Connected Vehicles: Data Capture and Dynamic Mobility Applications

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Weather Responsive Traffic Management Workshop
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The *Clarus* Initiative

*Clarus* is an R&D initiative to demonstrate and evaluate the value of “Anytime, Anywhere Road Weather Information” provided by both public agencies and the private weather enterprise to transportation users and operators.
The Clarus System

Data Flows

- Observations
- Metadata
- Quality Flags

Nationwide Data Management System for Surface Transportation Environmental & Pavement Condition Observations
Participation Status for Clarus as of August 24, 2011

Canadian Participation

Local Participation
- City of Indianapolis, IN
- McHenry County, IL
- City of Oklahoma City, OK
- Kansas Turnpike Authority
- Parks Canada

Clarus Connection Status

Sensor & Station Count
- 2,253 Sensor Stations (ESS)
- 52,471 Individual Sensors
- 81 Vehicles

Connected (37 States, 5 Locals, 4 Provinces)
Connected plus vehicles (1 state)
Pending (4 States, 3 Locals, 1 Province)
Considering (3 States, 1 Local)
# The Clarus System - fixed sensors

Over 75% of State DOTs (c.95% of the Nation’s sensors)

## Table of Observations

<table>
<thead>
<tr>
<th>Timestamp (UTC)</th>
<th>Observation Type</th>
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<th>Value</th>
<th>Unit</th>
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ITS Strategic Research Plan 2010-2014

Program Vision

To research and facilitate a national, multimodal surface transportation system that features a connected transportation environment around vehicles of all types, the infrastructure, and portable devices to serve the public good by leveraging technology to maximize safety, mobility, and environmental performance.
ITS Research Program Components

Applications
- Safety
  - V2V
  - V2I
  - Safety Pilot
- Mobility
  - Real Time Data Capture & Management
  - Dynamic Mobility Applications
- Environment
  - AERIS
  - Road Weather Applications

Technology
- Harmonization of International Standards & Architecture
- Human Factors
- Systems Engineering
- Certification
- Test Environments

Policy
- Deployment Scenarios
- Financing & Investment Models
- Operations & Governance
- Institutional Issues

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Connected Vehicles & Road Weather

Real-time Data Capture and Management

- Vehicle Status Data
- Weather Data
- Truck Data
- Transit Data

Data Environment

Dynamic Mobility Applications

- Reduce Speed 35 MPH
- Weather Application
- Real-Time Travel Info
- Fleet Management/Dynamic Route Guidance
- Signal Phase & Timing Adjusts Real-Time Conditions

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Connected Vehicles & RdWx - Vision

• Obtain a thorough picture of current weather and road conditions by including mobile sources
  - Higher resolution observations that spatially augment fixed sensors
  - Take advantage of existing standards and on-board sensors

• Improve weather-related decision support tools to mitigate safety and mobility impacts of weather
  - Based on ability to better detect and forecast road weather and pavement conditions
Weather & Road Condition Observations

- Barometric Pressure
- Windshield Wiper Setting
- Headlights Status
- Ambient Air Temperature
- Speed and Heading
- Adaptive Cruise Control (ACC)
- Location and Elevation
- Hours of Operation
- Anti-lock Braking System (ABS)
- Brake Status
- Stability Control
- Traction Control
- Yaw/Pitch/Roll
- Accelerometer
- Steering Angle
- Differential Wheel Speed
RdWx Research Questions

- Identify and explore a range of mobile platforms as a source of robust data
- Develop algorithms and processing capabilities to translate the mobile data into useable weather and road condition observations
  - Is the probe data of sufficient quality?
  - What are the minimum # of samples and minimum sampling period per road segment to get valid obs?
  - What QC algorithms are needed?
  - What are the best ways to package/disseminate the observations?
- Incorporate these observations into effective mgmt. systems and decision support tools (e.g., MDSS, weather-responsive traffic management strategies)
  - What is gained by utilizing mobile observations?
  - What are the resultant data and communications requirements?
Vehicle Data Translator

- Objectives
  - Develop and improve the Connected Vehicles’ role in “Anytime, Anywhere Road Weather Information”
  - Better characterization of current weather and road weather conditions
  - Accurate quality checking and/or quality control of vehicle data
  - Development of inferred road segment-specific weather and road weather information for end-user applications
Vehicle Data Translator (VDT)

Ancillary: Radar, Satellite, RWIS, Etc.

Stage I
- Mobile data ingesters
- QC Module
- Output data handler

Stage II
- Ancillary data ingesters
- Segment module
- QC Module
- Output data handler

Stage III
- Inference Module
- QC Module
- Output data handler

Parsed mobile data

Basic road segment data

Advanced road segment data

Apps and Other Data Environments

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Dynamic Mobility Applications & RdWx

There are any number of dynamic applications that could use vehicle-based observations:

- State DOT-based applications
- Broad transportation applications
- Other weather-related applications
State DOT-based Applications

- **Observation assimilation**
  - Fill in the gaps between fixed stations
  - Collect real-time pavement temperatures

- **Maintenance Decision Support**
  - What are the current roads conditions?
  - Accurate pavement temperature modeling

- **Manage Maintenance Actions**
  - End of Shift Reports
  - Materials Management

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Broad Transportation Applications

VDT-based weather alerts:
- Impending weather hazards
- Alerts from other vehicles
- Re-routing

*Simulated screen
Broad Transportation Applications

Winter Maintenance - Which roads have been treated?

Route Specific Impact Warnings for...

School Buses

Truckers

EMS

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Other Wx-related Applications

Numerical Weather Modeling

Traffic Modeling and Alerting

Weather Modeling - complex terrain

Other surface transportation users
Work Completed to Date

• Noblis conducted two analyses along the Dulles Toll Road (2006)
  - Exploratory look at mobile observing
• National Center for Atmospheric Research (NCAR) was tasked to develop the Vehicle Data Translator (VDT)
  - Feasibility study (2007)
  - VDT Ver1.0 (July, 2009)
  - VDT Ver2.0 (July, 2010)
  - VDT Ver3.0 (underway, target is April, 2012)
• Expanding data sources and applications
  - Getting data from MN & NV, other Connected Vehicle efforts
  - Develop ConOps on MDSS, MMS, Traveler Information, Traffic Management(?), 1201(?)
For More Information

www.its.dot.gov

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