FHWA Road Weather Management Program

"Weather and the transport of Hazardous Materials"

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U.S. DOT – Federal Highway Administration

Breakout Session: Using Technology to Dispatch and Monitor Shipments During Adverse Conditions

U.S. DOE National Transportation Stakeholder Forum

Presentation Contents

- Context
- *Clarus* Initiative
- Connected Vehicles & Weather

Weather's Wrath

Safety

- 1.57± million weather-related crashes/year
  - 7,400 fatalities; 690,000 injuries
- 24% of all crashes occurred on slick pavement or under adverse weather

Mobility: Cost of congestion is $9.45 billion/yr for the 85 major urban areas (weather causes ~25% of non-recurrent delay on freeways)

Productivity: Weather-related delay adds $3.4 billion to freight costs annually

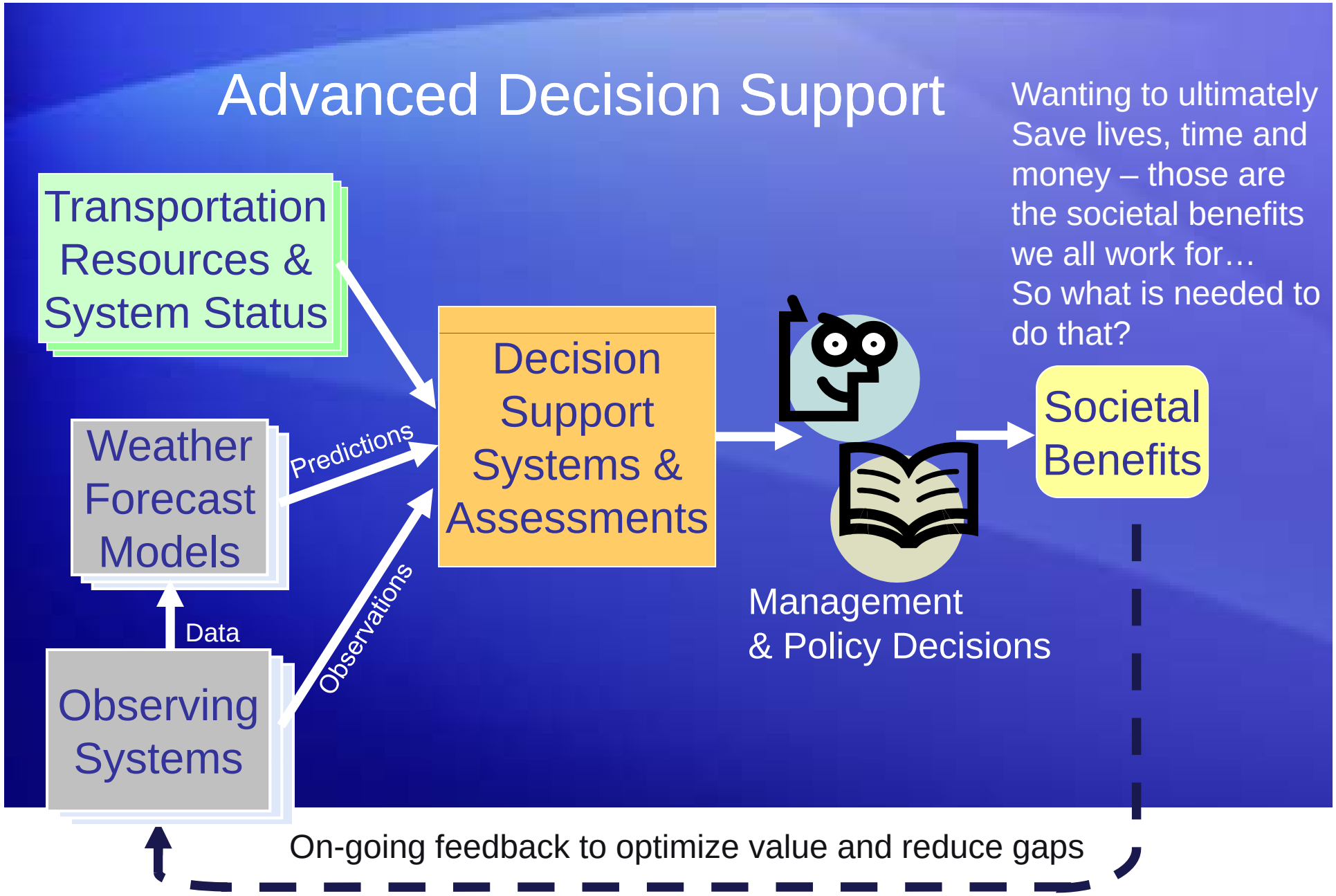
Environment: Chemicals effect watersheds, air quality and infrastructure

FHWA Road Weather Mgmt Program

1. Stakeholder Coordination
2. Applied Research
   - Observing & Forecasting
   - Weather-responsive Traffic Management
   - Decision Support
3. Technology Transfer, Training & Education
4. Performance Management & Evaluation

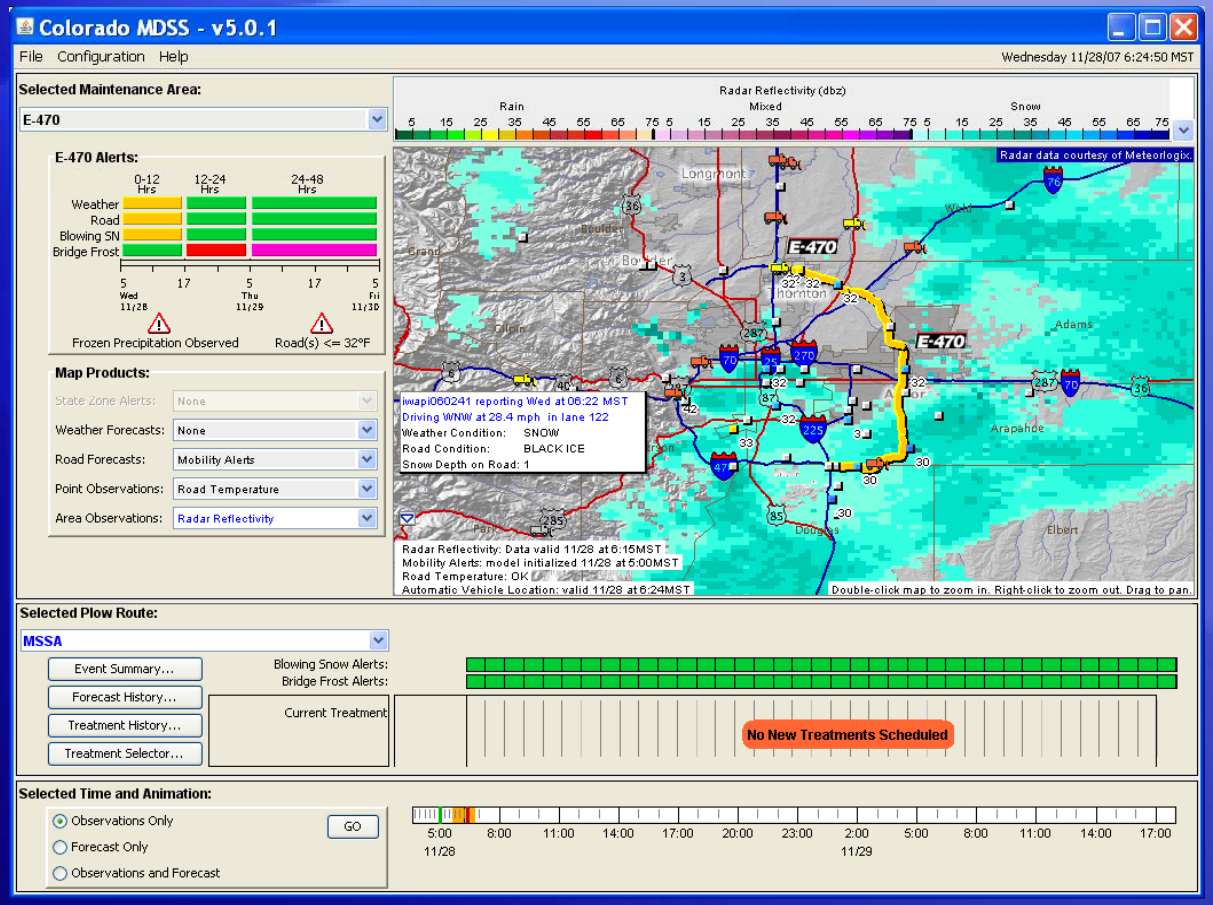
Anytime, Anywhere
Road Weather Information

Getting From Problems to Solutions



Maintenance Decision Support System

MDSS is a maintenance decision-support system that combines:



- Advanced weather forecasting
- Advanced road condition prediction
- Rules of practice for anti-icing

The system generates winter treatment recommendations on a route-by-route basis.

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* Initiative: 4 Objectives

1. Provide a North American resource to **collect**, **quality check**, and **disseminate** weather and road condition **observations**
2. Demonstrate that these observations will support **general purpose weather forecasting**
3. Demonstrate that the observations will support **real-time operational responses** to weather
4. Support the enhancement and creation of models to **improve forecasts at and near the earth's surface**

The *Clarus* System

www.clarus-system.com

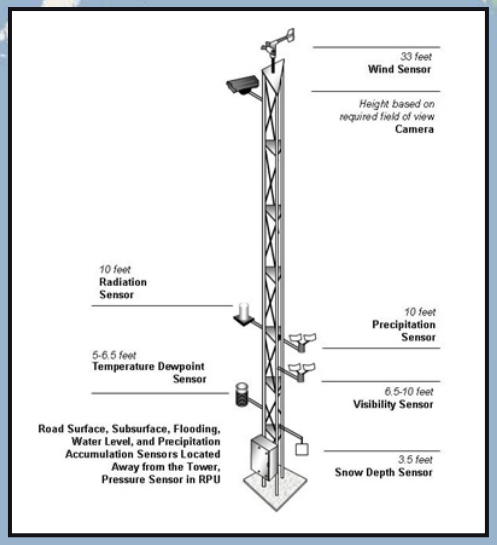
- ✓ A database management system for all surface transportation weather observations in North America
- ✓ One database removes borders
- ✓ Provides advanced quality checking for both atmospheric & pavement data
- ✓ Includes extensive metadata
  - Easy access via web portal & subscription
  - Once development completed, transfer to NOAA for operations

Clarus

A Clear Solution For Road Weather Information

Over 75% of State DOTs Participate in *Clarus*

www.clarus-system.com



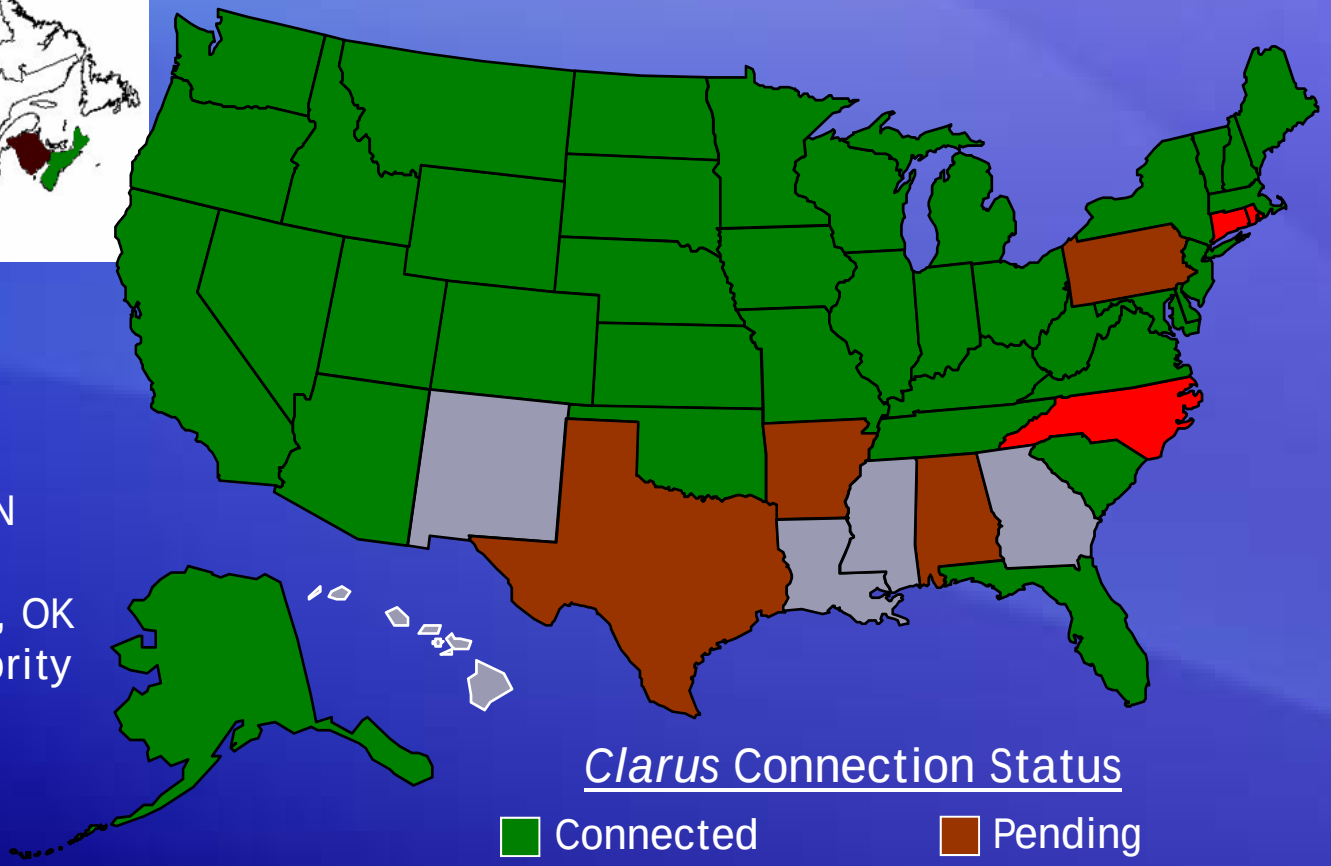
Sensor & Station Count

2,229 Sensor Stations (ESS)

51,722 Individual Sensors

Participation Status for *Clarus* as of April, 2011

Canadian Participation

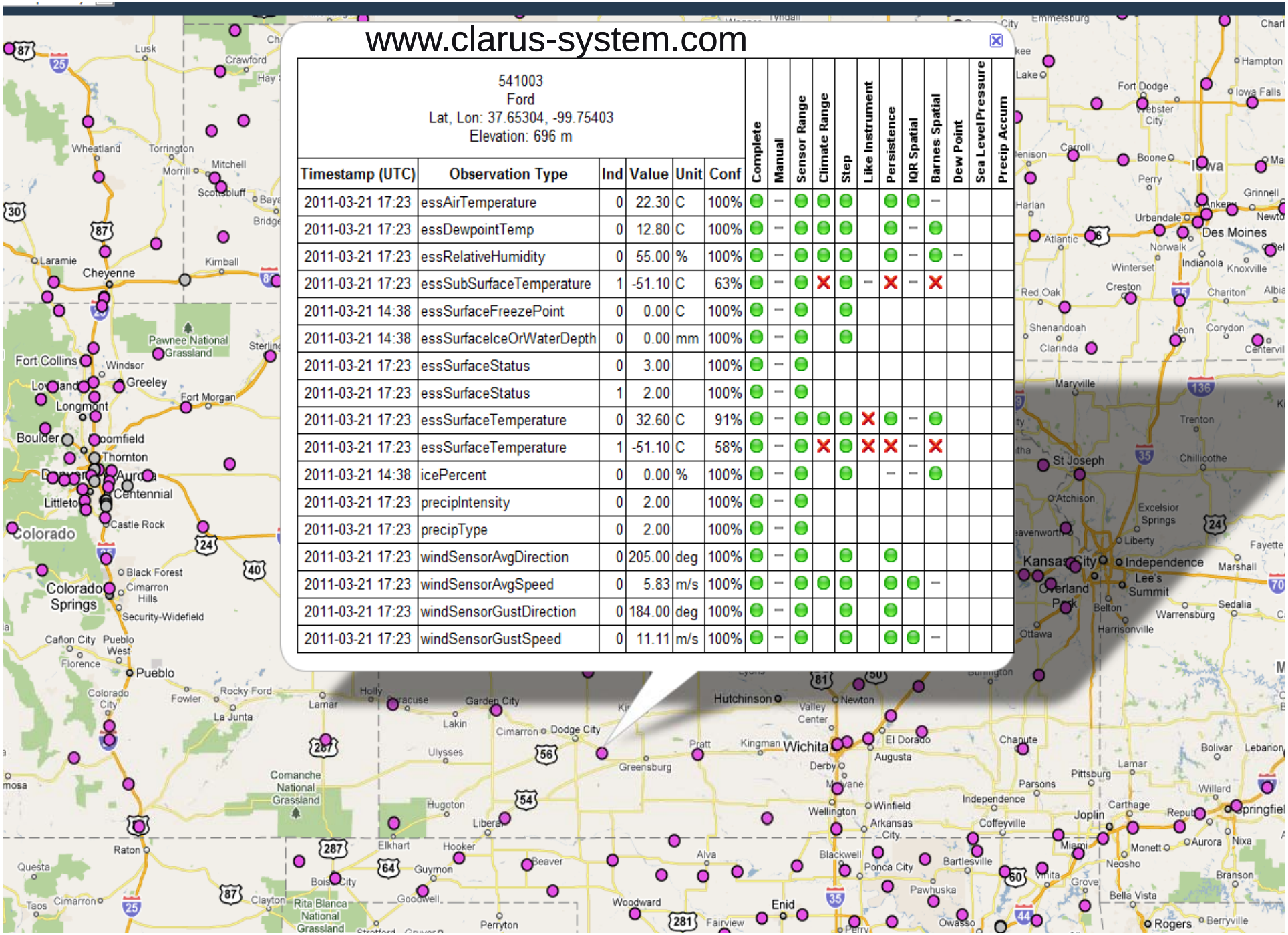


Local Participation

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

Clarus Connection Status

- Connected (38 States, 5 Locals, 4 Provinces)
- Pending (4 States, 3 Locals, 1 Province)
- Considering (3 States, 1 Local)



Timestamp (UTC)	Observation Type	Ind	Value	Unit	Conf	Complete	Manual	Sensor Range	Climate Range	Step	Like Instrument	Persistence	IQR Spatial	Barnes Spatial	Dew Point	Sea Level Pressure	Precip Accum
2011-03-21 17:23	essAirTemperature	0	22.30	C	100%	●	–	●	●	●		●	●	–			
2011-03-21 17:23	essDewpointTemp	0	12.80	C	100%	●	–	●	●	●		●	–	●			
2011-03-21 17:23	essRelativeHumidity	0	55.00	%	100%	●	–	●	●	●		●	–	●	–		
2011-03-21 17:23	essSubSurfaceTemperature	1	-51.10	C	63%	●	–	●	✗	●	–	✗	–	✗			
2011-03-21 14:38	essSurfaceFreezePoint	0	0.00	C	100%	●	–	●		●							
2011-03-21 14:38	essSurfaceIceOrWaterDepth	0	0.00	mm	100%	●	–	●		●							
2011-03-21 17:23	essSurfaceStatus	0	3.00		100%	●	–	●									
2011-03-21 17:23	essSurfaceStatus	1	2.00		100%	●	–	●									
2011-03-21 17:23	essSurfaceTemperature	0	32.60	C	91%	●	–	●	●	●	✗	●	–	●			
2011-03-21 17:23	essSurfaceTemperature	1	-51.10	C	58%	●	–	●	✗	●	✗	✗	–	✗			
2011-03-21 14:38	icePercent	0	0.00	%	100%	●	–	●		●		–	–	●			
2011-03-21 17:23	precipIntensity	0	2.00		100%	●	–	●									
2011-03-21 17:23	precipType	0	2.00		100%	●	–	●									
2011-03-21 17:23	windSensorAvgDirection	0	205.00	deg	100%	●	–	●		●		●					
2011-03-21 17:23	windSensorAvgSpeed	0	5.83	m/s	100%	●	–	●	●	●		●	●	–			
2011-03-21 17:23	windSensorGustDirection	0	184.00	deg	100%	●	–	●		●		●					
2011-03-21 17:23	windSensorGustSpeed	0	11.11	m/s	100%	●	–	●		●		●	●	–			

Clarus Regional Demonstrations - Objectives

- Ensure the *Clarus* System works as designed
  - Demonstrate the ability of the *Clarus* System to process and provide data from large numbers of ESS
  - Promote/educate on metadata collection
- Foster proactive transportation system management
- Encourage improved private sector services for road weather information enabled with data from the *Clarus* System

Clarus Regional Demonstration

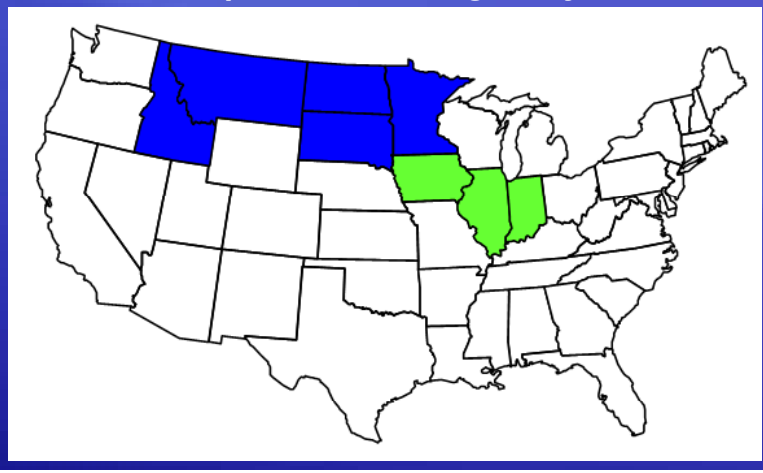
5 Use Case Scenarios

1. Enhanced Road Weather Forecasting Enabled by *Clarus*
2. Seasonal Weight Restriction Decision Support Tool
3. Non-winter Maintenance & Operations Decision Support Tool
4. Multi-state Control Strategy Tool
5. Enhanced Road Weather Content for Traveler Advisories

Meridian Team
Scenarios 1, 2, 5

Mixon Hill Team
Scenarios 1, 3, 4

State Transportation Agency Partners



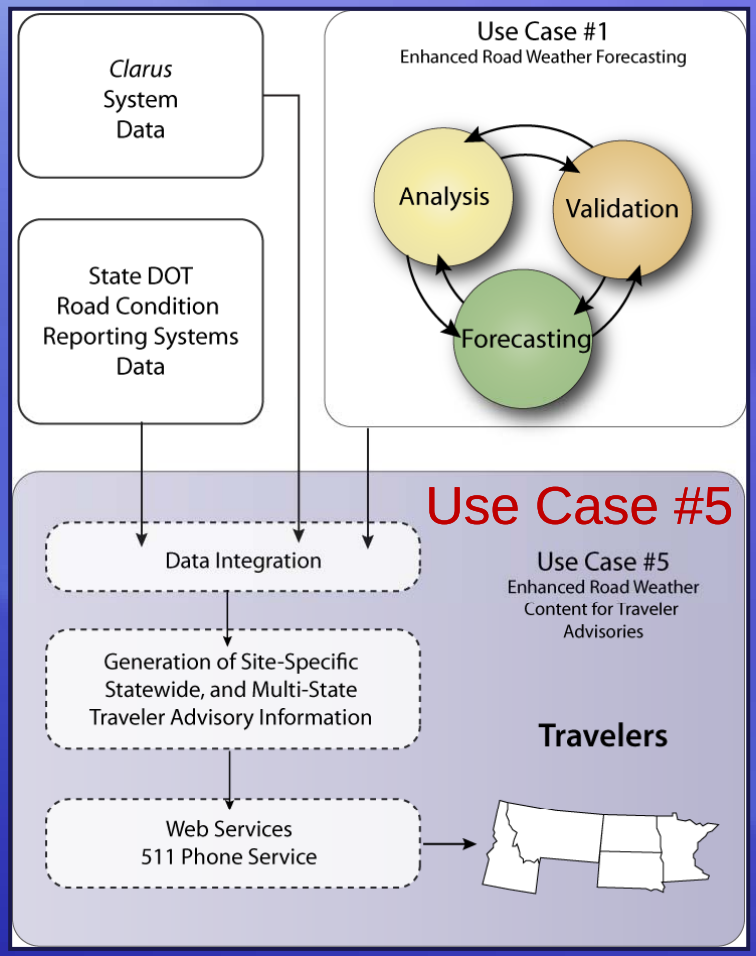
Enhanced Road Weather Content for Traveler Advisories

Goal:

Use Clarus' data to develop enhanced road weather information for travelers.

Methods:

- by leveraging the multi-state nature of Clarus to create a multi-state traveler information platform
- by applying Clarus' data to develop enhanced road / weather forecasts that can alert drivers of conditions before they occur



Use Case #5
Web Portal

Enhanced Road Weather Content for Traveler Advisories

Observed Road Conditions

- Good Driving Conditions
- Fair Driving Conditions
- Difficult Driving Conditions
- Road Closed/Blocked
- Unknown

Analysis Suggests Road Conditions

- May Change from Good to Fair Driving Conditions
- May Change from Good to Difficult Driving Conditions

Sensors indicate Conditions May Vary From Observed Road Conditions

Clarus & Transportation Decision Support

Integrated **traveler information -** *Clarus* System data provides decision support to track approaching weather systems.

Data delivery to trucking dispatch centers and transportation agency centers

Integration of vehicle detectors and radio frequency identification with ESS to provide value-added services to CVO services

Clarus

A Clear Solution For Road Weather Information

Hazmat transport & weather decision support…

Clarus Data…

pavement temperatures, which when combined with radar could provide an indication of potentially slippery or hazardous winter conditions for transporting HAZMAT. **This could result in decisions to either reduce speed, deviation of course or to delay departure, pending better weather conditions ;**

precipitation amount, which could provide an indication of excessive precipitation and the **potential of flash flooding**; **this could result in decisions to a deviation of course or to delay departure, pending better weather conditions;**

wind direction, which could provide an estimate of the trajectory for toxic plumes in the event of a release. If the winds are blowing toward a populated area, **this could result in decisions to change the route** so that the vehicle travels on the downwind side of a populated area;

wind speed, which could be used to determine if there will be excessive buffeting (high profile vehicles) which might lead to loss of control.

Next Steps… Connected Vehicles & Weather – Vision

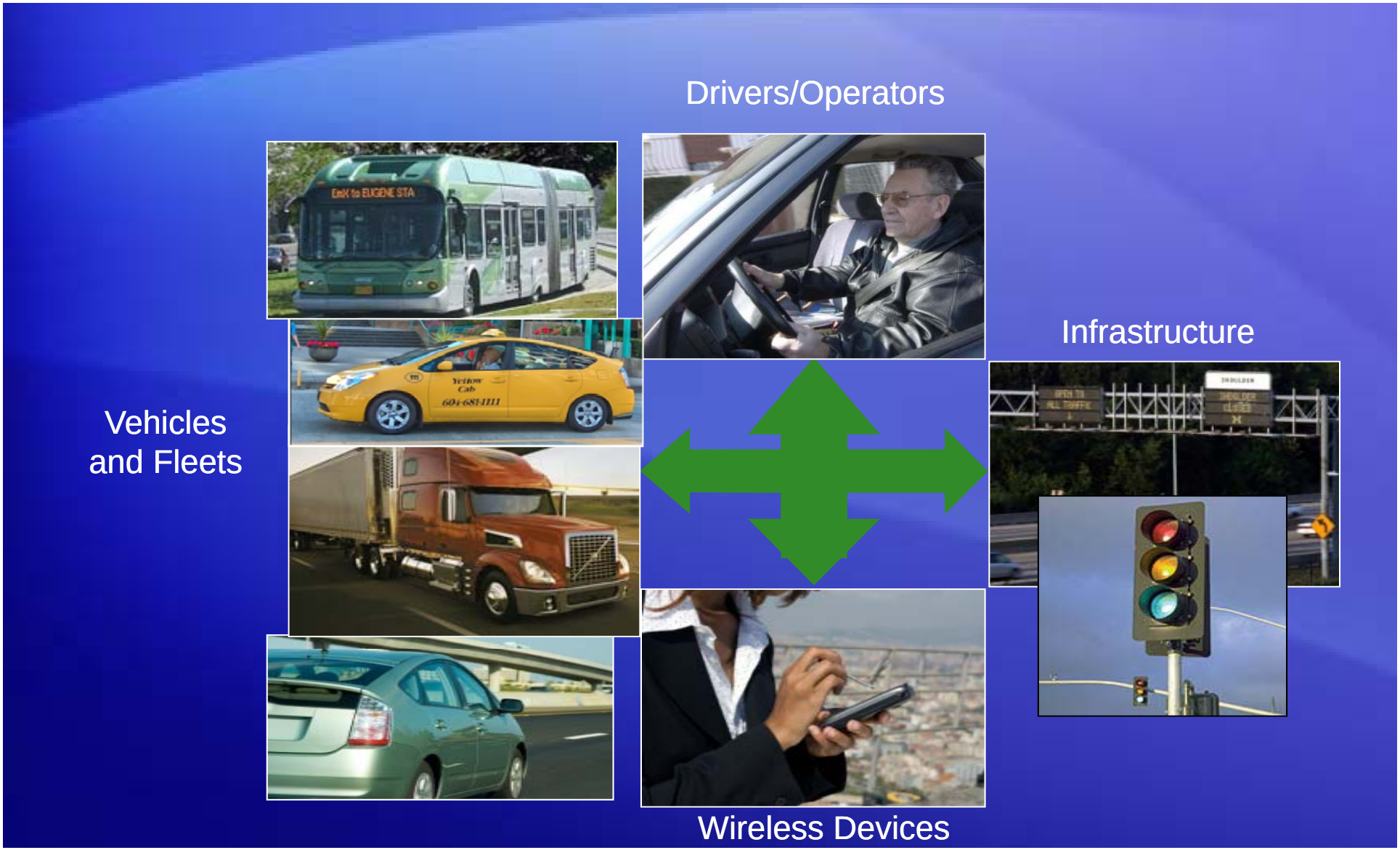
Obtain a thorough picture of current weather and road conditions by including mobile sources

- Higher resolution observations that spatially augment fixed sensors
- Take advantage of existing standards and on-board sensors

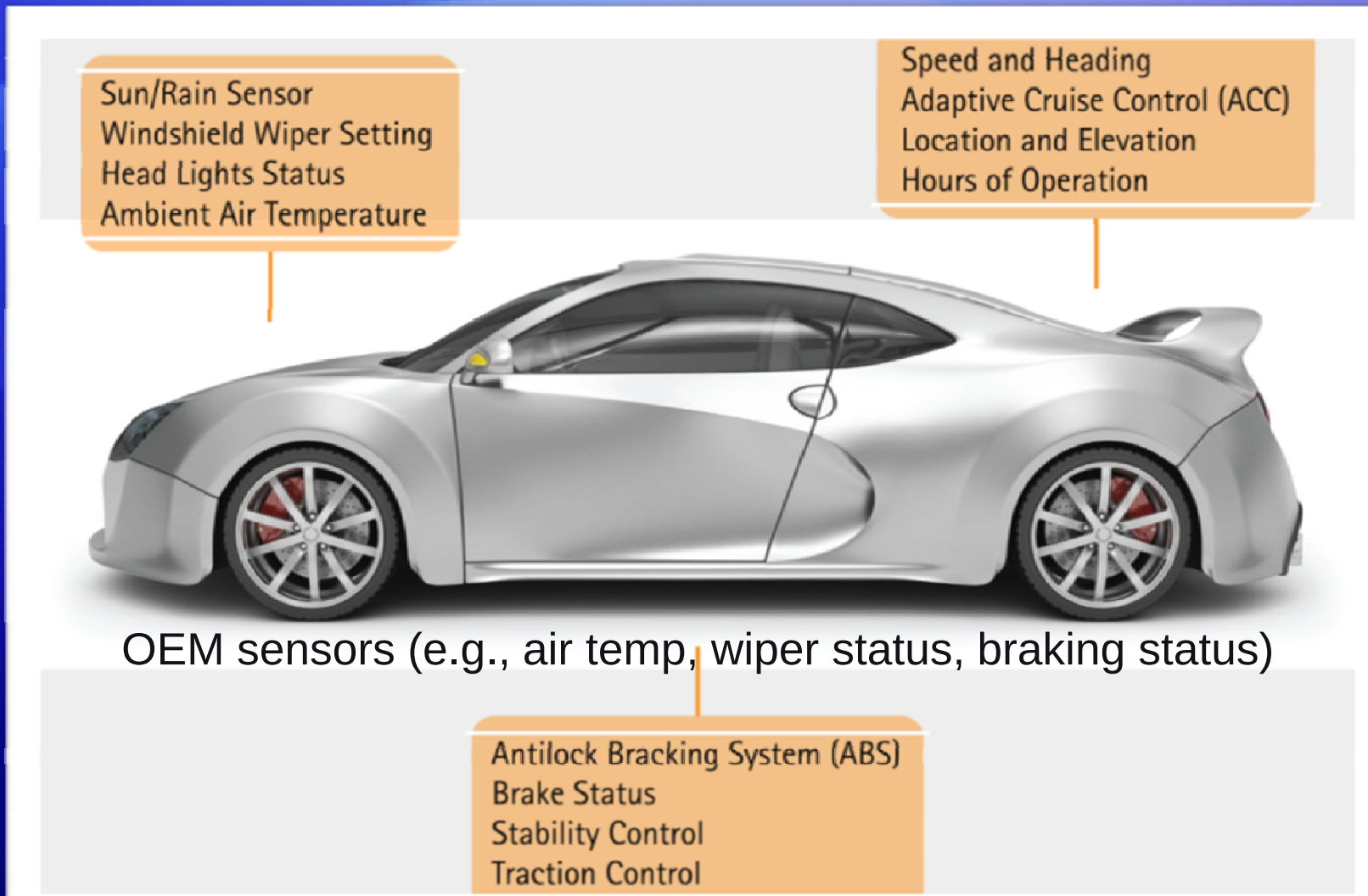
Improve weather-related decision support tools to mitigate safety and mobility impacts of weather

- Based on ability to better detect and forecast road weather and pavement conditions

Connected Vehicles & Weather – Vision

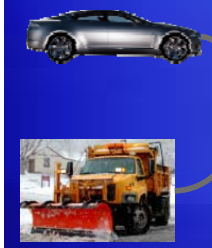


Vehicle data in Connected Vehicle



Vehicle Data Translator (VDT) Data Processing

Ancillary Data: Radar, Satellite, RWIS, etc. **Clarus** is one of the "ancillary" data source feeding into Stage II of the process; **Clarus** and other data are used to perform quality checks on the mobile data used to make the inferences/roadway hazard assessments in Stage III



Stage I

Mobile data ingesters

Output data handler

Stage II

Ancillary data ingesters

QCh Module

Statistics module

Output data handler

Stage III

Inference Module

Output data handler

VDT 3.0

Parsed mobile data

Qched data, Basic road segment data

Advanced road segment data

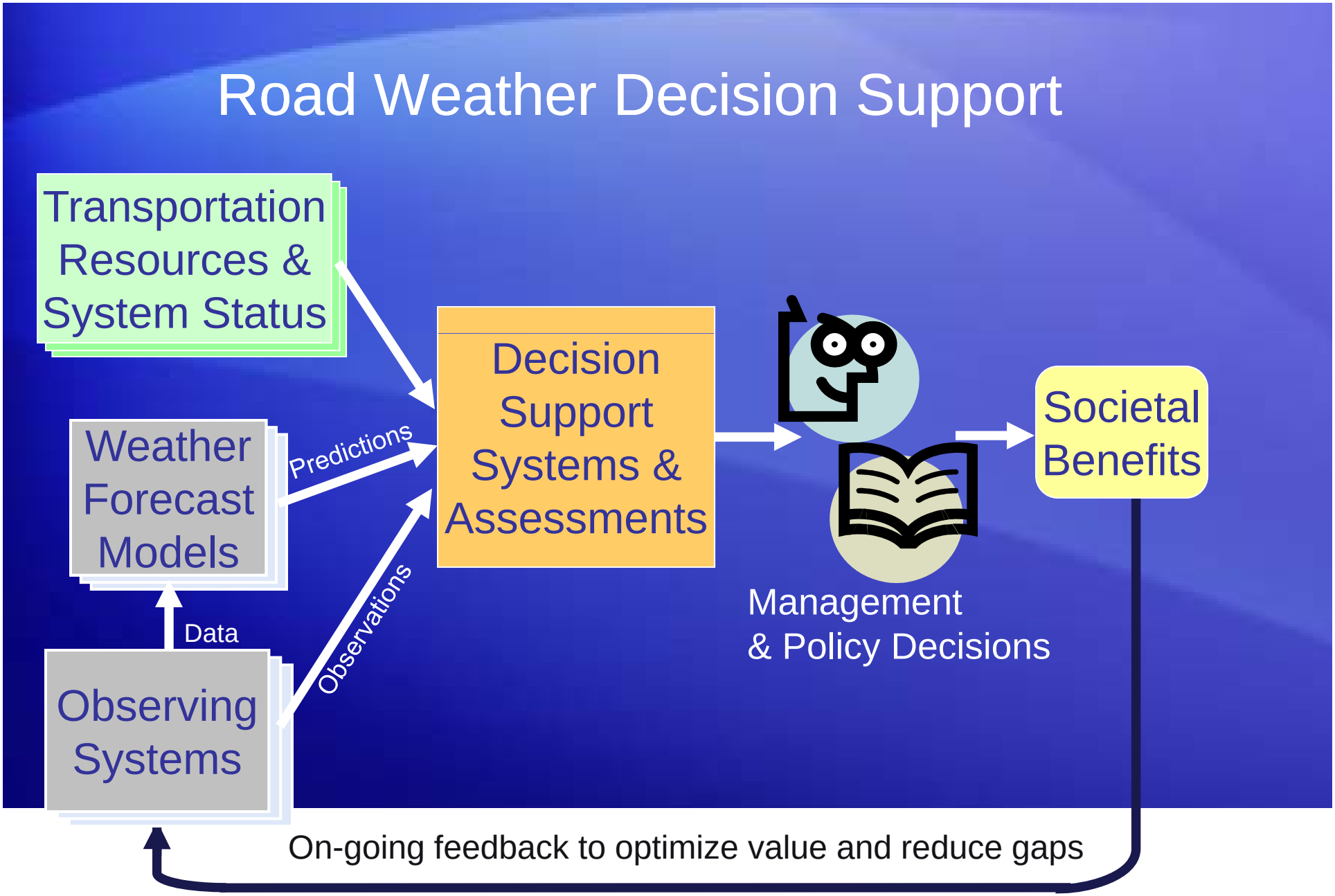
Apps

VDT Objectives

- ✓ Develop the Connected Vehicles' role in "Anytime, Anywhere Road Weather Information"
- ✓ Exploit any and all vehicle-based data
  - ✓ OEM sensors (e.g., air temp, wiper status, braking status)
  - ✓ After market sensors (e.g., pavement temp, plow status)
- ✓ Combine data from vehicles with fixed sources (*Clarus*)
- ✓ Output basic and inferred segment-based weather & road conditions to support all weather-related applications

Composite image simulates the road warning system being tested by NCAR.

Solutions to helping save lives, time & money



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FHWA Road Weather Management
www.ops.fhwa.dot.gov/weather