The Business of IT: Big Data in the Automotive Industry

“Focus on the Future”
UM Automotive Research Conferences

WELCOME!

Presentations available at: www.umtri.umich.edu/aad

Bruce M. Belzowski
Assistant Research Scientist
bbl@umich.edu
### Automotive Analysis
University of Michigan
Transportation Research Institute

#### Affiliates Members and Research Partners

<table>
<thead>
<tr>
<th>IT Organizations</th>
<th>Government/NGOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oracle Corporation</td>
<td>NREL / EPA</td>
</tr>
<tr>
<td>IBM</td>
<td>NSF</td>
</tr>
<tr>
<td>HP</td>
<td>Motor Carrier</td>
</tr>
<tr>
<td>Siemens-PLM</td>
<td>Energy Foundation</td>
</tr>
<tr>
<td>OEMs</td>
<td>The Hewlett Foundation</td>
</tr>
<tr>
<td>General Motors</td>
<td>National Resources Defense Council</td>
</tr>
<tr>
<td>Toyota Tech Center</td>
<td>Union of Concerned Scientists</td>
</tr>
<tr>
<td>Nissan Tech Center</td>
<td>Scientists</td>
</tr>
<tr>
<td>Ford Motor Company</td>
<td>CALSTART</td>
</tr>
<tr>
<td>Chrysler LLC</td>
<td></td>
</tr>
</tbody>
</table>
Affiliates Members and Research Partners

**Suppliers**
- Chevron
- Visteon
- Denso
- Dana
- Delphi
- Peterson Spring
- Continental
- TRW
- Valeo

**Suppliers**
- Michelin
- Continental
- JCI
- BorgWarner
- Yazaki
- Eaton
- BASF
- Dow
- Bosch

Automotive Analysis
University of Michigan
Transportation Research Institute

UMTRI
Upcoming UMTRI-AA Conferences

• November 13, 2013 (Wednesday): *Inside China: Understanding the Current and Future Chinese Automotive Industry.* Our 6th annual conference that brings to the audience the knowledge of people who truly know the Chinese auto industry.

• February 12, 2014 (Wednesday): *Automotive Safety: How Will Connected and Autonomous Vehicles Affect Automotive Safety?* This conference is a follow-up to our 2011 Automotive Safety conference. Since that time, there has been major technological progress in the areas of connected and autonomous vehicles. This conference will review what has happened to date, and what experts see for the next 5-10 years.
Upcoming UMTRI-AA Conferences

• **April 16, 2014 (Wednesday): Inside Russia: Understanding the Current and Future Russian Automotive Industry.** Russia is the final BRIC market in our study of the globalization of the auto industry that is expected to be a growth market for automakers in the future. This conference will provide insight into how government, industry, and consumers view the current and future Russian automotive market.

• **July 23, 2014 (Wednesday): Powertrain Strategies for the 21st Century.** Our 6th annual conference that provides insight into how manufacturers and suppliers are managing their resources to meet the needs of consumer while meeting government requirements.
Upcoming UMTRI-AA Conferences

The UM Alumni Discount
Alumni who sign up in advance for five conferences in a row receive a $250 discount
Panelists

AM Session

• Sanat Joshi, Vice President, Oracle Corporation

• Gahl Berkooz, Head of Information Management and Analytics, Ford Motor Company
Panelists

PM Session

- **Michael Cafarella**, Assistant Professor of Electrical Engineering and Computer Science, UM College of Engineering

- **Harriet Chen-Pyle**, Senior Business Developer: Traffic Product Unit, TomTom North America

- **Carol Flannagan**, Associate Research Scientist and Research Director of the Center for the Management of Information for Safe and Sustainable Transportation (CMISST)
Morning Schedule

- 9am
  - Bruce Belzowski
  - Sanat Joshi
  - Gahl Berkooz

- 10:40am-10:55am Break

- 10:55am-11:30 AM Session Q&A

- 11:30am-1pm Lunch
Afternoon Schedule

• 1:00pm
  – Michael Caffarella
  – Harriet Chen-Pyle
• 2:05pm-2:15pm Break
• 2:15pm
  – Carol Flannagan
• 2:50pm-3:30pm PM Session Q&A
• 3:30pm Adjourn
• What is Big Data? How does it differ from the analysis of data that has gone on in the auto industry for many years?

• What are some of the ways auto companies can use Big Data analytics internally as well as externally?

• Which functions within the manufacturers and suppliers are most likely to benefit from Big Data analytics?
Conference Questions

• What changes in hardware and software are necessary to perform Big Data analysis?
• What growth should we expect in Big Data analytics over the next five and ten years?
• What, if anything, is holding back the development and use of Big Data and analytics?
Conference Questions

• What are some examples of Big Data analysis of unstructured web-based data?
• What kinds of questions can be answered from social media data?
• Are there limits to the accuracy of Big Data gathered from the web?
• How can Big Data be used to measure dynamic processes like traffic?
Conference Questions

• What measurements go into predicting and reporting traffic?
• What are the challenges of predicting or measuring dynamic processes?
• How can large databases of accident information and driving behavior improve safety?
• How accessible are Big Data databases?
The Business of IT: Big Data in the Automotive Industry

“Focus on the Future”
UM Automotive Research Conferences

WELCOME!

Presentations available at: www.umtri.umich.edu/aad

Bruce M. Belzowski
Assistant Research Scientist
bbl@umich.edu
FHWA/MDOT/UMTRI
Integrated Mobile Observations 2.0 (IMO)

Michigan Department of Transportation
Steven J. Cook, P.E.
Tim Croze, P.E.
Matt Pratt, TMC

University of Michigan Transportation Research Institute (UMTRI)
Ralph L. Robinson
Bruce Belzowski
FHWA/MDOT/UMTRI IMO 2.0
Architecture

MDOT Vehicles - FHWA Data Collection

- Vehicle Positioning GPS
- Smartphone
- 3-axis accelerometer
- Cell Tower (4G/3G)
- Photo Image

Surface Temp & Atmospheric conditions
- Road Surface Roughness and Distress
- 20 with phones & 10 with S.P.
- 40 vehicles with phone & OBD key & 10 with S.P.

Data Users: UMTRI, NCAR, MDOT MDSS & DUAP & TOC/Navteq & RITIS/Atkins

- Cellular Service Providers Network Operations Center
- NCAR
- UMTRI MS SQL Server
- Traveler Information Systems
- Transportation Operation Center
- Winter Maintenance Operations
- Traffic Management Systems

MDSS & DUAP

UMTRI MS SQL Server

Automotive Analysis
DataProbe App on Android Smartphone

- DataProbe: Android application runs on Droid phones.
- Has Bluetooth, a USB port and a 3-axis accelerometer
  - Droid mounted in a windshield docking station
  - DataProbe can work alone or in combination with other data sources
- DataProbe gathers one set of data every second
- Five minutes (300 seconds) of data is collected in a data file and prepared for sending
- When the Droid has a cellular connection made (4G/3G), DataProbe sends available files (1MG) to UMTRI virtual servers.
- Collected to date: 35,000 vehicle miles of data (over 11 GB)
System Components

Surface Patrol HD
- Road Surface Temperature
- 12v switched vehicle power

CAN to Bluetooth
- Powered by CAN connector

Droid Interfaces with two Bluetooth devices
- Powered by USB connector take-out

Vehicle Switched Powerpoint
### DataProbe Data Sources

<table>
<thead>
<tr>
<th>SIGNAL</th>
<th>Droid</th>
<th>OBDKey</th>
<th>Surface Patrol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>speed</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>direction</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>altitude</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>distance</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>veh dynamics</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>roughness</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>imaging</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIN</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>RPM</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Throttle Position</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>ABS</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Trac Control</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>ambient temp</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>barometer</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>pavement temp</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>humidity</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>dew point</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

- Flexible configuration
- Near real time data access with cellular services
- Not all CAN networks have desired data
  - Varies by model year and car line
- Surface Patrol requires hardware installation
Roadway Camera Images

- Images (jpg files) taken with the Droid camera of the roadway
- Images can be triggered manually, on ABS lockup, or remotely
  - Optionally, a single or three image sequence can be captured
  - Three image sequence separated by two seconds between them
- All images are sent to servers within five minutes
Pushing Messages to Driver

- Operations center may send text message to driver of fleet vehicle for 10 second display
- Current display data is replaced with incoming text
  - Example text:
  - “Call the office when available”
  - “Redeploy to Exit 112”
  - “Take photos of problem area”
- No driver physical interaction required to get text display
- Display annunciation (“beep”) heard when text received
# Web Portal for Sending IMO Messages and Images

## DATAPROBE FLEET COMMUNICATIONS

**Message to be sent:**

<table>
<thead>
<tr>
<th>Region</th>
<th>Location</th>
<th>Driver</th>
<th>Year</th>
<th>Model</th>
<th>Config</th>
<th>In Service</th>
<th>Req Photo</th>
<th>Send Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWS</td>
<td>SOUTH HAVEN GARAGE</td>
<td>Mark Grazioli</td>
<td>2006</td>
<td>F250</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>PLAINWEL GARAGE</td>
<td>Tom Simpson</td>
<td>2008</td>
<td>F250</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>COLOMA GARAGE</td>
<td>Hussain Ibrahim</td>
<td>2008</td>
<td>F250</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>KALAMAZOO GARAGE</td>
<td>Scott Geiger</td>
<td>2009</td>
<td>SIERRA</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>COLOMA TSC</td>
<td>Keith Williams</td>
<td>2010</td>
<td>F250</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>COLOMA TSC</td>
<td>Ron Jackson</td>
<td>2009</td>
<td>SIERRA</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>JONES GARAGE</td>
<td>Rich Antuna</td>
<td>2008</td>
<td>F250</td>
<td>BCS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>FENNVILLE GARAGE</td>
<td>Mark Grazioli</td>
<td>2005</td>
<td>F250</td>
<td>BCS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>KALAMAZOO TSC</td>
<td>Tom Simpson</td>
<td>2006</td>
<td>F250</td>
<td>BCS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>JONES GARAGE</td>
<td>Hussain Ibrahim</td>
<td>2006</td>
<td>F250</td>
<td>BCS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>MARSHALL GARAGE</td>
<td>Scott Geiger</td>
<td>2008</td>
<td>Intern</td>
<td>BS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWS</td>
<td>COLOMA TSC</td>
<td>Keith Williams</td>
<td>2008</td>
<td>F250</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Operator types messages, selects vehicle, then clicks SEND.
- Operator selects images to be taken then clicks SEND.
- Vehicle fleet details maintained by administrator/operator.
- Identifies which vehicles are currently in-service.
Data Management and Distribution

- Data files (csv) sent to UMTRI servers are tested for validity
  - Files are stored on a secure University of Michigan Virtual Server with access to files limited to specific UMTRI, Intersog, and MDOT staff
- Non-valid files received at UMTRI are not re-transmitted
  - Containing errors (CRC checking)
  - GPS data without three or more satellites
  - Vehicle speed over file duration never over 0 mph (vehicle setting stationary for more than 5 minutes)
- Valid files are sent via FTP to Connected Vehicle servers
  - National Center for Atmospheric Research (NCAR)
  - Meridian: Maintenance Decision Support Systems (MDSS)
  - Data Use, Analysis, and Processing (DUAP) (Mixon-Hill)
  - Navteq (Data Management Systems (DMS) Travel Times)
  - Atkins (Regional Integrated Transportation Information System (RITIS) 4DX: User Delay Cost I-94)
Applications

- Weather and road condition data into MDSS
- Real time road quality monitoring
- Fleet monitoring and management (miles, hours, routine maintenance, etc.)
- Targeted individual messages (augments DMS)
- Provide travel times and incident updates
- Remote imaging and physical monitoring of environment
- Visibility monitoring (snow, fog, rain, etc.)
- Emergency detection (ABS lockup & differential wheel speed reports)
- Slippery surface notification
- Weather ground truth augments Electronic Switching System (ESS) (surface temperature, dew point, etc.)
- Vehicle/device health monitoring (are devices installed on vehicles working?)
- Vehicle diagnostics
- Performance Management
- Regain Times
Contact Information

Steven J. Cook, P.E.
Program Manager
Michigan Department of Transportation
cooks9@michigan.gov
517-636-4094

Bruce Belzowski
Co-Principal Investigator
UMTRI
bbi@umich.edu
734-936-2704

Ralph Robinson
Co-Principal Investigator
UMTRI
rrobins2@chartermi.net
734-451-1825