Michigan Connected and Automated Vehicle Working Group Meeting Packet

January 21, 2015

1. Agenda
2. Meeting Notes
3. Attendance List
4. Presentations

MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

Wednesday, January 21, 2015

SoarTech
3600 Green Court (Kiva Conference Room)
Ann Arbor, MI 48105

MEETING AGENDA

1:00 PM Introductions and Update, Richard Wallace, CAR

1:10 PM AI and Driver Assistance Systems, Andy Dallas, SoarTech

1:40 PM Reboot: Developing a New Automotive Dealer Experience for Connecting Drivers to Their In-car Technologies, Jeff Hannah, SBD

2:10 PM Update on the SE Michigan Connected Vehicle Corridor, Matt Smith, MDOT

2:25 PM Talking Cars—Secure at Any Speed, Mark Peters, Security Innovation

2:45 PM Networking Break

3:05 PM Updates on Planned Expansion of the Connected Vehicle Safety Pilot and Development of the MTF, Debra Bezzina, UMTRI

3:35 PM Sensing Solutions for ITS and ADAS, Colin Brooks and Bill Buller, MTRI

4:00 PM Adjourn

MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

The winter 2015 meeting of the Michigan Connected and Automated Vehicle Working Group was held at the SoarTech facility in Ann Arbor, Michigan, on January 21, 2015.

MEETING NOTES

Richard Wallace of the Center for Automotive Research (CAR) gave a brief welcome and began introductions around the room. After attendees introduced themselves, Richard discussed the meeting agenda, working group mission, and noteworthy connected and automated vehicle (CAV) news. He highlighted news from federal government agencies, as well as some of the announcements made at this year's Consumer Electronics Show in Las Vegas. Richard briefly discussed several upcoming CAV-related events, and he highlighted two workshops on cybersecurity and government vehicles that were hosted by SRI last year (with more to come). If you are interested in this topic and would like to engage with SRI, please contact Ken Augustyn (734-926-4422 or kenneth.augustyn@sri.com). An attendee added news from Verizon about an aftermarket telematics device and service: https://gigaom.com/2015/01/13/verizon-unveils-a-car-plug-in-module-providing-onstar-like-services/.

After completing his slides, Richard introduced Andy Dallas of SoarTech, who provided an overview of his company and its work. Andy showed two videos to illustrate SoarTech's capabilities. The first video discussed the Smart Interaction Device (SID), which was demonstrated using a remote helicopter. The SID interface allows the user to input routes, destinations, and areas to avoid and interact naturally and efficiently with the helicopter. The second video described SoarTech's Situation, Actions, Goals, Environment (SAGE) interface that can be used to monitor and control multiple robots. A team from SoarTech and the University of Michigan used SAGE to compete with other teams in the Multi Autonomous Ground-robotic International Challenge in Australia.

After Andy, Jeff Hannah of SBD discussed vehicle technology and its implications for automotive dealerships. Jeff discussed common challenges faced by customers, automakers, and dealerships. He noted that customers frequently required tech support for even basic tasks (e.g., entering destinations, making a call, or finding a radio station). Because automakers are installing ever more complicated infotainment systems, the role of dealerships is evolving to include more education and troubleshooting services to new-vehicle buyers. Jeff introduced Matt Messing of Gamivation, a partner company of SBD. The two companies have produced a whitepaper which can be accessed online (http://rebootwhitepaper.gamivation.com/).

Matt Smith of the Michigan Department of Transportation (MDOT) gave an update on the Michigan Smart Corridor that the agency is developing along with partners at General Motors, Ford, and University of Michigan. The corridor will be developed primarily along I-96/I-696 and I-94, but will also include part of US-23 and the Ann Arbor Connected Vehicle Testing Environment. Matt also discussed the U.S. DOT pilot deployments. The selected pilot sites will each receive between $1 million and $20 million for connected vehicle deployment projects. MDOT will submit a pilot deployment application and the proposed pilot site will build on the Smart Corridor effort. Matt encouraged attendees to engage with MDOT and provide feedback on its U.S. DOT pilot deployment application.

Following Matt, Mark Peters of Security Innovation presented on his company and CAV-related security concerns. Security Innovation is involved with connected vehicle standardization efforts in

the United States and Europe and provided security software for the Ann Arbor Safety Pilot as well as the upcoming Cadillac connected vehicle program. Mark noted that the IT industry, which has focused on security for more than a decade is still struggling, and he suggested that the automotive industry is years behind IT with addressing these concerns, formalizing processes, policies, and standards. Mark suggested that companies need to focus on developer training, standards, and security testing.

After a short break, Debby Bezzina of the University of Michigan Transportation Research Institute (UMTRI) provided an update on the Ann Arbor Connected Vehicle Test Environment (AACVTE). She reviewed the Ann Arbor Safety Pilot and spoke about how it is evolving into the AACVTE. The contract scope and metrics definition for the AACVTE is ongoing, but the goal is to transition the project from a government-funded test to a self-sustaining environment. Debby also spoke about the Mobility Transformation Center and "M City" (formerly known as the Mobility Transformation Facility). The asphalt and concrete for M City have been laid and additional work on other portions of the facility will continue this spring.

After Debby, Bill Buller of the Michigan Tech Research Institute (MTRI) discussed his organization's work with radar evaluations of crash test surrogates (i.e., fake vehicle rear-ends used to evaluate vehicle safety systems). MTRI designed new crash test surrogates and evaluated those used by NHTSA and UMTRI using radar image analysis. Bill also discussed a project that used RADAR and LiDAR to detect deer. The information collected from that project can be used to develop a safety system for identifying deer in poor visibility conditions.

The meeting concluded with a presentation from Colin Brooks of MTRI. Colin discussed his work to develop, test, and demonstrate how unmanned aerial vehicles (UAVs) can help provide MDOT with high-quality, low-cost visual inspections for bridges or construction sites, monitor traffic on the roadway, and provide information on other locations of interest. The project involved several types of UAVs (e.g., large hexacopter, medium UAV, micro-UAV, and tethered blimp) and sensors (e.g., camera, infrared, and LiDAR). Colin also highlighted MTRI's participation at the ITS World Congress involving UAV and the blimp demonstrations.

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). 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*.

MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

ATTENDANCE LIST

First	Last	Organization	Email
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MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

PRESENTATIONS

Michigan Connected and Automated Vehicle Working Group

SoarTech

Ann Arbor, MI

January 21, 2015

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 (Federal)

- ITS Joint Program Office
  - Unveiled updated ITS Strategic Plan released (for 2015-2019)
    - http://www.its.dot.gov/strategicplan/
  - Released a synopsis of its connected vehicle pilot deployment program going forward, along with the announcement that a procurement opportunity will be released by January 30, 2015 (expect multiple awards and phased deployments)
    - http://www.its.dot.gov/pilots/
- NHTSA
  - Released an RFI on security certificate management system (SCMS). Several entities have expressed interest in running the SCMS—unclear if it will be private or public (or partnership).

Noteworthy News (CES and Other)

- CVTA Certification Program launched (Scott M. to elaborate)
  - http://www.connectedvehicle.org/conference-discounts/
- Audi completed more than 550-mile automated driving trip from San Francisco to Las Vegas unveil its A7 concept car at CES
  - http://www.techtimes.com/articles/25327/20150108/ces-2015-how-did-audis-self-driving-car-travel-550-miles-from-san-francisco-to-las-vegas.htm
- Ford unveiled new Sync 3 infotainment system with over-the-air (Wi-Fi) update capability
  - http://www.ford.com/technology/sync/
- Agero and Progressive both unveiled new UBI services that do not require a OBD-II dongle
  - Agero's system uses a smart phone app and is insurance provider agnostic; Progressive teamed with OnStar to use on-board telematics

Upcoming Connected and Automated Vehicle Events

- CAR Cybersecurity Breakfast Briefing, February 17, Livonia, MI
- Automotive World Megatrends, March 17, 2015, Dearborn, MI
- Automotive Cybersecurity Summit, March 30-April 1, Detroit, MI
- SAE World Congress, April 21-23, Detroit, MI
- ITSA Annual Meeting, June 1-3, 2015, Pittsburgh, PA
- Telematics Detroit, June 3-4, Novi, MI
- TRB Automated Vehicle Symposium, July 21-22, Ann Arbor, MI
- CAR Management Briefing Seminars, August 3-6, 2015, Acme, MI
- UMTRI Global Symposium on the Connected Vehicle, September 2015, Ann Arbor
- ITS World Congress, October 5-9, Bordeaux, France

Cybersecurity for Government Vehicles – February 2014 Workshop

- Invitation-only
- Organized by SRI International in Washington, DC
- Focused on understanding the problem and possible solutions
- Summary of key points raised
  - Security by design and throughout the systems lifecycle; software assurance
  - Main types of solutions being developed: HSMs, firewalls, and IDS
  - Security is needed for wireless entry points, including OTA updates
  - DHS S&T is looking to start programs in the transportation sector
  - Government vehicles have some unique issues and requirements

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Cybersecurity for Government Vehicles – November 2014 Workshop

- Built on the results of the first workshop
- Focused on the development of concrete next steps to secure government vehicles
- Begin forming a community approach for developing and applying both stop-gap and longer-term risk mitigations to better secure government vehicles

Working sessions

- Government needs and coordination
- Industry guidelines
- Interim steps and testing
- Key research needs

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Cybersecurity and Government Vehicles—Next Steps

- More meetings coming
- SRI interested in partnering
- See Ken Augustyn at the break or otherwise contact him: call/email 734 926-4422 or kenneth.augustyn@sri.com

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Advanced AI for use in Drivers Aids, Autonomy, and Infotainment Interaction

February 2014

Andy Dallas

SOARTECH

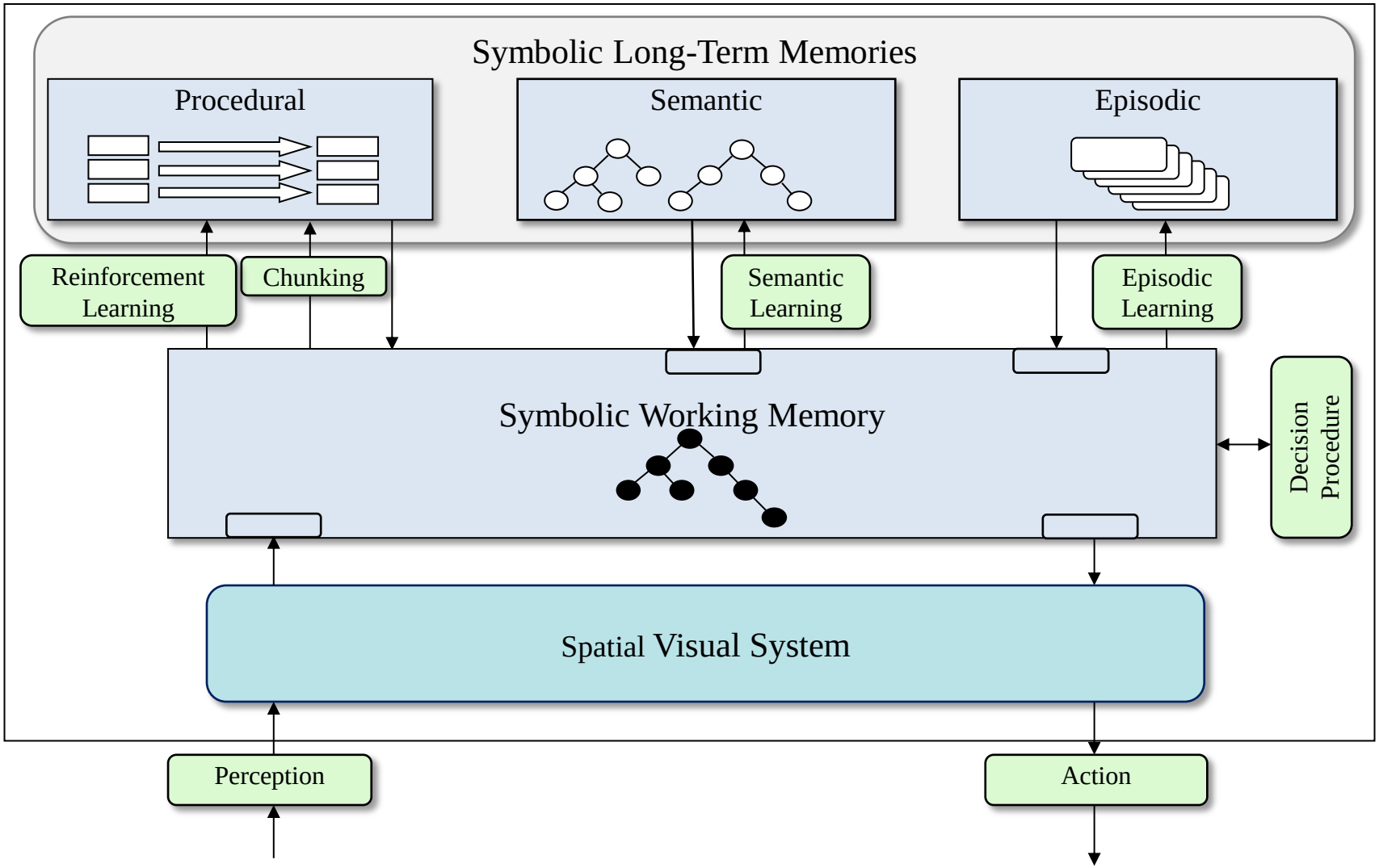
Modeling human reasoning.
Enhancing human performance.

Company Focus

- **Development of intelligent software that reasons like humans do to:**
  - Automate complex tasks,
  - Simplify human-machine interaction, or
  - Model human behaviors

- **Our philosophy is to:**
  - Be an augmentation to, not a replacement of, the human
  - Think “top-down, not bottom-up” (satisficing vs optimizing)
  - Be transparent—decisions and processing are communicated to the human and in human-like terms

Soar 9 Architecture

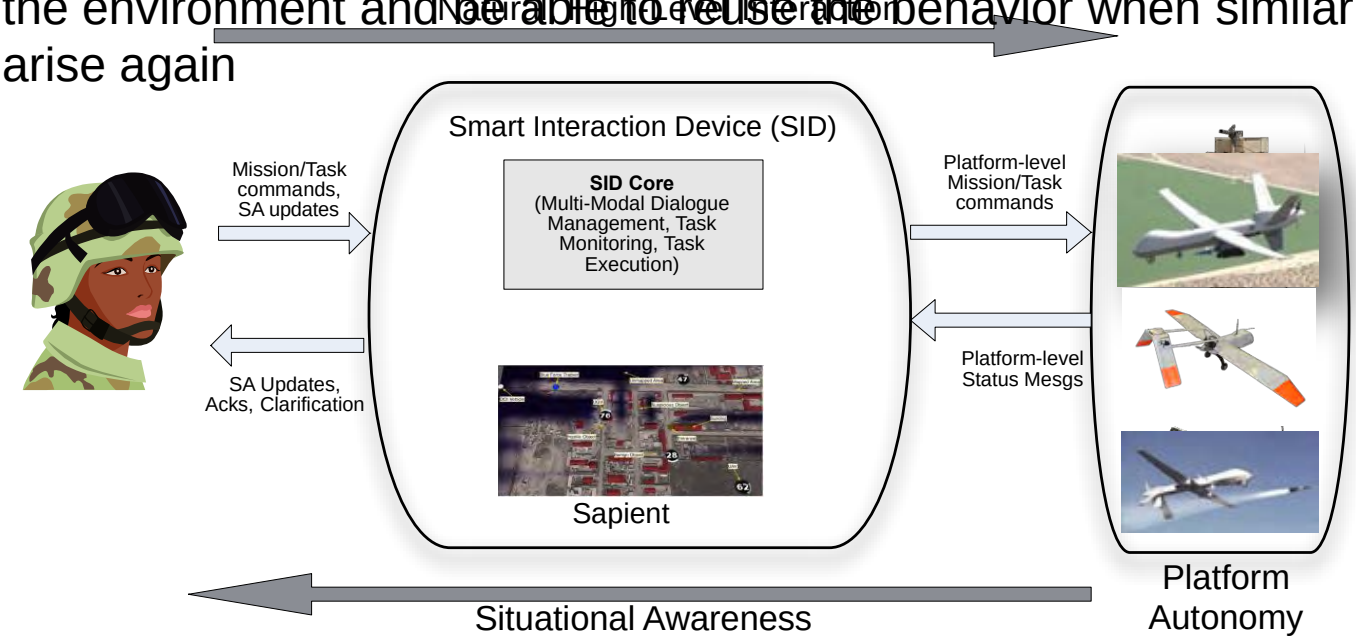


Why Cognitive Architectures (specifically Soar)?

- Capable of operating in real world environments
  - Reactive
  - Robust
  - Stable
- Capable of adapting to changing environments
  - Adapting the plan
  - Adapting the knowledge
- Capable of teamwork with people
  - Transparency = Trust
  - Multi-modal, natural (i.e. English) interaction
- Capable of introspection
  - Recognizes and overcomes gaps in knowledge

Human Machine Teaming

- Effective bi-directional flow of information requires:
  - **Autonomy** – the machine has to be able to execute some tasks on its own
  - **Human Machine Interaction**– the human and the machine both must be able to have a dialog
  - **Situational Understanding**– the human and machine must be able to maintain an understanding of the immediate mission and the external environment and be able to share this understanding
  - **Adaptation and Learning**—the machine must adapt to new events in the environment and be able to reuse the behavior when similar events arise again



Videos

What do Drivers do Today (the task)

- **Driving is a visual task defined by Situation Awareness**
  - V2V—Keeping track of the cars moving with me and toward me and potentially coming at me from the side, their relative velocities and potential for collision with where I'm going to be in the next seconds
  - V2I—Other activity, pedestrians, bicyclists, animals etc.
  - Predictions—Think, recognition of dangerous *patterns* of activity
  - *External Information*, maps—Where is the road and where is it going?
  - Environmental Regularities—Day/night
  - Environmental Irregularities—Weather
- **As drivers we operate in the time domain**
  - The scene is continually *changing* (Dynamic)
  - It is no more than about 5 seconds deep and continuously changing or updating as we move through space
- **The driver continually processes all this information, *makes predictions seconds into the future*, makes decisions based on these predictions, and controls the car**
  - Accelerator pedal
  - Brake pedal
  - Steering wheel

What Drivers do Poorly

- **Drivers look, but don't see**
  - Drivers do not have the same situational awareness that the cars of the future will have—cognitive dissonance
- **Drivers do not respond well in an instant**
  - Drivers are suited to tasks that require seconds to complete—slower processing speed than a computer
- **Drivers do not always recognize a dangerous situation**
  - This is a big problem for novices--inexperience.
  - Even experienced drivers don’t always recognize an event unfolding—poor pattern recognition.
- **Drivers are distracted**
  - Humans are prone to mind-wandering, fatigue.
  - Much of driving is done in the subconscious.
    - What happened in the last 10 miles?

How can AI help overcome these issues?

- **What approaches differentiate themselves from others?**
- **What is the value add?**

Possible Options

- Improved Driver Safety
  - Drivers Aids: improved driver safety by augmenting the driver with salient high-level information
  - Autonomy: allowing vehicles to act autonomously in well defined situations
- Intuitive Interaction: technologies that provide a natural interface with a vehicles informatics and communicative system

These options are driven by the same (or similar) reasoning processes – main difference is the output

Reboot: Developing a New Automotive Dealer Experience for Connecting Drivers to their In-car Technologies

MICHIGAN CONNECTED AND AUTOMATED VEHICLE WORKING GROUP

January 21, 2014

SBD & GAMIVATION

SBD's role since 1995

Noise Distraction Hype Uncertainty

Rapid changes in consumer needs, technical trends & government regulation are creating an environment of…

… making decisions harder, riskier and slower to take

SBD helps its clients make the **right decision** by filtering out distractions and providing **actionable**, **accurate** and **accessible** insights

SBD & GAMIVATION

What topics do we specialize in?

Connected Car

Infotainment

Telematics

Usability

Safe Car

Active Safety

Autonomous Cars

V2X

Secure Car

Mechanical

Electronic

Cyber Threats

SBD and Gamivation published a collaborative Whitepaper this fall on dealer technology challenges

We've evolved from a place where *cars have technology*, to a place where *technology has wheels* – *the auto dealer experience also needs to evolve*

The rush to infotainment innovation is placing immense pressure on auto dealerships, which face an expansion of their role from purely selling cars, to helping consumers understand, set-up and troubleshoot their new in-car technologies.

With automakers all implementing different strategies to support their dealer networks (including the much-hyped Genius Bars), SBD has partnered with Gamivation to analyze and highlight best practices and innovative solutions to overcome the disconnect between consumers, in-car technologies, and the auto dealers on the front lines of this ever changing landscape.

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The evolution of In-Car Technology

460

Average # of pages in car owner manuals

18

Average # of acronyms that a consumer is faced with

233

Average # of features available on leading Infotainment systems

130%

Growth in # of apps being offered by car makers since 2013

Today

"You can have any color as long as it's black"

Henry Ford - 1922

In the beginning....

1930 - First commercial car radio

1953 - First auto-tuner

1985 - First digital in-car navigation

1970 - First cassette player in car

Late 1990s - First telematics services

1915

1935

1955

1975

1995

2015

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What is the disconnect?

Consumers

Increasingly expect it…

A new class of on-line savvy car buyers is placing a greater importance on both CE and in-car technologies

Automakers

Have to offer it…

In addition to mounting pressure from competitors, automotive OEMs (now more than ever) face technology trends beyond their control (e.g. CarPlay & Android Auto)

In-car Technology

Apple CarPlay

android auto

Auto Dealers

Struggle with it…

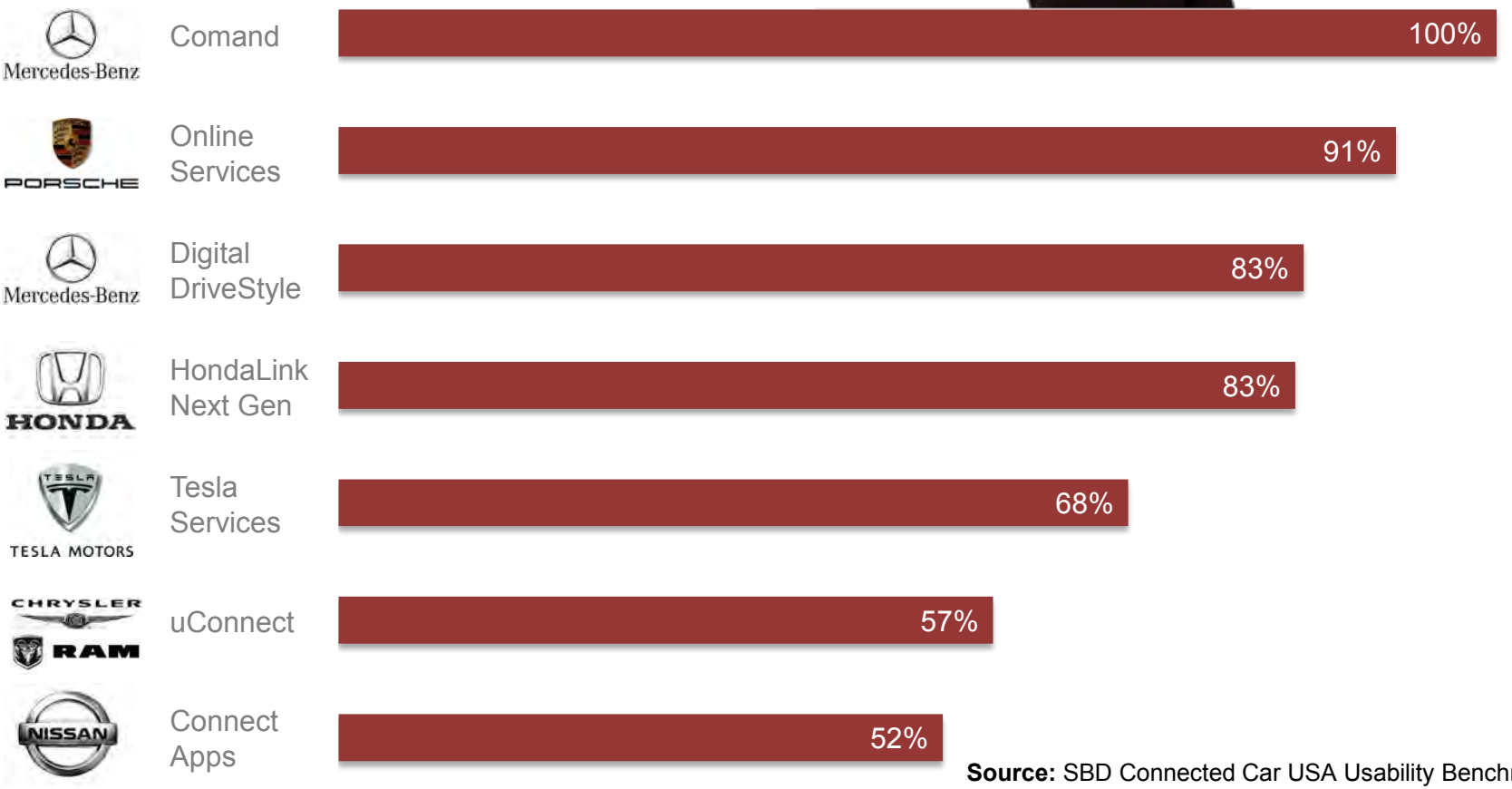
Sales targets	Limited time	High turnover
Dealer's primary role is to sell cars – not technology	Pressure to reduce the time-to-purchase / delivery > 3hrs	35% of their personnel leave each year, making training hard

Common challenges across the value chain

	Multiple systems per brand	Frequent software updates	Growing complexity of systems	Customer support services
Buyers	No rhyme or reason as to which models get the best technology	Is this car compatible with my Smartphone?	I just want it to work 'out of the box'	UGH! For a $60,000 car, a little help please!
OEMs	More fragmentation = lower risk (avoid putting all our eggs in one basket)	Lots of pressure to make new announcements during Trade Show!	It tested fine in the focus groups	Dealers never use the support we provide
Dealers	Even on the same model there are dozens of tech configurations	Every few months there is something new – how can we keep up?	I wish there was a 2-tiered system: one for dummies, one for tech-savvies	Everything is focused on a number – in-car tech makes "CSI" even harder

Recent SBD tests reveal trouble ahead

% of consumers who required support to complete one or more basic tasks when testing infotainment systems
(e.g. enter destination, call a friend, find a radio station)



Source: SBD Connected Car USA Usability Benchmarking - July 2014

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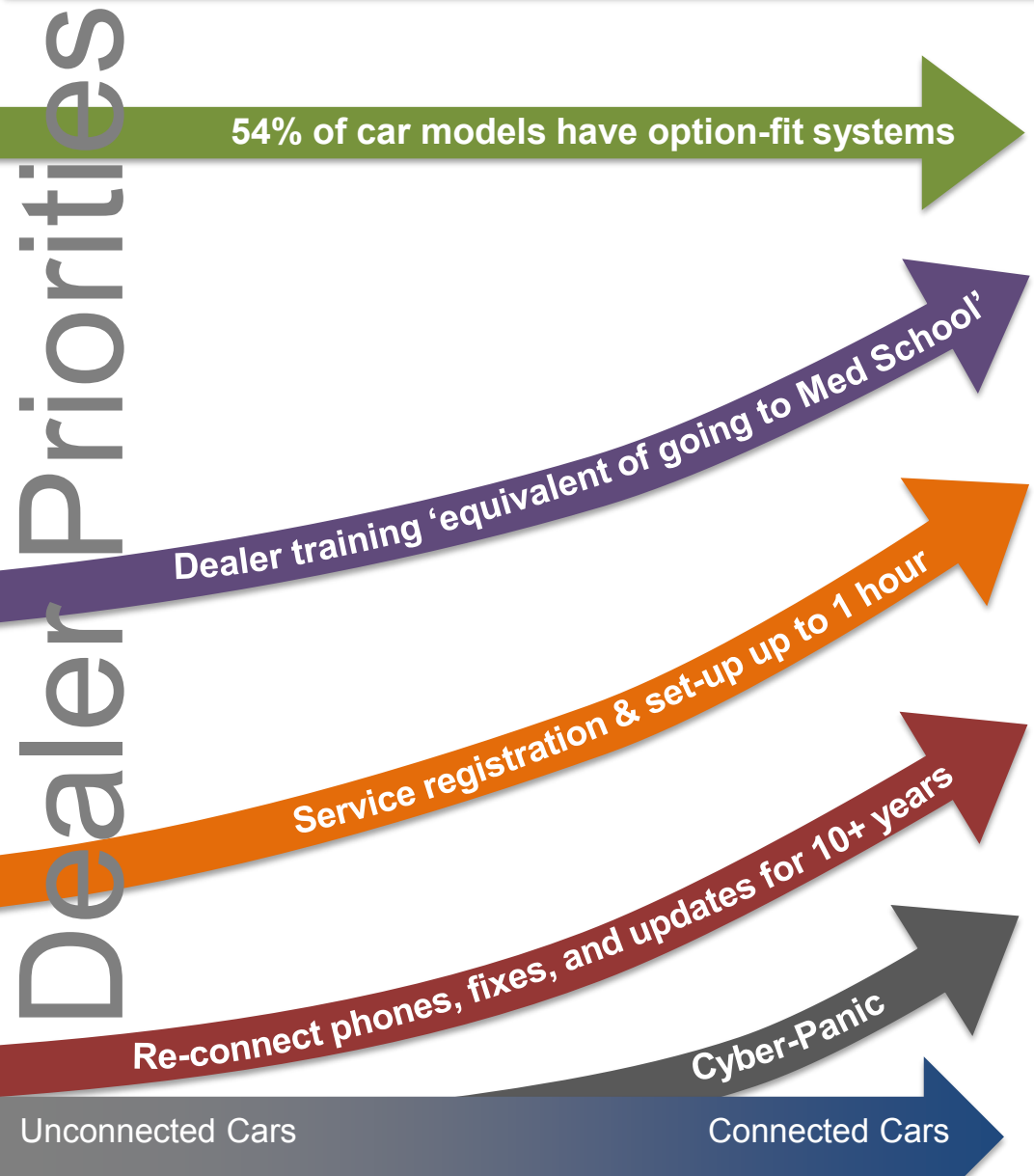
The evolving role of dealerships



Selling

Primary role of dealers is to sell cars, rarely incentivized to 'sell' technology

Educating

Dealers face an avalanche of training requirements which are nearly impossible to fulfill.

Setting up

Ever-expanding set-up process for dealers includes device pairing, registration, and activation

Troubleshooting

First point of contact when consumers have trouble with technologies in their cars

Emerging: Security

Protection of consumer data, and guarding against growing cyber-security threats

How are dealers adapting?

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Which dealers have the toughest job?

		Multiple systems per brand (based on # of different headunits offered by automakers in USA)	Frequent software updates (based on rate of new feature/service introductions by each OEM)	Growing complexity of systems (based on UX evaluation of headunits & set-up/ registration processes)	Customer support services (based on interviews with dealerships & assessment of online support)
Easier Position	Tesla	●●●●●	●●●●○	●●●●●	●●●○○
	Subaru	●●●●○	●●●●●	●●●●○	●●●○○
	Infiniti	●●●●●	●●●●○	●●○○○	●●●●○
	Mitsubishi	●●●●●	●●●●●	●●●●○	●●○○○
	Porsche	●●●●○	●●●●○	●●●●○	●●●○○
	Ford	●●●●○	●●●●○	●●○○○	●●●●○
	Volkswagen	●●●●●	●●○○○	●●●●○	●●●●○
	Cadillac	●●●○○	●●○○○	●●●●○	●●●●●
	Volvo	●●●○○	●●●●○	●●●○○	●●●○○
	Kia	●●●○○	●●●●○	●●●○○	●●●○○
	Buick	●●○○○	●●○○○	●●●●○	●●●●●
	Mazda	●●○○○	●●●●●	●●●●○	●●○○○
	Nissan	●○○○○	●●●●○	●●●○○	●●●●○
	Chevrolet	●○○○○	●●○○○	●●●●○	●●●●●
	Audi	●●●●○	●●○○○	●●○○○	●●●●○
	Acura	●●●●○	●●●●○	●●○○○	●●○○○
	Honda	●○○○○	●●●●○	●●○○○	●●●●○
	BMW	●●●●○	●●○○○	●○○○○	●●●●○
	Jeep	●●●●●	●●●○○	●●○○○	●●○○○
	Lexus	●●●●○	●●●●○	●●○○○	●●○○○
Tougher Position	Chrysler	●●●●○	●●●○○	●●○○○	●●○○○
	Mercedes-Benz	●●●○○	●●○○○	●○○○○	●●●○○
	Dodge	●●●○○	●●●○○	●●○○○	●●○○○
	Toyota	●●○○○	●●●○○	●●○○○	●●○○○
	Hyundai	●○○○○	●●●○○	●●○○○	●●●○○

SBD & GAMIVATION

Current solutions adopted by car makers

The ‘**Lonely Genius Bar**’

Mimic trendy consumer electronic chains with dedicated area, dynamic content, and “geeks”

The ‘**Frustrated Tech Specialist**’

“Certify” a few targeted individuals to answer questions, on-board customers, provide demos

The **Basic Infantry**

Provide base level of training to everyone in the dealership, every salesperson can explain features

The **‘Sell The Car & Worry About Tech Later’** Dealership

Focus on efficiency in selling and delivering car

Strengths & Weaknesses of each approach

'There's no perfect solution'

	The 'Lonely Genius Bar'	The Frustrated Tech Specialist	The Basic Infantry	Sell Car, Worry About Tech Later
Content Upsells				
Investment/Expense				
Support Expertise				
Sales Integration				
Customer Time				
Strengths	+ Proven C.E. Model	+ Targeted Training	+ Natural Sales Flow	+ Reduced Time
Weaknesses	- Doesn't Scale to Mainline	- Continuity: 1-2 Per Dealer	- Lack of Expertise	- Customer Inherits Problem

What's missing from these solutions?

How do OEMs communicate & measure dealers today?

- Infotainment training
- Calling customers
- Selling time with customers
- New product launches
- CSI Scores
- OEM Sales Training
- Paperwork & data entry
- Sales operations
- F&I Information
- Customer Surveys

What is this leading to?

What's missing?

- **Focused and On-Going Engagement**
- **Competitive Messaging**
- **Metrics and Measurement (Training and Effectiveness)**
- **Targeted Incentives**
- **Dedicated channel to salespeople**
- **Multi-Platform Solutions**

How Gamivation & SBD can help

GAMIVATION™

- Dealership-proven gamified learning platform
- Certification testing and quizzing engine to change behaviors and measure retention
- Big data on sales people with better visibility
- Increase sales and support new product and service launches
- Low risk and low-cost deployment options for OEMs to use with their dealers nationally

SBD

- 20+ plus years linking automotive technology strategies to vehicles sales
- Industry-first Tech Advantage Tool to message competitive differentiation
- Expert analysis and support for OEM go-to-market initiatives
- Industry leader in Infotainment consumer usability testing

To find out more information…

http://www.gamivation.com/

info@gamivation.com

http://www.sbd-na.com/

info@sbd-na.com

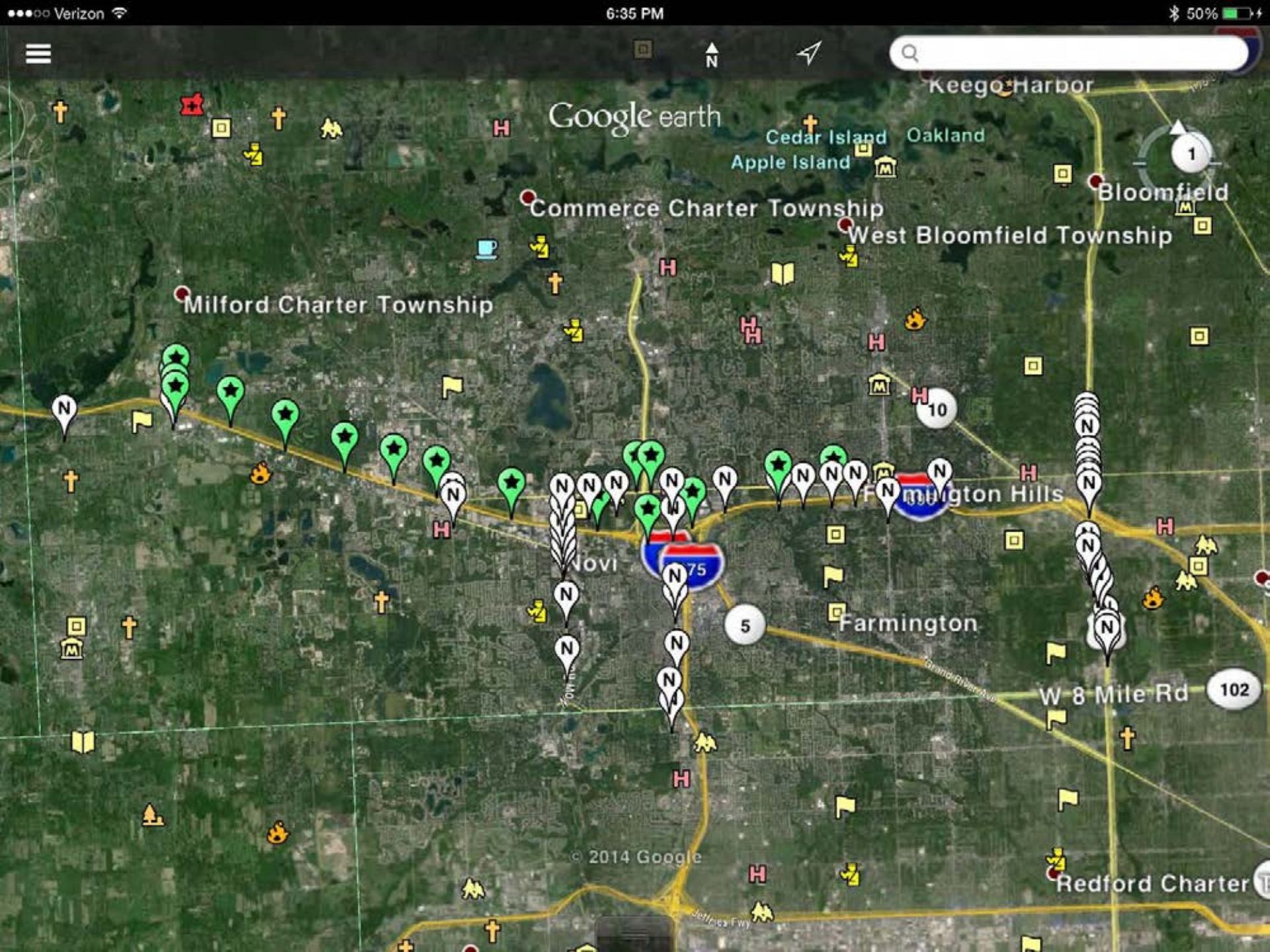
Learn. **Compete.** **Win.**

SBD & GAMIVATION™

Contact Us

If you are interested in discussing this presentation further, please contact:

Jeff Hannah
Director, SBD North America
JeffreyHannah@sbd-na.com
734-883-3417 (Cell)
www.sbd-na.com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Dearborn
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Detroit
Windsor
Lake St. Clair
12 MILE ROAD
10 MILE ROAD
8 MILE ROAD
GRAND RIVER AVENUE

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PURE MICHIGAN Michigan Economic Development Corporation

TALKING CARS

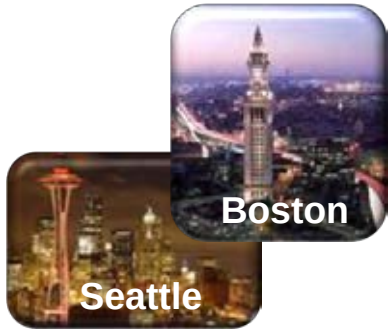
Mark Peters

Director Automotive
Business Development

Security Innovation®
THE APPLICATION SECURITY COMPANY

Who is Security Innovation (SI)

- We are Application & Data Security Experts focused on
  - Embedded systems, Web systems, and Software systems



- We help organizations….
  - Build internal security expertise for self-sustainability (secure SDLC)
  - Integrate security into design and development of software and systems
  - Harden applications and systems to prevent data breach
  - Meet security aspects of compliance

Training, knowledge-based products, consulting, & small, fast crypto libraries

Security Innovation®
THE APPLICATION SECURITY COMPANY

About Security Innovation

- Authority in Software Security
  - 15+ years research on vulnerabilities
  - Security Testing methodology adopted by Adobe, Microsoft, Symantec, McAfee, and others
  - Authors of 16 books, 4 co-authored with Microsoft
  - Security partner for Dell, Microsoft, Cisco, HP, IBM, PCI SSC, FS-ISAC, Trustwave, NXP, and others
  - 9 Patents

- Helping Organizations Secure Software wherever it runs
  - SOFTWARE SECURITY TESTING
  - TRAINING & STANDARDS
  - EMBEDDED SYSTEMS SECURITY

Security Innovation
THE APPLICATION SECURITY COMPANY

Participation in V2X

- Contributor to USDOT-funded research and standardization, editor of the 1609.2 specification
- Active members in the European Telecommunications Standards Institute (ETSI) and the Car 2 Car Consortium
- Supplier of security software for over half of the vehicles in the Ann Arbor Safety Pilot
- Aerolink selected for Cadillac V2V program

V2V: the worries

- Security
  - Will hackers be able to take control of my car?
  - Will terrorists be able to cause mass havoc

- Privacy
  - Will the government be able to track my every move?
  - Will I be issued automatic speeding tickets everywhere?

Security Credential Management System

- CAMP has designed a Security Credential Management system that:
  - Protects privacy
    - Multiple certs
    - No single component in the system can track
  - Allows revocation

Needs thorough system security testing

Future Challenges

- Cryptographic mechanisms
  - Algorithms need more work to standardize across EU/US
  - Post-quantum cryptography is a threat
- Multiple applications
  - No general framework in place to handle these
  - Privacy and device security come into play here as well
- New device types with V2x capabilities, e.g., smartphones
- Standards harmonization
  - US and EU not completely aligned (shocker)

Are our Software Development Teams Ready for Talking Cars?

- Modern day luxury car has ~100,000,000 lines of code
- AppSec Research Results from Ponemon Institute grim
  - Assessed maturity of an organization's AppSec programs
  - Analyzed 642 organizations in both executive and engineering positions
  - Over half of the respondents are employed by organizations of more than 5,000 employees

Key Findings

1. Most **organizations do not have a defined software development process** in place
2. The majority of organizations have **no formal application security training** program
3. Most organizations do not identify, measure, or understand application security risks
4. Significant **disconnect exists between executives and practitioners regarding security** maturity and activities
5. Policies, Requirements, and Standards are often ad-hoc and not Integrated into the Software Development Life Cycle
6. Most development teams are not measured for compliance with regulations and standards
7. Most organizations are **not testing for application security**

Next steps and where to focus

Software Security

- Developer training and standards
- Testing for and removing vulnerabilities in those 100,000,000 lines of code

Finalizing privacy mechanisms for V2x messages

- Standards/governing body agreement on encryption, pseudonymity, and certificate scale management
- Moving the mandate to law and complying with sovereign state privacy requirements

Thank You

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Ann Arbor Connected Vehicle Test Environment

Debby Bezzina

Senior Program Manager

University of Michigan
Transportation Research Institute

SPMD Review

- Safety Pilot Model Deployment
  - 30 month program
    - 12 months planning
    - 12 months deployment
    - 6 months decommissioning
  - Extended to 36 month program with limited decommissioning
  - 2800+ vehicles equipped
  - 73 lane-miles of roadway instrumented with 25 roadside equipment installations

Huron River
Whitmore Lake
Dhu Varren
Nixon
Plymouth
Pontiac
Barton
UMTRI
Green
Huron
Brooks
Summit
Maiden
Fuller
Glazier
Miller
Depot
Division
State
Glen
ANN ARBOR
University
1st
Liberty
Geddes
Earhart
Dixboro
Madison
4th
5th
7th
Hill
Hoover
Pauline
Packard
Huron River
Stadium
Clark
Main
Scio Church
Industrial

UMTRI

Data Set Collected To Date

- Data: 70 TB
- Trips: 5.3 Million
- Distance: 33.9 Million Miles
- Time: 1.2 Million Hours
- BSMs: 105.6 Billion records

Evolution to AACVTE

- UMTRI approved as the sole source to "operate, maintain, and upgrade Connected Vehicle Test Environment"
- Contract scope and metrics definition ongoing
- 3 year period of performance
- Builds upon SPMD

AACVTE Objectives

- Transition from a model deployment to an early operational deployment
- Transition from government funded to sustainable environment
- Stand up a robust, high quality environment

AACVTE Scope
Work Area 1

- Operate and Maintain Test Environment
  - Data Collection
  - 25 RSU Installation sites (minimum)
  - 2,000 BSM transmit only device equipped vehicles (minimum)
  - 200 BSM transmit and application hosting device equipped vehicles (minimum)
  - IRB Management
  - Subject Management

AACVTE Scope
Work Area 2

- Upgrade Infrastructure and Security in Test Environment Operations
  - Improve device robustness (implement corrective actions from SPMD)
  - Improve Quality of the environment
    - GPS Characterization Testing and improved verification process
    - Improve GPS quality
  - Transition to CVRIA
  - MTC Pillars 1 and 2
  - Conduct Focused Research

AACVTE Scope
Work Area 3

- Plan and Develop a Sustainable Operational Environment
  - Consolidated roadmap for MTC and AACTVE
  - Marketing Plan
  - Industry Outreach

AACVTE Scope
Work Area 4

- Support Other Related Research Activities
  - Develop Training Materials for transitioning a connected vehicle test site to an operational system
  - Other activities to be defined at a later date

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MICHIGAN MOBILITY TRANSFORMATION CENTER

The UM Mobility Transformation Center

Jim Sayer

Deployment Director

January 21, 2015

The MTC

A public/private R&D partnership
that will lead a revolution in mobility
and develop the foundations
for a commercially viable ecosystem
of connected and automated vehicles

developing an entire system of connected and automated transportation on the streets of southeastern Michigan through 2021

a shared initial investment of $100M over 8 years with 25% coming directly from the U-M

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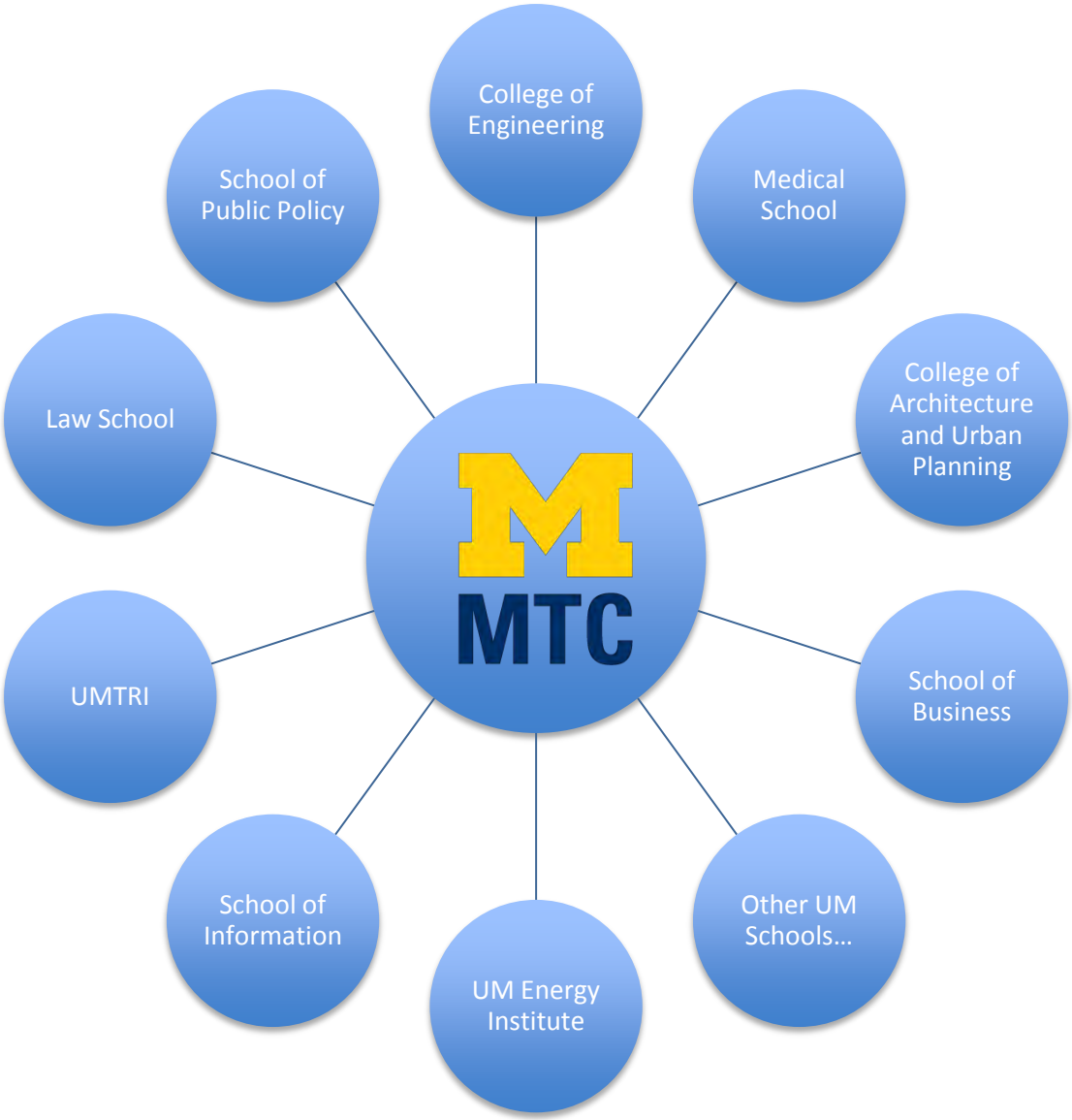
KEY TRANSFORMATIONAL METRICS

- Fatalities and injuries
- Delay in traffic
- Energy consumption
- Carbon emissions
- Transportation start-ups

MTC Research Thrusts

- Connectivity (V2X)
- Automation
- Cybersecurity
- ITS Interoperability
- Analytics
- Human Factors
- Energy
- Public Policy
- Infrastructure Design
- Urban Planning
- Social Implications
- Standards
- Regulatory Issues
- Compliance
- Legal Issues
- Insurance Implications
- Business Models
- Payment Methods
- Congestion Management

UNIVERSITY PARTNERS



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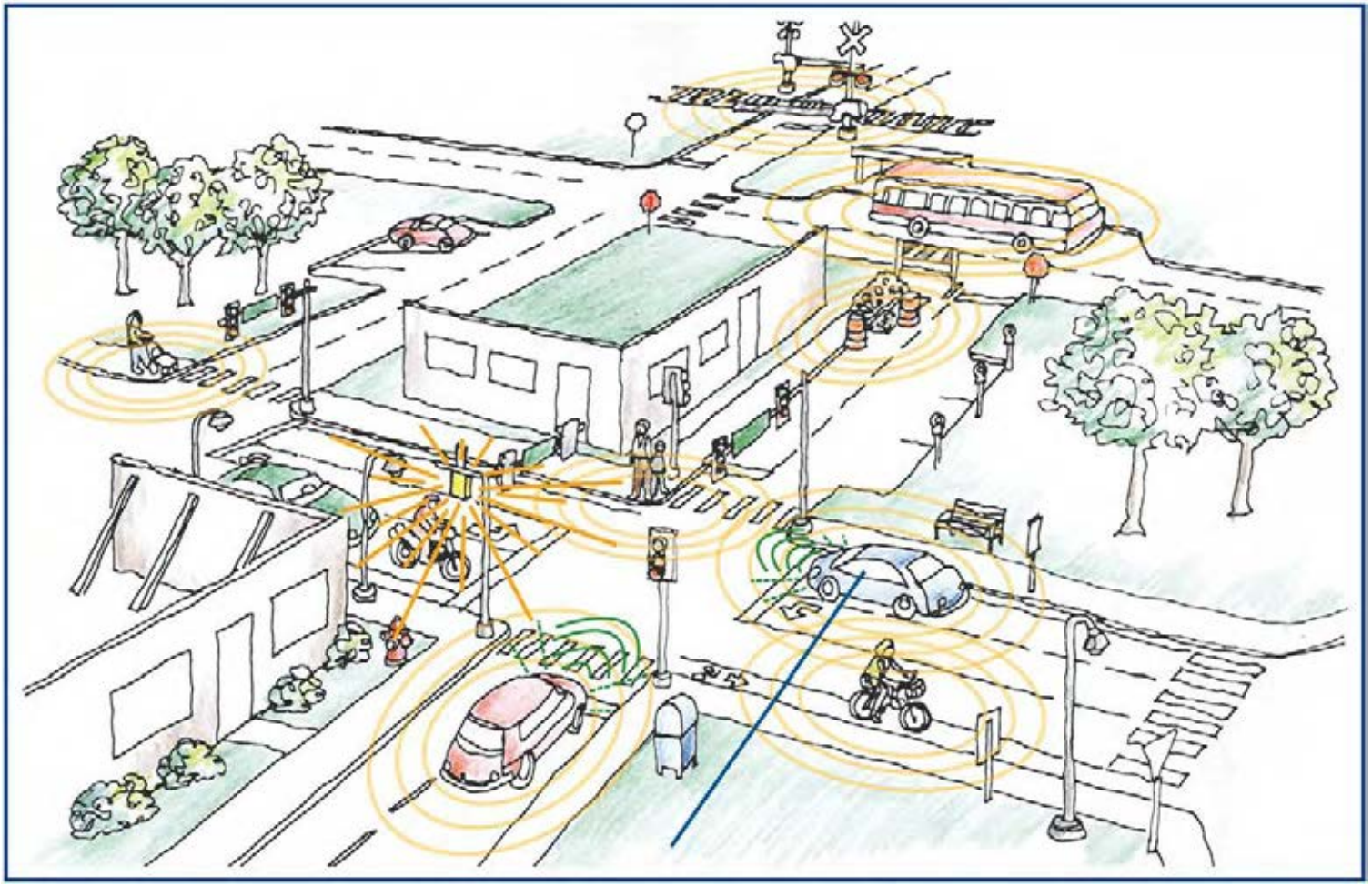
MTC Platforms for Innovation

Three pillar programs, in collaboration with MDOT:

1. **Ann Arbor Connected Vehicle Test Environment (2014+)**
   - 9,000 equipped vehicles
   - 27 sq. miles of equipped infrastructure
2. **Southeast Michigan Connected Vehicle Deployment (2015+)**
   - 20,000 equipped vehicles
   - 500 equipped nodes, including highways and intersections
   - MDOT smart corridor
   - 5000 devices including nomadic seed devices, extending to vulnerable road users (including pedestrians)
3. **Ann Arbor Automated Vehicle Field Operational Test (2016+)**
   - 2,000 connected and automated vehicles
   - Including Level 4 automated vehicles
   - 27 sq. miles of densely instrumented infrastructure

M City



M City

<u>Roadway Attributes</u>

- Signalized intersections
- 1000’ North/South straight
- Various road surfaces (concrete, asphalt, dirt)
- Variety of curve radii, ramps
- Two, three, four and five-lane roads
- Round-about and “tunnel”

<u>Road-side Attributes</u>

- Variety of signage and traffic control devices
- Fixed, variable street lighting
- Cross walks, lane delineators, curb cuts, bike lanes, grade crossings
- Hydrants, sidewalks, etc.
- Movable building facades

MDOT Michigan Department of Transportation

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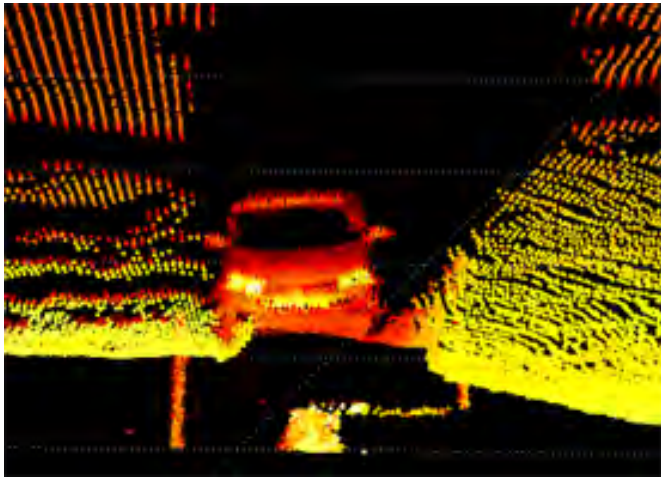
A REVOLUTION IN MOBILITY

MichiganTech Research Institute

Connected and Automated Vehicle Sensor Technology Research



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UMTRI
University of Michigan Transportation Research Institute

CSRC
Collaborative Safety Research Center Toyota

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

MichiganTech Research Institute

www.mtri.org

Research Areas

- Design of radar realistic crash test surrogate
- Radar evaluation of NHTSA crash test surrogate
- Design of pedestrian avoidance radar
- Measurements of deer with RADAR and LIDAR

Vehicles measured to understand radar signatures

Legacy Test Surrogates

*NHTSA Foam Car 1**

** The foam car, measured in this study, is nearly identical to NHTSA's FC1*

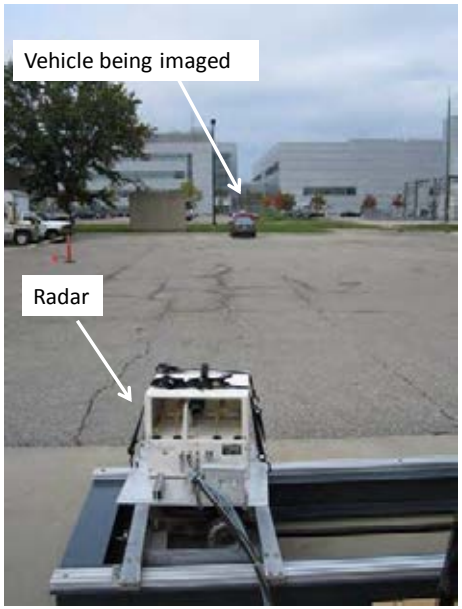
NHTSA Foam Car 2

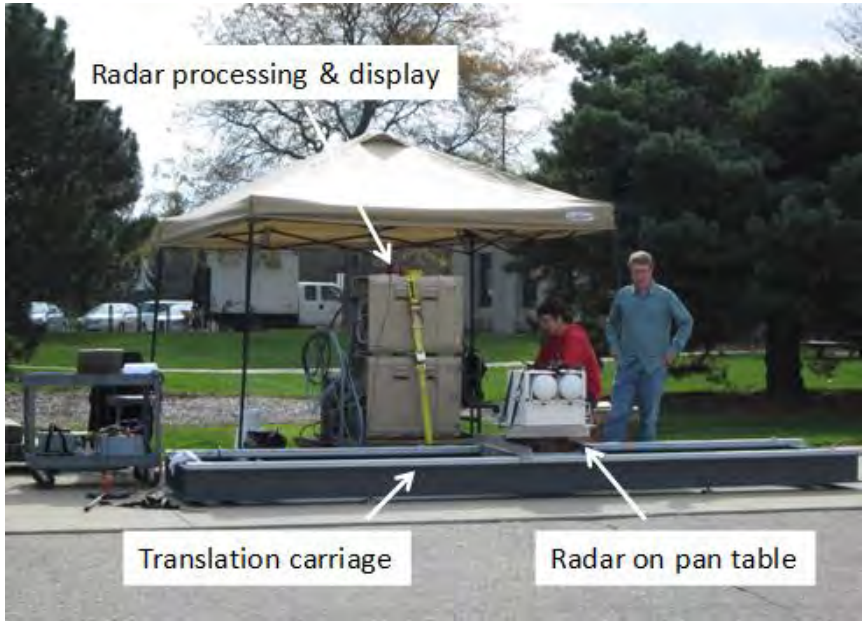
Helly Hansen
Spesialprodukter
Balloon Car

UMTRI Test Surrogate with MTRI designed radar element

Radar Setup and Antenna Specifications

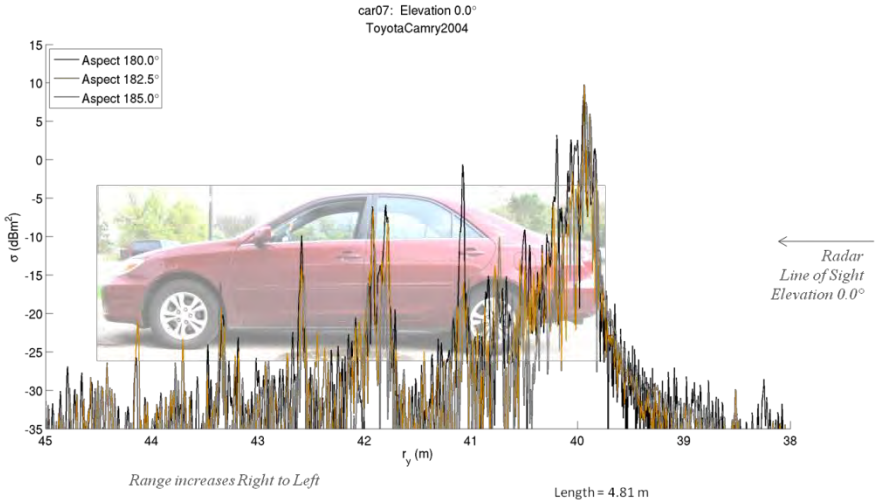
- The MTRI W-band radar employs
  - circular lens antenna
    - beamwidth of 1.5 degrees (illumination circle is 1 m at 40 m standoff)
  - Stepped-chirp waveform
    - Covers frequencies from 90 to 98 GHz
  - Range gate to reduce clutter

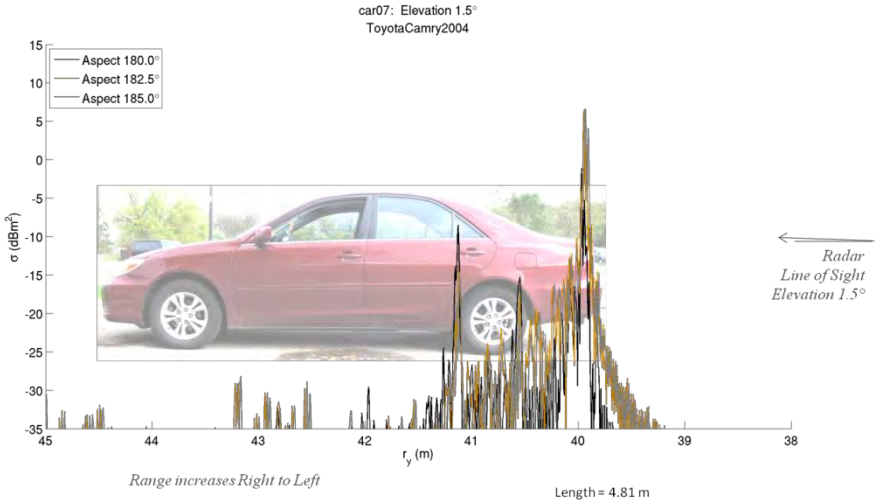




Radar measurements were made in conjunction with the University of Michigan's Transportation Research Institute (UMTRI)

Impact of Elevation on Radar Signature



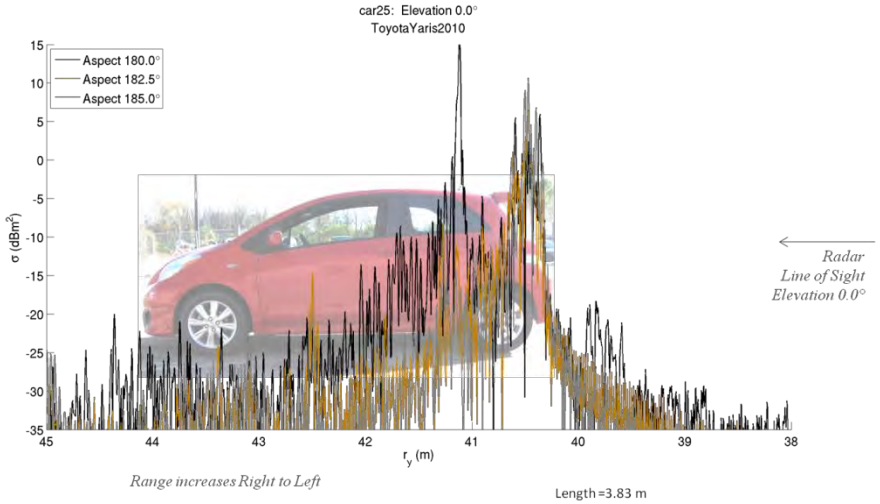


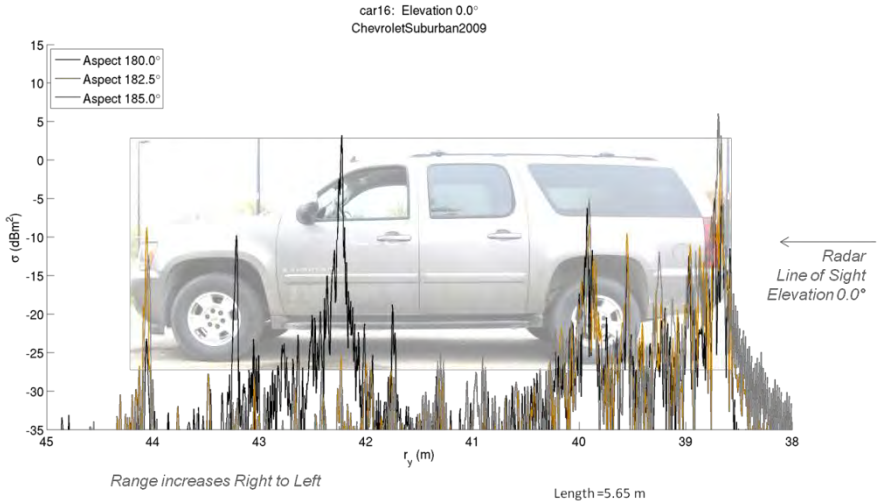
- Consistently across the vehicle types, low elevation scans produce greater signatures with greater range span of reflections
  - Returns collected with the radar aimed horizontally (0 degree elevation) show returns from
    - Rear bumper, License-plate shelter
    - Muffler
    - Rear-suspension, Differential and Chassis supports
  - Returns collected with the radar tipped up slightly (1.5 degree elevation) show returns from
    - Rear bumper, License-plate shelter
    - Interface of Rear-window and Roof, or back of cab on Pickup-Trucks

The Impact of Shape on Radar Signature is Much Greater than Size

Combination of low clearance and relatively high bumper produces a very large return from the Yaris chassis

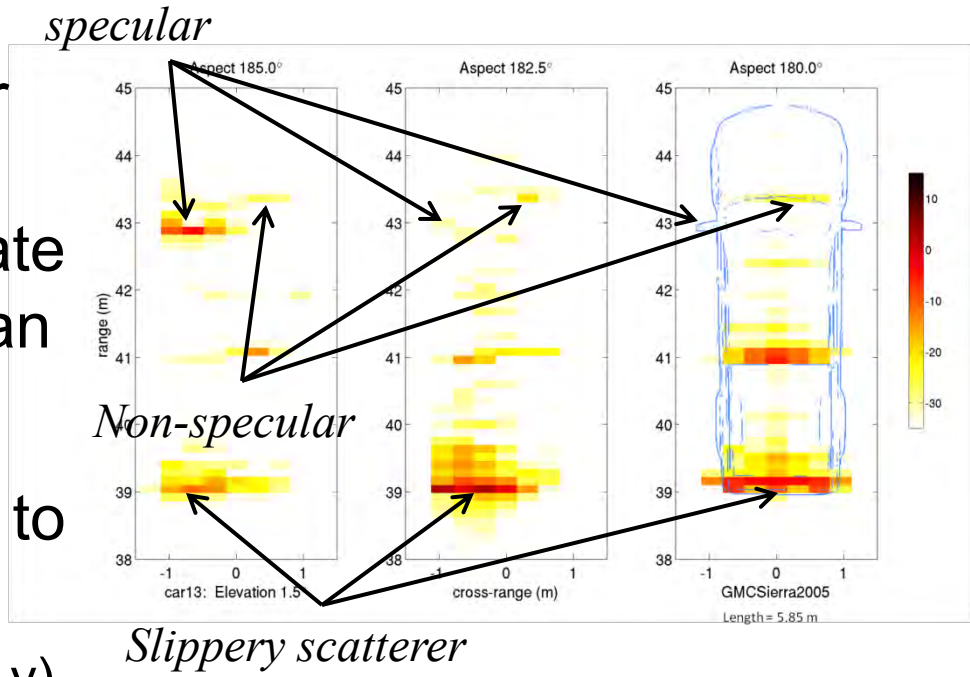
- The calibrated radar return data shows that scattering from elements of the 2010 Yaris at left, are significantly stronger than the returns from the 2009 Chevrolet Suburban at right
  - The Suburban is largely rounded at the back-end and the bumper's shape occludes much of the under carriage up to the forward suspension





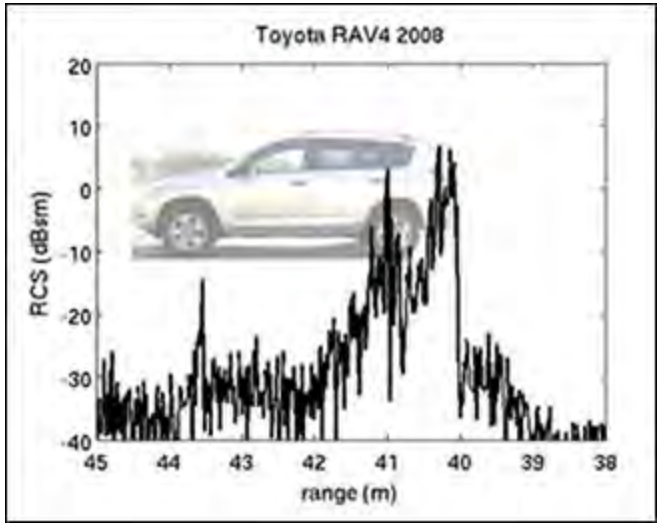
Radar Image Analysis

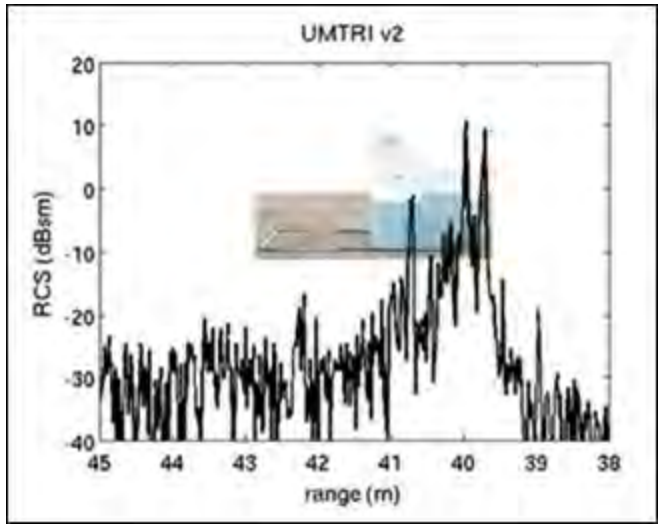
- Images of the vehicle radar sources are created by mapping the polar coordinate collection scans to Cartesian coordinates
- The images are processed to identify
  - Scattering source location (x, y)
  - Scattering source support (azimuth and elevation)
  - Scattering source size (radar cross-section)



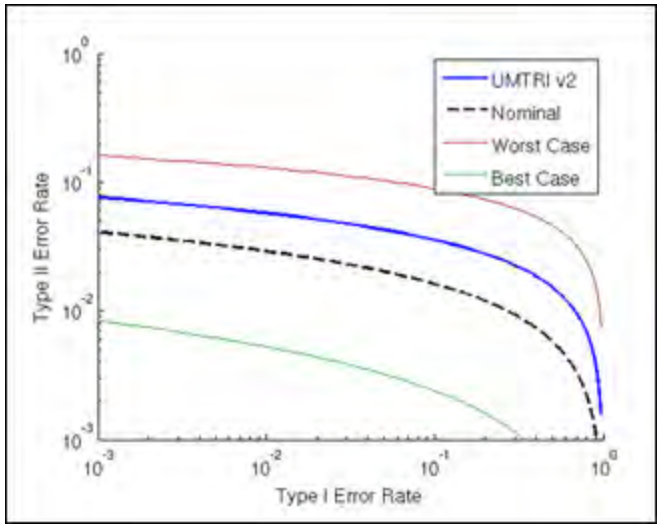
The problem of identifying scattering source type is simplified by having access to the cars. Knowing where the source is allows us to identify it.

Design produces RADAR Realistic Target





- RADAR system performance depends on target detection
- Detection performance of the UMTRI surrogate is realistic in comparison with the automobiles.



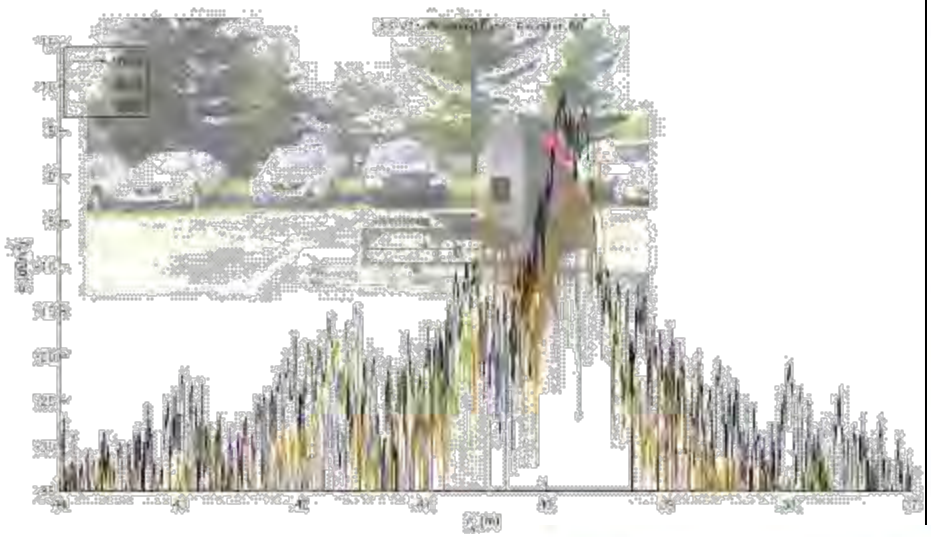
More about this program at:

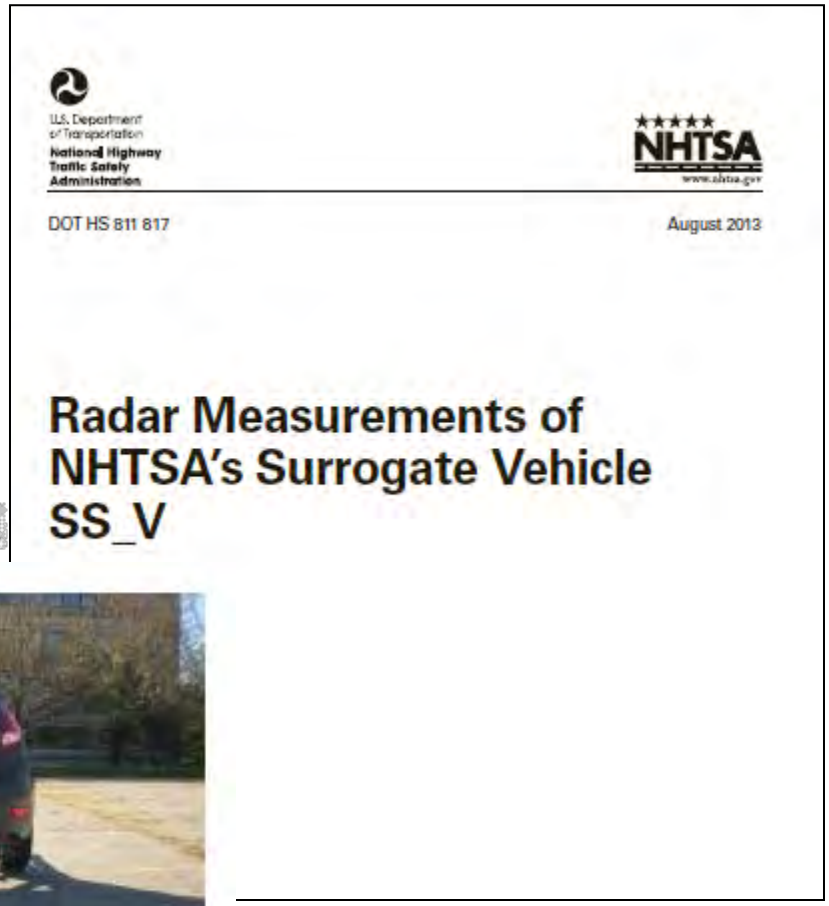
http://www.mtri.org/auto_radar_w_band.html

Measuring Realism of NHTSA Surrogate Vehicles

Government Report, DOT HS 811 817:

http://mcs.nhtsa.gov/index.cfm/product/924/radar-measurements-of-nhtsas-surrogate-vehicle-ss_v.cfm





U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
www.nhtsa.gov

DOT HS 811 817

August 2013

Radar Measurements of NHTSA's Surrogate Vehicle SS_V

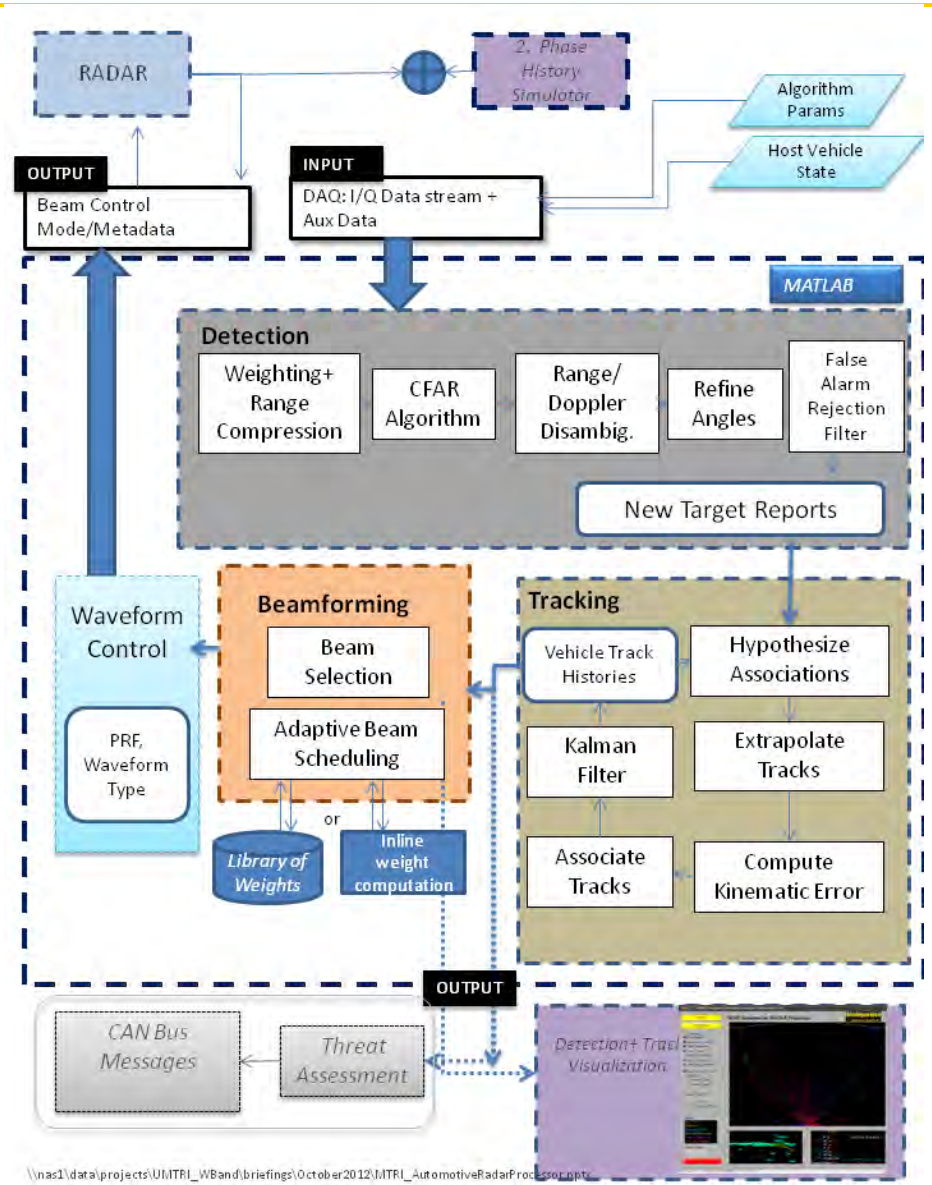
MTRI signal processing and simulation contribute to R&D Award

2014 R&D 100 Winner

Despite massive increases in overall safety, motor vehicles exact a distressing toll on human life each year, with more than 30,000 passenger deaths and 4,000 pedestrian injuries in the U.S. alone. As radar technologies improve, they are increasingly adopted by vehicle manufacturers as a way to reduce these losses. Several types of radar-enabled early warning and pedestrian sensing systems have been developed by automotive OEMs, but **Toyota Motor Corp.** is the first to manufacture an **Automotive Phased Array Radar (APAR)** that satisfies the requirements for widespread use in vehicle safety systems while also providing a wide 100-degree sensing arc capable of effectively detecting pedestrians. Developed by **Toyota Technical Center**, the **Univ. of California, San Diego**, **Fujitsu-Ten** and the **Michigan Technological Research Institute**

MTRI Automotive Radar Processor

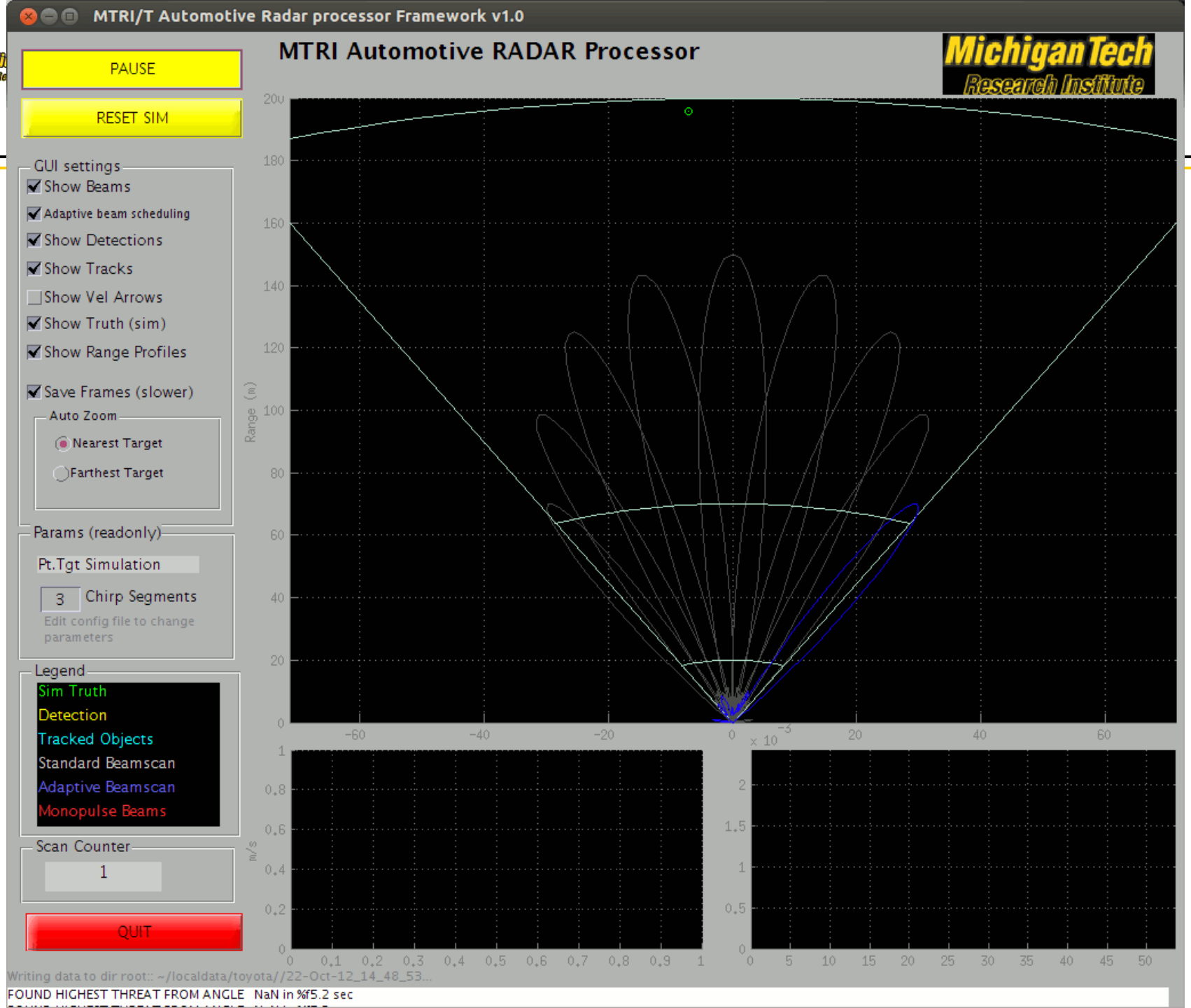
- CFAR detection algorithm
- Range/Doppler disambiguation
  - multi-slope chirp waveforms
- Track-association based on kinematic filters
- Angle Refinement
  - monopulse algorithm
- 2D tracker
- System timing studies
- For steered or multi-arrays
  - Beam Scheduling algorithm
  - Zone revisit rate studes
  - Adaptive beam-forming
    - bracketing highest-threat target in Target List to perform Sequential Monopulse angle refinement



MTRI Automotive Radar Processor

- Scenario generation capability enables performance evaluation to answer questions:
  - What are the optimal detection and track algorithms?
    - What are the minimum errors?
  - What are the optimal settings for detection and tracking?
    - For example, what is the system impact if detection and track thresholds are reduced to recognize pedestrians?
  - What is the benefit of multi-detection and multi-track algorithms?
  - If the system is set optimal for typical traffic, what is the behavior in challenging scenarios?

Scenarion I (Adapt On), Slow



Measuring RADAR and LIDAR Signatures of Deer

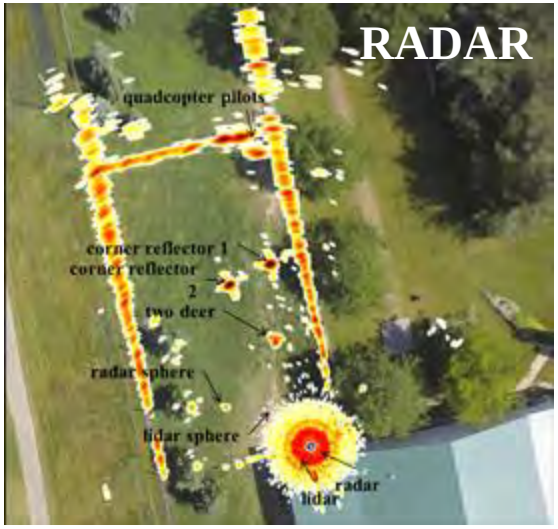
- The measurements made by the data collection team, capture the deer standing alone, feeding, walking, running, doe with fawns, bucks grooming each other and deer in groups. These are used to develop statistical models of the returns from deer expected for automotive active safety systems. The models characterize the detectability of deer with the sensors and provide information fundamental for system design and algorithm development.

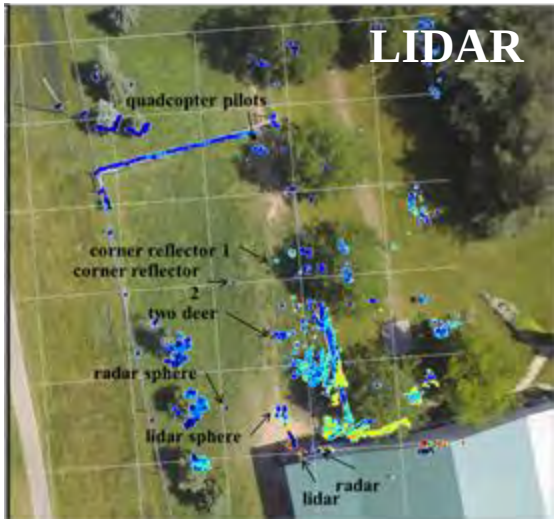
More about this program at:

http://www.mtri.org/animal_avoidance.html

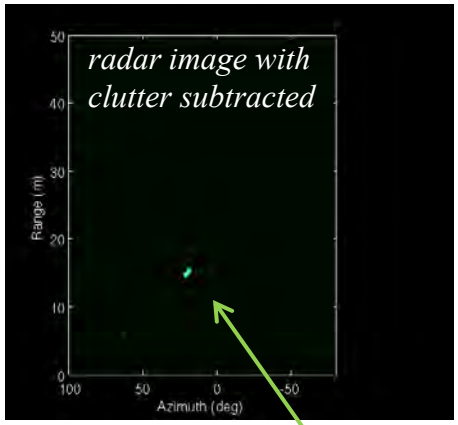
RADAR/LIDAR Sensing System

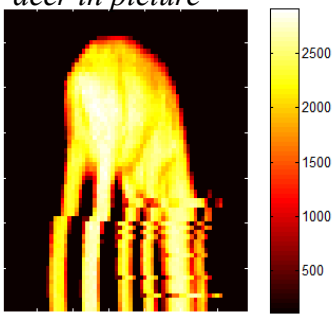
- In the spring of 2014, MTRI collected hundreds of thousands of measurements of white-tail deer with the RADAR/LIDAR sensor suite. The W-Band RADAR is operating at 76.2 to 76.8 GHz and the LIDAR sensor is operating at 905 nm. The collection area contains calibration targets allowing the measurements to be compared against targets with known cross-sections.
- Examples from the the spring 2014 simultaneous data collection are below. We vertically translated the scene for a 3D effect, using the RADAR, LIDAR, and a quadcopter for an aerial view.





Simultaneous data collection example





Thank you

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NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Michigan Tech Research Institute

www.mtri.org

MichiganTech Research Institute

Evaluating the Use of Unmanned Aerial Vehicles for Transportation Purposes

MDOT research project, contract no. 2013-067, Auth. No. 1, OR13-008

Michigan Tech team members: Colin Brooks (cnbrooks@mtu.edu, 734-604-4196), Thomas Oommen, Timothy C. Havens, Theresa M. Ahlborn, Richard J. Dobson, Dave Dean, Ben Hart, Chris Roussi, Nate Jesse, Rudiger Escobar Wolf, Michelle Wienert, Blaine Stormer, John Behrendt

MDOT program manager: Steve Cook; MDOT Research Manager: André Clover

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Objectives of MDOT Study

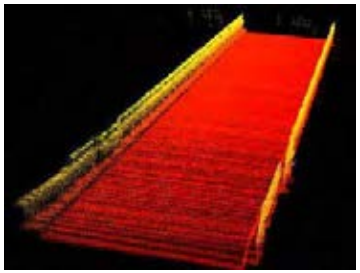
- Develop, test, and demonstrate how UAV technology can help provide visual inspections from above for a variety of structures and locations of interest to MDOT
  - Roadway Assets
    - Lighting, signs etc.
  - Confined spaces
    - Pump Stations
    - Entrances to Sewers and Culverts
- Demonstrate how a UAV system can be deployed to monitor traffic operations
- Investigate how UAV based optical and thermal IR technologies can be used to evaluate surface and structural integrity of bridge elements
- Demonstrate how a LiDAR sensor could be used to rapidly assess and inspect transportation infrastructure

Task 1: Develop, Test and Demonstrate How UAV Technology Can Help Provide Visual Inspections

- Multiple Platforms are proposed based upon space and sensor size restrictions

http://www.bergenrc.com/

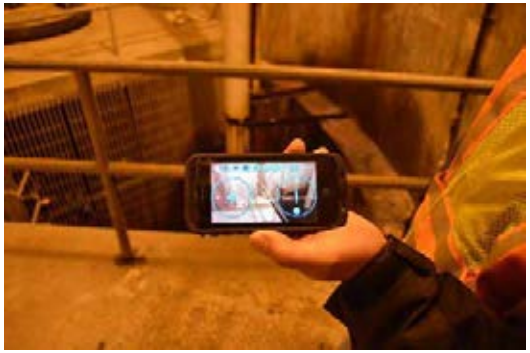
- Appropriate UAV Sensors
  - Digital Cameras
  - Thermal Infrared Sensors
  - LiDAR
- Demonstration Locations & Possible Platforms
  - Overhead Infrastructure: Bergen Hexacopter (MI company)
  - Bridge Elements: Medium UAV
  - Pump Stations and Culverts: Micro-UAV



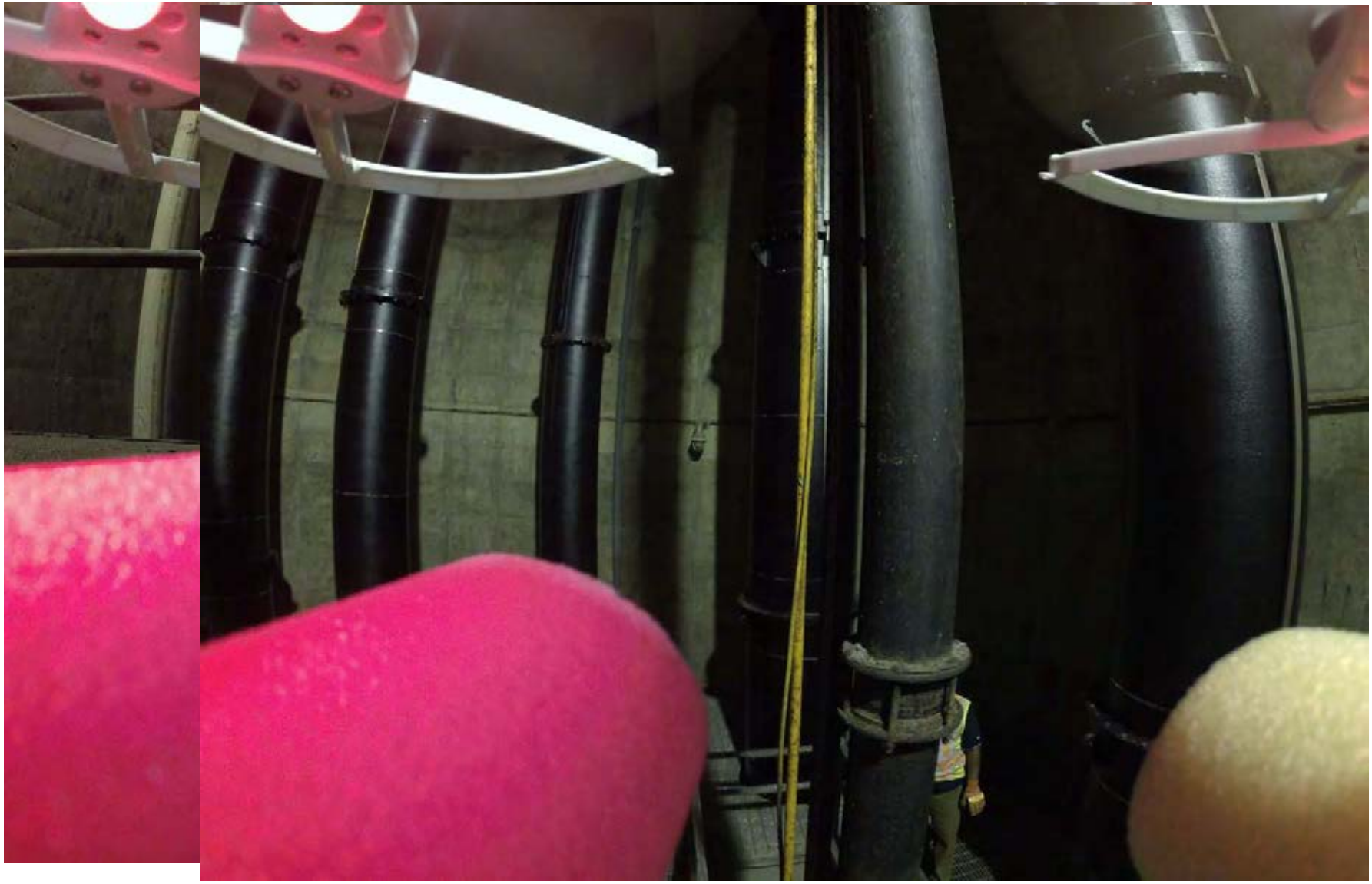
UAV Operations in MDOT pump station

Confined space inspection

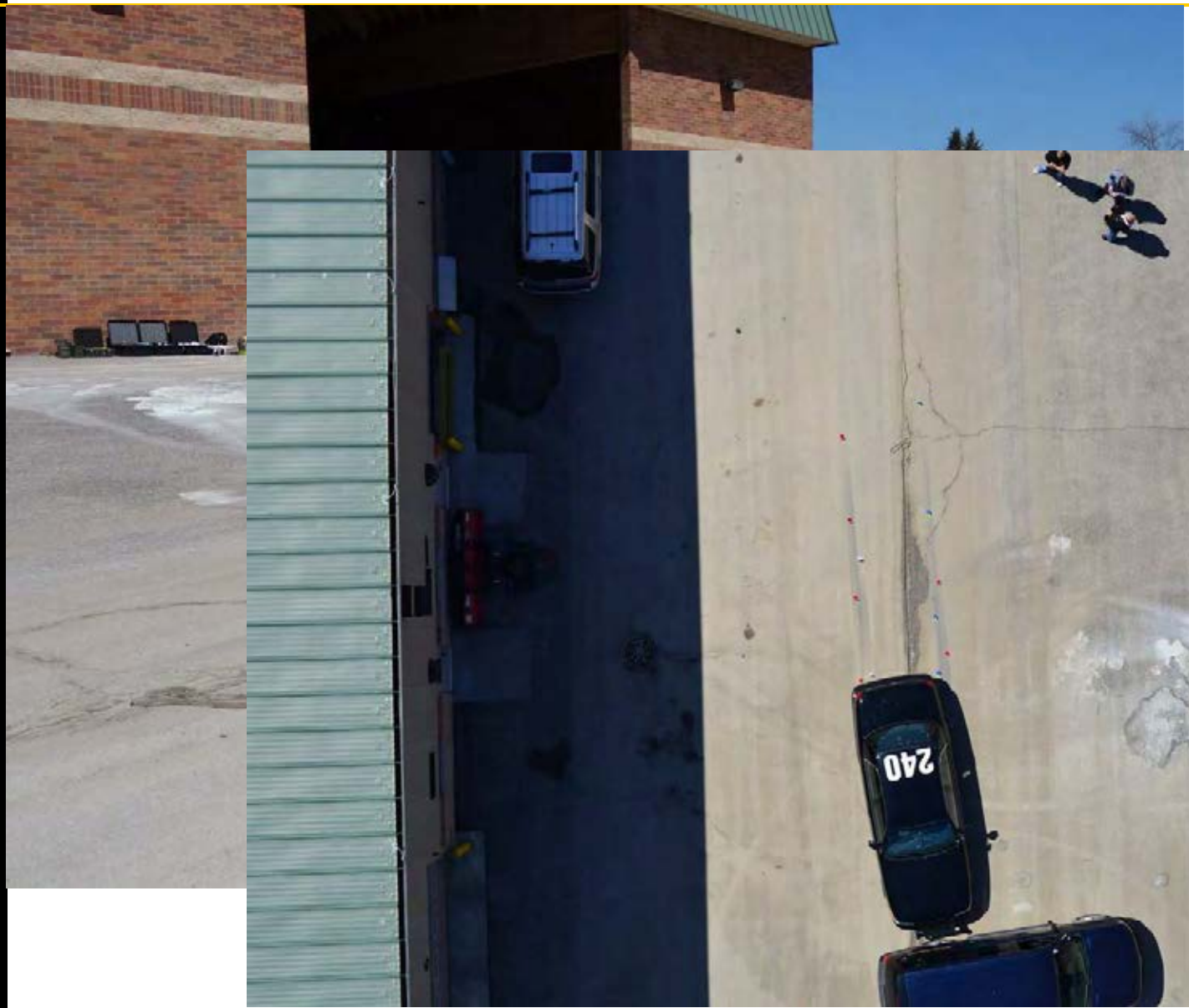
- Initial flights - understand capability to fly in confined spaces; later flights - smaller UAVs
  - MDOT Pump Station
  - 4’ culvert (1.2m)
- Is it safe to send a person into the pump station?
  - Eventually: unlit, retrieve through opening
- DJI Phantom 1, Walkera QR W100S, Helimax 1Si; Blackout Mini H Quad ready to fly



DJI Phantom imagery – wide FOV



Demonstration to SOCCIT – Southeast Oakland County Crash Investigation Team



Task 2: Provide a Demonstration of UAV Based Traffic Monitoring

- Extended Flight Time Required
  - Battery powered helicopter UAVs have max flight times of about 30 minutes (for <$20k ones)
  - Nitro powered helicopters have longer flight times but produce smoke and can leave an oil residue on equipment inc. cameras
- Imagery being collected through HD video or pictures taken with camera (DSLR, etc.)
- A tethered blimp has been proposed for long term traffic monitoring
  - Able to stay aloft for extended periods of time
  - Able to carry a variety of cameras
- Provides near-real time imagery of traffic conditions
  - Imagery transmitted via 4G to internet server

UAVs for Traffic Monitoring

- Aerostats/Blimps
  - Long loitering time on station – up to several days
  - Can be sized to payload requirements
  - Tethered, lower FAA requirements for flight operations, can operate at night
  - Some designs can operate in windy weather
  - Relatively large open area required for launch and recovery

Task 3: Investigate Non-Destructive Evaluation (NDE) of Bridge Elements

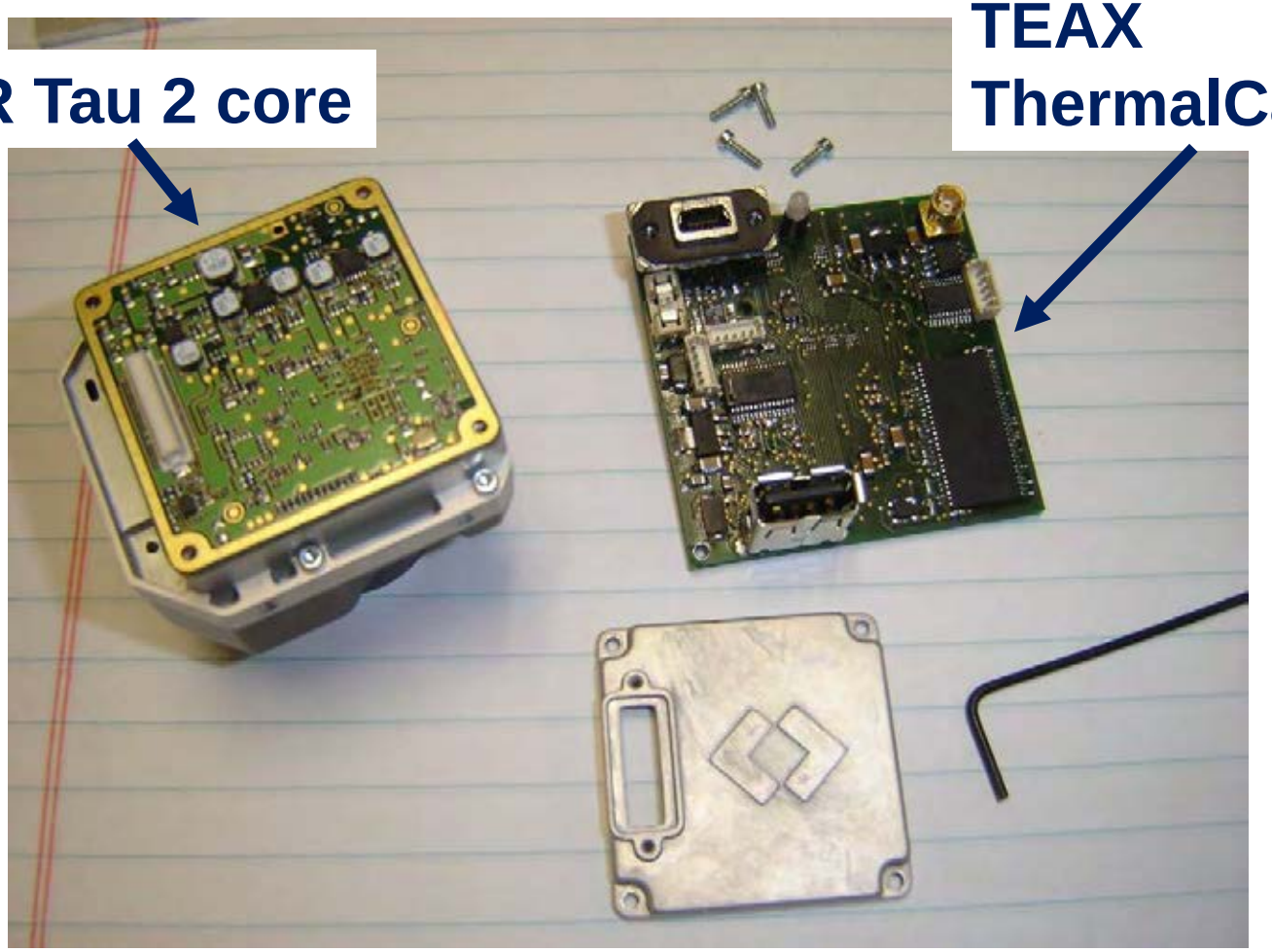
- Goals:
  - Develop technology to obtain bridge condition data from UAV platform to supplement routine inspections
  - Surficial condition
  - Non-destructive structural evaluation of bridge element integrity

- Optical and Thermal Sensors will be flown
  - Optical imagery will capture surface defects such as spalls
  - Thermal imagery will capture sub-surface defects such as delaminations

- 3D reconstructions from optical imagery will be used for automated detections of spalls
  - Similar to previous work done with vehicle based data collected and processed under the USDOT Bridge Condition Project (Ahlborn et al.)
- Optical and thermal data will be fused for a complete surface and sub-surface characterization of the bridge elements
- Also - Task 4: Demonstrate UAV Based LiDAR Inspection of Transportation Infrastructure

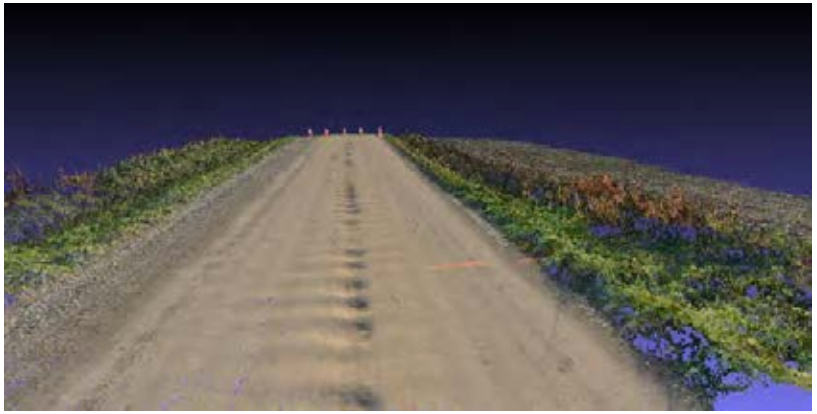
Techniques used with remote sensors for transportation

- Thermal:

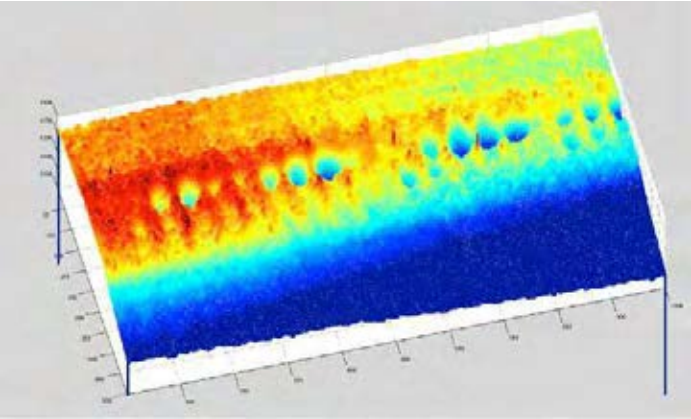


NDE Techniques: Optical, LiDAR

- Used to detect surface conditions
  - Spalling/potholes, cracks, etc.
  - We'll be applying our unpaved roads methods to bridges & other transportation infrastructure of interest to MDOT
  - When? Recommending spring 2014. MDOT – of what & where – need to know in advance to fly UAV over a bridge (COA application)
- Overlapping imagery will be used to generate 3D models to characterized condition
  - Close-range photogrammetry, Structure from Motion (SfM)
- LiDAR: terrestrial & mobile most common; new to UAVs – testing small LiDAR unit
  - 3D bridge models; detection of "road furniture" (signs, guardrails, etc. – assets)



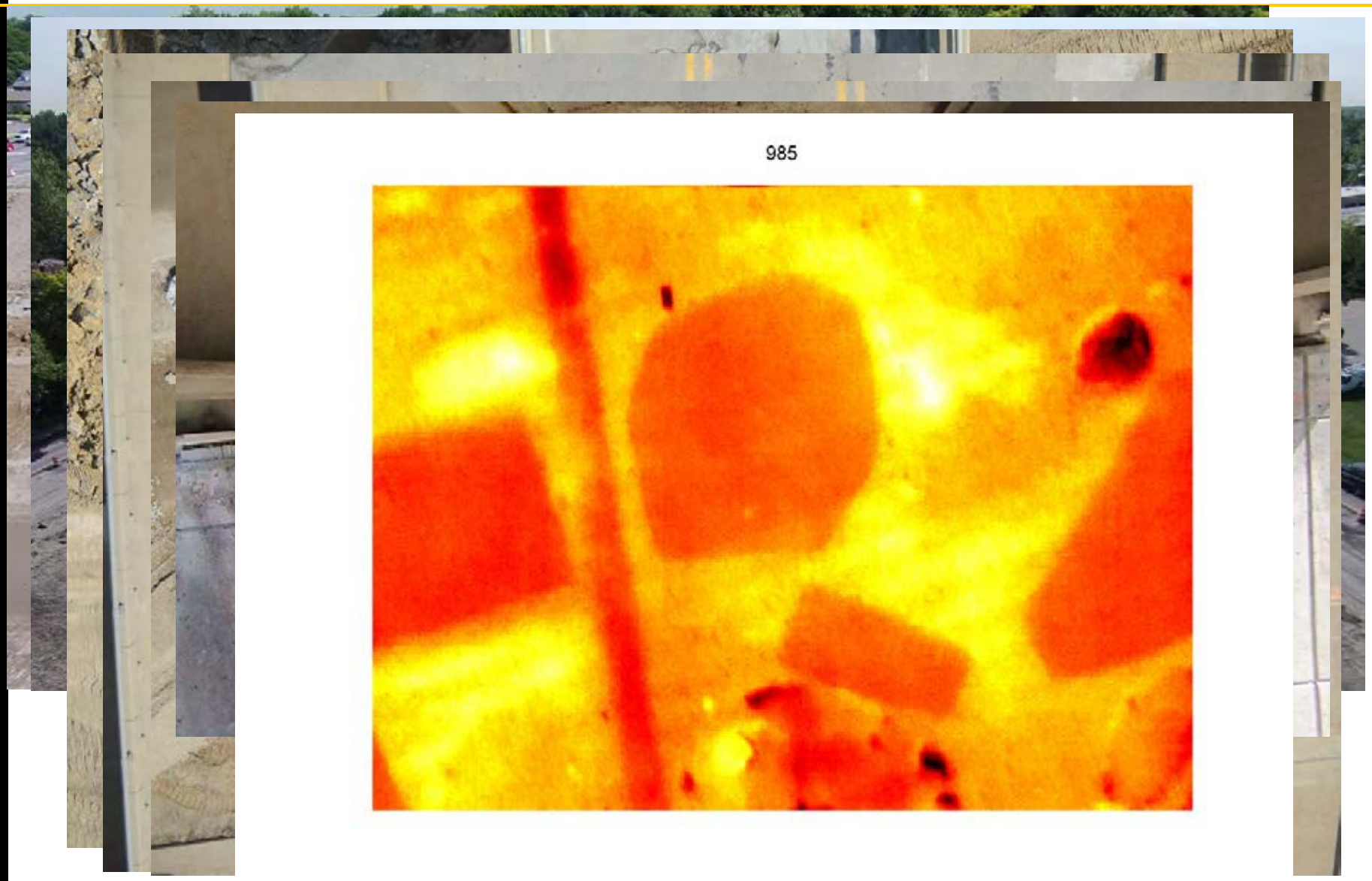
3D point cloud of an unpaved road generated using SfM techniques



3D height field showing potholes on an unpaved road

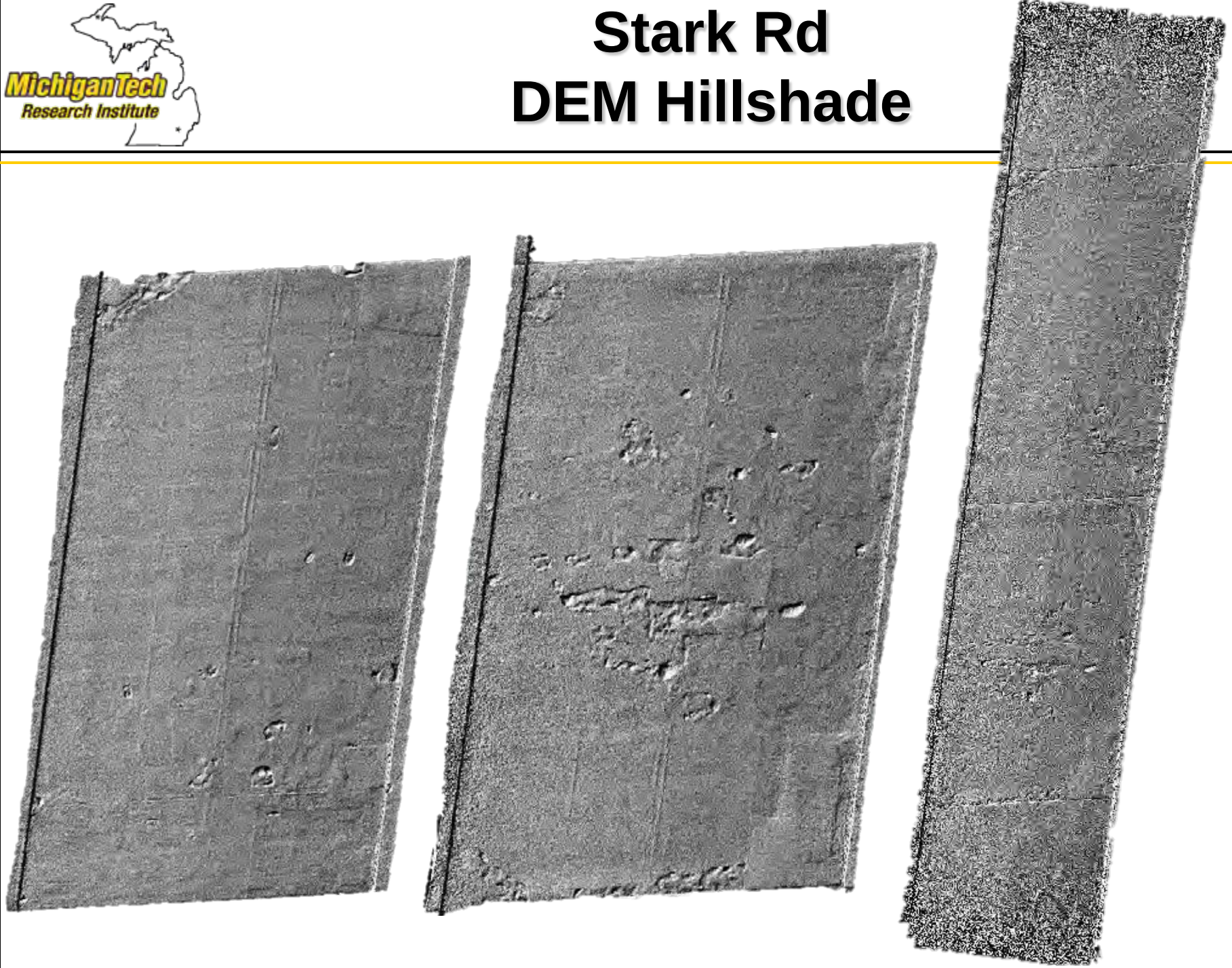
Bridge asset management & condition assessment imagery: collecting data

Bridge asset management & condition assessment imagery: examples



Stark Rd
Orthophoto – 2.5mm

Stark Rd
DEM Hillshade



Automated spall detection

- Automated spall detection algorithm (developed by Brooks, Dobson)
- Applied to high-resolution 3D elevation model (DEM) for Merriman East (pictured), Stark Road bridges.
- Merriman East: 4.4% spalled (150.0 square feet)

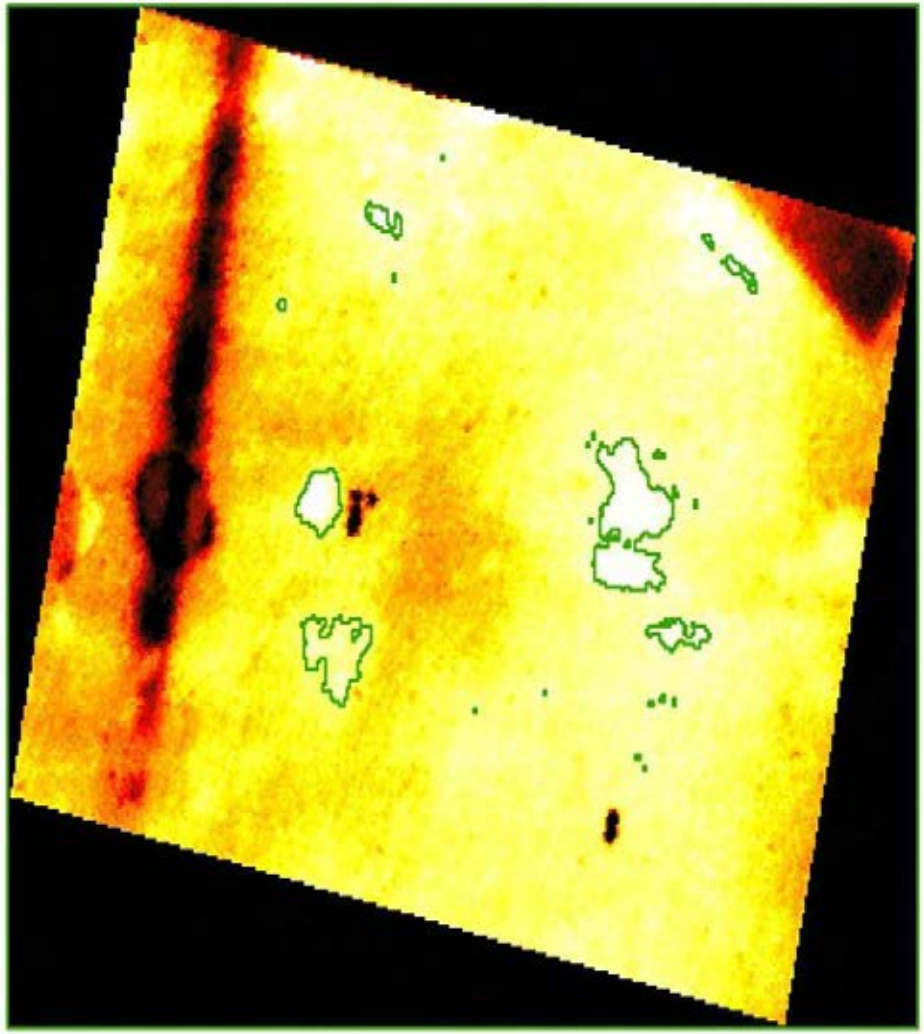
Combined thermal data for 2 bridges

Merriman

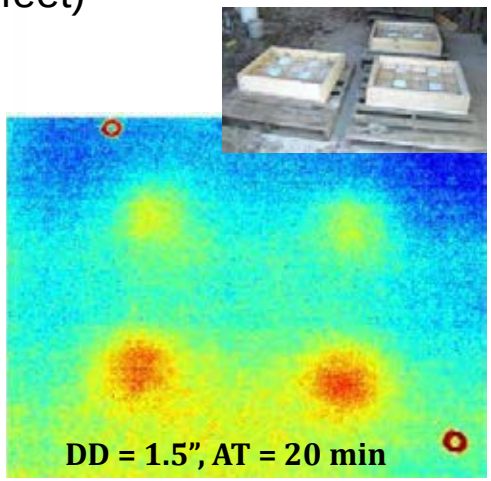
Stark

Automated delamination detection

Delamination should be evident in thermal but not in visible image



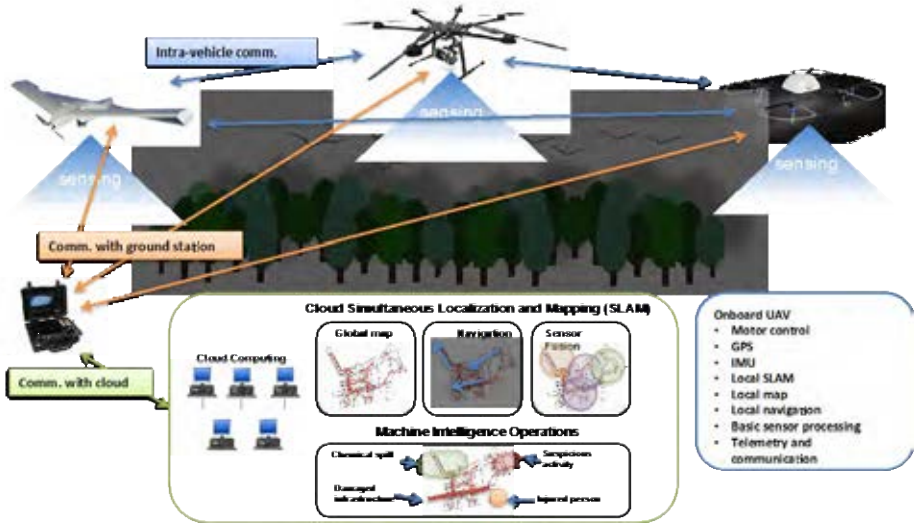
- Criteria can be added: eliminate small areas (e. g. single pixels, pixels with low number of neighbors, etc.), look at individual bands, etc.
- Only pixels with more than 6 neighbors.
- Area = 0.18 m^2 (1.9 square feet)

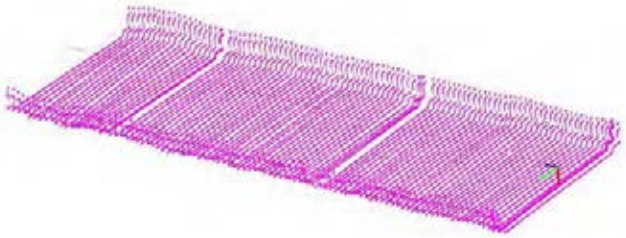


Lab testing of Tau2 thermal camera used with UAV

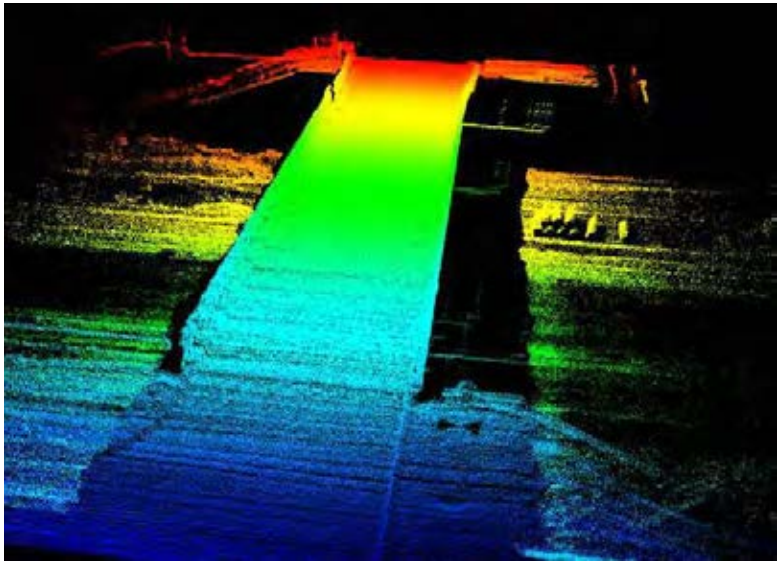
UAV-Based LiDAR & improved LiDAR processing (Task 4)

- LiDAR sensor pod developed
  - Hokuyo UTM-30LX LIDAR
  - VectorNAV MEMS IMU
  - Beaglebone Black onboard computer
  - WIFI bridge
  - LiPo battery power
- Three-dimensional Simultaneous Localization and Mapping (SLAM) algorithms developed





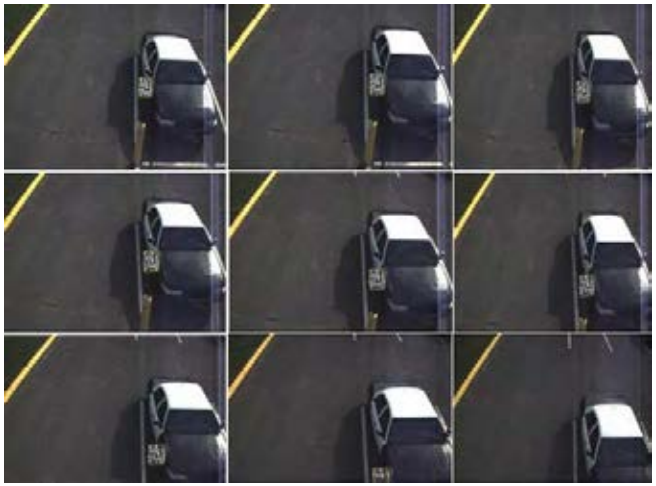
Bridge with linear interpolation assumption



Task 4-2: Roadway asset detection from UAV demonstration

- Featured-based algorithms & classifiers tested
- Classifiers can be “trained” with examples of roadway assets (road furniture)
- Examples of detecting no-parking signs tested; could be used for other assets (guard rails, lamps, etc.)

Detection of asset data in training imagery – stop signs, handicap signs, traffic lights

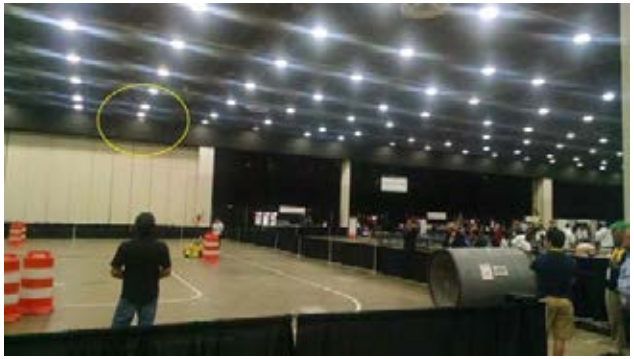


No Parking sign detected & tracked from UAV imagery

No parking sign – side view detection & tracking from UAV

ITS World Congress 2014 demonstrations

- Indoor flights at the indoor Test Track by the Demo Launch area
- Live video feed of Belle Isle from blimp displayed in MDOT Traffic Operations Center at Cobo Hall
- Outdoor demonstrations at Belle Isle – Technology Showcase
- Spotlight, technical session talks
- Mock Incident participation – UAV, blimp demos



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