Weather and the Connected Vehicle

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Federal Highway Administration

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Presentation Overview

• Context
• *Clarus*
• Weather & the Connected Vehicle
Weather & Roads – Safety

Bottom Line: 24% of all crashes occur under adverse weather conditions.

- 7,130 fatalities
- 673,000 injuries
- 1.5 million crashes

1995-2008 Average Annual Fatalities:

- Flood: 74
- Lightning: 44
- Tornado: 62
- Hurricane: 117
- Heat: 170
- Cold: 18
- Winter Storm: 41
- Wind: 47
- Total NWS tracked: 573
- Adverse Road Wx: 7130
Weather & Roads – Economy & Environment

Trucking delays due to weather = $3.1 billion/yr for the 50 largest cities

Lost commerce due to snow closures = $10 billion/day

More than $2 billion/yr is spent on snow and ice control by State DOTs

Weather accounts for 25% of non-recurring congestion

Chemicals affect watersheds, air quality and infrastructure
Road Weather Management

Goal – Improve mobility and safety by alleviating the impacts of weather on the surface transportation system

“Anytime, Anywhere Road Weather Information” is the program’s mission

This includes current and predicted information about weather’s affect on roads…

… and the decision support tools to aid road users and operators to make effective decisions, e.g.,

When to pre-treat roads for snow & ice control
When to post traveler advisories (fog, floods, rain, snow, etc.)
The Clarus Initiative

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

• To do so, FHWA created a robust
  ✓ data assimilation,
  ✓ quality checking, and
  ✓ data dissemination system

that can provide near real-time atmospheric and pavement observations from the collective states’ investments in environmental sensor stations (ESS).
The **Clarus System**

- A database management system for all surface transportation weather observations in North America
- One database removes borders
- Provides advanced quality checking for both atmospheric & pavement data
- Includes extensive metadata
- Easy access via web portal & subscription

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**Clarus**

A Clear Solution For Road Weather Information
Over 75% of State DOTs Participate in Clarus

Sensor & Station Count
2,253 Sensor Stations (ESS)
52,471 Individual Sensors
Participation Status for Clarus as of August 24, 2011

*1st time showing mobile data sources!

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

Clarus Connection Status
- Connected (37 States, 5 Locals, 4 Provinces)
- Connected plus vehicles (1 state)
- Pending (4 States, 3 Locals, 1 Province)
- Considering (3 States, 1 Local)

Sensor & Station Count
- 2,253 Sensor Stations (ESS)
- 52,471 Individual Sensors
- *81 Vehicles
Clarus System Observations
The Connected Vehicle
Improving Road Weather Awareness

Real-time Data Capture and Management

Dynamic Mobility Applications

- Reduce Speed 35 MPH
- Transit Signal Priority
- Weather Application
- Real-Time Travel Info
- Fleet Management/Dynamic Route Guidance
- Signal Phase & Timing Adjusts
- Real-Time Conditions
- Safety Alerts and Warnings
### Connected Vehicle Scenarios

<table>
<thead>
<tr>
<th><strong>Daily operations</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Recurring congestion and peak ridership conditions (i.e., the baseline for activities)</td>
<td><img src="image-url" alt="Image of traffic jam" /></td>
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<table>
<thead>
<tr>
<th><strong>Major traffic incident</strong></th>
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<tbody>
<tr>
<td>Extended closures/fatalities/ major structural damage occurring on either freeway or arterials with impacts for freeway, arterial, transit, and parking management</td>
<td><img src="image-url" alt="Image of emergency vehicles on road" /></td>
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<tr>
<th><strong>Major Evacuation</strong></th>
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<td>Major evacuation of large numbers of people caused by unpredictable events (e.g., wild fire, terrorist attack)</td>
<td><img src="image-url" alt="Image of wildfire" /></td>
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<th><strong>Major Winter Weather Event</strong></th>
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<tbody>
<tr>
<td>Major winter weather event (ice and snow) with a regional impact</td>
<td><img src="image-url" alt="Image of snowy road" /></td>
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<th><strong>Special Event</strong></th>
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<tr>
<td>Planned major event impacting corridors and downtown area</td>
<td><img src="image-url" alt="Image of stadium" /></td>
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</table>
Connected Vehicle “Anytime, Anywhere Road Weather Data”

- 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
Weather & the Connected Vehicle

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
Vehicle Data Translator (VDT)

VDT Objectives

1. Develop and improve the Connected Vehicle “Anytime, Anywhere Road Weather Information”
2. Better Characterization of current weather and road conditions
3. Accurate Quality Checking and/or Quality Control of vehicle data
4. Development of inferred road segment specific weather and road-weather information for end-user applications
Vehicle Data Translator (VDT)

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

Parsed mobile data

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

Stage III
- Inference Module
- QC Module
- Output data handler
- Advanced road segment data

Apps and Other Data Environments

Ancillary: Radar, Satellite, RWIS, Etc.

VDT 3.0
Integrated Mobile Observing & Dynamic Decision Support

- State DOT & Private Vehicle Data
- VDT (NCAR)
- Connected Vehicle Data Capture
- Clarus

Other Connected Vehicle Applications
What Can You Do With VDT-based Data?

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

- State DOT-based applications
- Transportation-specific applications
- Broad Weather & Transportation 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
Transportation-specific Applications

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

*Simulated screen – designed to not distract the driver
Broad Transportation Applications

VDT-based data

Winter Maintenance – Which roads have been treated?

Route Specific Impact Warnings for...

School Buses

Truckers

EMS

Tornado Warning! I-70 Denver to Limon Delay Until 3:30pm
Weather-related Applications

Numerical Weather Modeling

Traffic Modeling and Alerting

Weather Modeling – complex terrain

Other surface transportation users
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