

# Workshop on Control for Networked Transportation Systems (CNTS)

Necmiye Ozay

Assistant Professor of Electrical Engineering and Computer Science  
University of Michigan

**Expertise:** control, hybrid systems, formal methods, V&V, dynamics-  
based data analysis

# Challenges & opportunities

- How to evaluate autonomy for safety? How to define safety?  
Would the current road-testing methods scale, are they safe?
  - Correctness (safety) at different layers
    - algorithm, implementation, execution
  - Correctness (safety) at different scales
    - micro-scale (at the vehicle level) guarantees to macro-scale guarantees
- Benefits/impact vs penetration levels
- Heterogenous sensory data
  - Offline data: learning enabled control
  - Online data: high-volume of data at run-time – perception in-the-loop  
→ ability to predict ahead (effects on safety, fuel-efficiency); context-awareness as opposed to robustness, non-traditional uncertainty models

# Mcicity & Open CAV



## Mcicity: A 32-Acre Outdoor Lab

Mcicity is the world's first full-scale simulated urban environment designed expressly for testing the performance and safety of connected, automated, and autonomous vehicles under controlled and realistic road conditions. It is a 32-acre outdoor laboratory for advanced mobility systems that includes:

- Urban and suburban streets, including various lane configurations and sidewalks, pedestrian crossings, bike lanes, ADA ramps, street lights, parallel and diagonal parking, and a bus turnoff/stop.
- Instrumentation throughout, including a control network to collect data about traffic activity using wireless, fiber optics, Ethernet, and a highly accurate real-time kinematic positioning system.

Other features include:

**Straight gravel roadway** with a railroad crossing.

**Traffic circle**, a smaller version of a roundabout that is common in Europe and some older cities in the U.S.

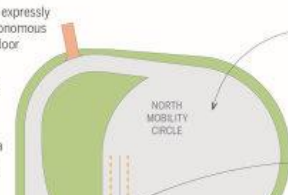
**Signalized intersections** in different configurations, with mast arms, wood and metal poles, and pedestrian crossings.

**Trunk line road**, a rural roadway with a fully equipped railroad crossing, guard rail, and temporary and permanent pavement markings.

**Brick paver road** simulated with stamped concrete.

**Underpass**, simulated by a tunnel that blocks vehicles from wireless and satellite signals.

**Roundabout**, an increasingly common approach to intersection design intended to improve safety.



**Open test area** that can be configured for a wide range of scenarios, including parking lots and novel intersection geometries.

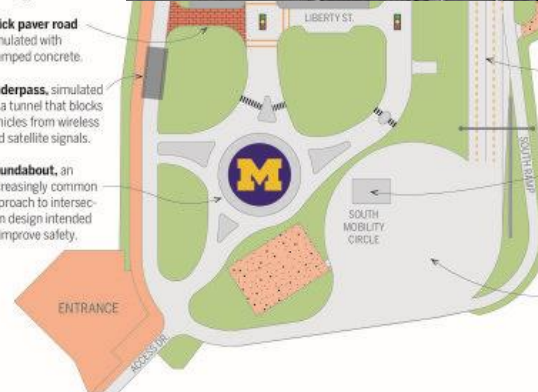
**4-way stop intersection**, with straight as well as tight and sweepingly curved approaching driveways.

**Tree canopy**, a simulated tree cover that reproduces the attenuation of signals that pass through trees.

**Metal bridge deck**, bridge surface that poses special challenges for radar and image processing sensors.

**Two-level building** canes up to two stories high allow researchers to test the effects of various materials and geometries on sensor performance.

**Wandering gravel roadway**



**Limited access freeway** with access ramps, highway signage, guardrails, crash attenuators, and a concrete jersey-style barrier.

**Calibration mound** to calibrate inertial measurement sensors on vehicles.

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