Michigan Connected and Automated Vehicle Working Group Meeting Packet

July 27, 2015

1. Agenda
2. Meeting Notes
3. Attendance List
4. Presentations
MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

Monday, July 27, 2015

Macomb Community College, South Campus
Student Center, Room K-324
14500 East 12 Mile Road
Warren, Michigan 48088-3896

MEETING AGENDA

1:00 PM Introductions and Update, Richard Wallace, CAR, and Robert Feldmaier, Macomb Community College

1:10 PM Overview of Connected Vehicle Certification Program, Scott Morrell, Danlaw

1:35 PM TARDEC CAV Activities, David Thomas, Director, National Automotive Center at TARDEC

2:00 PM Advanced Antenna Technology for Connected Vehicles, Amar Amar, M2M Engineering Manager, Laird

2:25 PM NETWORKING BREAK

2:40 PM MTC Research Plan and Mcity Launch, Debra Bezzina, UMTRI

3:00 PM Crowdsourced Transportation Data: Review of Methods and Proposed Taxonomy, Eric Paul Dennis, CAR

3:15 PM Update on Michigan Smart Corridor, Matt Smith, MDOT

3:30 PM Tour of MCC South Campus Automotive Facilities (led by Robert Feldmaier)

4:00 PM Adjourn
MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

The July 2015 meeting of the Michigan Connected and Automated Vehicle Working Group was held at the South Campus of Macomb Community College (MCC) in Warren, Michigan, on July 27, 2015.

MEETING NOTES

Richard Wallace (CAR) and Bob Feldmaier (MCC) welcomed attendees to the meeting. Richard reviewed the MI CAV Working Group mission statement, recent CAV news, and noteworthy upcoming CAV events.

Scott McCormick of the CVTA provided a brief overview of the connected vehicle credentialing program being offered in late October by CVTA, SAE International, and Mobile Comply.

Scott Morrell of Danlaw presented the USODT Connected Vehicle Certification Project being developed in cooperation with Danlaw, 7Layers, and OmniAir. Roughly half of the funding for this effort is being provided by private partners, and the other half is provided by USDOT. It is a two-year project that started in January 2015. The goal is to develop a self-sustaining certification environment and development of software suites by each of the three private-sector partners. Vendors will need this certification for participation in the connected vehicle pilots. Procedures and tests will all be publicly available (as this is partially a USDOT-funded project). Another goal is to develop procedures that allow for self-certification. The focus is on data flows between equipment and warehouse, security certification, steps and procedures, and standards. The three private partners are working collaboratively, and one key focus is device certification for the upcoming V2I pilots.

Dave Thomas, Director of the National Automotive Center at TARDEC, provided an overview of autonomous vehicle design and testing activities at TARDEC. In general, the increasing capabilities and system integration are big challenges. Applying the technologies to an unstructured environment is also challenging. TARDEC is partnering with MDOT on I-696 corridor test with DSRC integration. Areas of focus include mixed fleets—both in terms of automation and vehicle type. Preliminary findings and considerations of the defense-focused environment suggest that leader-follower behavior in a platoon is inappropriate as any vehicle could become a potential leader. Thus, automation systems generally must support a human driver, or every vehicle must be highly automated. TARDEC is not planning on using civilian-grade DSRC standards.

Amar Amar of Laird presented the architecture and some performance results of a prototype smart antenna that contains full DSRC V2X functionality and intelligence capability within the antennae body. Advantage of integrated approach is lower cost and compact design. 8-pin Ethernet cable connects smart antennae to interface. They are also upgradable. The prototype uses standard Ethernet, but Laird is also investigating broad-reach automotive standard. This approach might also allow for aftermarket production magnetic mount antennae.

Debby Bezzina of UMTRI represented MTC (with which UMTRI is closely affiliated). Debby generally highlighted the successful MCity grand opening and related demonstrations. Additionally, she updated status of the MTC’s funding, partners, and such. The MTC “Leadership Circle” now has 15 members—all new members must be voted in. Additionally, it now has 33 affiliates.
Eric Paul Dennis of CAR presented the findings of a study done by CAR and MDOT investigating the potential for crowdsourced data to be used in transportation system management. Jon Coleman from Macomb County Department of Roads revealed that MCDR had tried using an innovative “internet-as-a-sensor” method of measuring traffic network speeds after learning about the methods when interviewed for the study.

Matt Smith of MDOT provided a general update about connected vehicle activities going on in the state. Matt relayed that with recent additions to the “Michigan Connected Vehicle Corridor,” and he explained that it is no longer appropriate to refer to it as a “corridor,” and MDOT is considering rebranding the effort (e.g., connected vehicle environment or similar). Matt had no new information about the connected vehicle (V2I) pilot grant applications—still waiting for USDOT announcement of winners. Phase 2 of the Michigan connected vehicle effort is underway. There was previously an RFP for deployment, but it has now been recalled and is being reconsidered.

MDOT will soon be posting an RFI inquiring about potential business models to support a public-private partnership to expedite the rollout of connected vehicle infrastructure—particularly the backhaul communications infrastructure. More information will soon be posted on MDOT’s consultant services webpage.

MDOT has settled on five connected vehicle applications that are particularly worthy of pursuing, because they line up with MDOT’s business model:

- **Red light violation warning**
- **Work zone warning**, particularly for short-term work zones, moving vehicles, etc. This can also be extended, for example, to emergency vehicle warning.
- **Road weather information systems (RWIS)**
- **Boarder wait time applications**
- **Pavement Condition Data (non-DSRC)**

Matt also reported that the USDOT is looking to transition control of federal DSRC infrastructure in Michigan to local control. The current model is for USDOT to co-own DSRC infrastructure with MDOT and local agencies. This is unusual, because USDOT is not normally an owner of any infrastructure. It is an exciting opportunity, however, because it gets us closer to a sustainable connected vehicle environment.

The meeting concluded with two tour options available, one of MCC automotive facilities and one of the Macomb County traffic operations center (COMTEC). Attendees also had the option of doing both tours.

MDOT maintains a webpage dedicated to its work related to CAV technologies ([http://www.michigan.gov/mdot/0,1607,7-151-9621_11041_38217---,00.html](http://www.michigan.gov/mdot/0,1607,7-151-9621_11041_38217---,00.html)). The page includes documents, presentations, and other materials that may be of interest to CAV stakeholders. Meeting packets containing materials (e.g., agenda, meeting notes, attendance, and presentation slides) from past Michigan Connected and Automated Vehicle Working Group meetings can also be found on the page in the bottom right corner under the heading *Connected Vehicles Working Group*.

Slides from all presentations also are included in this packet for speakers who used them (Feldmaier and Smith did not).
## MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

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MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP
PRESENTATIONS
Agenda for This Afternoon

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Working Group Mission

- Cooperatively pursue projects and other activities that are best accomplished through partnerships between multiple agencies, companies, universities, and other organizations and that ultimately advance Michigan’s leadership position in connected and automated vehicle research, deployment, and operations.
  - Benefit our state and our industry (automotive and more)
  - Enhance safety and mobility in Michigan and beyond
Noteworthy News

- NTSB has called for immediate action on collision avoidance systems—wants manufacturers to make these standard now

- Cybersecurity back in the news with public hack of Jeep Cherokee

- Grand Opening of Mcity
Mcitcy Grand Opening

Detroit Cuts a Path for Driverless Cars

By Michael Ramsey

ANN ARBOR, Mich.—Toyota Motor Corp. and a clutch of other companies are backing a $40 million testing ground at the University of Michigan for self-driving vehicles, an investment that could boost Detroit's ability to compete in the auto industry's emerging tech war.

The 32-acre facility, dubbed Mcity and opening Monday, will give the auto industry a hub that can be used by anyone researching autonomous vehicles.

In addition to being one of the few open-source test centers of its kind anywhere, it is also one of the few situated in a cold climate that could present challenges to self-driving cars.

"There's nothing else like it in the world," said Peter Sweatman, director of the university's Mobility Transformation Center, a public-private research institute that includes the testing area.

The race to provide vehicles with more autonomous features or the capability to operate without driver intervention is one of the auto industry's primary pursuits, requiring billions of dollars in capital and a shift in how products are developed. The trend has attracted new players to the industry, including Google Inc, while boosting the fortunes of companies, such as Israeli components-supplier Mobileye NY, that formerly filled niches.

The cost of Detroit auto makers has faded in recent decades, but Southeast Michigan and the state's biggest university house some of the industry's leading researchers, many corporate technical centers and a network of test facilities. Google's autonomous-vehicle testing activities in California and Texas have attracted a lot of publicity, but much of the development of these vehicles is being done in the Rust Belt by international auto companies with big operations near Detroit.

Ann Arbor, where the University of Michigan is located, is already the testing site for 3,000 vehicles that have been outfitted with transmitters capable of vehicle-to-vehicle and vehicle-to-infrastructure communication, a technology that will hit roads within a year or so on General Motors Co's Cadillac models. That test, which began in 2012, is the basis for a Transportation Department effort to push for widespread deployment of the technology to reduce traffic and improve safety.

Much of the world's driverless-car research, which is done in facilities in Japan, Sweden, China and other nations, occurs in proprietary environments closed to outsiders. The University of Michigan's effort, which includes about four miles of roadways, is designed to simulate real-world situations as a variety of parties experiment with ideas.

Toyota has a simulated urban environment in Japan, but it isn't open to other companies or researchers. In the U.S., Toyota has been joined by GM, Honda Motor Co., Delphi Automotive PLC and other auto companies in backing the venture. State Farm Automobile Insurance Co. is also behind the center, an indication that insurers are eager to understand liability issues related to autonomous vehicles.

Toyota, which employs more than 1,500 at an engineering center near Ann Arbor, sees the facility as a legitimate alternative to testing on public roads.

"We have been using high-speed tracks for a lot of safety testing, but now our focus as an industry is how to cope with traffic accidents at intersections," Hideki Hada, a Toyota manager based in Michigan, said.

"We cannot test prototypes on public roads for a variety of reasons.

The companies that have tested driverless cars on public streets have the advantage of gathering real-world data and interacting with other vehicles in a way that's not possible in a closed-course setting. Google has gathered mountains of data by testing autonomous vehicles of its own, but the testing comes with a risk of accidents and damage to costly prototypes.

The Mcity's four miles of roadways include highway on-and-off ramps, roundabouts, railroad crossings, dirt roads and cobblestones to challenge the vehicles' computer brains.

In addition, the track should give researchers a place to test in rain or snow without endangering other drivers. Some of the prototypes' components don't currently function as well in inclement weather.
Upcoming Connected and Automated Vehicle Events

- **CAR Management Briefing Seminars**, August 3-6, 2015, Acme, MI
- **Autonomous Cars**, August 24-26, 2015, Detroit, MI
- **UMTRI Global Symposium on the Connected Vehicle**, September 30, 2015, in conjunction with the MichAuto Summit, Detroit
- **ITS World Congress**, October 5-9, 2015 Bordeaux, France
- **Active Safety: ADAS to Autonomous 2015**, Oct 12-13, 2015, Novi
- **North American International Cyber Summit**, Oct. 25-26, Detroit
- **Connected Vehicle Professional Short Course**, Oct. 26, Novi (Hyatt)
- **6th Summit on the Future of the Connected Vehicle**, Oct. 27, Novi
- **Connected Fleets**, Nov. 16-17, Atlanta, GA
- **Transportation Research Board**, January 10-14, 2016, Washington, DC (paper submissions due August 1)
USDOT Connected Vehicle Certification Project

Review for Michigan Connected and Automated Vehicle Working Group
27 July 2015
Introduction

USDOT grant awarded as a cooperative agreement to 3 companies to establish a future certification environment for Connected Vehicle devices.

- Danlaw
- 7Layers
- OmniAir

Goal is to have a self-sustaining certification environment at the end of the project.
### Certification Levels -

1. **Environmental Abilities including Physical Security**
2. **Communication Protocol Abilities**
3. **Interface Abilities (both the syntax and contents of the message payload transmitted over the communications medium)**
4. **Overall Application**
Certified for Pilots

- **Certifying data-flows not products**
- Modular approach to certification focuses on the core functionality and interoperability
- Product suppliers can pick and choose the appropriate modules for their product
- Customers may mandate some or all as a prerequisite to acceptance for the pilot
- Security certificates will not be issued unless compliance has been proven
- Self certification options are available
Focus on Key Interfaces during Pilots

Vehicle Situation Data: All basic safety messages (BSMs) meet performance requirements

Field Situation Data: All MAPs and signal phase and timing (SPaT) created using the same interpretation

Application Protocol Data Units
- Traveler Situation Data:
  Use common distribution
- Security:
  Use one system
Certification Modules

Typical Data-flow

- Each Purple box represents a certification module.
- There will 15-20 of these certification modules supporting 4 different data flows.
- Not certifying applications / products.
- PICS guiding the test process – where possible.
- Where PICS are missing we are creating them.
  - Protocol Implementation Conformance Statement.
How do I get my module certified?

- Study the requirements for certification or attend a training course
- Develop device or software to be used on pilot
- Submit the complete module for evaluation to a member of the certification team
- After successful certification apply for the required security certificates
Test Suite is using the Danlaw Mx-Suite™ system for controlling the test environment. Commercial available DSRC equipment for Tx/Rx interface with the System Under Test.
Automated Vehicle Design & Testing
Overview

David Thomas
National Automotive Center
U.S. Army TARDEC

27 July 2015
Background: Automated Vehicle Convoy OPS

**Sustainment Operations (SO)**
- Integrate autonomous capabilities into operational theater movement and distribution missions. Vehicle capable of either manned or unmanned operations:
  - Driver Assist/Leader Follower/Autonomous Convoy Operations (ACO)
  - Tactical convoys (Line Haul) at Echelons Above Brigade

**Enabling “Stepping Stone” Capabilities**

**Driver Safety / Assist**
Augment manned vehicles through integration of active safety technologies (e.g., collision warning/avoidance)

**Leader / Follower**
One manned (Leader) to ‘n’ un-manned (Follower) vehicles performing convoy operations.
- Capabilities support autonomous guidance, navigation, control and fault management to follow lead vehicle

**Autonomous Convoy Operations (ACO)**
- Completely un-manned (optional) convoy operations
- Capabilities support autonomous guidance, navigation, control and fault management to execute mission
Background: AGR Architecture Capabilities and Functions

By-Wire Control
- Electronically Controlled Engine, Transmission, & Drivetrain
- Electronically Controlled Steering & Braking

Optionally Driven
- Convoy Leader-Follower
- Auto-Pilot Co-Pilot
- Tele-Operation
- TARDEC SMI
- Operator Control Unit (OCU)
- "Rules of the Road"
- Fail-Safe Architecture

Optionally-Manned/Un-Manned Systems
- Go to Point
- Waypoint Follower
- U-M/U Teaming
- Dynamic planning and re-planning
- Remote Over watch
- Gesture Recognition
- Voice Command Recognition
- Fault-Tolerant Architecture

Human - Machine Interface (HMI)
- Crew Station
  - Visual Feedback
  - Audio Feedback
  - Haptic Feedback
  - Workload & Fatigue Monitor
  - Driver Warnings

Active Safety
- 360 SA
  - V-V & V-I
    - Collision Avoidance - Brakes - Steering
  - ACC w/ FCW
    - Backing Aids - Side Object (Blind Spot) Detection
  - Virtual Lane Centering w/ LDW
    - Integrated Collision Warning
  - Pedestrian Detection & Avoidance
  - Geo-Data Map Based Speed Mgmt
  - Curve/Speed Warning & Control

Energy Management
- Vehicle Diagnostic Information

Active Roll Control
- Active Damping

Variable Height Suspension

Fault-Tolerant Architecture

By-Wire/Active Safety (B)

Payload (C)

Autonomy Subsystem (A)
AMAS JCTD Hardware Concept

Autonomy Kit

- Autonomous Functionality
- LIDARS
- Other Sensors
- Radio Network Integration Kit (RNIK)
- Autonomy Computer
- Navigation
- Logger
- High Precision GPS

By-Wire/Active Safety Kit

- Driver Warning /Driver Assist Functionality
- Automotive Sensors
- Overall Vehicle Controller
- User Interface
- Dashboard User Interface
- J1939
- Steering ECU
- Brake Actuation
- EngineECU
- Transmission ECU
- ECU
AMAS 1.0 - JCTD

By-Wire/Active Safety Kit
- Navigation
- Driver Warning and Assist

Autonomy Kit
- Autonomy CPUs
- Data Radio (RNK)

Expansion & Payload Kits
- High-End Nav
- Add-On CPUs
- Manipulator
- Tac Radio
- Product Support

Sensors
- OVC

Computing
- Navigation Logging
- OCI

Other Components
- Actuation

Install

Active Safety and Autonomy Enabled

Increasing functionality with a “Crawl, Walk, Run” approach
Automated Vehicle Architecture Development
Process Roadmap

Model-Based Reference Architecture

Concept
- Management Plan
- AVS CONOPS

Development
- Specification of Functional Architecture
- Design and Implementation of the System
- Component Testing

Requirements
- System Level
- Component Level
- System

On-Road Testing
- Test Plans
  - Simulation
  - HIL & SIL
  - Bench Top
  - Proving ground
  - Controlled field
  - Operational
  - Natural use

Rapid Prototyping of Automated Vehicle Systems

Bench Top and Simulation Testing
- Use Cases
  - dSPACE
  - Matlab/Simulink
  - Vector Bench Top
  - HIL and SIL
  - TruckSum

Simulation of functional, physical, electrical and safety systems

TARDEC Partners: U-M, SAE ORAV, M-DOT
# Unmanned/Optionally Manned Vehicle Safety Requirements

<table>
<thead>
<tr>
<th>HAZARD SEVERITY</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probable</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occasional</td>
<td>C</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Remote</td>
<td>D</td>
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<tr>
<td>Improbable</td>
<td>E</td>
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</tr>
<tr>
<td>Eliminated</td>
<td>F</td>
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</tbody>
</table>

**HAZARD PROBABILITY**

- Decreasing proximity to soldiers
- Increasing size/speed

- Small UGVs: PacBot, Talon
- Medium size & speed, closer proximity to people
- Large, fast UGVs, medium close proximity to people

**MIL-STD 882E**
Functional Testing Overview

• **Electrical (EMI/EMC, ESS)**
  - Radio, WIFI, Cellular jamming and communications disruptions
  - Data Bus (CAN and Ethernet serial data) corruption
  - Component overvoltage (spikes)

• **Cyber**
  - Spoofing remote commands/data, GPS signals, or vehicle displays

• **Physical/Environmental**
  - Damaged/degraded sensors, by-wire actuators, computers, data busses
  - Temperature, Humidity, etc.
Operational Testing Overview

• **Inter-Operability Profile (IOP)**
  - Physical, Electrical, Software – Standard Interfaces & Functions
  - Testable compatibility between By-Wire/Active Safety & Autonomy subsystems
  - Bench tests, H-I-L (component), Serial Data tools

• **Mission Performance**
  - Use Case testing
  - MOP/MOE
  - Modeling & Simulation/ Virtual Proving Ground

• **Operational Safety**
  - Safety Use Case testing
  - Modeling & Simulation/ Virtual Proving Ground
AMAS JCTD
Physical Testing

AMAS avoided or mitigated accidents with simulated obstacles.

AMAS avoided or mitigated accidents w/ simulated pedestrians.

Demonstrated 10-vehicle robotic convoys with up to 6 vehicle types.

Demonstrated in day/night, dust, rain, and on trails, secondary, and primary roads.

User interface and MUA scenarios developed with user input.
AMAS JCTD
Vulnerability Testing

Attack Laptop plugged into USB Port.

Attack GPS Elevation Pattern.

Attack LIDAR with high power IR source.

Attack radar with jammer.
Smart Antenna Technology for Connected Vehicles

Amar C. Amar
Engineering Manager,
Laird Telematics M2M BU

July 27th, 2015
We are a TRUSTED PARTNER to our customers

We protect electronics and enable connectivity, creating value through ...
Serving Market Leaders

Key partner to our markets’ most recognizable brands
# Enable Connectivity

<table>
<thead>
<tr>
<th>Telematics/ Machine-to-Machine</th>
<th>Wireless Automation and Control</th>
<th>Infrastructure Antennas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect, sense, manage and control data across devices and systems with the world leader in the integration of wireless technologies and electronics into compact form factors.</td>
<td>Power remote or handheld wireless communication devices to improve safety, efficiency and productivity for machine operations.</td>
<td>Enable smart technology for a wireless world with the global leader in the design and manufacture of antennae for mobile devices, wireless data, telecom, two-way radio and RFID.</td>
</tr>
</tbody>
</table>
V2X On-Board Unit (OBU)
Based on Smart Antenna Module
Laird V2X OBU Vision

Complete integration including V2X antennas & intelligence in a single unit

Lower Cost and Compact Design

Easily upgradable while technology matures

No RF coaxial cable needed for V2X (only Ethernet)

Re-use of existing and proven Shark Fin Antenna technology
Laird’s V2X Smart Antenna Module (SAM)

- Roof-mount shark fin design
- Built-in full V2X solution
- Includes the following V2X functional blocks: RF transceiver, communications processor, Hardware Security Module (HSM), GNSS Receiver, CAN Phy & Ethernet Phy (at 100Mbps).
- Includes antennas for diversity V2X, GNSS, 4G LTE MIMO & Satellite Radio (optional for NA) and can include AM/FM.
- Powered via 8-pin cable harness.
- Communicates with vehicle on-board Electronic Control unit (ECU) and vehicle CAN bus.
- Design for operation at maximum range.
- Includes V2X communications & security stacks and can include V2X safety applications.
- Currently based on Autotalks solution with future development of NXP solution
V2X Smart Antenna Module
Technical Specifications

- IEEE 802.11p Standard
- Secured Communications for Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I)
- Runs at 5.9GHz frequency
- Range of > 1000m
- Data rates of 6 to 27Mbps
- Low latency ~100msec
- V2X antenna gain of -2dBi at 0 degree elevation

- LTE antenna bands: B1 (2100), B3 (1800), B5 (850), B8 (900), B34 (2000) & B39 (1900).
- LTE Antenna Average gain of -3 to -6 dBi at 0 degree elevation (without vehicle harness)
- GNSS Bands include: GPS & Glonass
- GNSS passive antenna gain of more than +2dBic at boresight.
- GNSS receiver sensitivity: -162 dBm tracking mode
- GNSS Output format: NMEA
Laired’s SAM Block Diagram
V2X

Architecture – Details
V2X SAM
PER vs Distance

Zero packet error rate up to 1200m
V2X SAM

RSSI vs Distance
Infrastructure Antenna System (IAS)

DSRC - V2I
Proposed IAS Content for V2I

Laird V2I content will consist of:

- Roadside Unit (RSU)
- Omnidirectional Antennas
  - Stick Antennas
- Directional Antennas
  - Sectors
  - Yagis
- Backhaul Antennas
  - Dish
  - Panels
Laird Antenna Solutions
Summary

• The approach to integrate Smart Antenna technology with single OBU, provides superior performance and cost effective DSRC V2X solution.

• This approach leverages the common design for V2X Road Side Unit (RSU).
The UM Mobility Transformation Center
Center Update
Debby Bezzina
AACVTE Program Manager

July 27, 2015
MCITY GRAND OPENING

- 700+ Attendees
  - Industry Members (LC, Affiliate)
  - Government Partners/Supporters (MDOT, MEDC, USDOT, USDOE)
  - Academic Partners (UM, CMU, etc)
MCITY GRAND OPENING

- Guest Speakers
  - Regent Shauna Ryder Diggs
  - UM President Mark Schlissel
  - Kirk Steudle (MDOT)
  - Governor Snyder (Via Video)
  - Congressman Dingell
  - Senator Stabenow
  - Senator Peters
  - AA Mayor Christopher Taylor
15 Connected and Automated Demonstrations

- Bosch: Lane Keep Assist*
- Delphi: Automated Driving & Driver State Sensing
- Denso: Automated Driving Technologies
- Econolite: Connected Vehicle Kiosk
- Ford: Trailer Back-Up Assist*
- Honda: Vehicle to Pedestrian Communication*
- Iteris: Bicycle Detection* & Advanced V2I Implementation
- Qualcomm – DSRC Enabled Wireless Charging*
- Toyota – Vulnerable Road User Test Mannequins
- UM/Local Motors – Smart Cart 3-D Printed Autonomous Cart
- Verizon – Car-Sharing Technology
- Zerox – Passenger Detection* & Connected Parking Technologies*

*Moving Demonstrations
MCITY GRAND OPENING

- World Wide Media Coverage
  - July 20:
    - ~5M twitter impressions
    - Over 40 media present
    - Over 75 stories
  - Going Forward:
    - Follow on opportunities with national and international media
    - Keep Michigan and the region in the lead for CAV dialogue
MCITY GRAND OPENING

- AVS15 Demonstrations
  - July 21 – July 22
    - Bosch
    - Changan
    - Denso
    - Delphi
    - HERE IAV
    - Iteris
    - Rosco
    - SWRI/TARDEC
    - UM/Local Motors
    - Verizon

- Public Grand Opening
  - July 23
    - Over 1000 attendees
      - General public
      - UM employees & faculty
      - Industry
    - Walking tours
WORKING GROUPS

- MTC and LC Member Co-Chairs
- Meet Monthly/Quarterly
- Help to refine the research roadmap
- Identify key research questions & key objectives
- Kicked Off in 2015:
  - Pillar 1 – Connected Ann Arbor
  - Pillar 2 – Connected SE MI
  - Pillar 3 – Connected & Automated Ann Arbor
  - Cybersecurity
  - Legal, Liability & Insurance
WORKING GROUPS

- Future Working Groups:
  - Data
  - Standards, testing
  - Customer Value
  - Societal Impacts
  - ....
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MTC AFFILIATES - 33

- Auto Club Enterprises, an AAA affiliate
- AGC Automotive
- Allstate Insurance Co.
- Arada Systems, Inc.
- Autoliv
- Brandmotion LLC
- Calspan Corporation
- Changan Automobile
- Cohda Wireless
- Desjardins
- DURA Automotive Systems
- Faurecia
- Harada Industry of America, Inc.
- Harman International Industries
- HERE, a Nokia company
- Hitachi, Ltd.
- IAV
- IDIADA
- LG Electronics
- Mechanical Simulation Corporation
- Munich Re
- Nexteer Automotive
- OSIsoft, LLC
- PTC, Inc.
- Realtime Technologies, Inc.
- Renesas Electronics America Inc.
- Savari Inc.
- Subaru
- Sumitomo Electric Industries, Ltd.
- Suncorp Group
- TASS International, Inc.
- TRW Automotive
- Zip Car
Crowdsourced Transportation Data: Review of Methods and Proposed Taxonomy

Michigan Connected and Automated Vehicle Working Group
Warren, MI

July 27, 2015

Eric Paul Dennis (CAR), Richard Wallace (CAR), Matt Smith (MDOT) and Bill Tansil (MDOT)

This work is a product of a State Planning & Research grant from the Michigan Department of Transportation.
Background

• Project conducted under ongoing research contract with Michigan Department of Transportation (MDOT) to investigate impact of crowdsourced information on transportation system administration.

• Literature review and critical analysis

• Interviews with six Transportation Operations Centers (TOCs) in State of Michigan.
  ✓ MDOT Statewide TOC
  ✓ Macomb County Department of Roads (MCDR)
  ✓ MDOT West Michigan TOC (WMTOC)
  ✓ Road Commission for Oakland County (RCOC)
  ✓ MDOT Southeast Michigan TOC (SEMTOC)
  ✓ MDOT Bluewater Bridge TOC
Scope

• *Crowdsourcing*: Leveraging the combined intelligence, knowledge, or experience of a group of people to answer a question, solve a problem, or manage a process.

• Not included in scope:
  – Data acquisition systems fitted to agency-owned fleet vehicles
  – Any data collected by agency employees in the course of their job
  – Traditional traffic sensors
  – Reidentification via License plate, Bluetooth, or WiFi.
  – Public Meetings
Crowdsourced Transportation Data Types

- Third-party Aggregated Data
- Direct Engagement over Social Media
- Internet-as-a-Sensor
- Dedicated Platforms
Third-party Aggregated Data

- Historical and Real-time Traffic Data (Probe Vehicles)
  - Traffic condition tracking and management
  - Planning
  - Reporting

- Large-sample Geolocation Data
  - Aggregated mobility patterns
  - Replacement for citizen travel journals
Social Media for Public Engagement

• Americans spend more online time using social media than any other online activity.
• Represents opportunity for meaningful public engagement.
• Collection (and dissemination) of system status information
  – Example: NY Metro Transit Authority (MTA) use of Twitter during Hurricane #Sandy
• Planning and project prioritization
  – Alternative to public meetings
  – Example: City of Austin Social Networking and Planning Process (SNAPP)
The Internet as a Sensor (IaaS)

- **Sensor**: Any device that takes a measurement and converts it into readable data.
- Data-mining social media data can supplement public participation
- Open traffic data is available (some with APIs)
- Data-mining may help predict traffic spikes
Dedicated Platforms for Transportation Systems Management

- When existing platforms do not provide desired data, option to create purpose-built platform.
- Big challenge is attracting enough users to contribute data
- Examples: Automated vehicle location for public transit, pavement condition data collection, bicycle travel and infrastructure data
TOC interviews suggested there are not any hard technical barriers to incorporating new data sources into existing practices.

All TOCs already incorporate crowdsourced data in some way.
Summary

• Transportation agencies are already using crowdsourced data.
• Opportunity for further utilization.
• Few hard barriers.
• Many opportunities for innovation.
Crowdsourced Transportation Data: Review of Methods and Proposed Taxonomy

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