Observing Road Weather Conditions Using Passenger Vehicles

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International Road Weather Conference
Vehicle Infrastructure Integration

Motivation

Safety

Over 1,500,000 crashes occur each year during poor weather conditions, which result in more than 690,000 people injured and nearly 7,400 fatalities.*

Efficiency and Mobility

It is estimated that 554 million vehicle-hours of delay per year result from snow, ice, and fog.+

* FHWA/Mitretek Systems (now Noblis)
+ Transportation Research Board
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Conventional Data

Need for increased spatial and temporal near-surface observations to support roadway operations

Automated Surface Observing Systems (ASOS) & Automated Weather Observing Systems (AWOS) have long served as the foundation for surface observations

36 km/22 mi.

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Conventional Data

Roadway operations solution

Deploy Road Weather Information System (RWIS)
Environmental Sensor Stations (ESS)

- Atmospherics
- Road weather variables
- Localized conditions
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Needs and Requirements

**General road weather needs**

- Need weather information on very small scales (city blocks/minutes)
- Measurements that address surface transportation needs & requirements

**Specific diagnostic and prognostic road weather needs**

- Precipitation
  - Occurrence
  - Type
  - Amount
- Cloud cover/insolation
- Water vapor (fog, frost, etc.)
- Extreme events (heat, cold, wind, etc.)
- Pavement conditions (dry, wet, icy, etc.)

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Needs and Requirements

- Develop methods to convey data, information, and uncertainty to decision makers
- Develop techniques to deliver data and information to the traveling public in a timely, consistent manner
- Improve forecast capacity, specifically boundary layer conditions
- Develop a better understanding of hazardous road weather conditions
- Extend the current observation network to better capture the conditions that impact roadway operations
USDOT DEFINITION: Vehicle to Infrastructure (V-I) and Vehicle to Vehicle (V-V) communication (two-way) through Dedicated Short Range Communications (DSRC-wireless radio comm. 5.9 GHz)*

*Other wireless comms. are also being considered (WiFi, WiMAX, Satellite, etc.)
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Example Case

1 June 2007 17:44 UTC (1:00 PM)

1 June 2007 17:47 (1:47 PM)
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Example Case

1 June 2007 17:54 UTC (1:54 PM) 1 June 2007 18:14 UTC (2:45 PM)
### Weather-Related Traffic Hazard Diagnosis

- Precipitation (e.g., rain, snow, etc.)
- Dense Fog
- Smoke
- Pavement Conditions (e.g., wet, snow covered, etc.)
- Severe Thunderstorms
- Hail
- Flooding
- Blowing Snow/Ground blizzards

### Numerical Model Initialization

- Surface Pressure
- Air Temperature
- Relative Humidity
- Wind (speed and direction)
- Visibility
- Precipitation (occurrence, rate and type)

### Miscellaneous Products and Applications

- Input for Decision Support Systems
- Pavement Temperature Analysis
- Diagnosing Boundary Layer Water Vapor
- Improved Weather Characterization in Complex Terrain
- Identification of Radar Anomalous Propagation
- Identification of Virga
- Air Quality Monitoring
**Vehicle Infrastructure Integration**

**Detroit, Michigan Proof of Concept (PoC)**

- June 2008
- 57 Roadside Equipment (RSE) unit
- 25 well-equipped vehicles
- 6 week period

### Key PoC Data Elements

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barometric Pressure</td>
<td>Brake Status</td>
</tr>
<tr>
<td>External Air Temperature</td>
<td>Brake Boost</td>
</tr>
<tr>
<td>Date (Year, Month, Day)</td>
<td>Accelerometer (lateral, long.)</td>
</tr>
<tr>
<td>Time (Hour, Minute, Sec.)</td>
<td>Yaw Rate</td>
</tr>
<tr>
<td>Location (lat/lon)</td>
<td>Headlight Status</td>
</tr>
<tr>
<td>Elevation</td>
<td>Traction Control</td>
</tr>
<tr>
<td>Vehicle Heading</td>
<td>Stability Control</td>
</tr>
<tr>
<td>Vehicle Velocity</td>
<td>Wiper Status</td>
</tr>
<tr>
<td>Hours of Operation</td>
<td>ABS Status</td>
</tr>
</tbody>
</table>
VII-enabled data are complex and pose a significant challenge, particularly when it comes to measuring or deriving weather and road condition data. Data issues include:

- Data volume
- Timeliness
- Quality
- Representativeness
- Format
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Weather Data Translator (WDT)

Data processing for weather applications and products

- Points
- Road segments
- Grids or regions

The use of ancillary data, as well as data fusion techniques, will be important

- ASOS/AWOS
- RWIS
- Radar
- Satellite
- Model analyses
VII-enabled Capabilities

VII enables tactical and strategic response to weather related surface transportation hazards.

New weather and road condition data (incl. VII and Clarus data) should be integrated into a seamless information database(s) to support:

- 511
- In-vehicle information
- Traveler information
- Highway operations
- Control systems
- Weather Prediction
- Road Condition Prediction
- Etc.
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Weather Applications and
Products Enabled Through
Vehicle Infrastructure Integration (VII)

http://ops.fhwa.dot.gov/publications/viirpt/index.htm#toc
http://www.ral.ucar.edu/projects/vii