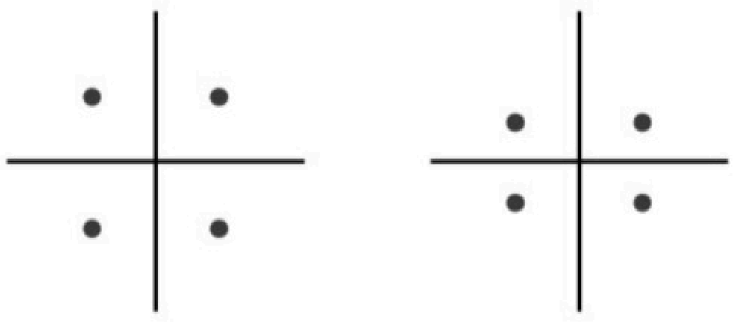
①

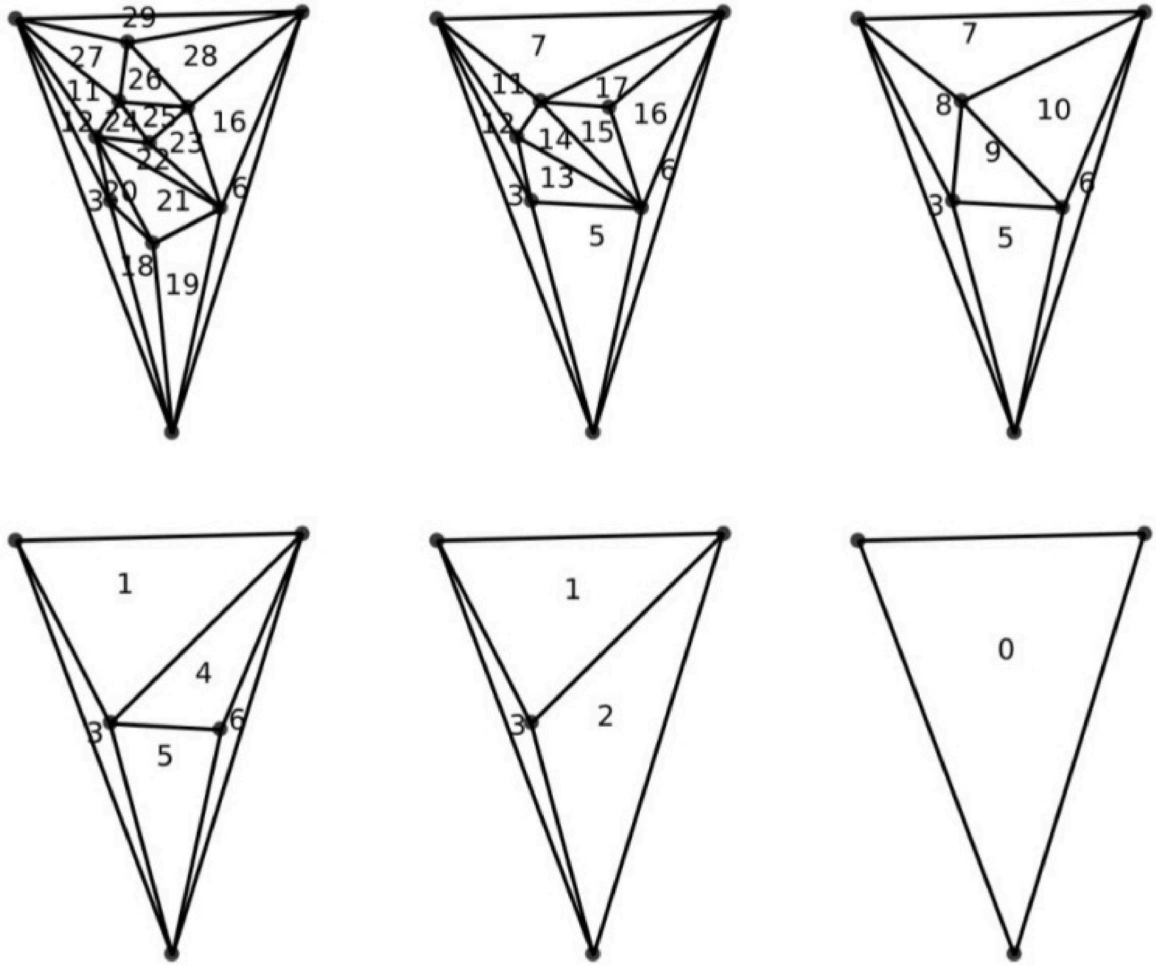
As shown below, this example shows how a Voronoi diagram may correspond to different point sets



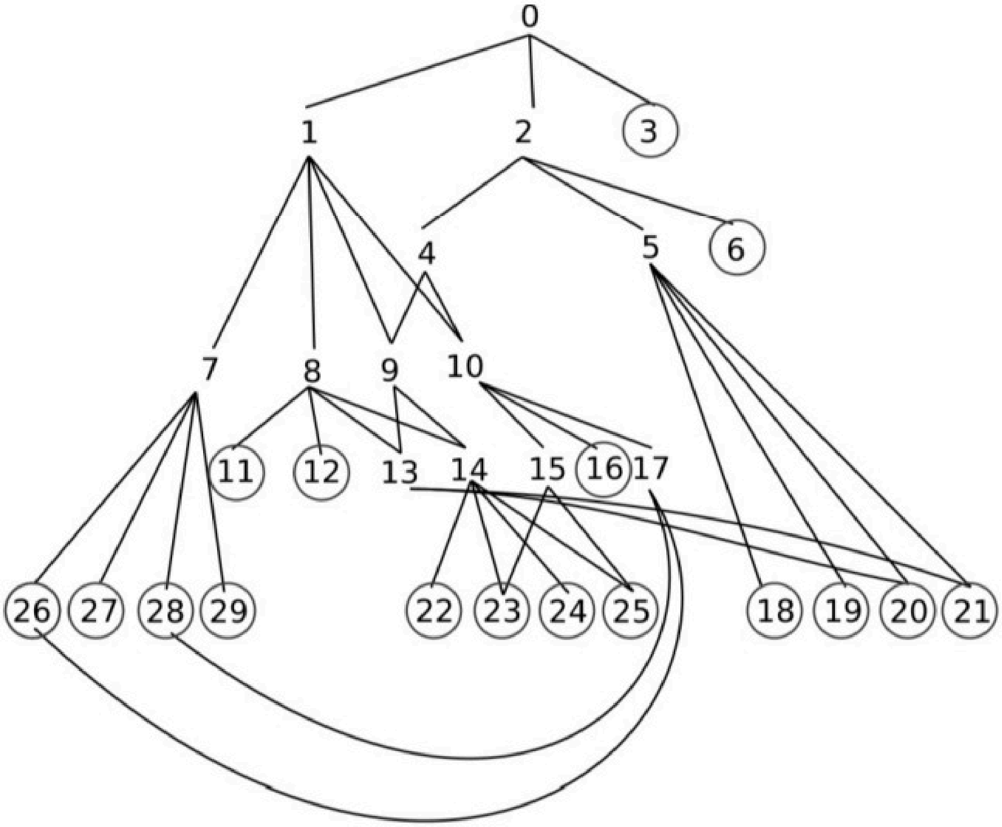
We can accordingly give the conditions for a Voronoi Diagram to have a unique pointset:
If a Voronoi Diagram cannot coincide with itself under a scaling transformation or a compression transformation in any direction, then the corresponding point set is unique.

②

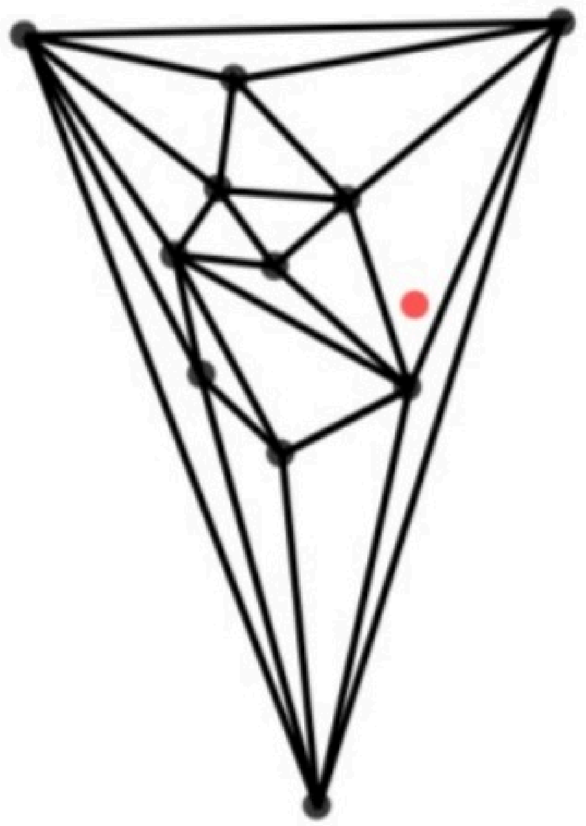
The sequence of triangulations is shown in the figure below.



Correspondingly, the directed DAG is shown below.


0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

If the query point is the red point below,



then the nodes to be traversed are 0→2→4→10→16

③

The steps and timelines are listed below.

1. Needs Assessment: The first step is to identify the needs and requirements. This will involve consultations with different stakeholders, including transportation operators, commuters, and government officials. It will take around 2-3 months.

2. Data Collection: The second step is to collect the data for the system. This will include transportation routes, schedules, stops, etc. The estimated timeline is around 3-4 months.

3. GIS System Design: The third step is to design the GIS system. This will involve selecting the appropriate GIS software, data storage solutions, and system architecture. The estimated timeline is around 1-2 months.

4. Data Processing and Integration: The fourth step is to process and integrate the collected data into the GIS system. This will involve data cleaning, geocoding, and data integration. The estimated timeline for this step is around 6-8 months.

5. System Testing and Validation: The fifth step is to test and validate the GIS system. It takes around 1-2 months.

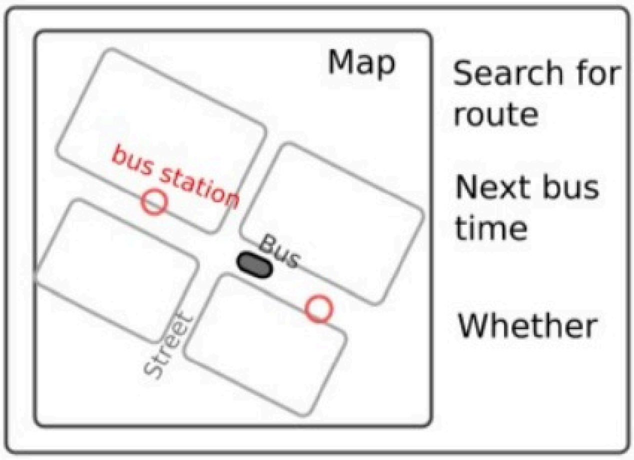
6. Implementation and Deployment: The final step is to implement and deploy the GIS system. It may take around 2-3 weeks.

Some steps may take longer than others. For example, data collection may take longer due to the need to gather data from different sources and formats.

Some functionalities I want to build in are listed below.
1. Real-time tracking of buses and their routes on the map to help passengers to plan their travel routes.
2. Integration of real-time traffic data to predict bus arrival times and provide route suggestions for commuters.
3. Integration of weather data to alert commuters about any potential delays or cancellations of bus services.
4. Application that allows commuters to view real-time bus locations, bus routes, and estimated arrival times.

The mock-up is shown in the following figure.

The user interface



For the client-side, users can use the web browser or a mobile application to use the system. The client-side hardware requirement will be minimal, and the software must be compatible with popular web browsers and mobile platforms such as Android and ios systems.
For the server-side, engineers should use GIS software, database management system, web server, and high-performance computing platform to implement the system.

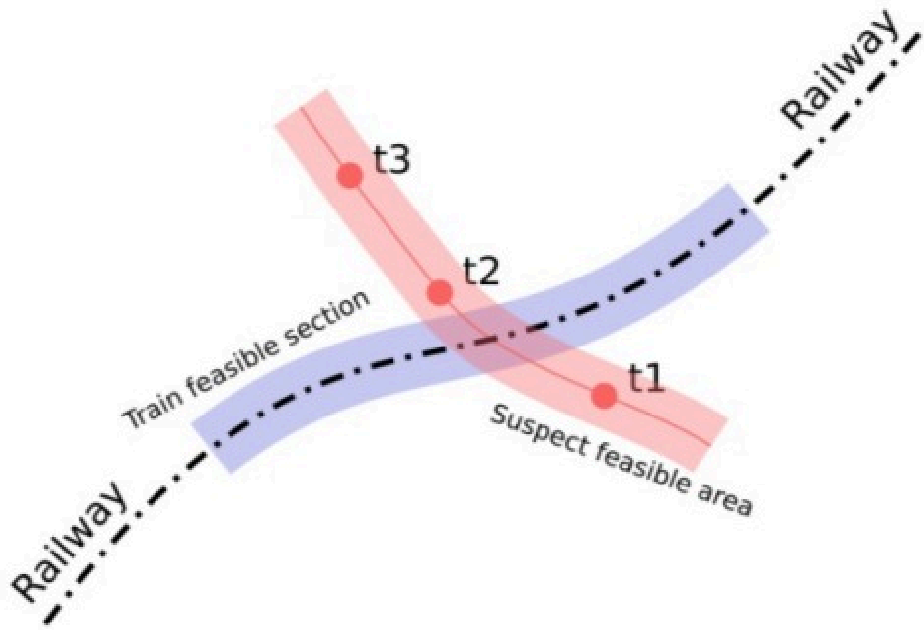
The GIS algorithms such as routing, network analysis and spatial analysis, spatial queries will be used in the system. For example, the routing algorithm is for route planning for users.

The data can be obtained from several sources, such as open data sources, private data sources, and collaborative data collection. Open data sources provide basic geographic information, while Private Data Sources can be a good supplement. collaborative Data Collection is the data provided by some operators or weather service providers, which can provide real-time information to our system.

The functionality of the system will gradually increase until a certain point where it basically meets the needs of the user. At this point, users can easily come to the city and move around freely with the help of this system without the need of a paper map. Users can get real-time information about public transportation, weather, can buy tickets online, etc.

④

Using spatio-temporal GIS, we can create a map of the train's journey and overlay it with the suspect's cell phone data as shown in the figure below.



We can overlay the suspect's movement lines onto the train's path and look for any intersections or close proximity. If we find an intersection or close proximity between the suspect's movement lines and the train's path around the time of the shooting, we can narrow down the suspect's location at that time and focus the investigation on that area.

By calculating the distances and times between the suspect's locations and the train's location at each point in time, we can determine if the suspect had the opportunity to shoot at the train.
We can also use the map to identify possible escape routes for the suspect