2023 TRB AEP40 Network Modeling Student Problem Solving Competition
Problem Description – v1.0

Transportation for the People: Addressing Mobility and Equity through Innovative Planning and Open Data

1. Problem description

One of the primary challenges in designing and managing transportation systems is ensuring equal distribution of transportation outcomes among different individuals and population groups [1][2]. This is crucial as limited access to transportation services restricts people's access to opportunities and resources, which are essential for their well-being and prosperity. The question then arises: how can equity be systematically incorporated into the design and management of our interdependent multimodal transportation systems?

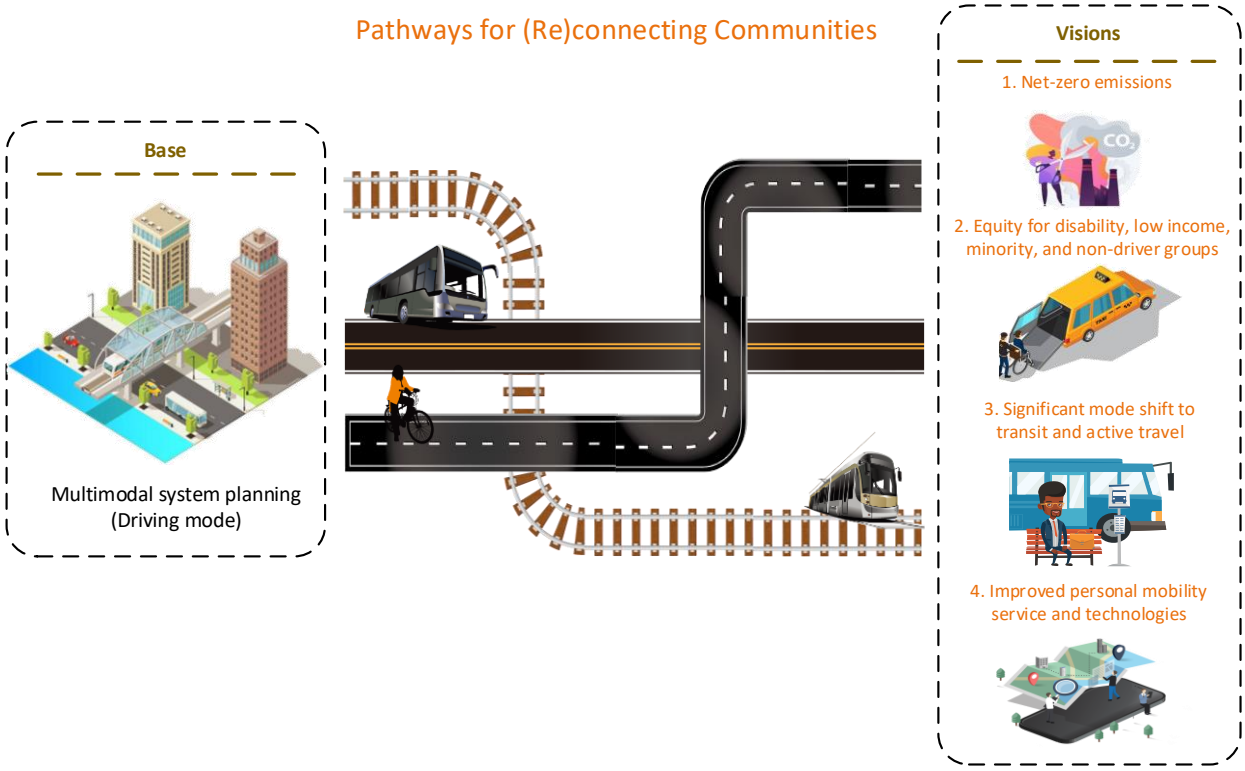

Figure 1. A conceptual framework for equitable multimodal transportation network.

Equity in transportation can be defined in a variety of ways, such as equal access to transit services, sufficient accessibility and mobility for all communities, prioritization of service and resources for disadvantaged groups, and broad engagement during decision processes. It can also be quantified using metrics such as network-wide multimodal accessibility, and interzonal maximum accessibility to name a few. Figure 1 displays the conceptual design of an equitable multimodal transportation network. By addressing these metrics within the transportation planning process at the local, regional, and national

levels, transportation planners and policymakers can better identify areas for investment and improvements, evaluate the potential impacts of planning solutions on communities and groups, and ensure that all communities have equal access to transportation services and opportunities.

The aim of this competition is to promote the development of open-source algorithms and data processing methods for assessing and optimizing equity in multimodal transportation systems. The competition will focus on addressing challenges related to complex interactions between communities and modal transportation subsystems, and design and management of equitable transportation networks that lead to equitable outcomes for all communities. The competition will specifically address one or both of the following areas:

(1) **Equity assessment** that assists transportation agencies in evaluating the equity performance of existing multimodal transportation networks.
(2) **Equity optimization** that facilitates moving transportation agencies from the status quo towards more equitable multimodal transportation network systems.

The goal of this competition is to stimulate innovative ways to define equity problems and address them at the network design level, with an emphasis on a fair distribution of transportation outcomes. Participants will be provided a set of open data set and tools, and they can freely define their research questions within the scope outlined above. Each team must deliver the following:

- A scientific paper in TRB format, consisting of 2-5 pages, which covers detailed research questions, problem formulation, and solution approaches.
- Description of the development process of decision-support tools, including clear open-source license rights and source codes.
- Video showcases that demonstrate the outcomes of the developed solution approaches.

The competition is sponsored by TRB's Standing Committee on Transportation Network Modeling (AEP40), and is organized by

- Cafer Avci (National Electric Vehicle Sweden, NEVS),
- Zhiwei Chen (Drexel University)
- Tierra Bills (University of California, Los Angeles)
- Xuesong (Simon) Zhou, (Arizona State University)

The advisory board, whose members also serve as the judges, includes

- Guy Rousseau (Atlanta Regional Commission)
- Ben Stabler (PTV Group)
- Marty Milkovits (Boston Region Metropolitan Planning Organization)
- Stephen Boyles (University of Texas at Austin)
- Avinash Unnikrishnan (Portland State University)
- Yu (Marco) Nie (Northwestern University)
- Lili Du (University of Florida)
- Joseph Chow (New York University)
- Janille Smith-Colin (Southern Methodist University)
- Yanfeng Ouyang (University of Illinois at Urbana-Champaign)

2. Open-source specification, data and tools

Algorithms and methods developed in this competition should be tested using data from the Atlanta Regional Commission's (ARC) Activity-Based Model (ABM) [4]. This data is publicly available for use in regional transportation planning and includes multiple forecasting tools suitable for planning challenges

[5]. Teams are also encouraged to utilize ARC's publicly available accessibility calculator, which calculates logsum-based accessibility for different time periods, income categories, and auto ownership definitions for each traffic analysis zone pair [6].

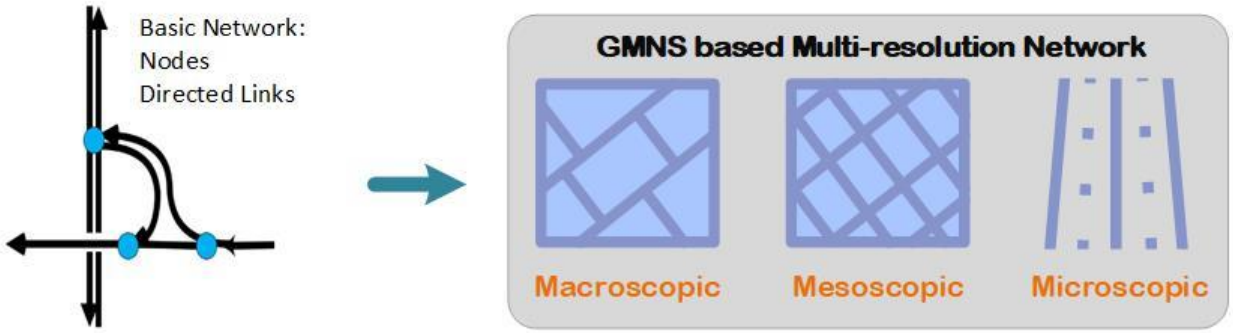

Figure 2. GMNS in different resolutions [7]

In addition, teams are expected to use the General Modeling Network Specification (GMNS), which was developed under the Zephyr Foundation with the assistance of the Federal Highway Administration [8]. Figure 2 provides an example of the way GMNS can be used at different resolutions. GMNS provides a uniform format for sharing routable road network files that are easily readable by both humans and machines. Research papers addressing mobility and equity can be found in references [9], [10], and [11]. Participants are expected to use road network files consistent with the GMNS generated from OpenStreetMap (OSM) with provided inputs using open-source frameworks. Teams can easily generate their open datasets by using the open-source tools Aequilibrae [12], AB Street [13], osm2gmns [14], grid2demand [15], path4gmns [16], OSMnX [17], NetworkX [18], DLSim-MRM [19].

The submitted tools should allow comparison of different equity definition and quantification methods, foster algorithmic innovation and research in this area, and provide actionable solutions that would directly benefit communities.

3. Competition rules

3.1. Registration

Participation in this competition requires **registration by April 15th, 2023**. Each team must register by the deadline to participate. To register, please send the following information to **networkmodelingequitychallenge@gmail.com** by the deadline.

- For each team member: Name, Email, Organization, Position.
- A brief statement describing what motivated you to participate.

After submitting your registration email, you will receive an email confirming your team's successful registration and eligibility, and you will be added to the competition's channel in Slack.

3.2. Timeline

- Registration Deadline: **April 15th, 2023**
- Q&A Period: Open from **March 27th, 2023**, until the submission deadline.
- Solution Submission Deadline (Technical Paper + Results + Video): **May 12th, 2023**. **Submissions must be sent to networkmodelingequitychallenge@gmail.com**
- **Winners Announced: June 5th, 2023**, at the TRB AEP 40 midyear meeting in the TRB Innovations in Travel Analysis and Planning (ITAP) Conference.

3.3. Certification & Support

Winner teams will be invited to present their work and findings at the ITAP conference in June 2023, and receive award certificates from TRB. Winner teams will also get support in the form of free conference registration assistance.

3.4. Qualification

- Entries may be submitted by a single participant, or by a team of multiple participants.
- No single person may participate in more than 2 submissions, in any combination of single- or multi-member teams.
- Current graduate students and postdoctoral advisees of the judging team are ineligible to submit entries or participate on teams.
- Each entry will consist of one or more source codes, files, written in a programming language in common use, and for which a free, open-source compiler is available.
- Any additional program libraries must be clearly specified in a readme file and submitted together with the source code, and must also be open-source and available freely. This readme file should also contain any other instructions needed for compiling the code (e.g., make-files, compiler flags). Participants are discouraged from submitting entries that require complicated compilation processes or libraries) If the judging team is unable to compile an entry, it will be disqualified.
- This code should be platform-independent. Do not require any specific hardware features (e.g., availability of a GPU) or operating system features.
- All entries will be compiled and executed on one same desktop machine, with the same operating system, for fair comparison.

3.5. Judging Criteria

The criteria that judges will use to evaluate a solution include the following:

- Innovation of the proposed solution (30%).
- Computational complexity of the proposed solution approach. (15%)
- The quality and clarity of the documentation describing the problem definition, model formulation, solution approach. Design approach, code quality, readability (40%)
- Clarity of video presentation (15%)
- The ARC dataset and dataset generated by teams by using open-source tools are required to be included in the submission.
- Teams need to submit the source code of their approach. All teams agree to make their code available publicly under an open-source license after the competition has concluded.

References

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