2025 ICM
Problem D: A Roadmap to a Better City

Background:

Transportation systems can help or harm a city's growth and the lives of its residents. A successful transportation **infrastructure** can attract businesses, schools, tourists, and new residents. The transportation challenges that cities face are complex and intertwined. The various stakeholders (city residents, business owners, suburban residents, commuters, **passthrough** travelers, tourists, etc.) have different needs and priorities within those systems. Often one element or component of a transportation system favors one stakeholder over others therefore creating an interference with other needs of the system. Highways, bus routes, and rail systems can interfere with local city bikers and pedestrians and vice versa when vehicle drivers are delayed by city walkways and traffic lights. Sometimes, the biggest obstacle to effective transportation systems is the city's geography – water (rivers, harbors, streams, drainage runoff) or landforms (hills, ditches, valleys, slopes). Even soil composition and weather conditions can be disruptive.

Situation:

Baltimore, Maryland, USA is a city affected by aging infrastructure and limited transportation options that impact people's lives and hinder its economic growth. Adding to that is the recent collapse of a major bridge (Francis Scott Key Bridge) closing a major highway across its busy harbor. Baltimore has been making plans to improve its transportation network through infrastructure improvement and enhancing its public transportation as a part of its sustainability goals. These goals are based upon identifying, prioritizing, and implementing initiatives such as collaboration between stakeholders, maintaining or updating its physical systems, using data more effectively, and seeking technological advancements that enhance the lives of its residents and visitors.

Baltimore has a bustling port and shipping center along with being located on a major interstate highway (I-95). Several of its passthrough and commuter highways and rail lines block or interfere with streets and neighborhoods making it difficult for city residents to access job opportunities in the shipping industries and for local businesses to transport goods into and

around neighborhoods. Through planning initiatives to repair roads, build bypasses, expand public transit options, and improve access to ports and airports, Baltimore hopes to facilitate commerce and make the city a better place to live, work, and visit.

Recently, through national funding and support, US cities have developed infrastructure plans to remove highways that divide neighborhoods into their downtown areas and seek to replace them in ways that reconnect and revitalize those areas. While the highways allow suburban residents to commute downtown or across the city to their jobs, urban neighborhoods were separated or destroyed in the construction of these highways. Baltimore hopes to reconnect these communities and provide more sustainable communities with more green spaces, better public housing, and opportunities for community entertainment and recreation.

As examples, four transportation issues are outlined in these references:
1. The rebuilding of a collapsed bridge (Francis Scott Key Bridge) in the Harbor.[1]
2. The inadequacy of the minimal public rail systems (MARC, light rail, heavy rail), which connect suburbs that already have several transportation options. The rail transits are not substantial enough to enable commuters and residents to easily use the system to get to the workplace and the downtown free buses primarily help tourists and not the residents of intercity communities.[2]
3. Planning for fixing the disruption over decades on urban communities by US-40 (Highway to Nowhere) through the collaborative West Baltimore United Project.[3]
4. A travelogue of a resident of Brooklyn (community in Baltimore) and his ordeal of trying to use buses to get home after attending a football game in the city.[4]

Requirements:

All of Baltimore's transportation plans affect multiple stakeholders with differing perspectives. Your team's assignment is to improve the lives of the city's residents by recommending ways to improve Baltimore's transportation network.

A file with vehicle counts on **street segments** is provided. Creating transportation networks for Baltimore or one of its areas and communities will help you visualize and understand the issues. Therefore, you should build a network model(s) for some part or element of Baltimore's transportation system.

Using your model, consider projects related to these transportation issues:
1. The collapse of the Francis Scott Key Bridge had a large impact on the transportation system of Baltimore. What does your network model(s) show is the impact of the bridge collapse and/or the reconstruction of the bridge? Be sure to highlight the impacts on the various stakeholders in and around Baltimore.

2. Many residents of the City of Baltimore walk or travel by bus. Select a project or potential project that impacts the bus or pedestrian walkway systems. What does your network model(s) show is the impact of this project? Be sure to highlight the impacts on the various stakeholders in and around Baltimore.
3. Recommend a project for the transportation network that best improves the lives of the residents of Baltimore.
   a. What are the benefits to residents of this project?
   b. How does your project impact other stakeholders?
   c. Explain the ways that your project disrupts other transportation needs and people's lives.

Share Your Insights
- Safety is a significant issue facing the City of Baltimore. How can the transportation system be used to best address this issue?
- Write a one-page memo to the Mayor of Baltimore describing two of your projects, including the benefits and drawbacks on the people and their safety in the city.

Your PDF solution of no more than 25 total pages should include:
- One-page Summary Sheet.
- Table of Contents.
- Your complete solution.
- One-page memo
- References list.
- AI Use Report (If used does not count toward the 25-page limit.)

Note: There is no specific required minimum page length for a complete ICM submission. You may use up to 25 total pages for all your solution work and any additional information you want to include (for example: drawings, diagrams, calculations, tables). Partial solutions are accepted. We permit the careful use of AI such as ChatGPT, although it is not necessary to create a solution to this problem. If you choose to utilize a generative AI, you must follow the COMAP AI use policy. This will result in an additional AI use report that you must add to the end of your PDF solution file and does not count toward the 25 total page limit for your solution.

NEW MCM/ICM: Online Submission Process
The purpose of this article is to assist and guide students and advisors participating in MCM/ICM. In the article, COMAP, provides information about the new online submission process using the new online submission page https://forms.comap.org/241335097294056. You will need your team's control number, advisor id number and your problem choice to complete your submission.

Files provided

These files are provided to assist students with finding data relevant for Baltimore to begin this problem, particularly to build a network model to study these problems. Real data, like that in the sets provided, is often quite messy. For example, many roads in Baltimore not only have a route number identifying them, but also a street name that may change from one section to another. Therefore, the data will require manipulation. Decisions and assumptions about how to manipulate the data are an important part of the modeling process. Moreover, teams are not limited to these data.

2025_Problem_D_Data.zip: This zip file contains all 9 of the data files listed below.

1. **Bus_Routes.csv**:[5] This dataset represents the locations of MTA bus routes within the City of Baltimore as of 2022.
2. **Bus_Stops.csv**:[6] This dataset represents the locations of MTA Bus Stops as of 2022 within the City of Baltimore.
3. **nodes_all.csv**:[7] This dataset represents the locations of tagged geographic attributes by OpenStreetMaps[8] that provide transportation data points in Baltimore. Generally, these are locations where two transportation paths (road, highway, bikeway, walkway, etc.) intersect.
4. **nodes_drive.csv**:[7] This dataset represents the locations of tagged geographic attributes by OpenStreetMaps[8] for car travel. Generally, these are locations where two roads or highways intersect.
5. **edges_all.csv**:[7] This dataset represents the transportation paths between two nodes from the nodes_all.csv dataset.
6. **edges_drive.csv**:[7] This dataset represents the roadways between two nodes from the nodes_drive.csv dataset.
7. **MDOT_SHA_Annual_Average_Daily_Traffic_Baltimore.csv:**[9] MDOT SHA Annual Average Daily Traffic (AADT) data consists of linear & point geometric features which represent the geographic locations & segments of roadway throughout the State of Maryland that include traffic volume information. Traffic volume information is produced from traffic counts used to calculate annual average daily traffic (AADT), annual average weekday traffic (AAWDT), AADT based on vehicle class (current year only) for roadways throughout the State.
8. **Edge_Names_With_Nodes.csv**:[7] This dataset pairs the information from the nodes_all.csv dataset with information from the edges_all.csv dataset to provide street names with nodes.
9. **DataDictionary.csv**: This data file describes the features in each of the data sets provided for this question.

There are many valuable data sets available at: https://baltometro.org/about-us/data-maps/regional-gis-data-center and https://opendata.baltimorecountymd.gov/

Glossary

Passthrough: A place that travelers have to go through to get to their destinations.

Infrastructure: A structure or facility that is used to support or conduct transportation of people or goods

Street segments: virtual edges in a dataset or map of locations of parts (usually with a start point and end point) of a street or road.

References

[1] Rebuild of Baltimore's Key Bridge to start ConstructConnect. Rebuild of Baltimore's key bridge to start. ConstructConnect. 2024 Jan 18. Available from: https://www.constructconnect.com/construction-economic-news/rebuild-of-baltimores-key-bridge-to-start

[2] Reconnecting communities in West Baltimore SCIRP. Reconnecting communities in West Baltimore. SCIRP. 2023 Dec 10. Available from: https://www.scirp.org/journal/paperinformation?paperid=138654

[3] Reconnecting communities in West Baltimore Streets of Baltimore. Reconnecting communities in West Baltimore. Streets of Baltimore. 2024 Jan 15. Available from: https://streetsofbaltimore.com/reconnecting-communities-in-west-baltimore

[4] Transportation equity problems in Baltimore WYPR. With the national spotlight on Baltimore, transportation equity problems shine through. WYPR. 2024 Feb 26.

[5] City of Baltimore. Baltimore Transit Data: Bus Routes [Internet]. Baltimore, MD: City of Baltimore; 2025 [cited 2025 Jan 7]. Available from: https://data.baltimorecity.gov/datasets/d17c836e96324823b989378735b52249_0/about

[6] City of Baltimore. Baltimore Transit Data: Bus Stops [Internet]. Baltimore, MD: City of Baltimore; 2025 [cited 2025 Jan 7]. Available from: https://data.baltimorecity.gov/datasets/baltimore::bus-stops/explore?location=39.285971%2C-76.620462%2C10.70

[7] Boeing, G. 2024. "Modeling and Analyzing Urban Networks and Amenities with OSMnx." Working paper. URL: https://geoffboeing.com/publications/osmnx-paper/

[8] OpenStreetMap contributors. OpenStreetMap [Internet]. [place of publication unknown]: OpenStreetMap Foundation; 2025 [cited 2025 Jan 10].

[9] Maryland Department of Transportation. MDOT SHA Annual Average Daily Traffic (AADT) Locations [Internet]. Baltimore, MD: Maryland Department of Transportation; 2025 [cited 2025 Jan 10]. Available from: https://data.imap.maryland.gov/datasets/maryland::mdot-sha-annual-average-daily-traffic-aadt-locations/explore