

## **TEAM 2**

### **Traffic Management Utilizing Drones**



## **INFM 600**

### **Final Project Summary Report**

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## **I. Introduction**

Being informed about the traffic conditions in the area a person lives in, traveling to, or commuting is very useful since it could help them plan or save time by selecting a different route. We wanted to create a mobile application that will inform the users at a new speed about these traffic conditions. With the help of drones that will travel around the city, we will provide fast updates in real-time to city residents through our mobile application. Our product will not only include real-time updates on traffic conditions such as accidents or high levels of traffic, but it will also include construction, city events such as parades, or natural events such as flooding. Our application will provide alternative routes based on the live footage shared through our drones. City residents will also be able to view live streams from the drones traveling around the city. We have planned first to launch this application and the drones in Seattle. However, if this project continues to grow, we hope to launch it in other cities.

## **II. Project Vision**

From the beginning of the semester, we always wanted to center our project towards helping people find out quickly about traffic information. We first thought about focusing on the University of Maryland area since our team comprises University of Maryland students, and we are familiar with the campus. However, before we chose this idea, we consulted with Dr. Wang, and he guided us to choose a large city instead. Looking back, it was a great decision because a large city is where this project could be more practical and reach more people. The brainstorming process of choosing what city to use included choosing a city where the population was growing.

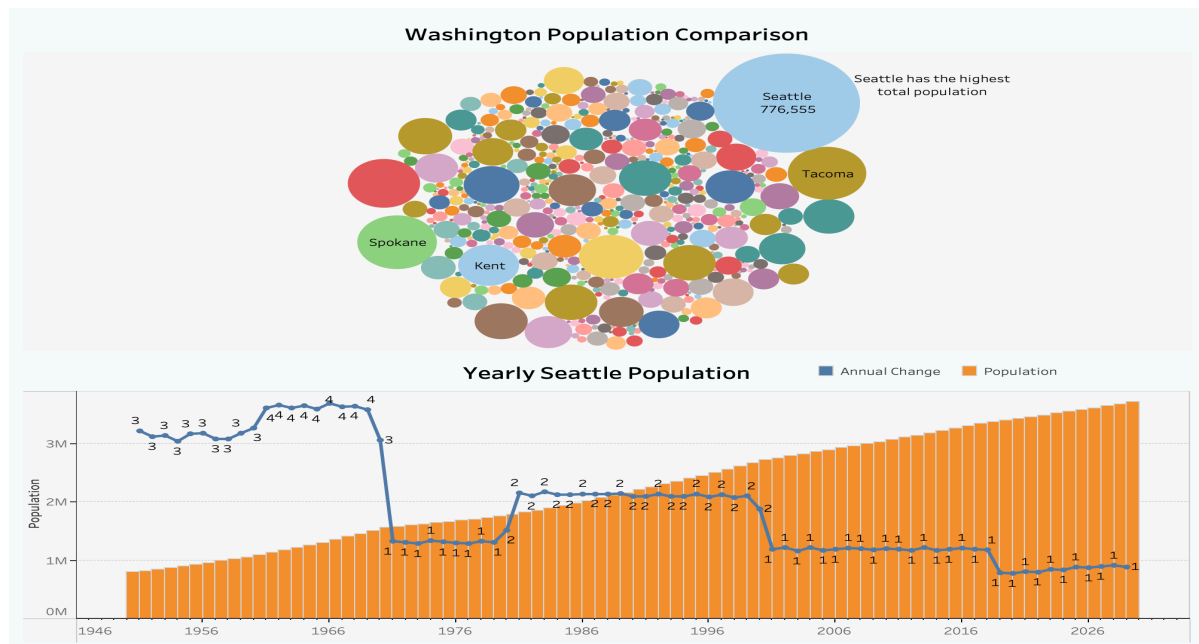
After a group discussion, we considered Charlotte, Austin, and Seattle as final candidates. We then used a website called *macrotrends.net*, which gives statistics on population growth for cities.<sup>1</sup> When we looked at Charlotte, we saw the population growth rate decrease over the past three years, from 2019 to 2021.<sup>2</sup> In Austin, we saw similar results where the population growth

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<sup>1</sup> *Largest cities by population in 2021*. MacroTrends. (n.d.). Retrieved December 14, 2021, from <https://www.macrorends.net/cities/largest-cities-by-population>

<sup>2</sup> *Charlotte Metro Area Population 1950-2021*. MacroTrends. (2021). Retrieved December 14, 2021, from <https://www.macrorends.net/cities/22954/charlotte/population>

rate decreased from 2019 to 2021.<sup>3</sup> However, with Seattle, we saw that the city's growth rate started to increase in the past two years, 2020 and 2021.<sup>4</sup> During this period the population increased by 30,000.<sup>5</sup> This is an optimistic growth for us and this made choosing our target city easier. We created a visualization of this population growth in order to visualize how the population is growing, the bottom Tableau visualization in the image down below shows this.<sup>6</sup> We also wanted to compare the city of Seattle to other potential cities in the state of Washington, we also did this through Tableau using a data source called [worldpopulationreview](https://worldpopulationreview.com). In the top visualization in the image down below, we can see that the largest bubble is for the city of Seattle and this shows that it has the highest population in the state. This removed the doubts that we had about choosing Seattle as our city since we now compared it to other cities in the state.



<sup>3</sup> *Austin Metro Area Population 1950-2021*. MacroTrends. (2021). Retrieved December 14, 2021, from <https://www.macrotrends.net/cities/22926/austin/population>

<sup>4</sup> *Seattle metro area population 1950-2021*. MacroTrends. (2021). Retrieved December 14, 2021, from <https://www.macrotrends.net/cities/23140/seattle/population>

<sup>5</sup> *Seattle metro area population 1950-2021*. MacroTrends. (2021). Retrieved December 14, 2021, from <https://www.macrotrends.net/cities/23140/seattle/population>

<sup>6</sup> *Seattle metro area population 1950-2021*. MacroTrends. (2021). Retrieved December 14, 2021, from <https://www.macrotrends.net/cities/23140/seattle/population>

After finding our target city and learning more about metrics such as the city's population, we then thought about how we would monitor the traffic conditions around Seattle while also providing updates in real-time. We started brainstorming potential ideas on how we could monitor traffic conditions. We came up with the idea of drones that will travel around Seattle, which will be used to see the traffic conditions in places such as highways. We thought drones would be a more easier and feasible option to acquire when it comes to monitoring traffic conditions in comparison to other technologies such as satellites. We have also decided to create our own mobile application and users can use it to view those live streams. The reason why we chose to create our mobile application was to guarantee safety and privacy of the shared information and correctly interpret it. The following section, which is called Research/Data Discovery, goes more in detail about the specifications of these drones. It will also go more in depth about the traffic index in Seattle, the funding of our idea, and information about privacy.

### **III. Research/Data discovery**

#### **A. Drones**

In order to successfully implement the new traffic management system in Seattle, drones were to be selected. After thorough research on many different drones, the team finally narrowed down the option to two different models, DJI Mavic 2 Enterprise and DJI Air S2. These drones were finalized based on their prices and features that fulfill our needs. A brief chart down below shows the specifications of these models, a more in depth explanation is also below this chart.

	<a href="#"><u>DJI Mavic 2 Enterprise</u></a>	<a href="#"><u>DJI Air 2S</u></a>
Price	\$1,200	\$999
Camera	4K Camera with an optical zoom of 2x and 3x	4k video at 60fps and a 5.4k video at 30fps
Flight time	31 minutes	31 minutes
Range	5 miles	18.5 km
Storage	24 GB internal storage	8 GB internal storage

Autopilot Software	<a href="#">DJI GS Pro</a>	<a href="#">APAS 4.0</a>
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When looking at this chart, the similarities between these two drones is that they both feature cameras with 4k level quality and this will be helpful when viewing live streams since they would be shown in excellent resolution. They also both have flight times that are about 31 minutes long. According to *dronethusiast.com*, 20 minutes is a very common flying time for drones.<sup>7</sup> Therefore both drones have a good flying time, which is a feature we wanted, since these drones will be traveling through Seattle. The main feature that both of these drones have is the ability for autonomous flying and this is the main reason why we choose these two drone models. With this feature, we wouldn't have to manually control every drone we deploy in Seattle. This allows our team to spend more time on other tasks such as monitoring live streams.

However, there are some differences between the drones. One major difference is that the DJI Mavic 2 Enterprise is an enterprise model and in order to obtain this enterprise drone we would need to contact/negotiate a deal with DJI.<sup>8</sup> Whereas the other model, the DJI Air 2S, is a model that is available to everyone.<sup>9</sup> Other notable differences are in price and technology. The first difference is in price, the DJI Air 2S is a cheaper option in comparison to the DJI Mavic 2 Enterprise however the DJI Mavic 2 Enterprise has more advanced technologies that could be useful to our project. For example the DJI Mavic 2 features a camera that has more zoom capabilities than the DJI Air 2S. This could be very useful to us since it could allow our team to see what is going on in roads and highways more up close, which could help us make more accurate decisions. Also the DJI Mavic 2 Enterprise has 24 Gigabytes of storage whereas the DJI Air 2S has 8 Gigabytes of storage. While we currently do not need the extra storage since these drones will only be used for live streams, it could potentially be used in the future if we ever

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<sup>7</sup> Martinez, K. (2021, June 7). *Best drone with longest flight time [June 2021] longest flying drones*. Dronethusiast. Retrieved December 14, 2021, from <https://www.dronethusiast.com/best-drones-with-longest-flight-times/>.

<sup>8</sup> *Mavic 2 enterprise series - DJI*. DJI Official. (n.d.). Retrieved December 14, 2021, from <https://www.dji.com/mavic-2-enterprise>

<sup>9</sup> *Buy DJI air 2s*. DJI store. (n.d.). Retrieved December 14, 2021, from [https://store.dji.com/product/dji-air-2s?site=brandsite&from=buy\\_now\\_bar&vid=104122](https://store.dji.com/product/dji-air-2s?site=brandsite&from=buy_now_bar&vid=104122)

wanted to store and collect data about live streams. The last difference is in autopilot software, both drones feature different autopilot softwares. The DJI Air 2S features APAS 4.0 and the DJI Mavic 2 Enterprise features DJI GS Pro. Both softwares have the ability for autonomous flying however the DJI GS Pro has features that upgrade the experience of using an autonomous flying drone.<sup>10</sup> For example the DJI GS Pro has an iPad app where you can create pre planned routes through the app and data about the drone flights are also available on the cloud.<sup>11</sup> Also with the DJI GS Pro app, it makes it easier to view all of the drones and its data directly on the app.<sup>12</sup> This is a very useful tool because it helps make the process of accessing and using these drones much easier.

While the DJI Mavic 2 Enterprise is our first choice when it comes to selecting a drone, we understand that trying to contact and negotiate a contract with DJI may not work out. Therefore, while the DJI Air 2S may not have the same technologies that the DJI Mavic 2 Enterprise has, we believe it is still a great option and it is sufficient for our needs due to the main task of these drones is to record highways/roads.

## **B. Traffic Index and Population**

Our team also researched the traffic index and population density for each city area in Seattle to get a better idea of how using drones can help improve the current traffic situation. Based on our research, we noticed that the days where the traffic congestion is the worst is on Wednesdays, Thursdays and Fridays.<sup>13</sup> This is especially in the mornings and the evenings,

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<sup>10</sup> *Dji GS Pro - DJI*. DJI Official. (n.d.). Retrieved December 14, 2021, from <https://www.dji.com/ground-station-pro?site=enterprise&from=nav>

<sup>11</sup> *Dji GS Pro - DJI*. DJI Official. (n.d.). Retrieved December 14, 2021, from <https://www.dji.com/ground-station-pro?site=enterprise&from=nav>

<sup>12</sup> *Dji GS Pro - DJI*. DJI Official. (n.d.). Retrieved December 14, 2021, from <https://www.dji.com/ground-station-pro?site=enterprise&from=nav>

<sup>13</sup> *Seattle Traffic Report: Tomtom traffic index*. report | TomTom Traffic Index. (n.d.). Retrieved December 14, 2021, from [https://www.tomtom.com/en\\_gb/traffic-index/seattle-traffic/](https://www.tomtom.com/en_gb/traffic-index/seattle-traffic/)

which is usually the time people are going/leaving work.<sup>14</sup> We have noticed there has been a decrease in traffic during the year 2020 due to the pandemic but there has been an increase in congestion from 2020 to 2021.<sup>15</sup> We also researched the areas that usually have the worst traffic, which happened to be the same congested spots. These spots were Denny Way, between First and Fairview avenues, I-5 through downtown, Intersection at First and Columbia that leads to S.R. 99 on-ramp, Downtown on-ramps to I-5 at Yale Street, Sixth Avenue between James and Columbia streets, and Mercer Street from Seattle Center to I-5.<sup>16</sup> The evidence suggests there will be an increase in traffic in the year 2022 and the way we will respond to this situation is by having our drones spend more time in these congested spots to monitor the traffic conditions. We hope that the deployment of our drones helps the congestion significantly.

### **C. Funding**

When it comes to how we will fund our project, we have two plans. The first plan would be to work together with the city/local government or DJI. We hope they will support our project by having a partnership or contract with them. Another plan would be solely relying on our start-up funds from our team and the app revenue itself. We decided to have a free version of the app for the first two years. The free version would have advertisements as our primary revenue generator. We concluded that we could earn more revenue from our research by deploying a free version rather than a paid version in those first five years. Our advertisements in the app would earn approximately \$1.6 per user in a day. After two years, depending on our current revenue and user feedback, we might add a paid version where users can opt out of the ads on their app and access special features. The user would need to pay \$4.99 per month with this paid version. This would allow us to scale the company in the future. We project that the revenue we will get is \$123,520 per month or \$1,482,240 per year.

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<sup>14</sup> *Seattle Traffic Report: Tomtom traffic index*. report | TomTom Traffic Index. (n.d.). Retrieved December 14, 2021, from [https://www.tomtom.com/en\\_gb/traffic-index/seattle-traffic/](https://www.tomtom.com/en_gb/traffic-index/seattle-traffic/)

<sup>15</sup> *Seattle Traffic Report: Tomtom traffic index*. report | TomTom Traffic Index. (n.d.). Retrieved December 14, 2021, from [https://www.tomtom.com/en\\_gb/traffic-index/seattle-traffic/](https://www.tomtom.com/en_gb/traffic-index/seattle-traffic/)

<sup>16</sup> *Worst traffic spots in Seattle*. Seattle Magazine. (2018, November 27). Retrieved December 14, 2021, from <https://seattlemag.com/article/worst-traffic-spots-seattle>



We will also have our own team, which will consist of 5 people. This team will have a mobile developer, a back end developer, systems administrator, and two people who will be involved in drone monitoring/support. When it comes to the developers, they will be responsible for building, implementing and maintaining the application. The systems administrator will be in charge of the design, installation, maintenance, and optimization of the servers for our mobile application. Whereas the two people who will be involved in drone monitoring and support will watch the streams while also troubleshooting any problems the drones run into. When it comes to salaries, we will use the ad revenue to pay our employees. The salaries will depend on the role and how demanding that role is. For example the two developers would be paid around \$70,000 to \$80,000 each since they have the demanding role of building and maintaining our mobile application. This salary level was created based on the average salary of a software engineer in the Seattle area, which according to *salary.com*, is \$78,634.<sup>17</sup> The hiring criteria that we have for our developers is a bachelor's degree in Computer Science and some experience developing mobile applications. When it comes to our server administrators, they would get a salary of around \$60,000 to \$65,000. This salary was based on the average salary of a system administrator, which according to *payscale.com* is \$63,368 per year.<sup>18</sup> The hiring criteria for our server administrators would be a bachelors degree in Information Technology or a related field. We would also require some experience when it comes to maintaining and operating servers. When it comes to our drone support/monitors, both of them would get a salary of \$50,000 each. The hiring criteria would be someone who has experience with traffic control since the role would be about monitoring traffic conditions. We would also prefer if they lived in the Seattle area for at least 5 years as well since they would have experience understanding the daily patterns of Seattle traffic. We based the salary of our drone support/monitors based on the average salary of traffic controllers since their tasks are similar to what our drone

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<sup>17</sup> Salary.com, S. built by: (n.d.). *Software engineer I salary in Seattle, WA*. Salary.com. Retrieved December 14, 2021, from <https://www.salary.com/research/salary/benchmark/software-engineer-i-salary/seattle-wa>

<sup>18</sup> *Average systems administrator salary*. PayScale. (n.d.). Retrieved December 14, 2021, from [https://www.payscale.com/research/US/Job=Systems\\_Administrator/Salary](https://www.payscale.com/research/US/Job=Systems_Administrator/Salary)

support/monitors will do and according to zippia.com, the average salary is \$47,000 a year.<sup>19</sup> Therefore the total cost of hiring the employees would be around \$325,000.

We will also need funding in regards to equipment as well. We will need a computer that will act as a server for our mobile application. Also every team member will need their own laptop in order to do their tasks and our two drone support/monitors need a tablet as well. The reason why our two drone support/monitors need a tablet as well is for drone applications such as the DJI GS Pro that are only available on a tablet such as an iPad.<sup>20</sup> In regards to operating systems, we will be having both Windows and Mac OS computers for our employees just in case if an employee has a preference for a specific operating system. We selected four laptop models that we believe are well equipped to complete the tasks for our team and a tablet model for our drone support/monitors. We also selected a computer that will act as a server as well. Below is a chart that shows the models of the equipment we will provide, the price of each device, and the quantity of each device. The total funding cost of all the equipment we need would be \$11865.95.

Device	Price	Quantity
<a href="#">Dell XPS 13</a>	\$1519.99	1
<a href="#">Apple MacBook Pro M1 chip (13 inch)</a>	\$1499.99	3
<a href="#">Lenovo ThinkPad P15 Gen 2</a>	\$1759.00	1
<a href="#">HP Spectre X360 (15 Inch)</a>	\$1399.99	1
<a href="#">Apple iPad Air</a>	\$599	2
<a href="#">Dell Precision 3450 Small Form Factor Workstation (server)</a>	\$1,489.00	1

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<sup>19</sup> *Average Traffic Controller Salary*. Zippia. (2021, August 18). Retrieved December 14, 2021, from <https://www.zippia.com/traffic-controller-jobs/salary/>

<sup>20</sup> *Dji GS Pro - DJI*. DJI Official. (n.d.). Retrieved December 14, 2021, from <https://www.dji.com/ground-station-pro?site=enterprise&from=nav>

## D. User Privacy

Since drones fall into new and advanced technology, the FAA has not finalized its privacy laws.<sup>21</sup> Also since we plan to use drones for traffic management, we expect not to have many restrictions. Based on the current Seattle law, drones can fly within the city as long as they have proper permits and licenses.<sup>22</sup> The permit is called the *City of Seattle Film Permit* and is needed if we want the drones to fly over places such as city streets and city parks.<sup>23</sup> These are regulations that we will follow and we will first apply for these permits before deploying our drones. Since privacy is a core value to our team, we also developed our own privacy rules that are designed for our team to follow as well. We looked at sources such as [faa.gov](https://www.faa.gov), and tried to incorporate some of the same rules the agency has for themselves. For example we tried to incorporate some of the details from the FAA's *Privacy Act of 1974*, most notably the ability to request access to your information.<sup>24</sup> We will also give our users the right to access the data that we collect about their usage. Also as an extra step to make sure our user's privacy is protected, personal information will be encrypted. Members of our team will also not be able to access user information such as their names and home addresses. Therefore even though we will collect data on traffic patterns and usage, team members will not be able to identify a specific user. Another

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<sup>21</sup> 91.7 WVXU | By Ann Thompson. (2020, October 12). *As drones become more common, privacy concerns arise*.

WVXU. Retrieved December 14, 2021, from

<https://www.wvxu.org/local-news/2020-10-12/as-drones-become-more-common-privacy-concerns-arise>

<sup>22</sup> *Commercial filming use of UAS (drones)*. Commercial Filming Use of UAS (Drones) - filmandmusic. (n.d.).

Retrieved December 14, 2021, from

[https://www.seattle.gov/filmandmusic/film/film-permits/uas-\(drone\)-use#:~:text=Hobbyist%20drone%20use%20can%20operate,Municipal%20Code%20\(SMC\)%2012A](https://www.seattle.gov/filmandmusic/film/film-permits/uas-(drone)-use#:~:text=Hobbyist%20drone%20use%20can%20operate,Municipal%20Code%20(SMC)%2012A)

<sup>23</sup> *Commercial filming use of UAS (drones)*. Commercial Filming Use of UAS (Drones) - filmandmusic. (n.d.).

Retrieved December 14, 2021, from

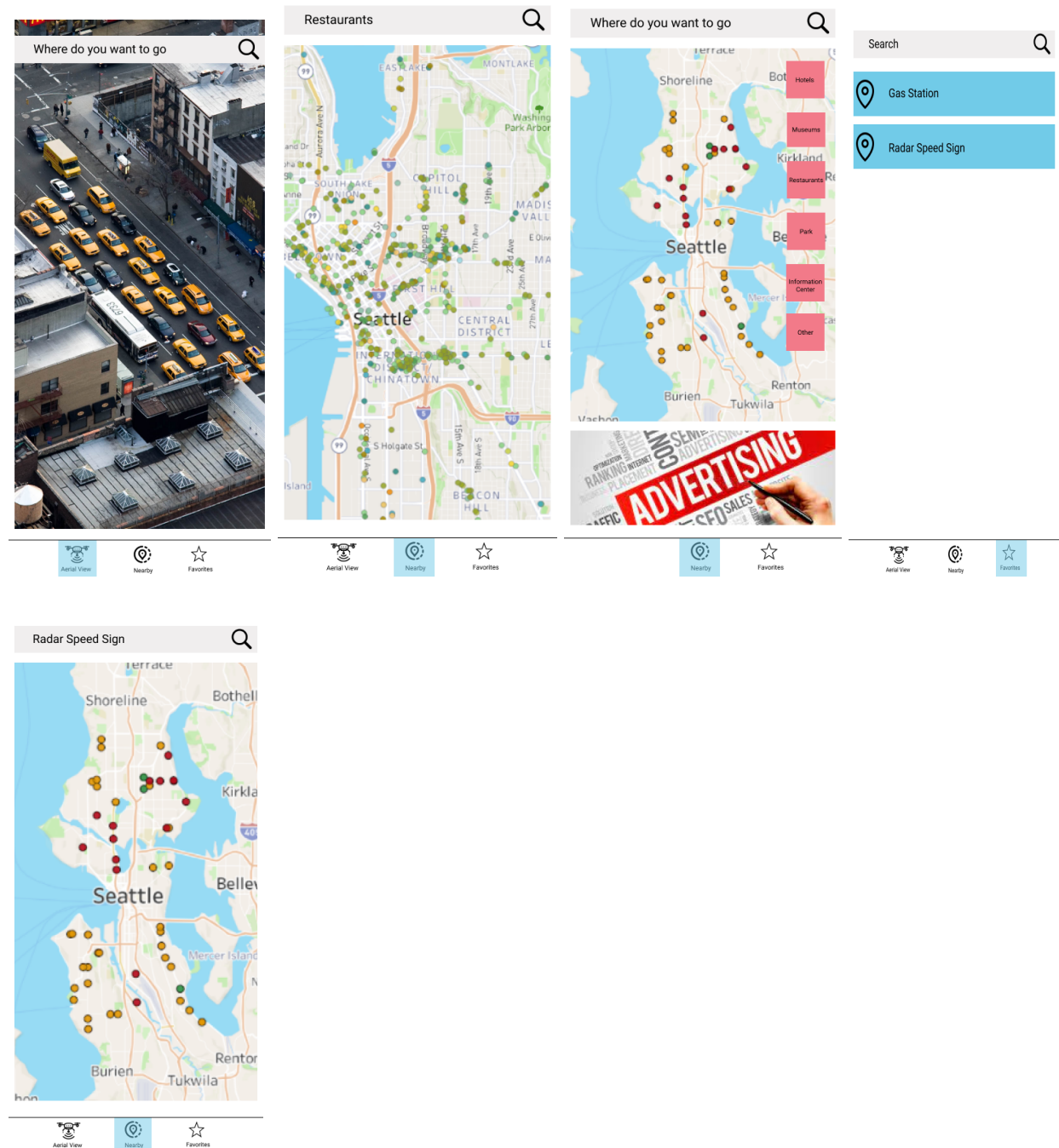
[https://www.seattle.gov/filmandmusic/film/film-permits/uas-\(drone\)-use#:~:text=Hobbyist%20drone%20use%20can%20operate,Municipal%20Code%20\(SMC\)%2012A](https://www.seattle.gov/filmandmusic/film/film-permits/uas-(drone)-use#:~:text=Hobbyist%20drone%20use%20can%20operate,Municipal%20Code%20(SMC)%2012A)

<sup>24</sup> *FAA Privacy and Website Policy*. Federal Aviation Administration (FAA). (2020, April 8). Retrieved December

14, 2021, from [https://www.faa.gov/privacy/#privacy\\_act](https://www.faa.gov/privacy/#privacy_act)

step we took in order to protect user privacy is deciding to create our own mobile application, instead of outsourcing this task to a third company. By doing this, it lowers the amount of data that is shared with companies that are outside our team and it gives us more control of what is going on in our mobile application. As stated previously, privacy is a core value for our team, and we believe these steps would help make sure user privacy is protected.

#### IV. Project Development



To ensure we are able to showcase the appearance of the mobile application once it is developed, a simple prototype was created. This prototype shows some features and capabilities that differ from other mobile maps. One of them is the Aerial View which shows the live stream video from the closest drone's location. This feature will help users see how the current road condition or environment looks before starting their trip. This feature will give them a visible view if there has been any recent accident or any other road situations that ordinary maps do not usually show. They would be able to zoom in or zoom out as well as pause or resume. Our map is flexible since we would always update its features based on the current event/situation. For instance, during the pandemic, the map would have the ability for users to pick what type of services that restaurants near them are open for. They can filter restaurants according to the services they offer like dine-in, pick up, drive-thru, and others.

Moreover, the drones would detect if there was an accident or a construction area, predict the traffic and let the users know, and show a different route to their destination before the traffic actually occurs. We have used the data from Seattle's population, Radar speed signs, and Washington's population to make sure the drones know which areas to concentrate. We have used these as our base data to create the app.

Each screen on our app will have a search bar for users to type their destination address. However, we will just have the main advertising section on the home page.

In order to implement this prototype, we need a team consisting of developers that would be building and maintaining our application and analysts to view the live streams and make updates on traffic conditions. Our team would use the computers to code the application, monitor the live streams of the drones, and provide updates on traffic conditions.

## **V. Appendix: Project Artifacts in Github**

Related Documents, Tableau visualizations, prototypes, and presentations are available on Github using the following link, <https://github.com/nisaputri/INFM600-TEAM2>. An appendix is provided down below, which provides information about the related artifacts.

1. ReadMe File
2. Project Proposal
3. Road Map
4. Research Materials

5. Tableau Visualizations
6. App Prototype
7. Final Summary Report
8. Team Project Presentation
9. Main Project Data Sources
  - a. <https://data.seattle.gov/>
  - b. [https://www.seattle.gov/Documents/Departments/SDOT/About/DocumentLibrary/Reports/2020\\_Traffic\\_Report.pdf](https://www.seattle.gov/Documents/Departments/SDOT/About/DocumentLibrary/Reports/2020_Traffic_Report.pdf)