2013 National Winter Maintenance Peer Exchange "Moving from Art to Science" Vancouver, WA

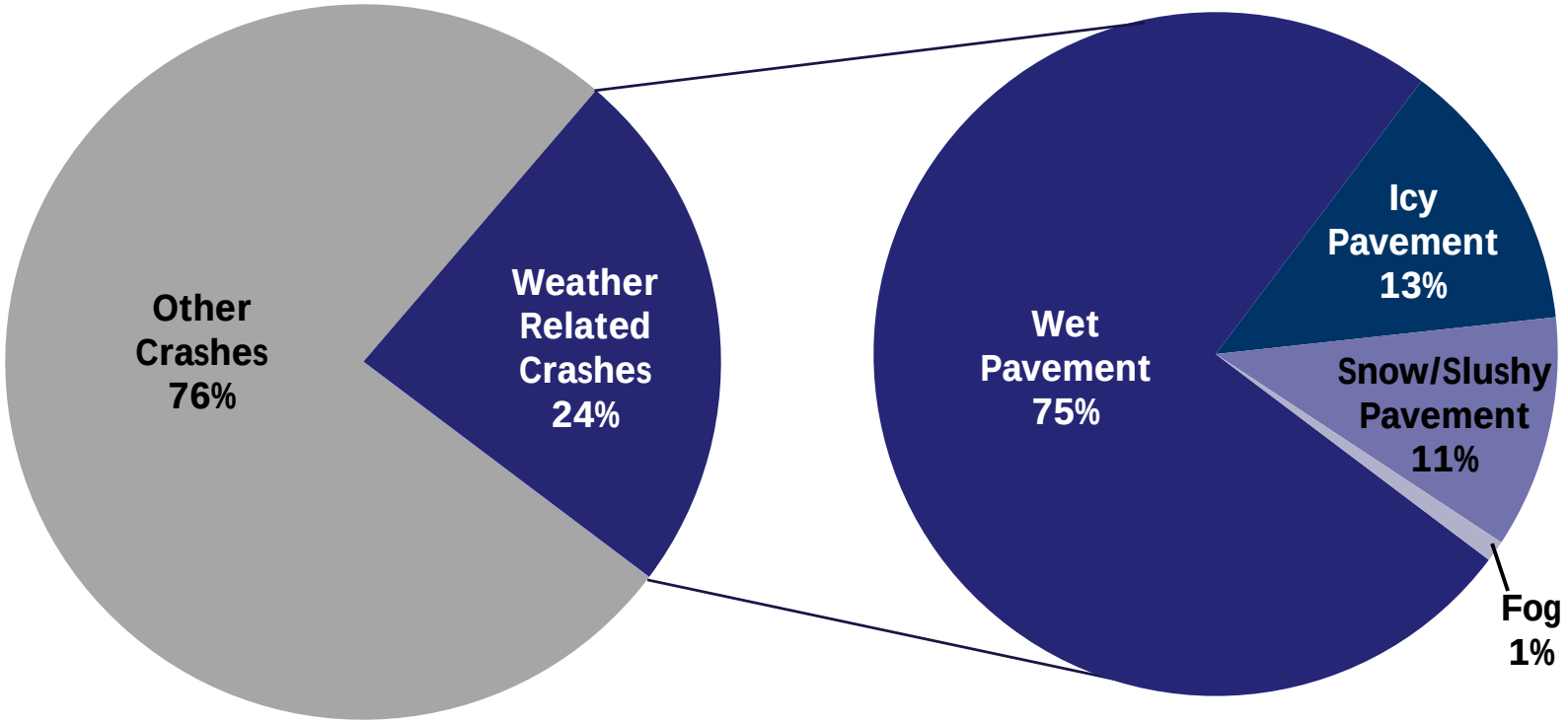
FHWA Update

Gabriel, Guevara, PE

Crash Situation Under Adverse Weather

Total Annual Crashes
Average = 6,301,000

Weather Related Crashes
By Road Weather Condition*



*Crashes that occurred under adverse conditions; additional factors such as rain, snow, and fog are not disaggregated from pavement conditions in this graphic. The percentage due to fog is for those crashes that occur under foggy conditions, but not wet, icy, or snowy pavement conditions.

Weather Impacts on Safety

Annual average from 1995-2008

Road Weather Conditions	Crashes	Injuries	Fatalities
Wet Pavement	1,128,000	507,900	5,500
Rain	707,000	330,200	3,300
Snow/Sleet	225,000	70,900	870
Icy Pavement	190,100	62,700	680
Snow/Slushy Pavement	168,300	47,700	620
Fog	38,000	15,600	600
Total Attributable to Weather*	1,511,200	629,300	7,130

*The sum of the crashes under each road weather condition does not equal the total number attributable to weather; crashes may be double counted, e.g. wet pavement and rain.

Source: *http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm*

Weather Impacts on Mobility

Weather Conditions	Freeway Traffic Flow Reductions		
	Average Speed	Volume	Capacity
Light Rain/Snow	3% - 13%	5% - 10%	4% - 11%
Heavy Rain	3% - 16%	14%	10% - 30%
Heavy Snow	5% - 40%	30% - 44%	12% - 27%
Low Visibility	10% - 12%	-	12%

- On signalized arterial routes, speed reductions can range from 10% - 25% on wet pavement and from 30% - 40% with snowy or slushy pavement

Source: *http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm*

Weather Impacts on Productivity

- Adverse weather can increase operating and maintenance costs of:
  - winter road maintenance agencies
  - traffic management agencies
  - emergency management agencies
  - law enforcement agencies
  - commercial vehicle operators (CVOs)
- Annual cost to trucking industry due to weather-related delay is ~ $7.9 billion per year

Source: *http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm*

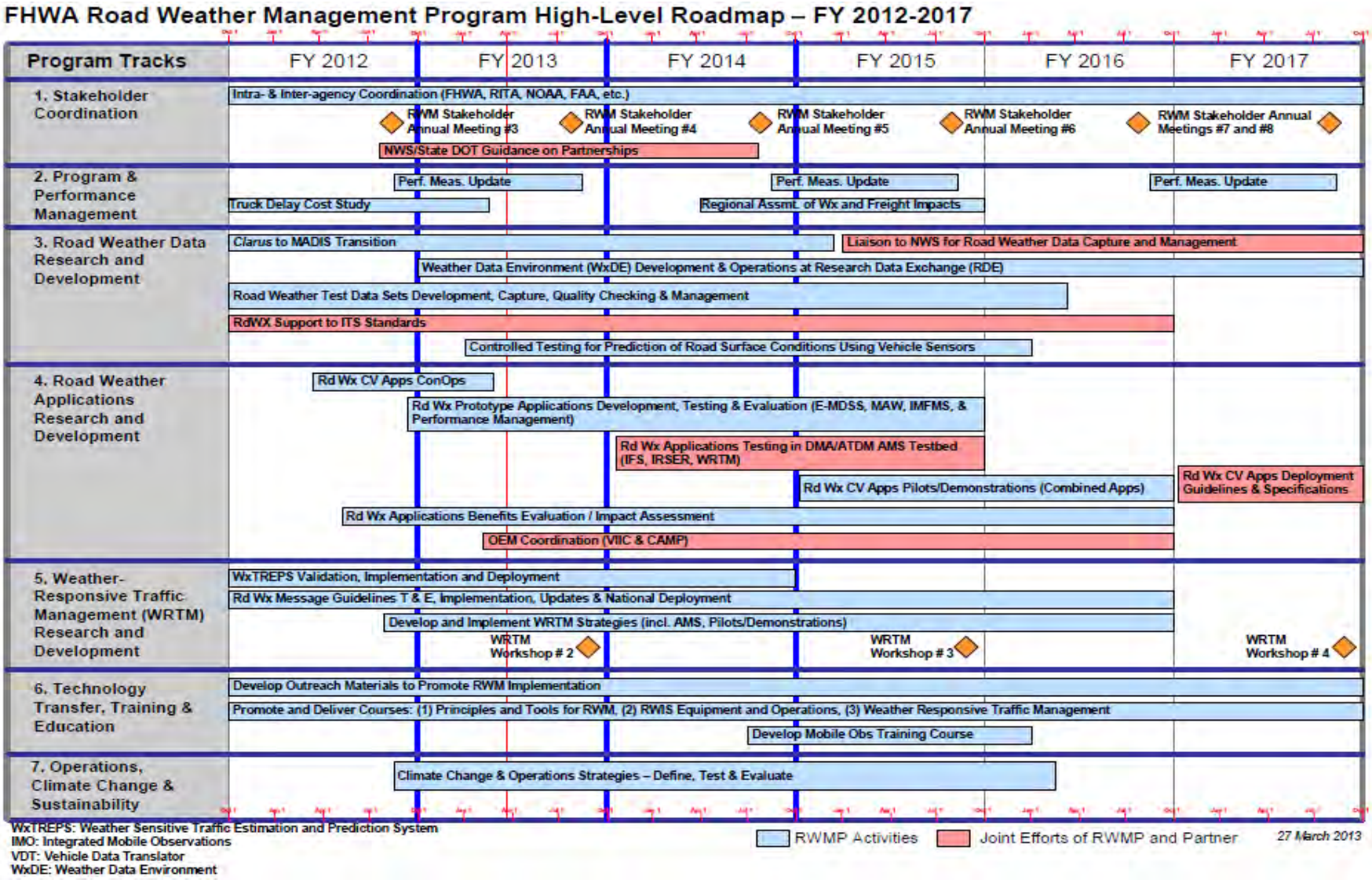
SAFETEA-LU, Section 5308

- Establish a Road Weather R&D program:
  - Follow *Where the Weather Meets the Road*
  - Promote Technology Transfer
  - Expand Research & Development
- Multi-disciplinary stakeholder input:
  - NOAA
  - NSF
  - State DOTs (AASHTO)
  - Private Sector
  - Non-profit Organizations
- Funding: $5m/yr for 4 years
- MAP-21- we lost the dedicated funding stream
- Need to make our case in the ITS Strategic Plan

High Level Roadmap

Focus Areas		Activities	Objectives
Stakeholder Coordination		Lots of interesting projects	Build partnerships
Program & Performance Management			Ensure investments pay off
R&D	RdWx Data Capture & Mgmt		Transportation & weather communities use fixed and mobile observations
	RdWx Dynamic Applications		Integrate RdWx observations into advanced decision support tools
	Weather-responsive Traffic Mgmt		Advance the state-of-the-practice through tailored management strategies
Tech Transfer, Training, Education			Raise road weather capabilities across the industry
Operations & Climate Change			Operations is engaged with climate change community

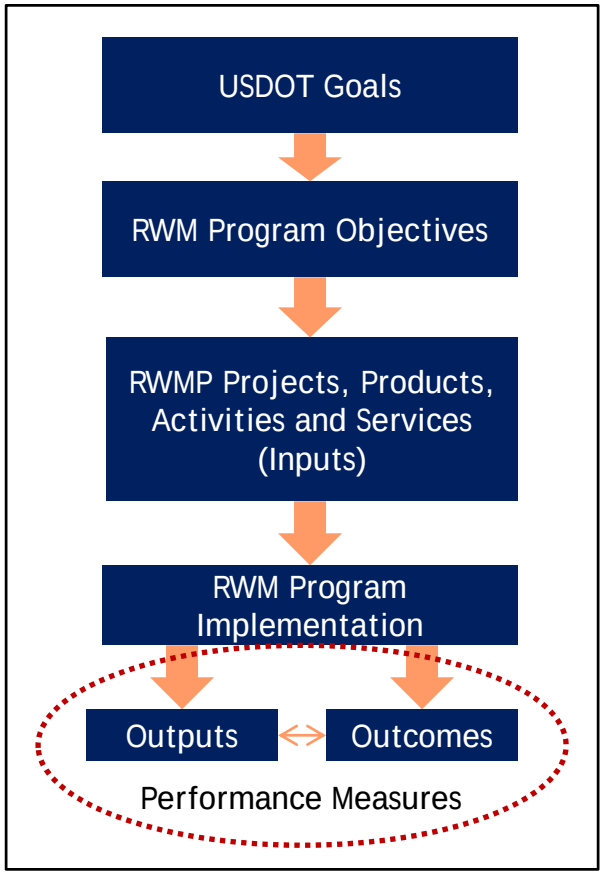
High-Level Roadmap



RWMP Performance Measurement

Developed performance measures in following areas for evaluating success

- Building partnerships with transportation and weather communities
- Raising RWM knowledge and capabilities across transportation industry
- Advancing collection, processing & distribution of fixed and mobile RdWx observations
- Increasing use of Wx-enabled decision-support tools and DMA
- Developing & supporting operational deployment of advanced RWM strategies
- Improving overall system performance during weather events



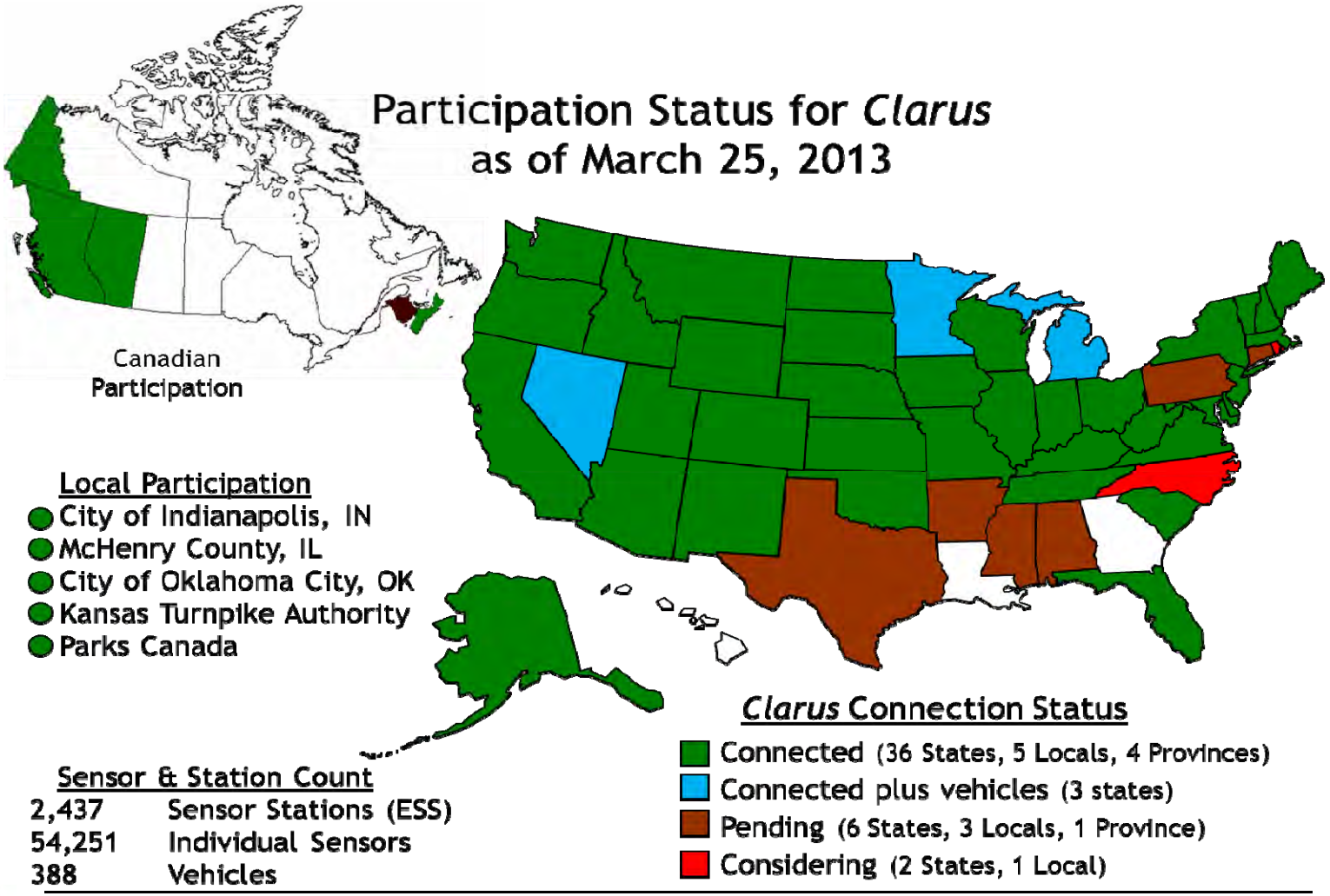
Track 2- Weather & Freight Delay: study findings

- Annual cost to trucking industry due to weather-related delay is ~ $7.9 billion per year
  - Nearly double previous estimates that were based on congestion in largest metropolitan areas
  - Nationwide estimate based on truck speed data from ATRI and NOAA weather stations located along the interstate system
- Trucks spend ~ 6% of their time in adverse weather conditions; this increases their total travel time by 1.3%
- Key weather events are thunderstorms, fog, and snow/ice
- 92% of weather-induced delay occurs on freeways

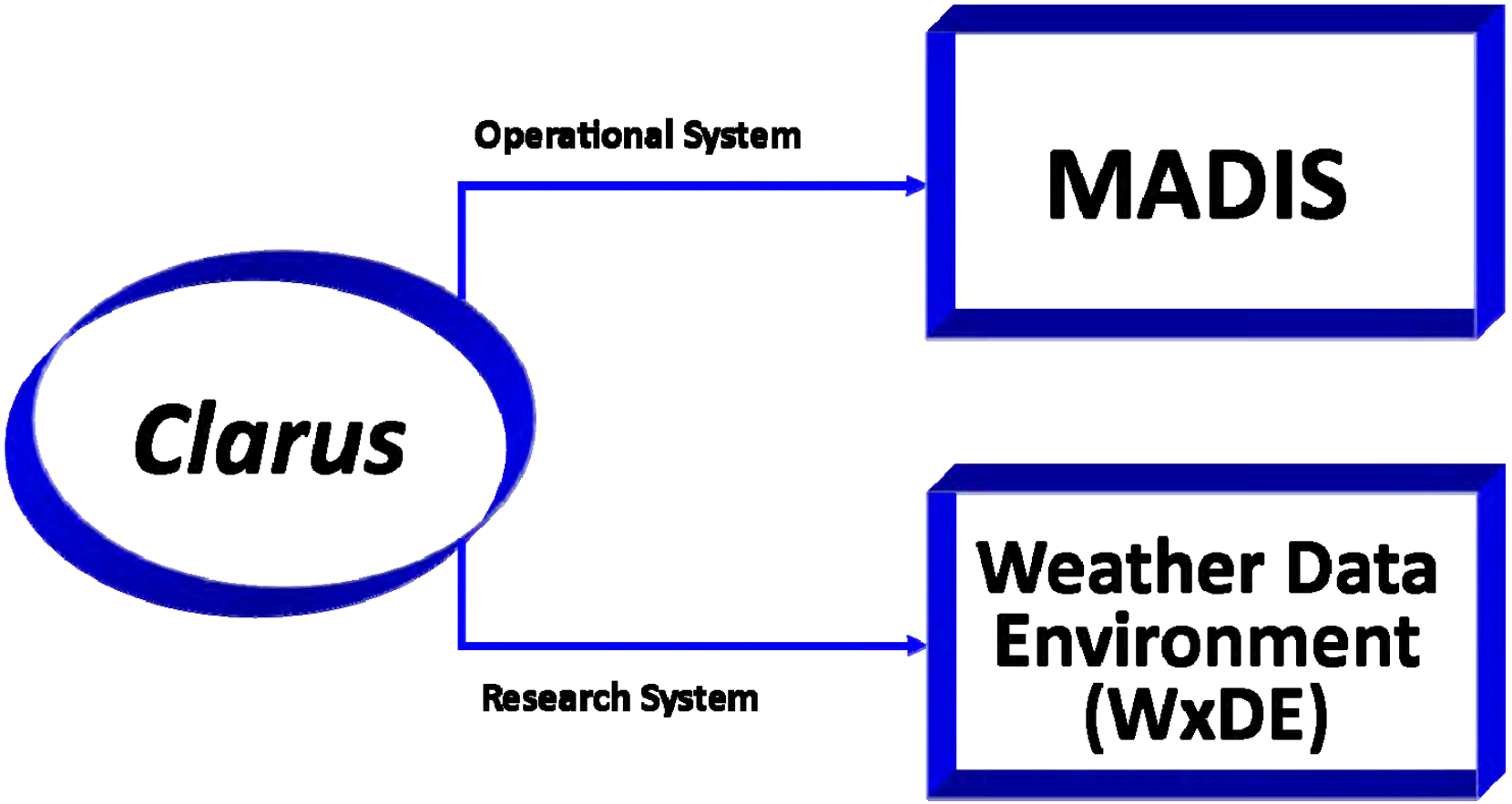
Track 3

- Road Weather Data Research and Development
  - *Clarus*
  - *MADIS*
  - *Weather Data Environment*
  - *Other Datasets*

Clarus States Map



Clarus Transition Track



Weather Data Environment

- Develop a WxDE that:
  - Manages and archives real-time weather data from both static and mobile sources
  - Incorporates VDT functionality
  - Supports the development of connected vehicle applications
  - Integrates with other Real-Time Data Capture and Management Program environments
- Other data sources being considered
  - Naturalistic Driving Study (SHRP-2)
  - Weather Telematics and other private data sources

MADIS Transition Schedule

The *Clarus* transition consists of three delivery dates of MADIS enhancements

Enhancements to MADIS	Delivery Date
• RWIS observations • RWIS contributors • RWIS data displays • RWIS metadata displays & dissemination	June 15, 2013
• RWIS multiple observations of the same type. • *Clarus* background fields required for QC. • Enhanced subscription service capabilities. • Display enhancements for RWIS data/metadata.	December 31, 2013
• RWIS QC implemented. • Contributor constraints. • Display enhancements for QC additions.	December 31, 2014

Contributing to MADIS

- **Goal**: Ingest RWIS data from all providers
- **RWIS Contributor Role:**
  - Give written ok to be moved to MADIS.
  - Provide access restrictions to be applied to RWIS data/metadata in writing.
  - Work with MADIS team on access to RWIS data/metadata files
    - Fix anomalies
    - Verify RWIS obs have been added to the MADIS surface display.
    - Verify RWIS obs are available for download from the MADIS surface viewer.
- *Clarus* **Team Role:**
  - Coordinate written approvals from the contributors to be added to MADIS and the access restrictions on RWIS data.
  - Provide the MADIS team with the RWIS Contributor contact information and contributor server information.
  - Verify metadata information.
  - Once contacted by the MADIS team that the provider has been fixed/added to MADIS verify that the data and metadata matches *Clarus*.

MADIS/WxDE Data Sharing Agreements

- MADIS
  - Current environment in Colorado: only an email is needed
  - Operational Environment in Maryland (2015): unrestricted or restricted data sharing agreement will be required
- WxDE
  - Currently: only an email is needed
- Two formal Agreements will be needed. Ongoing coordination to request signatures for both only once.

Track 4 – Road Weather Applications Research and Development

All efforts support two goals:

1. Identify weather-related data elements to be included in the NHTSA decision

2. Demonstrate the value of connected vehicle data via the development, test and evaluation of a few key applications

Priority Vehicular Data

BSM Part 1

- Brake system status
  - Brake applied status
  - Traction control status
  - Anti-lock brake status
  - Stability control status

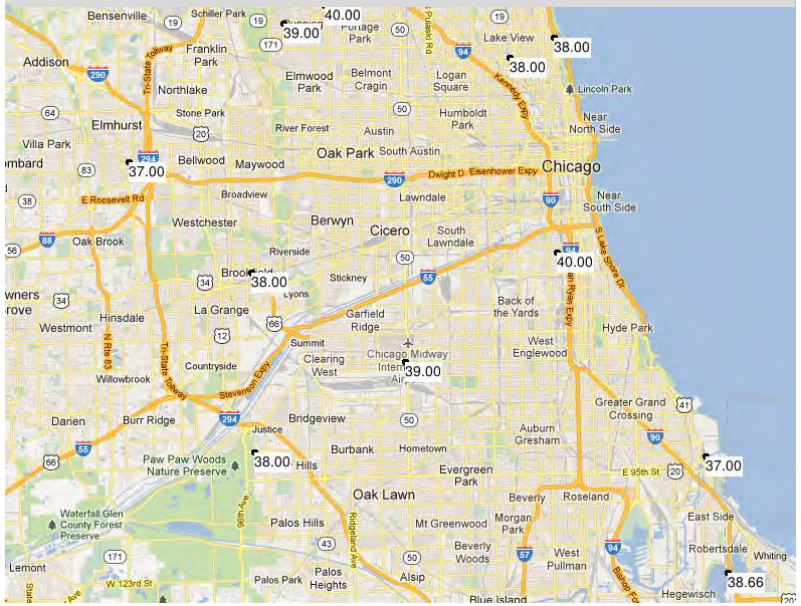
BSM Part 2

- Vehicle status
  - Exterior lights
  - Wipers
  - Brake system status
  - Roadway friction
  - Rain sensor
  - Ambient air temperature
  - Ambient pressure

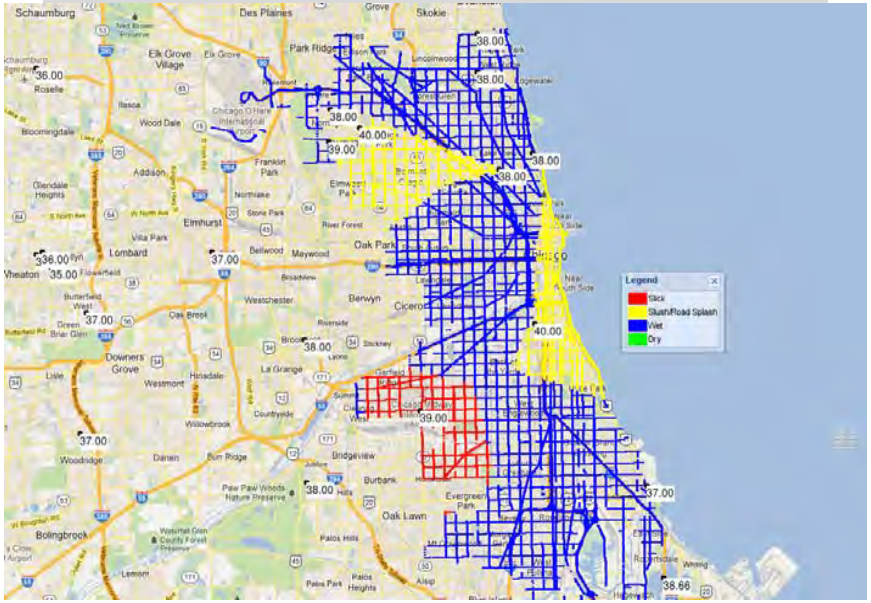
- "Black Ice" warning requires near-instantaneous information while other algorithms operate with data rates from once per second to once every 30 seconds
- 15 observations per segment (e.g., 1 mile) per time step (e.g., 15 min) should be sufficient for confidence in the application outputs
- Bandwidth required for data transmission is minimal (85-365 bytes)

The Potential of Higher Resolution

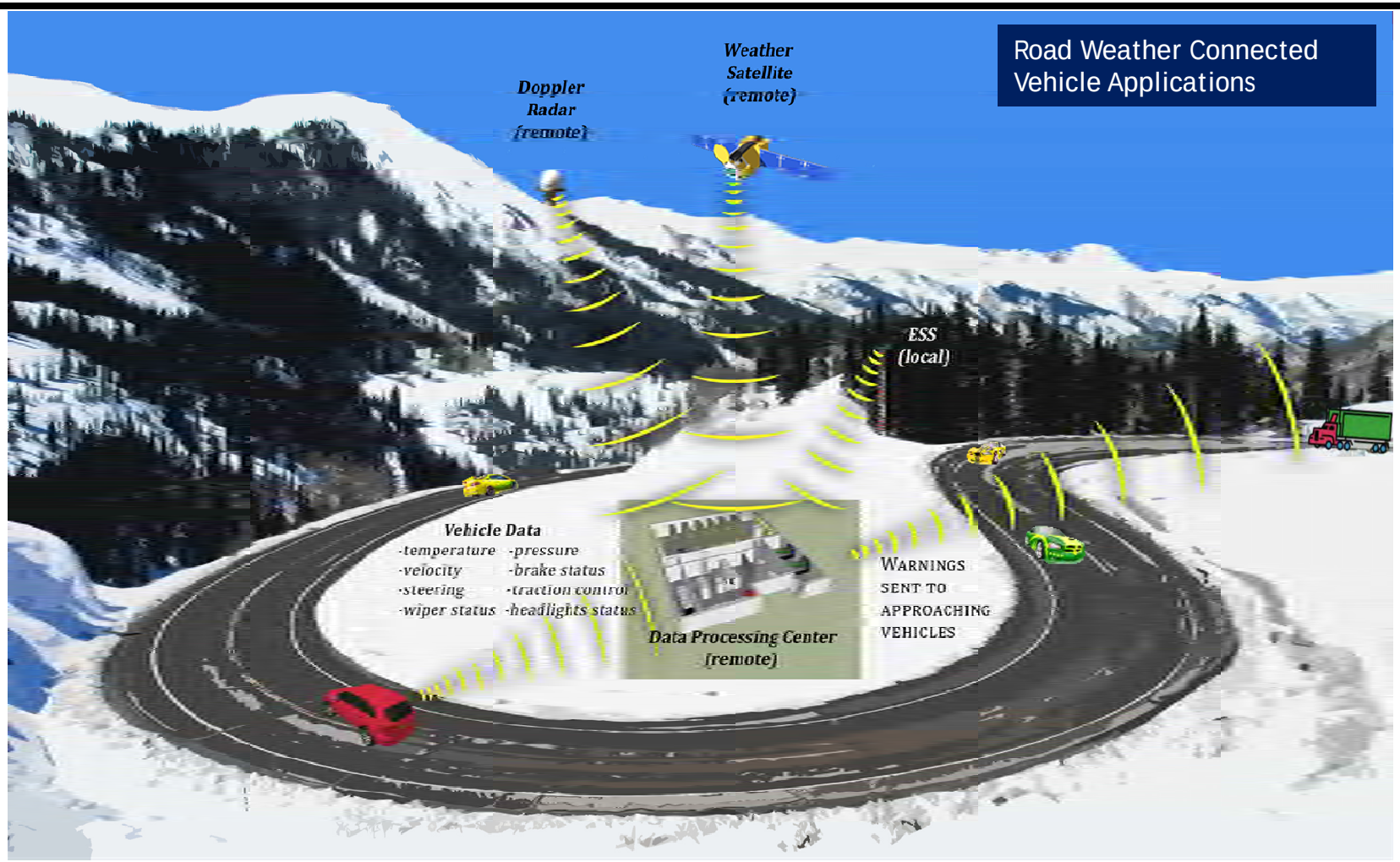
Today
A 60% chance of snow, mainly afternoon. Sunny early, then becoming cloudy.



Future
Connected vehicles provide continuous picture of what's happening on the roadways



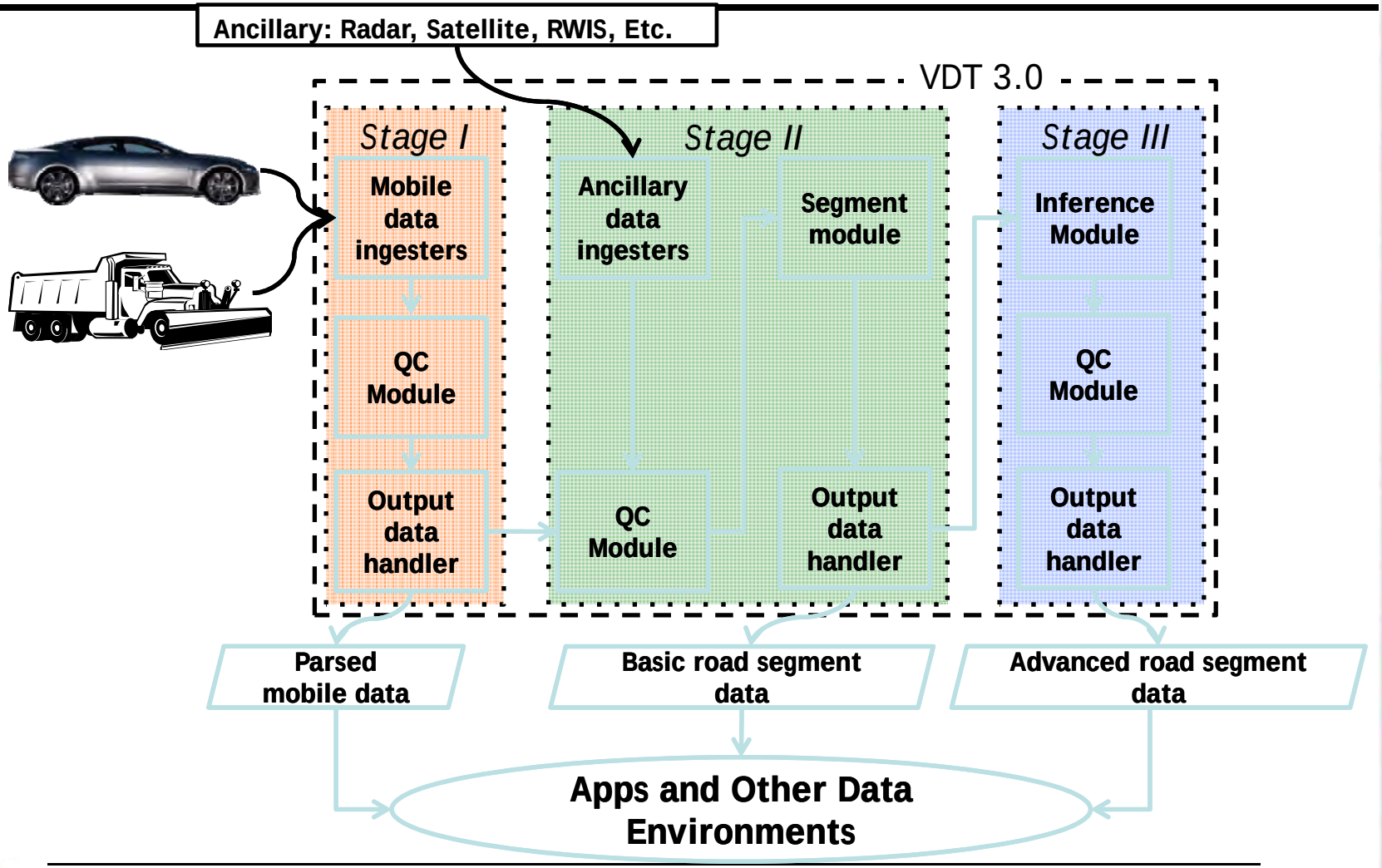
Connected Vehicles & Road Weather: Illustrative Concept



Road Weather CV Applications

- Enhanced Maintenance Decision Support
- Information for Maintenance and Fleet Management Systems
- Weather-Responsive Traffic Management
  - Variable Speed Limits
  - Signal Timing Optimization
- Motorist Advisories and Warnings
- Information for Freight Carriers
- Information and Routing Support for Emergency Responders

Vehicle Data Translator (VDT) 3.0



VDT 4.0 (NCAR)

- Develop and test connected vehicle applications
- Enhance VDT to support applications
- Ingest vehicular data from State DOTs
- Demonstrate usefulness of mobile data in road weather applications
- Advance understanding of applications benefits
- Support the NHTSA rulemaking decision
- Provide outreach support / Address IP

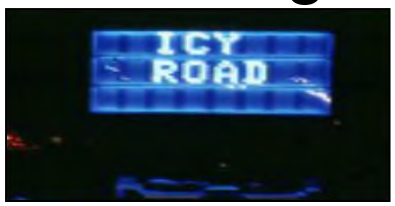
IMO 2.0

Participating states are serving as both providers of mobile data (CAN-Bus and external sensors) as well as users of the information / RdWx CV applications

- Michigan DOT
  - Instrument and deploy 20 snow plows and ~40 passenger vehicles and light-duty trucks with CV technologies
  - Input mobile & ancillary collected data into their Dataprobe application to evaluate pavement condition, measure performance, and make the data available to other weather-related application & data environments
- Minnesota DOT
  - 305 heavy duty trucks and 30 light duty trucks
  - Implement and operate applications (Enhanced MDSS, Information for Maintenance or Fleet Management Systems, Records Automation, and Motorist Advisory Warning)
- Nevada DOT
  - 25 vehicles (mix of plows, light duty vehicles, and passenger cars)
  - Enhance Maintenance Management System (MMS)

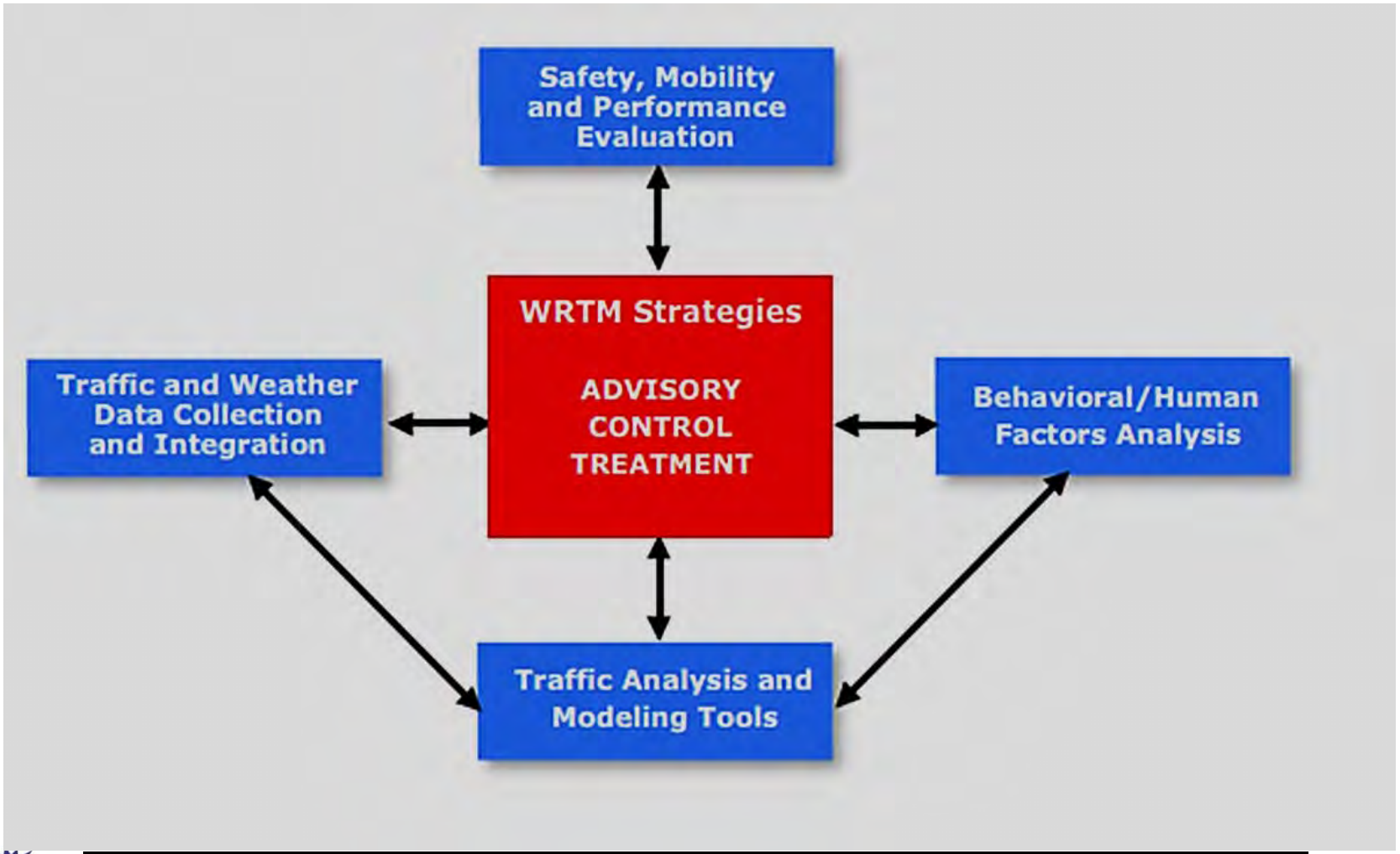
Track 5- Weather-Responsive Traffic Management (WRTM) R & D

- Goals: Develop strategies and tools to help agencies effectively manage traffic and highway operations during inclement weather



- WRTM Strategies:
  - Advisory
  - Control
  - Treatment

WRTM Framework



Track 2- Road Weather CV Apps B/C Analysis

- Estimate potential national costs and benefits resulting from the implementation of RdWx connected vehicle applications
- Being developed in two phases:
  - Phase I
    - Focuses on safety aspects of the applications
    - Due late August, 2012
  - Phase II
    - Focuses on mobility and environmental aspects
    - Due for completion December, 2012
- Will help establish the most critical weather-related vehicle data elements

Reducing the Impact of Adverse Weather

- The societal cost of adverse weather in terms of crashes, fatalities, injuries, and property damage through 2055 is **$23,074 trillion***

Crashes	Fatalities	Injuries	Property Damage
66,000,000	325,600	30,360,000	$258 Billion

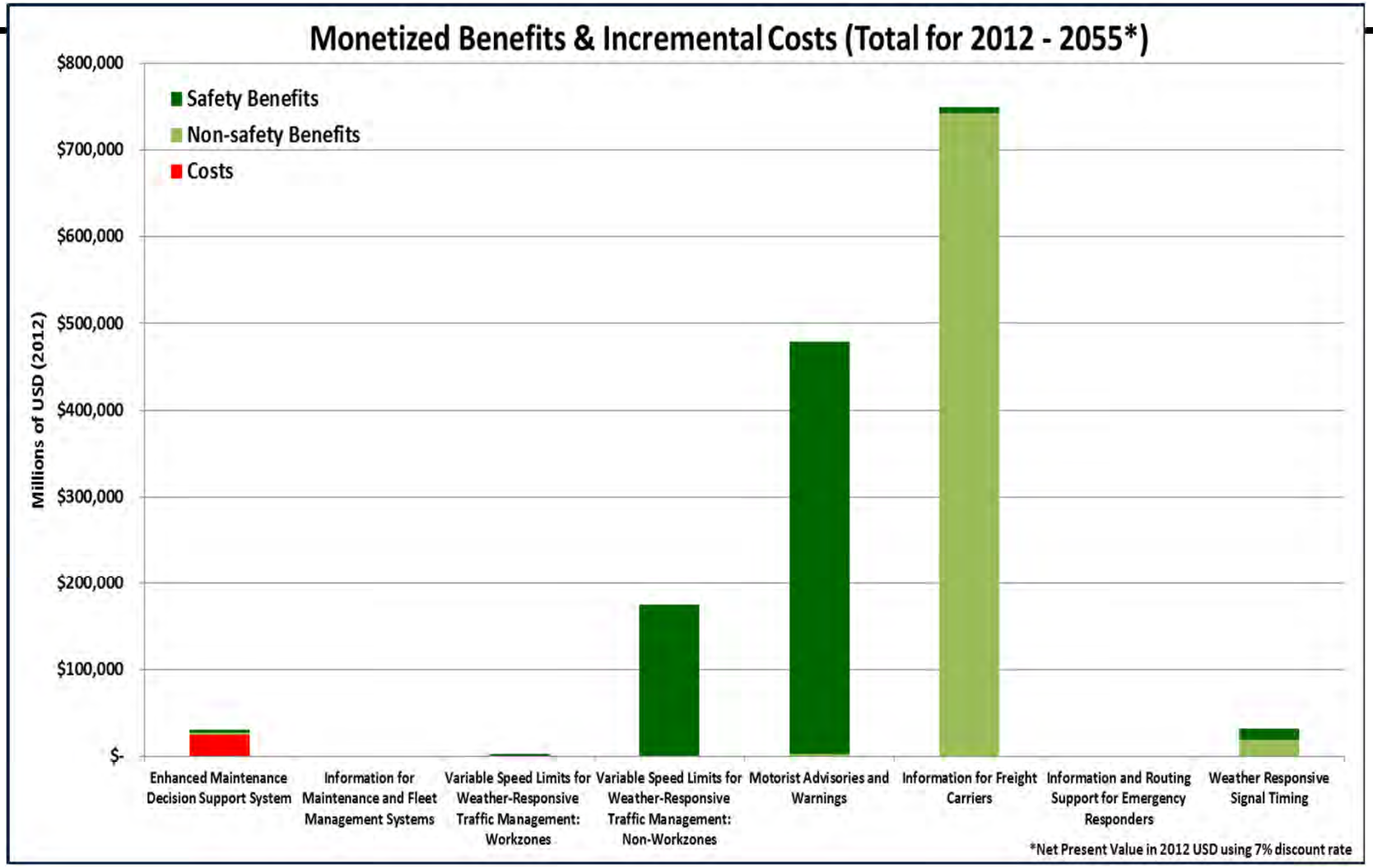
- To deploy, operate, and maintain the road weather management connected vehicle applications (including the core connected vehicle infrastructure) for 2012 through 2055 is estimated to cost **$45 billion***
- The applications are expected to yield safety and non-safety benefits from 2012 through 2055, equivalent to **$1.3 trillion**

Crashes Avoided	Fatalities Avoided	Injuries Avoided	Property Damage Avoided
6,417,482	28,099	2,601,571	$16 Billion

- The benefit to cost ratio of the applications is **28:1**; a very high return on investment, although, out of all safety impacts associated with adverse weather for the period of analysis, approximately **10%** of impacts are avoided

*Costs in net present value using a 7% discount rate for the period 2012 through 2055

Applications Comparison



Track 6- Technology Transfer, Training and Education

Best Management Practices 3.0

- Version 3.0 captures the state-of-the-art
- Contains 27 case studies
- From 22 states
- Showcases systems in that improve roadway operations under inclement weather conditions
- Each case study has six sections including a general description of the system, system components, operational procedures, resulting transportation outcomes, implementation issues, as well as contact information and references.

http://ops.fhwa.dot.gov/weather/mitigating_impacts/best_practices.htm

Thank you!

RWMP Contacts

Paul Pisano- Team Leader
(paul.pisano@dot.gov)

Gabriel Guevara- CV
(gabriel.guevara@dot.gov)

Dale Thompson-JPO Liaison
(dale.thompson@dot.gov)

Roemer Alfelor- WRTM/PM
(roemer.alfelor@dot.gov)