

Challenges, Roles, and Actions for Testing Connected & Automated Vehicles

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American Center for Mobility
CONNECTED. AUTOMATED. VALIDATED.

What is the American Center for Mobility?

A not-for-profit, PPP
national test facility

- Product development, testing and validation
- **Lead and accelerate the identification and development of standards**
- Education and training of the workforce & public



A USDOT- Designated Automated Vehicle Proving Ground

The challenge is cross-disciplinary

Connected & Automated Vehicles



Standards across industries

CAV cross-disciplinary challenge

- International Standards Organization (ISO) TC 22 (Road Vehicles) and TC204 (ITS)
- Institute of Transportation Engineers (ITE)
- American Association of State Highway and Transportation Officials (AASHTO)
- SAE
- IEEE
- GENIVI
- Open Connectivity Foundation (OCF)
- MirrorLink®
- 5GAA
- ETSI (European Telecommunications Standards Institute)
- Connected Vehicle Trade Association (CVTA)
- ITS-America and its V2I Coalition working groups 3 and 5
- Transportation Research Board (TRB)- Various Committees including NCHRP (National Cooperative Highway Research Program)
- 3GPP
- Telecommunications Industry Association (TIA)
- International Telecommunications Union (ITU)
- Consumer Electronics Association (CEA),
- W3C
- WiFi Alliance
- ...



Actions: Decomposing the tests

Objective outcomes Performance-oriented

Subjective outcomes “Decision” -oriented

Component	Software	System
<ul style="list-style-type: none">• Characterize capabilities• Defect rate• Physical interfaces• Messages & labeling• HMI	<ul style="list-style-type: none">• Validation• Lessons from aviation• Functional reliability• Quality & best practices (e.g. CMMI)	<ul style="list-style-type: none">• Test / Evaluate the “driving task”• Inter-Operator and VRU interaction• Defining Scenarios: variables & patterns; assign acceptable ranges• Evaluating Scenarios: socially-constructed “success”
Laboratory/Traditional Proving Ground		AV Proving Ground/ On-road

ACM Standards Program

Scenario catalogue

- Scenario definition
- Cooperation:
 - Pegasus
 - Streetwise
 - ENABLE S3

PG cooperation

- DOT AVPG community of practice
- International co-od and participation in non-profit CAV PGs and consortia.
- ICPGS

Collaborating on development

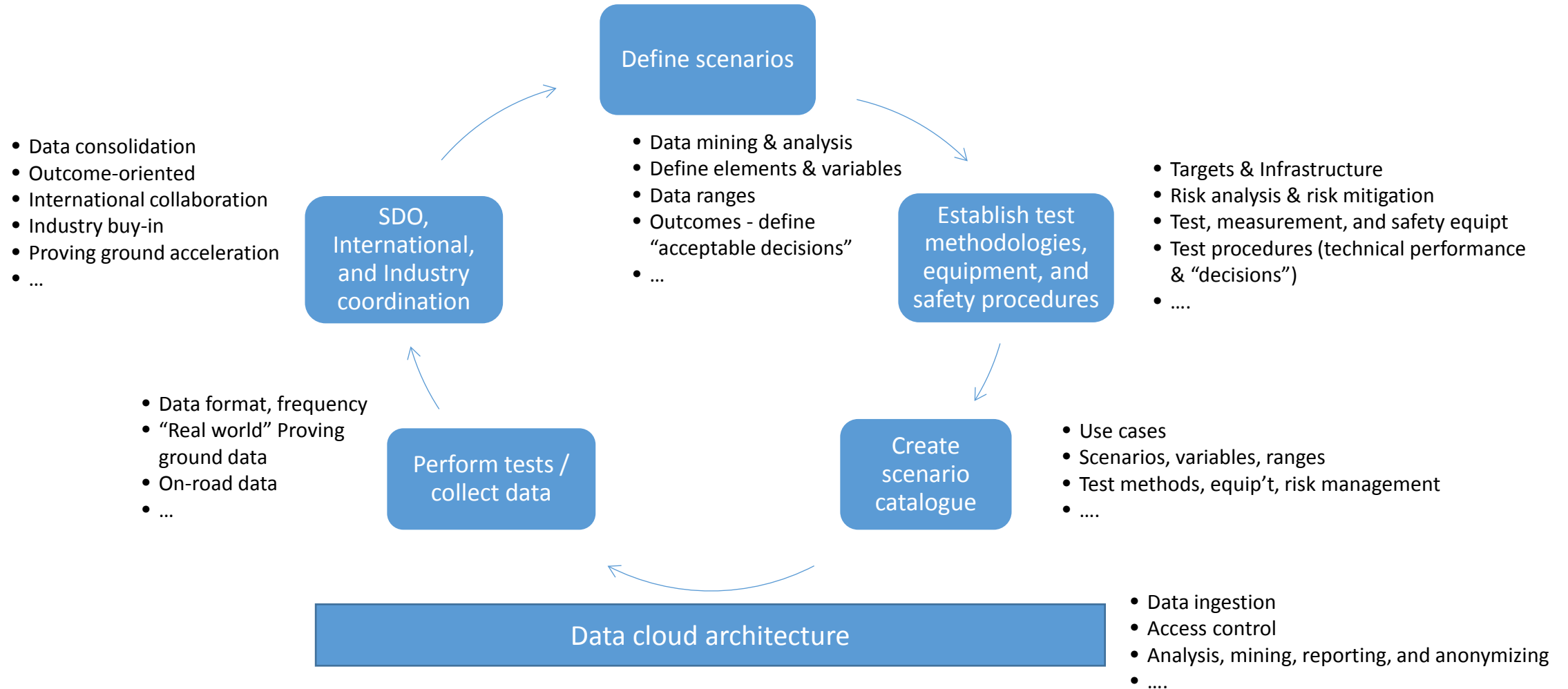
- Accelerate process with SME(s) and dedicated TechPM
 - SAE
 - IEEE
 - ITE
 -

Test development

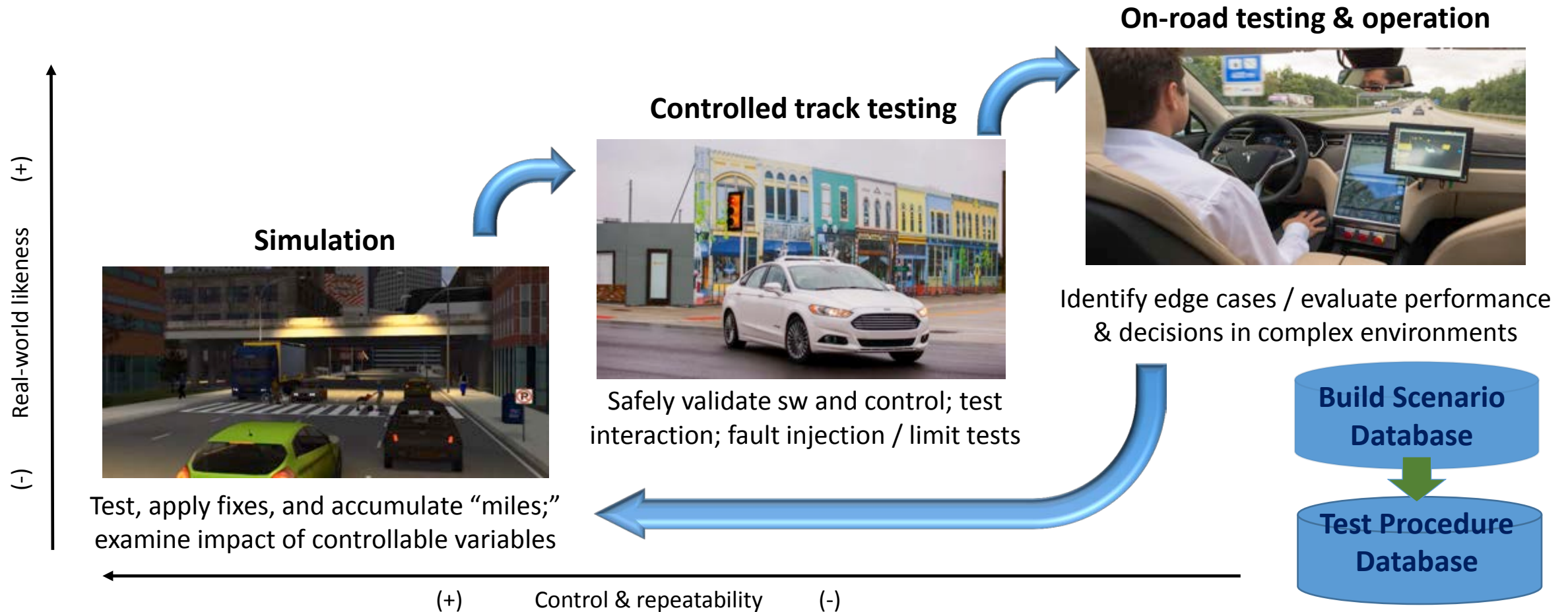
Test methodologies and safety procedures that support the standardized test, verification, and validation of CAV performance against transportation scenarios



Building a Scenario Catalogue



Product development & validation: Structured combination of three methodologies

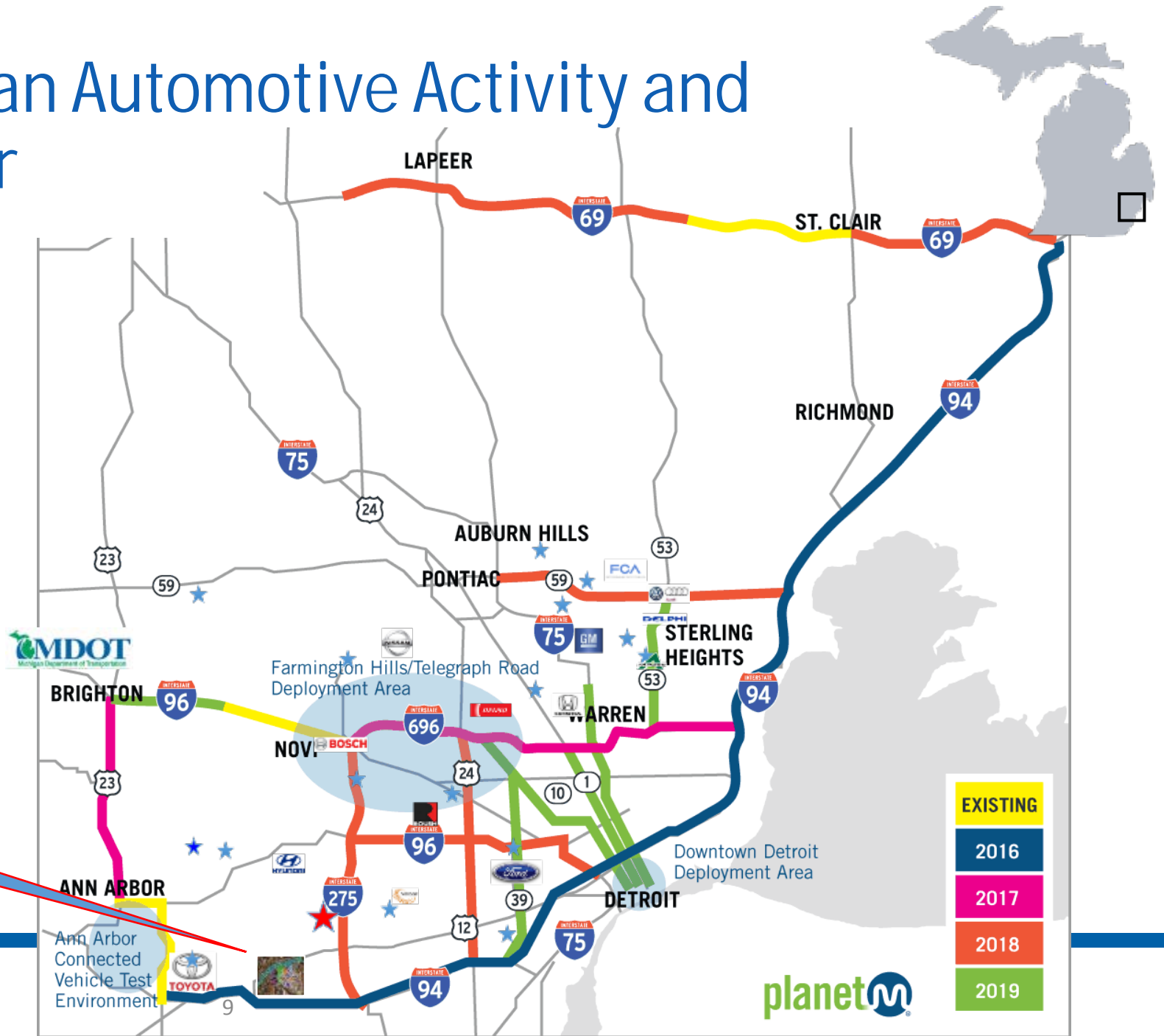


Southeast Michigan Automotive Activity and the Smart Corridor

Michigan is home to the **largest concentration of automotive R&D and manufacturing in the world** as well as the **largest deployment of Vehicle to Infrastructure (V2I) technology in the United States.**

ACM

More info at: <http://www.planetm.com/>



A new type of proving ground

- Traditional proving grounds *still req'd* for vehicle development
 - *e.g. ride & handling, braking, component test, etc.*
- **AV Proving Ground**
 - Real world physical environments
 - Infrastructure
 - Communications
 - Safely & consistently test scenarios
- Investment through Public – Private Partnerships
 - Engagement across industry, academia, government
- Test methodology and best practice collaboration
 - USDOT AVPG
 - ICPGS
 - International 3rd party non-profit PG consortium



Federally-designated AV proving grounds

U.S. Department of Transportation Designates 10 Automated Vehicle Proving Grounds to Encourage Testing of New Technologies

WASHINGTON – U.S. Transportation Secretary Anthony Foxx announced today that the U.S. Department of Transportation (DOT) has designated 10 proving grounds to encourage testing of new technologies and information sharing around automated vehicle technology. The designated proving grounds will foster innovations that can safely transform personal and commercial transportation and open new doors to disadvantaged people and communities. This is a key step in the Department's effort to advance the safe deployment of automated vehicles.

"The designated proving grounds will collectively form a national network for testing and operations as they are developed, enabling the public to test and operate at a faster rate and accelerating the pace of safe deployment of automated vehicles," said Secretary Foxx. "This group will openly share information and testing and operations as they are developed, enabling the public to test and operate at a faster rate and accelerating the pace of safe deployment of automated vehicles."

The proving grounds will also provide critical insights into operational requirements for automated vehicle testing and will serve as a foundation for building a national database of vehicle research.

Designees were selected from a competitive group of over 60 institutions, state Departments of Transportation, cities, and universities. The proving grounds designees all have different facilities that can be used to test and operate on various roadways and conditions, and handle various types of vehicle

The Proving Ground designees are:

1. City of Pittsburgh and the Thomas D. Larson Pennsylvania Transportation Institute
2. Texas AV Proving Grounds Partnership
3. U.S. Army Aberdeen Test Center
4. American Center for Mobility (ACM) at Willow Run
5. Contra Costa Transportation Authority (CCTA) & GoMentum Station
6. San Diego Association of Governments
7. Iowa City Area Development Group
8. University of Wisconsin-Madison
9. Central Florida Automated Vehicle Partners
10. North Carolina Turnpike Authority

Federally-designated AV proving grounds



Consortium of Internat'l 3rd Party Proving Grounds

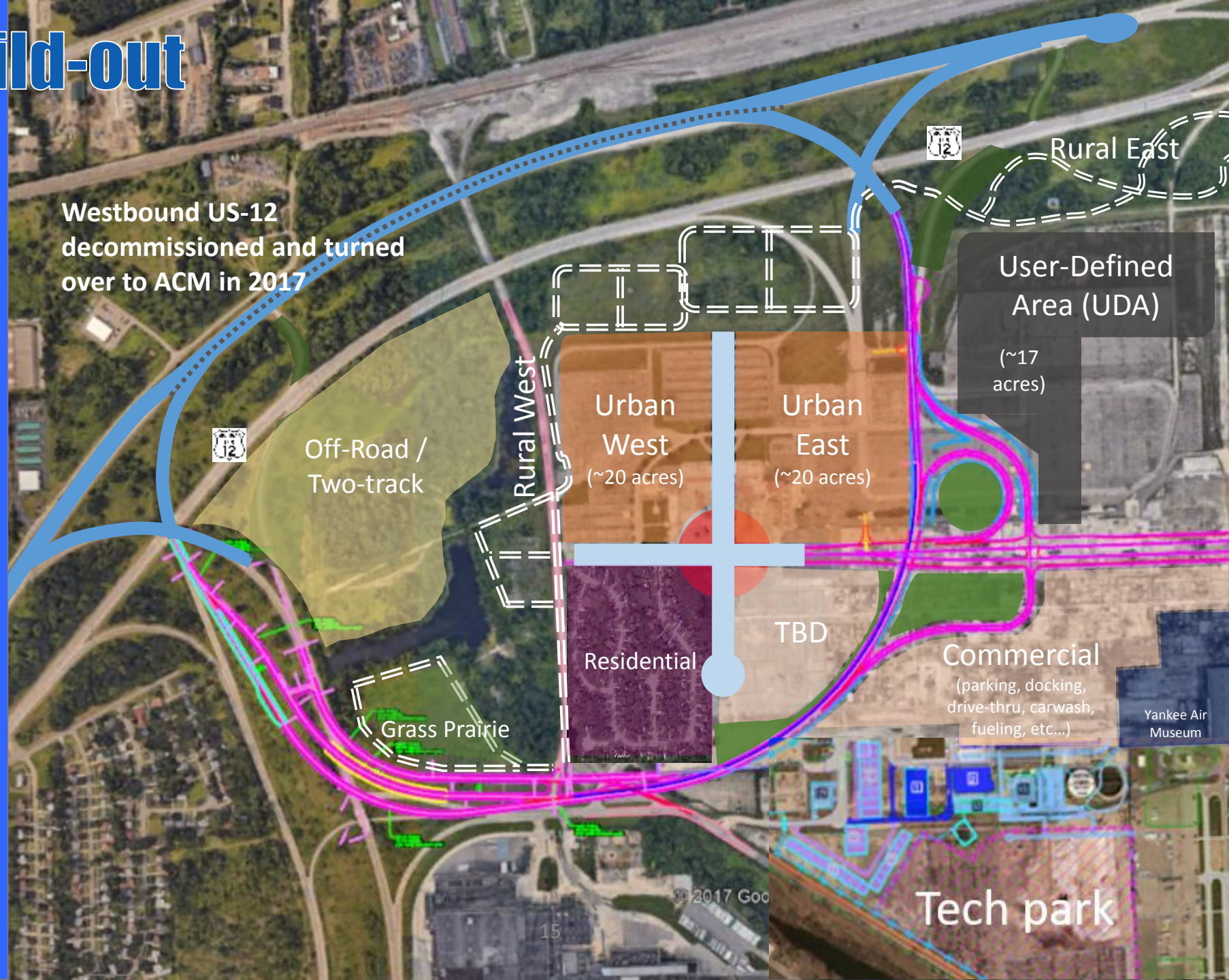
- ACM
- ASTAZero
- K-City
- Singapore
- ...



ACM Build-out

Highway test environment

- 2.4 mile loop
- 1.5 mile arterial
- 65-70mph
- On and Off-ramps
- Triple overpasses
- Multiple merging scenarios
- Surface color variation
- Lane marking
- Signage / gantries
- 2/3/4/5 lanes
- 700' tunnel on bend
- Lighting
- Environmental simulation (tbd)
- 300m, 500 radius bends
- Multiple pull off areas w/ fibre optic link



Real world test environments:

- Highway
- Urban
- Rural
- Off-road
- Commercial
- Residential

Network:

- DSRC
- 4G LTE
- 5G
- Cloud
- Traffic control

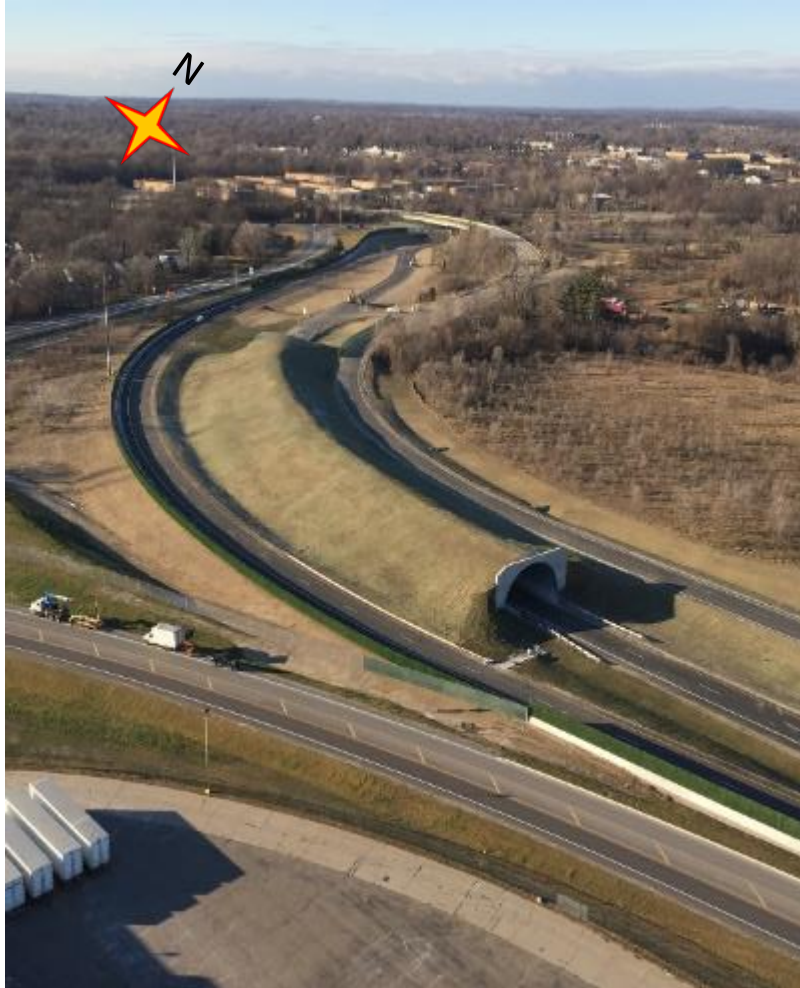
Campus-Operations:

- Test Supt
- Convening for Standards
- Cybersec Lab
- Education
- Tech Park

Facility Features



Tunnel and by-pass



Highway ramps and merges

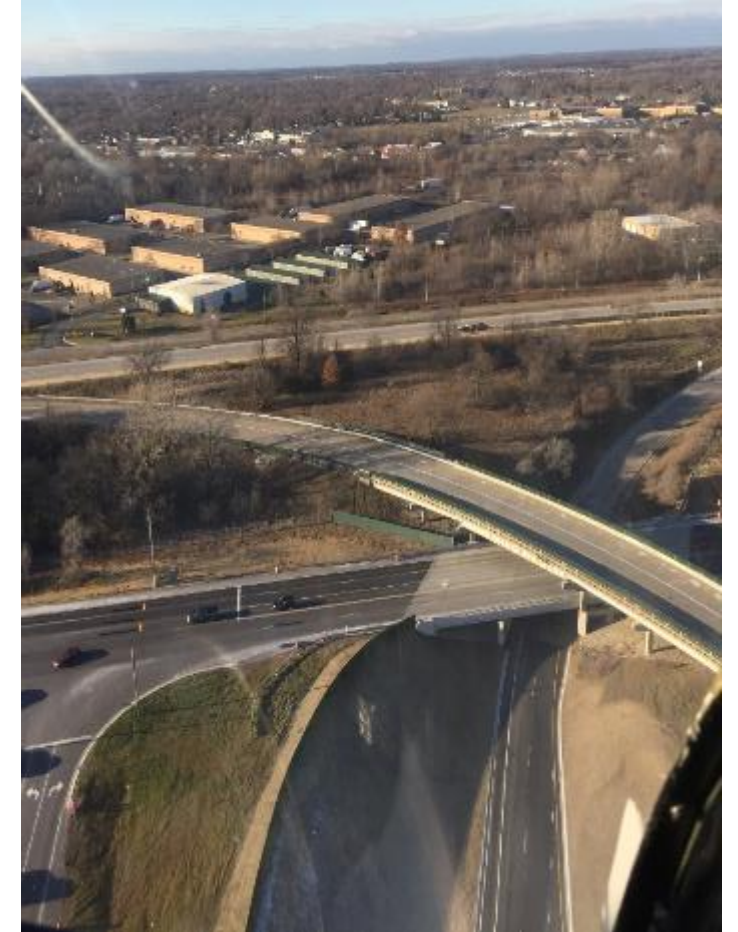


Inter-urban arterial roadway



- 1.5 miles
- Decommissioned section of US-12
- 11' lanes
- Lane-width shoulders
- Merge & diverge options
- Gantries
- Dynamic signage (2018)

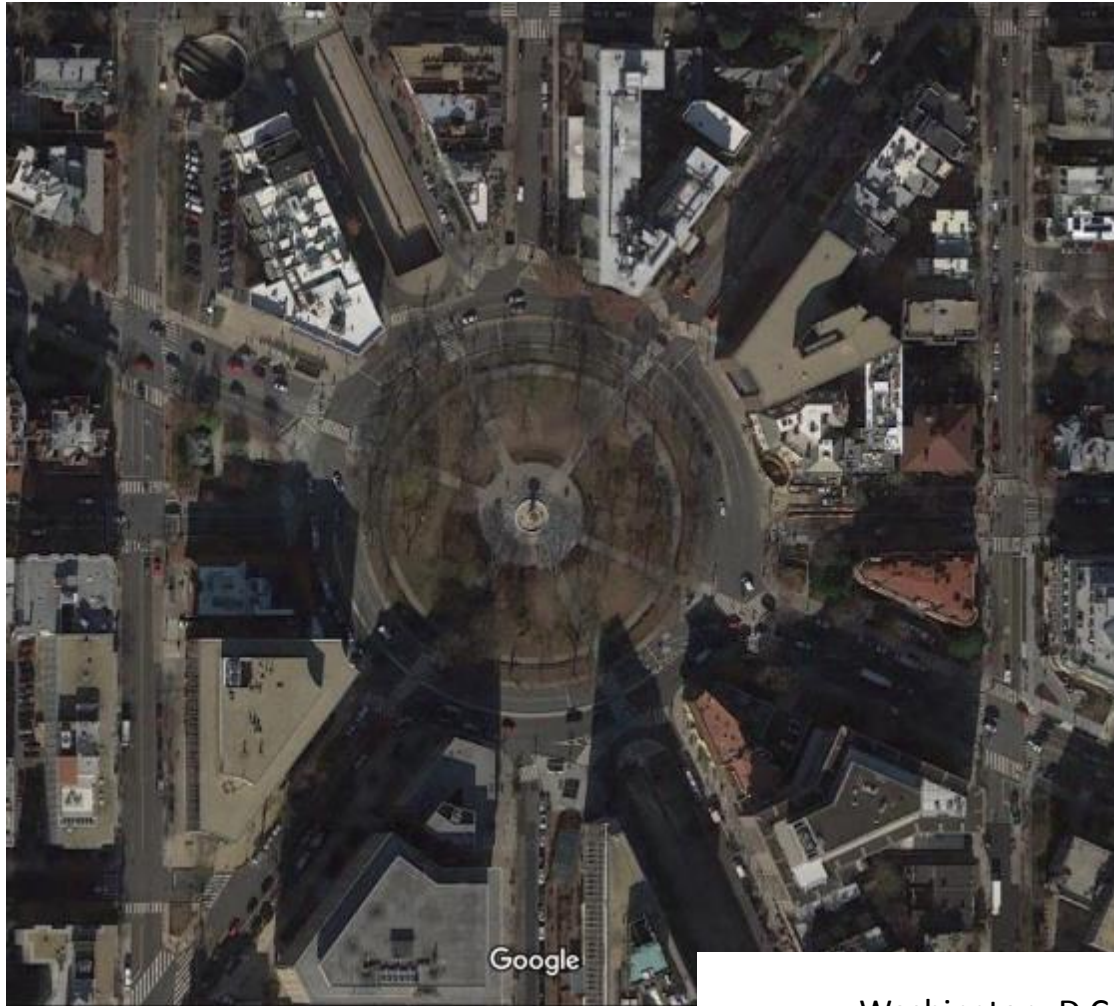
Tri-level overpasses



Facility Features



Recreating complicated real-world urban examples:



Washington, D.C.



Recreating complicated real-world urban examples:



Atlanta

Recreating complicated real-world urban examples:



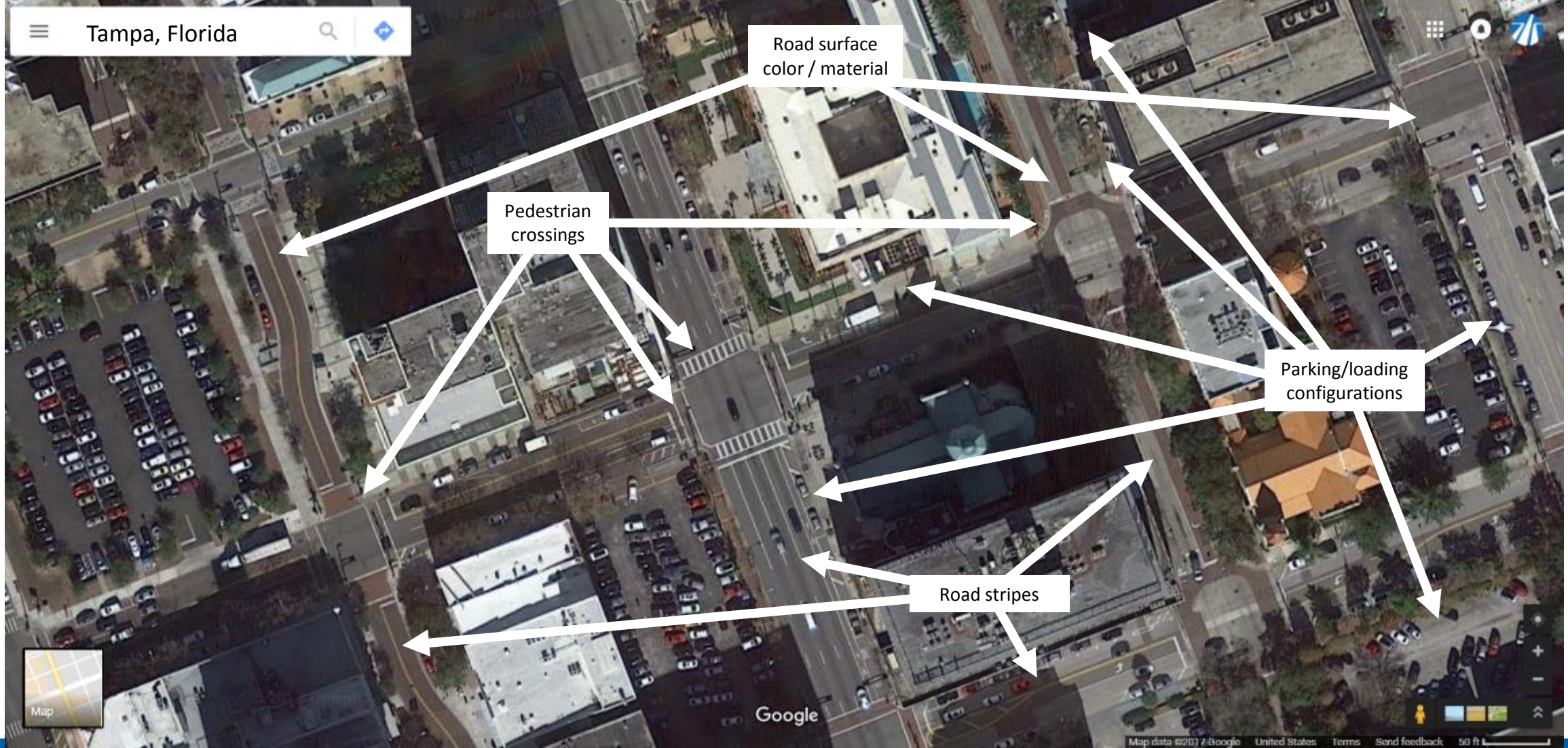
near Detroit, MI

Recreating complicated real-world urban examples:



Indianapolis, IN

Recreating complicated real-world urban examples:



ACM Academic Consortium



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