be convenient
- Being able to use a park and ride
    - Parking fills up pretty fast though by 6 am and 7 am

- More link station would be ideal
- Van Pools are nice but the schedules are too strict
- Trolleys are convenient
    - They run every 15 minutes
    - Sometimes it doesn't come every 15 minutes
- Rapid Ride buses are quick and go to underserved areas
    - Comes more frequent and direct
- Understanding traffic schedules would be easy
- Google Maps has gotten better but still can be better
    - The widget when you slide left on the home screen is nice
- Notifications would be nice
    - Traffic is not consistent so sometimes
- Figuring out where the bus stop is very hard, especially in an unfamiliar location
    - Signage needs to change
- Understanding OneBusAway delays
    - Okay, it's 2 minutes late but why?
- Buses are filled
- Capacity information on buses in Korea
    - Tells you when buses are full or not

- Information about buses that need to be communicated towards rides
    - Capacity
    - Delay Reasons
    - Bus stop locations

High-level notes

- Very difficult to convince people to mode shift
- Access to parking garage helps make leaving their car much more enticing
- If given the recommendation to wait X hours, people are willing to do that without the guidance of what to do within that time span
    - Time shift was a viable option for participants
- Widget for bus delay notifications or major incidents gives an opportunity for easily glanceable information
- Lack of capacity information, delay reasons, and accurate bus stop locations are barriers in using public transit
    - Can we build a better OneBusAway?

Appendix B. Terminologies

Major Incident:

- an incident that happens once or twice a year, i.e. 12-car pileup

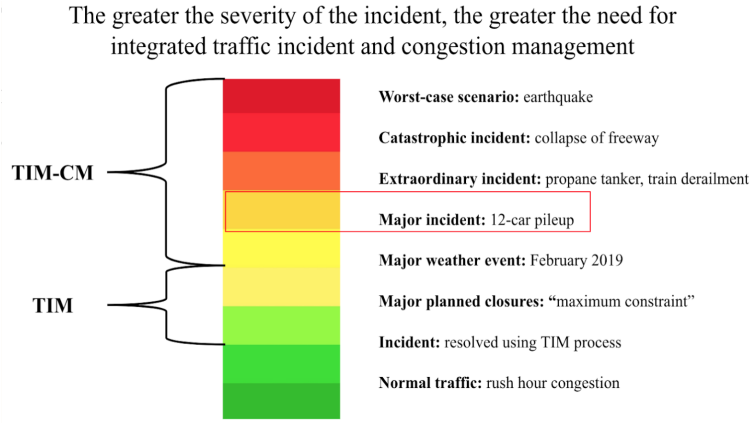

Figure B1: Scale of Incident Severity

Time-shift:

- changing planned departure time.

Route-shift:

- changing planned routes.

Mode-shift:

- changing from one mode of transportation to another during the same trip,

Mobile Ticketing:

- pay for transit tickets via mobile phones.

Appendix C. GTFS-Realtime Implementation Resources

GTFS-Realtime Overview

- What is GTFS: General Transit Feed Specification
- What types of information it supports:
    - Trip updates - delays, cancellations, changed routes
    - Service alerts - stop moved, unforeseen events affecting a station, route or the entire network
    - Vehicle positions - information about the vehicles including location and congestion level
- More information: https://developers.google.com/transit/gtfs-realtime/

Live updates format

- The GTFS Realtime data exchange format is based on Protocol Buffers
    - A language-neutral, platform-neutral extensible mechanism for serializing structured data.
- Data Structure
    - The hierarchy of elements and their type definitions are specified in the gtfs-realtime.proto file.
- More information: http://maps.google.com/help/maps/mapcontent/transit/live-updates.html

Transit partner dashboard

- More information: https://support.google.com/transitpartners/answer/6375243?hl=en

Transitfeed ScheduleViewer

- Transitfeed Repository

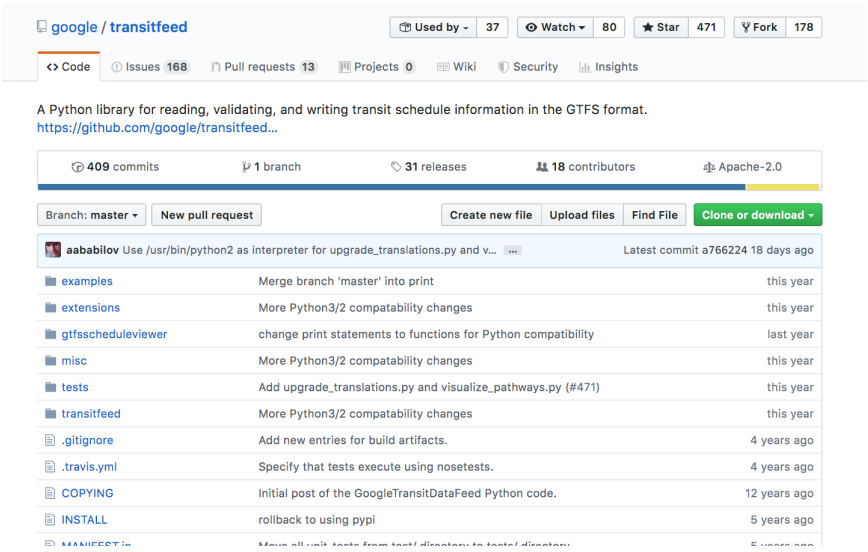

Figure C1: Transitfeed GitHub repository screenshot

- An example

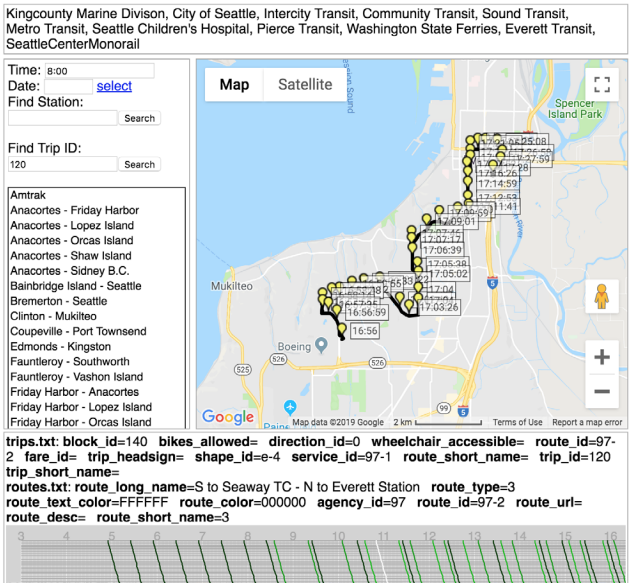

Figure C2: Transitfeed ScheduleViewer example screenshot

- More information: https://github.com/google/transitfeed

GTFS Official web

- More information: https://gtfs.org/

Google GTFS samples

- More information: https://developers.google.com/transit/gtfs-realtime/examples/python-sample

Appendix D. System Design

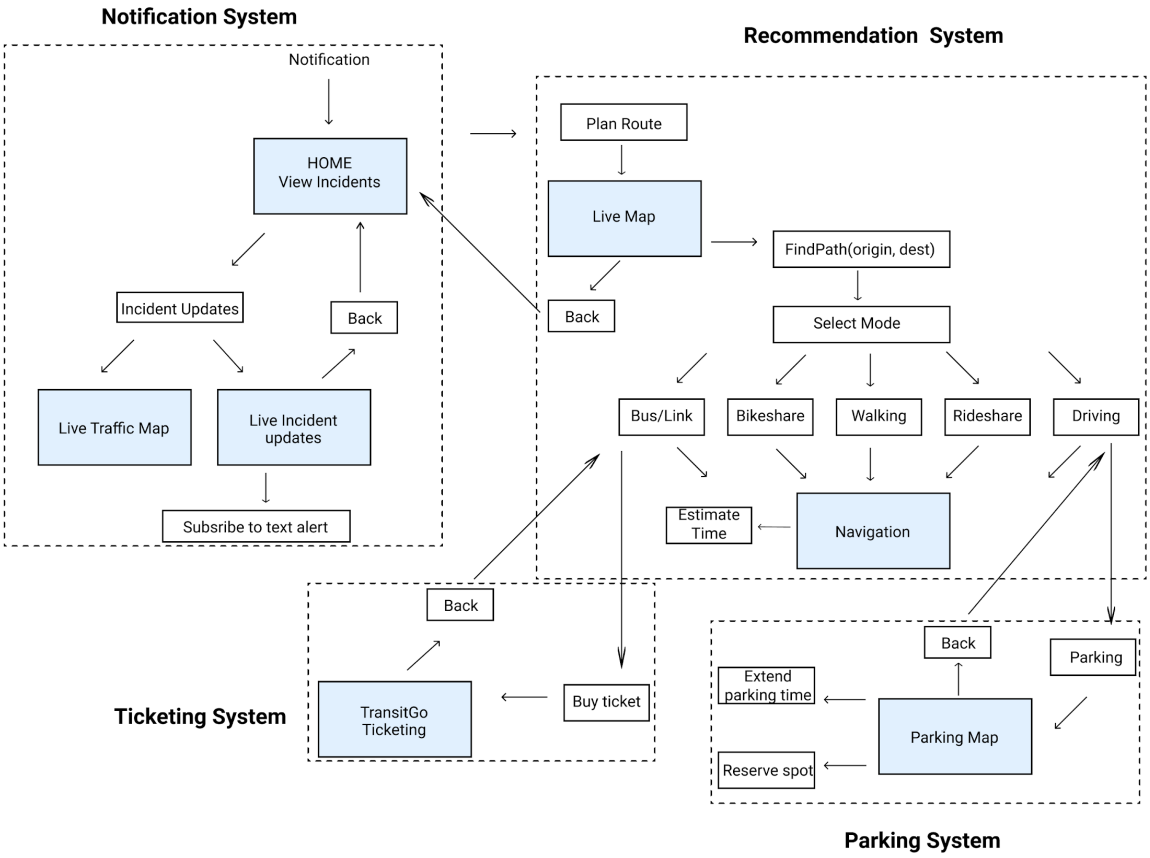

Figure D1: Recommended System Design

Appendix E. Design Work

Design Iterations

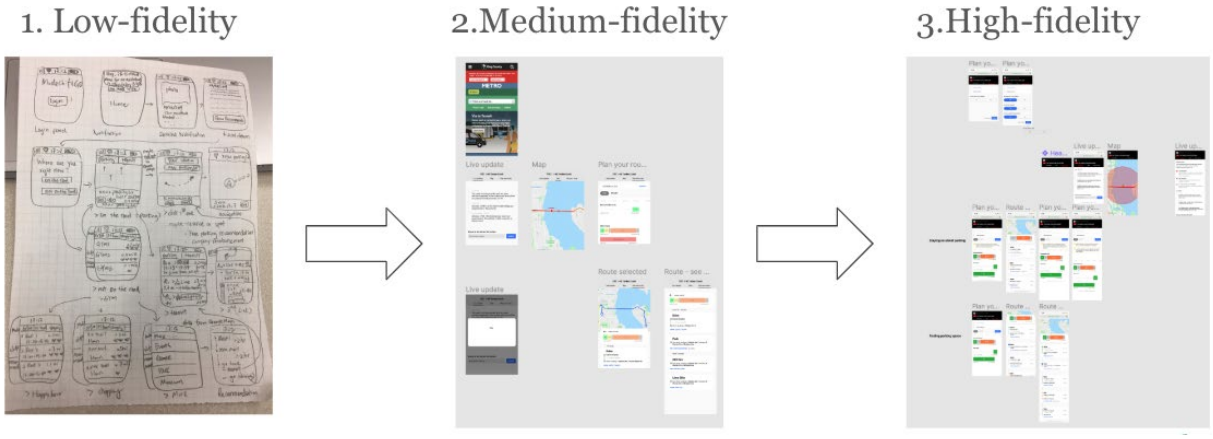

Figure E1: Design Iterations Overview

Mobile & Web High-fidelity Design

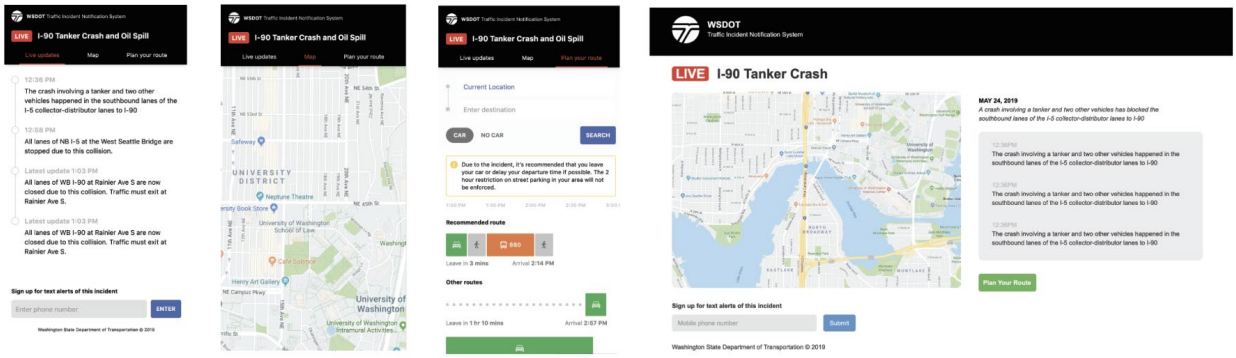

Figure E2: Mobile & Web High-fidelity Design Overview

Appendix F. Implementation Work

Implementation Iterations

- 1st Iteration
- 2nd Iteration Code (no server)
- 2nd iteration Code (with server)
- 3rd iteration (Web Design Implement)
- Final Demo (Combined Design and functionalities)

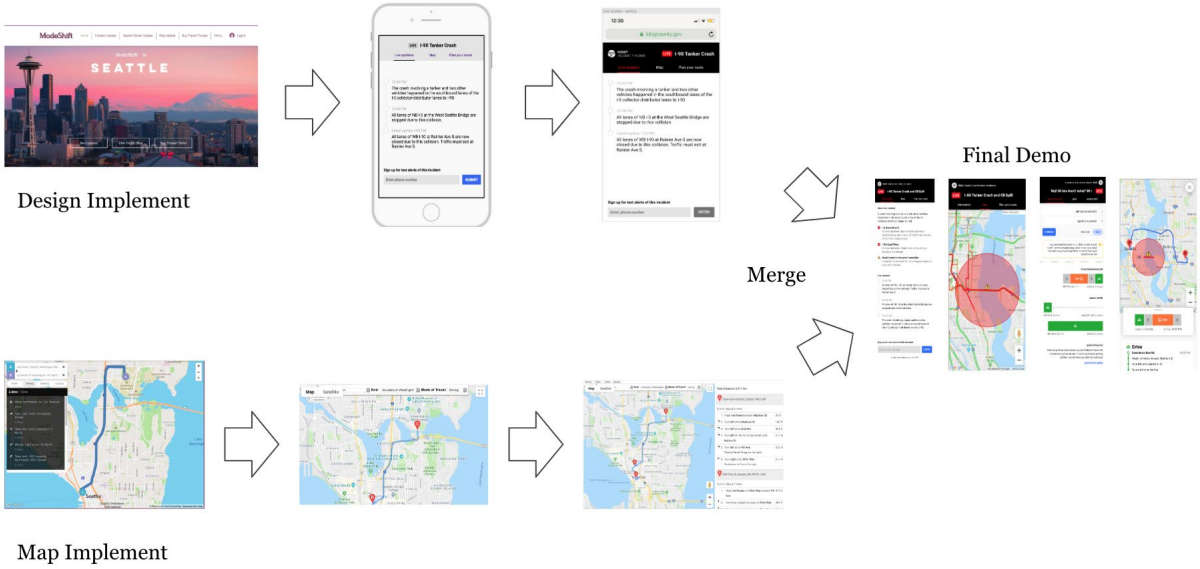

Figure F1: Implementation Iterations Overview

Mobile & Web Map Implementation

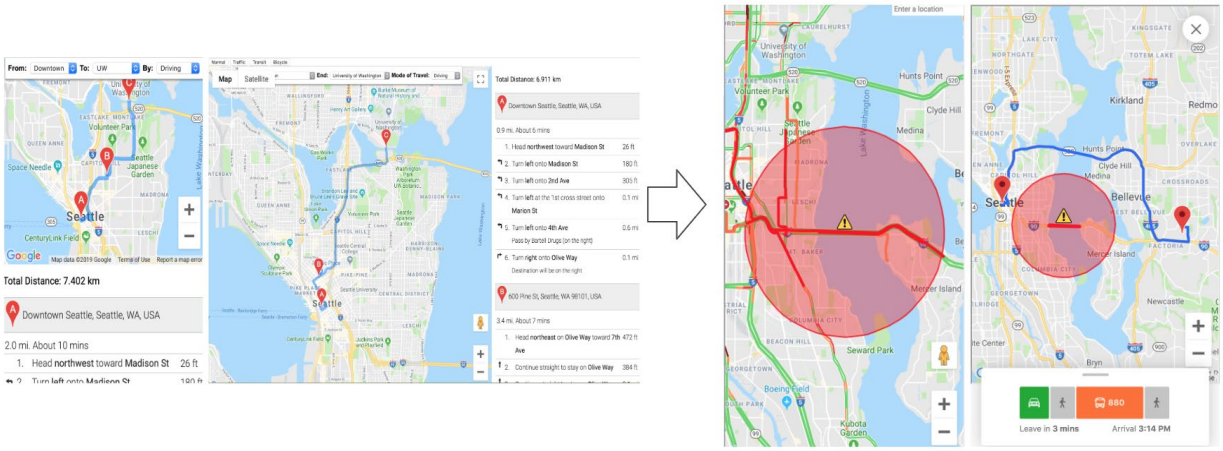

Figure F2: Mobile & Web Map Implementation Overview

Appendix G. Discussion of current solutions and our solution

Current solutions for incident notification

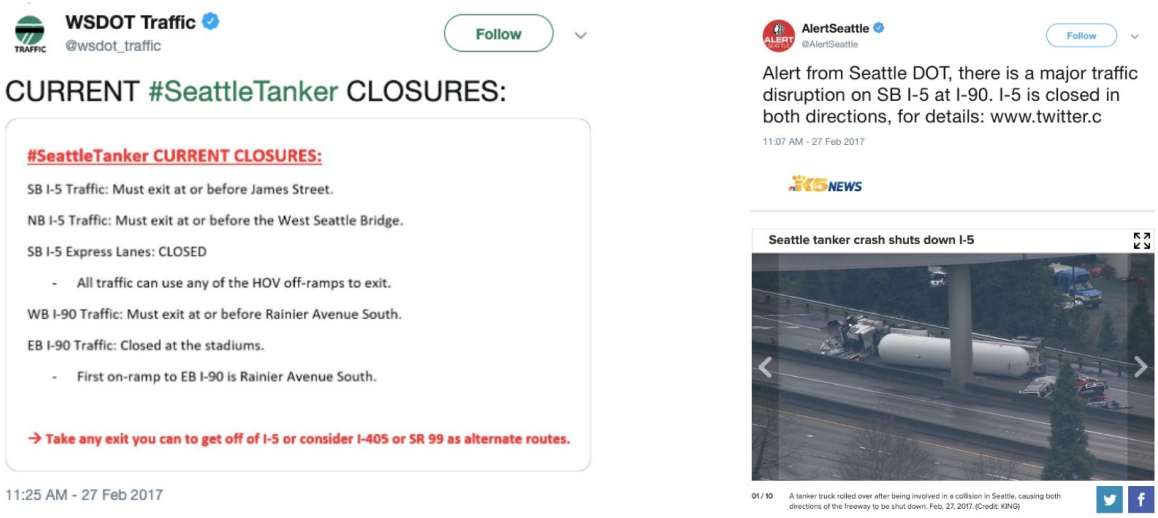

Figure G1: Screenshots of current incident notification solutions

Current solutions for actionable recommendations

	Incident Notification	Trip Planning	Rerouting	Mobile Tickets	Transit Schedule
TransitGo		✓		✓	
OneBusAway				✓	
Google Maps		✓	✓		✓
Puget Sound Trip Planner		✓			✓
WSDOT App	✓	✓			✓

Figure G2: Comparison table of current solution for actionable recommendations

Our Solution

According to all user studies we carried out, we understand the current best solution for users is to check AlertSeattle for incident information and ask Google Maps for routing recommendations. In 2 years 2021, after VCC actually gets working, we would imagine once an incident happens, commuters would go to our website Saia instead. Here is why our solution is better than two of the current best solutions: AlertSeattle & Google Maps:

Why our solution works better than AlertSeattle

First, it provides timely congestion information and incident notification in a well-organized way with our highly intuitive designs.

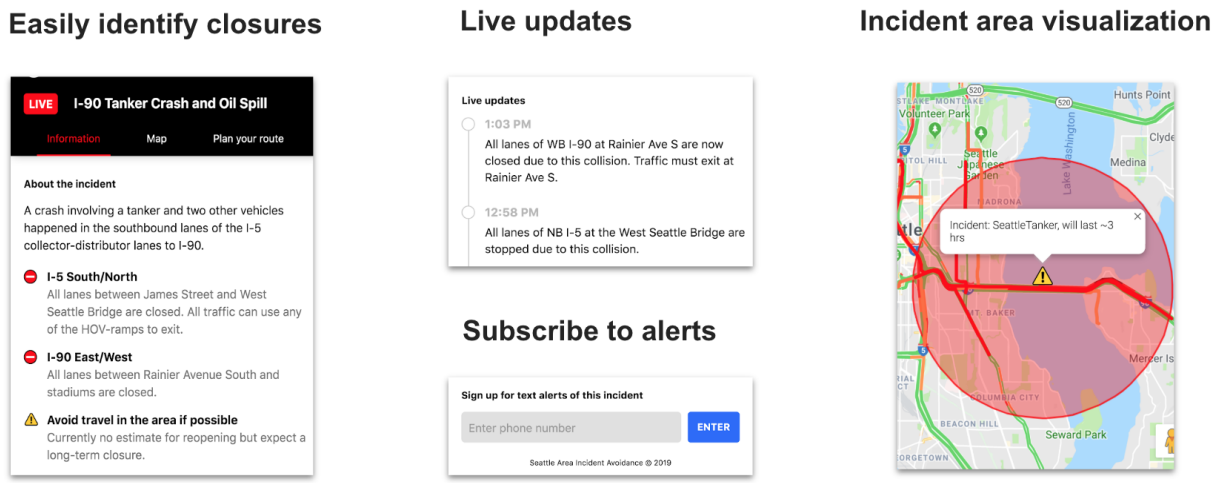

Figure G3: Three places where our solution designed to work better than AlertSeattle

There are three places where our solution is designed to work better than AlertSeattle:

- Easily identifiable road closures;
- Live updates in timeline format & easy subscription for alerts;
- Incident area congestion information visualization.

With this dedicated information page, it gives the general population a clear source of truth during an incident.

Why our solution works better than Google Maps

The second part of our solution is to provide the transportation mode shift.

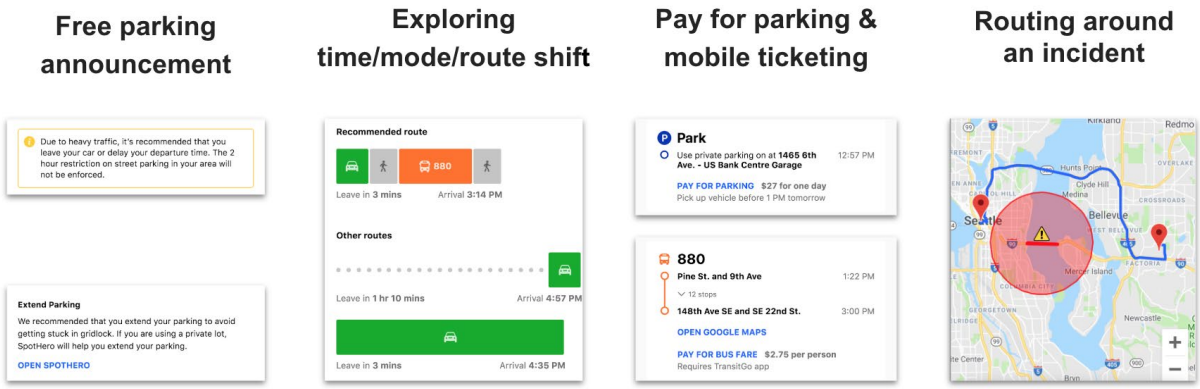

Figure G3: Four places where our solution designed to work better than Google Maps

There are four places where our solution is designed to work better than Google Maps:

- Instantly communicated free parking announcements,
- Options to extend parking,
- Real-time display of transportation options,
- Dynamically personalized parking and transit recommendations,
- Visually intuitive routing directions.

Here, it integrates with SpotHero and Transit GO to support users with easily accessible mobile ticketing and parking services while shifting their transportation modes during unanticipated major congestion scenarios

As you can see, our solution is designed specifically for Seattle areas and will serve as a bridge between commuters and transit agencies. With this user-friendly, Seattle and incident-specific page, it gives the general population a reliable source of guidance to get around an incident.

Therefore two parts as a whole work to enhance mobility and reduce regional traffic delays for major incidents happens once or twice a year.

Appendix H. Tech Stack & Evaluations

Tech Stack for the final demo

1) Design:

- Figma

2) Design Implementation:

- Webflow

3) Map Implementation:

- Google Directions API
- Google Maps JavaScript API
- Google Places API

4) Final Demo:

- HTML5
- CSS3
- JS
- jQuery

5) Tools Used:

- Git
- GitHub
- IntelliJ

Figure H1: Software/APIs for the final demo

Software & Platforms, Pros & Cons

Software & APIs	**Pros**	**Cons**
Wix *Early web design and development*	Easy-to-use template Allows responsive design	Do not allow source code download Restrictions in design
Webflow *Web design & development*	It is great for design Allows source code download Allows responsive design	Steep learning curve Impossible complex code level customizations Unintuitive js event handles and variable names
Proto.io and **Figma** *Prototyping and wireframing*	Allows for real-time collaboration Could be incorporated into the website	Does not allow high-fidelity interactive prototypes
Google Maps API (Maps JavaScript API, Directions API, Places API) *Map and rerouting*	Provides public transit, driving, walking, and biking directions Provides familiar and easy-to-use user interface	Does not allow routing algorithm customizations Relatively expensive plan
Mapbox API *Map and rerouting*	Provides driving, walking, and biking directions Free in general	Does not provide public transit information itself Does not allow routing algorithm customizations More Limitations in map uses

Figure H2: Software & Platforms Evaluation

Appendix I. Traffic Analytics Graphics

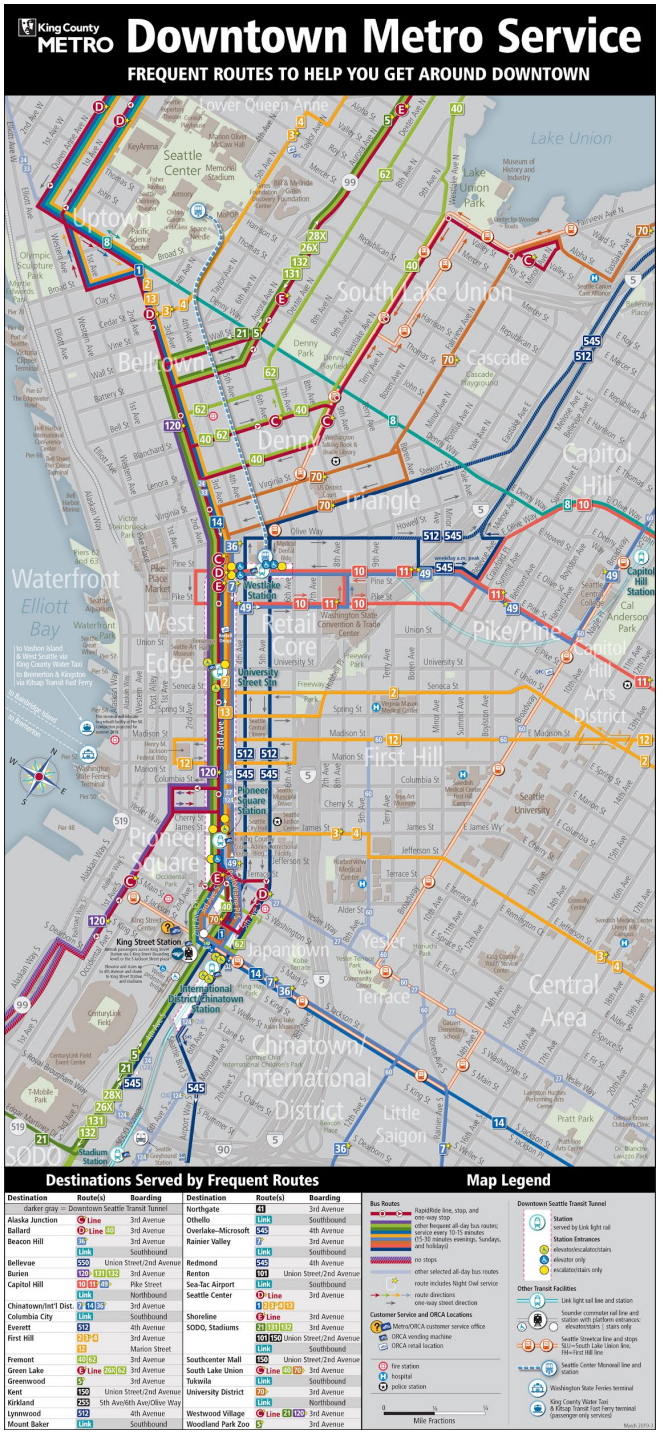

Figure I1: Downtown Metro Service. Source: King County Metro

Low Capacity Links Can be Used for Rerouting

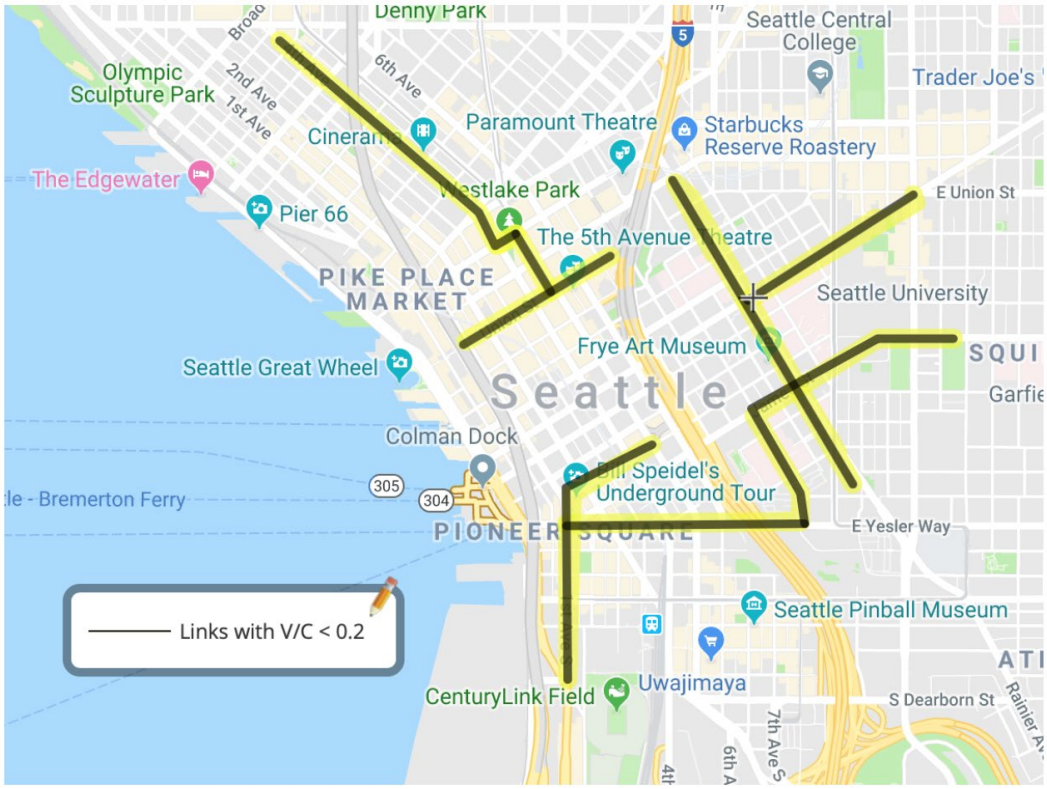

Figure I2: routes with V/C lower than 0.2

Figure I3: Network performance of 2nd and 4th Ave closed for transit only with 100 percent vehicle volume

Figure I4: Network performance of one lane closed for each way in I5 for transit with 100 percent vehicle volume

Figure I5: network performance of 2nd and the 4th street closed for transit only with 70 percent vehicle volume

Figure I6: network performance of one lane closed for each way in I5 for transit only with 70 percent vehicle volume

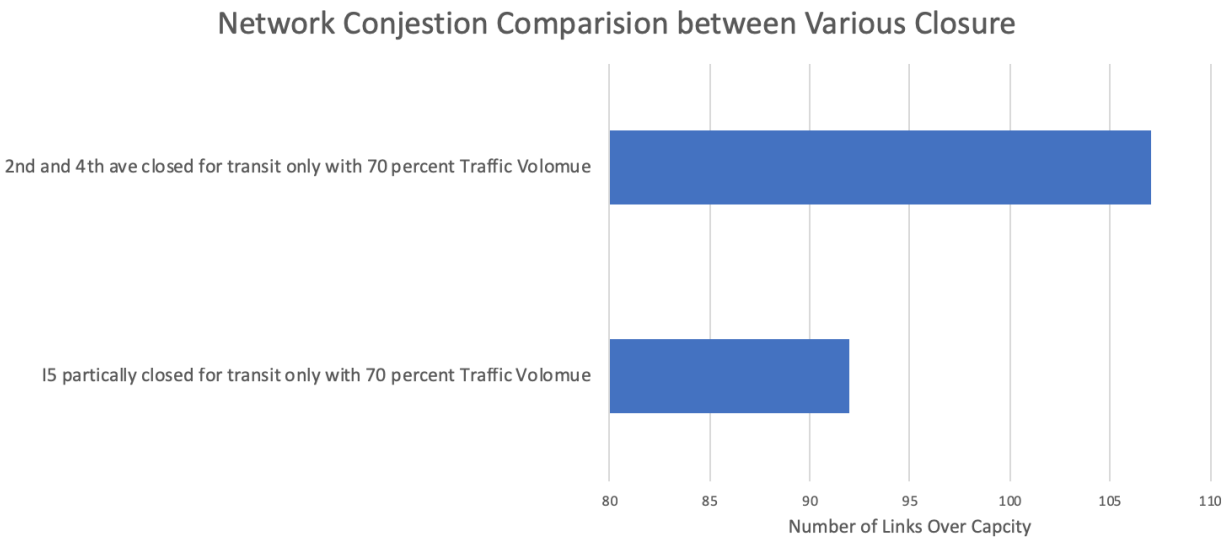

Figure I7: network congestion comparison between various closure

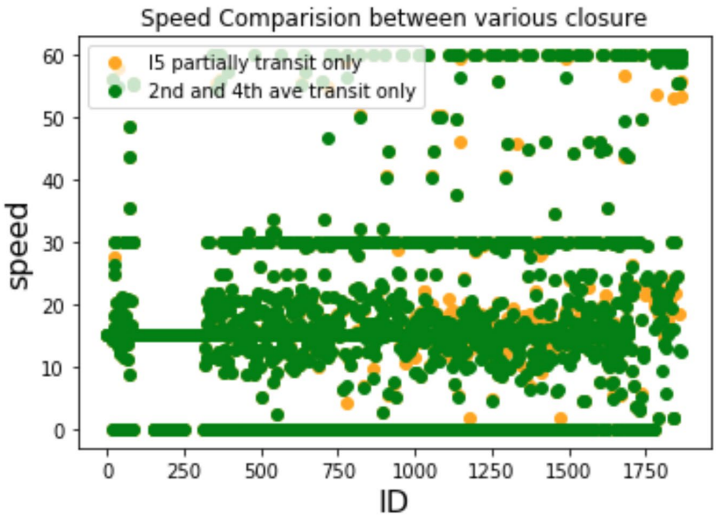

Figure I8: Speed Comparison between various closure

Appendix J. All websites in one place

Web Demo

- DemoWebpage (annykong.github.io/uwcapstone-modeshift/)
- Demo GitHub Repo (Source Code)
- Demo Wikipage (More details about Demo)

Team Web

- Team Webpage | Team GitHub Repo

Map Test

- Map-Test Webpage | Map-Test Repo

Development Iterations

- 1st Iteration Webpage
- 2nd Iteration Commits (no server)
- 2nd Iteration Commits (with server)
- 3rd Iteration Webpage (Web Design)
- Final Demo (Web Design & functionalities)