IntelliDrive[SM] End-to-End Road Weather Management Project

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Foreword:

This document describes the intention of the Road Weather Management and IntelliDrive[SM] Programs to conduct a study that makes use of mobile observations and dynamic decision support tools (such as *Clarus,* MDSS, vehicle probes, etc) in an effort to provide a safer and more efficient transportation network under all weather conditions.

Background:

IntelliDrive[SM] is a multimodal initiative to enable wireless communications among vehicles, the infrastructure, and passengers' personal communications devices. IntelliDrive[SM] will enhance Americans' safety, mobility and quality of life, while helping to reduce the environmental impact of surface transportation.[1]

The IntelliDrive[SM] vision includes collection of vehicular and environmental status data by millions of passenger and commercial vehicles. The data will be transmitted to other vehicles and to the infrastructure to be used for IntelliDrive[SM] safety, mobility, and environmental applications. Environmental data will include weather and road condition data such as ambient air temperature and pressure, road surface temperature, and road friction coefficient. Some vehicle status data will also be related to weather and road conditions, such as windshield wiper status, antilock brake system (ABS) status, and electronic stability control status.

Given the wide array of sensors contributing data to this effort, it is recognized that rigorous data formatting and communication protocols will need to be adhered to. The SAE J2735 standard has been designed for transmitting weather and road condition observations and other information in "heartbeat" and probe messages with minimal transmission delay (low latency) using Dedicated Short Range Communications (DSRC). In situations other than safety applications where low latency is required, the J2735 standard may still be used with other wireless communications methods such as 3G/4G cellular communications or radio frequency data channel. The IntelliDrive[SM] program includes transmission of data from vehicles to the infrastructure using any of these wireless communication technologies.

Three series of tests with instrumented vehicles have been conducted at the IntelliDrive[SM] Michigan Testbed (IMT) outside Detroit, Michigan: the 2008 Proof of Concept trials and winter weather tests conducted by the National Center for Atmospheric Research (NCAR) in 2009 and 2010. The latter two set of trials placed a heavy emphasis on the collection of weather measurements. These trials have

[1] http://www.intellidriveusa.org/about/overview.php

been successful at demonstrating one component of IntelliDrive, data transmission from Onboard Equipment (OBE) to Roadside Equipment (RSE) using DSRC messages and the J2735 standard.

NCAR is using data collected in these tests to develop and refine algorithms for its Vehicle Data Translator (VDT) utility. The VDT collects data from mobile sources, tests for data quality, and aggregates multiple observations that are close to each other in time and location into a set of observations to act as data from a "pseudo" weather station representing that road segment or area.

Objectives

The FHWA Road Weather Management Program desires to demonstrate how weather, road condition, and related vehicle data may be collected, transmitted, processed, and used for decision making as part of the IntelliDrive[SM] program. Using wireless communications technology and the existing fleet infrastructure of the participating State Departments of Transportation (DOTs), the project will help determine standards and procedures to accomplish the objectives of such demonstration.

The objectives of this project are to:

1. Derive both data and communications requirements for weather, road condition, and vehicle status variables from mobile platforms, in this case using State DOT vehicles as the source,
2. Enhance and expand post-processing algorithms to turn the data into useful observations that are tied to existing mesonets, and
3. Explore the use of these observations in weather-related decision support systems.

Other factors to incorporate into this project include:

- Testing the suitability and completeness of the J2735 standard for transmission of these data.
- Evaluating the role that the NTCIP 1204 standard plays in the transmission of weather and road condition observations to collectors.
- Algorithms will be developed within the context of the Vehicle Data Translator (VDT) and the observations will be linked to the *Clarus* system.
- The weather-related decision support systems will be evaluated to assess whether the application and the operational decisions it leads to are enhanced by the incorporation of the mobile data collected.

Ultimately, decision-makers will have the benefit of decision support tools that have access to data provided by millions of vehicles through the IntelliDrive[SM] program. Weather-enabled decision support tools will support the goals of performance measurement of the roadway system. This project will help pave the way toward that ultimate goal by prototyping the process of integrating weather, road condition, and vehicle status data messages into existing programs.

The following list captures some of those programs, including those sponsored by State DOTs and the USDOT, as well as others provided by commercial firms:

- *Clarus* System for road weather data collection, quality checks and dissemination
- *Clarus* Regional Demonstrations for forecasting and decision support tools using road weather data
- Maintenance Decision Support System (MDSS) for winter maintenance decision support using road weather forecast data
- Maintenance Management Systems (MMS) for tracking availability and utilization of maintenance assets
- IntelliDrive[SM] Data Capture and Management program for collecting, quality-checking, and archiving mobile data
- Other IntelliDrive[SM] applications, yet to be determined. These applications will likely receive data through the IntelliDrive[SM] Data Capture and Management component.

Step 1 Data Acquisition

The participating State DOT(s) will collect and transmit weather and road condition data using their existing fleet and data management infrastructure. Such data will originate from both the Controller Area Network Bus (CANBUS) and any supplemental controllers that support maintenance and operations. It will be transmitted as IntelliDrive[SM] messages, i.e., following the prescribed standards, back to State DOT facilities and from there to the National Center for Atmospheric Research (NCAR), and to the *Clarus* servers, and possibly to an IntelliDrive[SM] Data Capture data environment. The step will be undertaken by one or more State DOTs, with assistance from USDOT FHWA. The step consists of the following four sub-steps.

1.1 Collect weather, road condition, location, and vehicle status observations on instrumented fleet vehicles. The following variables are just a few of the data elements recommended for inclusion, since the sensors and procedures for collecting them have already been successfully tested:

a. Windshield wiper status
b. ABS status
c. Electronic stability control status
d. Atmospheric temperature
e. Dewpoint temperature
f. Barometric pressure
g. Road surface temperature
h. Location, direction, and speed using Automatic Vehicle Location (AVL) and Global Position System (GPS) systems
i. Plow, spreader, and materials status

The vehicle status observations leading the list above will be available from the vehicle's onboard diagnostics (OBD2) unit, and may be used to infer precipitation status and weather-related road

surface conditions. The weather and road condition observations may come from sensors that are external to the OBD2 unit.

1.2 On each vehicle, assemble the weather, road condition, location, and vehicle system status data in the form of a J2735 data probe message as defined in the most recent SAE J2735 standard. As of this writing, the current version is the 2nd Edition (Version 36), published in October 2009.

1.3 For the duration of the project, transmit the data in J2735 messages at regular intervals, possibly through a contractor to the participating State DOT(s) using wireless data communication technology currently possessed by the State DOT(s). This may be 3G or 4G cellular transmission or radio frequency data transmissions (800 MHz data channel) or other wireless data communication technology. From the DOT, transmit the data to *Clarus* and NCAR, and possibly to an IntelliDrive℠ Data Capture data environment via the internet. NCAR and Mixon/Hill Inc. will be charged with coordinating with the Step 1 participants regarding the types of variables to be transmitted, the required metadata, and the method and format of transmitting the data over the internet.

Step 1 Responsible Party or Parties

The responsible party or parties for Step 1 execution will be one or more State DOTs or multi-state consortia. Participating State DOT(s) should have the following characteristics:

- A fleet of vehicles equipped for wireless communication
- The capability to collect weather and road condition data and related vehicle data from the vehicle fleet, or the ability to add that capability quickly
- The capability to receive and read (i.e., in an open, non-proprietary format) weather, road condition and vehicle data from fleet vehicles in near-real time (less than five minutes) for use in applications
- One or more weather-related applications, such as the Maintenance Decision Support System (MDSS), that make significant use of weather and road condition data (see Step 5)

In addition to State DOTS, multi-state consortia such as Clear Roads, Aurora, AASHTO IntelliDrive, and the MDSS Pooled Fund Study (PFS) may be participants in this project. For example, the Clear Roads pooled fund consortium is currently finalizing the Concept of Operations and Specifications for mobile data platforms on DOT vehicles.

The demonstration vehicle jointly owned by FHWA and Noblis already has some of this instrumentation and may be used as an additional data collection source and FHWA project demonstration capability in the Washington DC area. The vehicle was one of the FHWA-sponsored vehicles in the "Mobile Sensing Platforms for Meteorological Observations" test in 2005 and 2006. This vehicle may also be used as a

test bed to prototype the installation and integration of weather related sensors, and to demonstrate access to vehicle OEM equipment data via OBD2.

Step 2 Data Synthesis

This step is to be performed by the National Center for Atmospheric Research (NCAR); it involves the processes of receiving the data collected by the State DOT vehicles, performing initial quality checks, and consolidating multiple mobile measurements into link-based measurements. The primary tool for accomplishing these processes is the Vehicle Data Translator (VDT) prototype, developed by NCAR. This step consists of four sub-steps:

2.1 Develop the next version of the VDT prototype, designed to accept J2735 messages from State DOT vehicles; process the pavement, weather, location, and vehicle status data and metadata contained in the messages; and produce (be able to report) road weather measurements in near real time. It is anticipated that multiple sensor measurements within a short time span on the same link will be combined to generate a set of road weather observations treated as if they came from a weather station at a single point along the link. Mobile observations may be combined with other traditional observations.

2.2 Establish the communications capability and identify interfaces between data management and processing points to receive the data in near real time (less than five minutes) from State DOTs to NCAR or another location where the VDT is hosted. This sub-step complements sub-step 1.3 for the State DOT participants. If more than one State DOT is collecting data, the procedures for transmitting the data into the VDT and the method of processing the data may be the same or may be different for the different states.

2.3 Define open source algorithms within the VDT prototype to improve the accuracy of the data and then develop them. Develop a test plan and targets for algorithm improvements. Document each of the algorithms in terms of data needs, procedures, and confidence intervals.

2.4 Operate the VDT to perform the steps listed in sub-steps 2.1 through 2.3 during execution of the project.

Step 2 Responsible Party and Participants

NCAR will be the party responsible for the execution of Step 2. However, the states and/or consortia participating in Step 1 must coordinate data transmission from their collection systems to NCAR. However, if at least one Step 1 participant sends data to the VDT, another participant may send the data directly to the *Clarus* system.

Step 3 Processing by the *Clarus* System

This step is to be accomplished by the host of the *Clarus* System (Mixon/Hill Inc.) FHWA has sponsored the design and construction of the *Clarus* System to collect, process, and disseminate road weather data. Thirty-six states and three Canadian provinces participate in the *Clarus* System by submitting data on a regular basis. Although *Clarus* functional requirements specify the ability to receive and process data from mobile sensors, this project will provide the first data derived from mobile sensors to be entered into *Clarus*. Two sources of mobile data are anticipated:

1. Processed data from the VDT, which characterizes conditions along road segments of varying length.
2. Measurements directly from State DOT vehicles, tagged with the time and location where the measurements were taken by a mobile sensor.

This step consists of four sub-steps. The sub-steps are to be applied for both sources of mobile road weather information mentioned above. Each step includes identifying interfaces between data management and processing points.

3.1 Ensure that the *Clarus* System is ready to receive data and associated metadata derived from mobile sources, and establish the methods for designating the locations from which mobile data are received. For data processed by the VDT, new station identifiers will be used to indicate the data locations (perhaps as a set of pseudo-stations). For data coming directly from DOTs, each set of observations may come from a different location, so the location must be part of the observation metadata.

3.2 Develop procedures for disseminating data and quality checked results derived from mobile sources. Currently data dissemination options are based on a list of fixed station locations. *Clarus* data dissemination must accommodate both types of data described above.

3.3 Establish the capability for receiving weather and road condition data derived by the VDT into the *Clarus* System, and from one or more State DOTs into the *Clarus* System. This sub-step complements sub-step 1.3 for the State DOT participants. If more than one Step 1 participant is collecting data, the data from one may be sent directly to the *Clarus* System, and the data from the other may pass through the VDT before being sent to the *Clarus* System.

3.4 As *Clarus* System functionality is being integrated into the National Weather Service (NWS) Meteorological Assimilation Data Ingest System (MADIS), this step will include working with the MADIS operators to support collection, processing, and storage of mobile weather and road condition data by MADIS.

Step 3 Responsible Party

The primary responsibility for Step 3 will lie with Mixon/Hill Inc. (MHI). MHI currently holds the FHWA contract for operating and improving the *Clarus* system.

Step 4 Plan Integration into IntelliDrive[SM] applications

The State DOT(s) or consortia selected for this demonstration will develop a concept of operations and work plan for collecting and transmitting IntelliDrive-enabled weather, road condition, and vehicle status data to one or more applications, and describe how the data is going to enhance the performance of such applications and DOT operations. For the application selected by the participants, there are three sub-steps as follows. Implementation and operation of the plans and requirements developed in Step 4 will take place in Step 5.

4.1 Write the concept of operations and high-level requirements for enhancing the application to ingest road weather data derived from mobile sources and to use the data to enhance or improve the output of the application. The concept of operations will describe how the application will benefit from using the IntelliDrive-enabled weather and road condition observations, and how the output of the application enhances performance measures inherent to the activity supported by the application.

4.2 Write the concept of operations and requirements to incorporate quality checked, IntelliDrive-enabled weather and road condition observations from the mobile data platform(s) into the application in near real time.

4.3 Describe how State DOT operations (e.g., traffic management, maintenance management, construction planning, traveler information) will be improved by the enhanced output of the application, and establish quantifiable performance measures.

Possible candidate applications include

1. *Clarus* Regional Demonstration Use Cases 2 through 5.
    a. The Seasonal Weight Restriction Decision Support Tool (Use Case Two) analyzes the sub-pavement conditions, given near real-time *Clarus* ESS observations, historical weather and historical pavement conditions, to provide estimates of road segment locations and time periods where vehicle weight restrictions are necessary. Montana, North Dakota, and South Dakota DOTs are participating in this regional demonstration.
    b. Non-Winter Maintenance and Operations Decision Support Tool (Use Case Three) expands decision support beyond snow and ice control. It focuses on how *Clarus* data can be used year-round to assist in decision making for road maintenance scheduling

decisions. Illinois, Indiana, and Iowa DOTs are participating in this regional demonstration.

c. Multi-State Control Strategy Tool (Use Case Four) takes a highway control action, once it has been performed, and facilitates the transmission of this information to a common repository or data warehouse where the information from all jurisdictions can be stored and made available for posting to appropriate channels of information dissemination. Illinois, Indiana, and Iowa DOTs are participating in this regional demonstration.
d. Enhanced Road Weather Content for Traveler Advisories (Use Case Five) provides improved content related to enhanced road weather advisories to traveler information systems. Minnesota, Idaho, Montana, North Dakota, and South Dakota DOTs are participating in this regional demonstration.

Each of these Use Cases uses enhanced forecasts from Use Case 1 and a similar approach is expected within this project. Meridian is currently implementing Use Cases 2 and 5; Mixon/Hill is currently implementing Use Cases 3 and 4. Appendix A provides more information on these projects.

2. Maintenance Decision Support System (MDSS). MDSS derives road condition forecasts from atmospheric weather forecasts and current road condition observations, and recommends amounts and schedules for road treatments. NCAR currently maintains the MDSS Federal Prototype, and commercial versions of MDSS are owned and operated by multiple providers.
3. Maintenance Management Systems (MMS). These are management systems used by State DOTs to track the availability and use of labor and material assets. Some have been developed by the DOTs themselves, while others are provided by commercial companies. Several MMS currently in use include wireless communications from State DOT-operated maintenance vehicles. MMS are often used to generate performance measures for road maintenance.
4. Other IntelliDrive^{SM} applications. Various applications are being developed as part of the IntelliDrive^{SM} Dynamic Mobility Applications program, in close coordination with the IntelliDrive^{SM} Data Capture and Management program. These applications provide data that support Safety and Environmental applications. The IntelliDrive^{SM} Data Capture and Management program may archive mobile weather data, since the *Clarus* System does not archive data beyond one week.

Step 4 Responsible Party (ies) and Participants

The state DOTs or consortia that are participating in Step 1 are responsible for producing the concept of operation and work plans described above. The weather, road condition, and vehicle status data collected by the Step 1 participants will be fed into the decision support tools or other weather-sensitive programs operated by those participants. NCAR and MHI will also participate with respect to describing the data to be transmitted and developing data transmission plans.

Step 5 Implementation and Operation

Some, or all, of the application enhancement plans submitted under Step 4 will be selected for implementation. This step entails implementing the concept of operations and work plan for transmitting IntelliDrive-enabled road weather data to one or more IntelliDrive[SM] applications. For each application there are three sub-steps as follows:

5.1 Enhance the application to ingest quality checked weather and road condition observations derived from mobile sources and use the data to enhance or improve the output of the application.

5.2 During the project, transmit quality checked, IntelliDrive-enabled weather, road condition, and vehicle status observations from the *Clarus* System to the application.

5.3 During the project, demonstrate that the application is using the IntelliDrive-enabled observations, resulting in quantified benefits as measured by the performance measures defined in sub-step 4.3.

Step 5 Responsible Party(ies) and Participants

The party(ies) responsible to see that the Step 5 objectives are accomplished will be the state DOTs or consortia that are participating in Steps 1 and 4. The quality checked weather, road condition, and vehicle status observations collected by the Step 1 participants will be fed into the decision support tools or other weather-sensitive programs operated by those participants. Consequently, NCAR and MHI will also participate with regard to processing and consolidating the data.

Summary

Transmission of data from vehicles via wireless communications is one component of IntelliDrive[SM] that is currently available on vehicles operated by several State DOTs. The proposed project will show how weather, road condition, and vehicle system status data collected on mobile platforms can be transmitted via wireless technology using the J2735 standard. Using J2735, NTCIP 1204, or other applicable standards, the road weather data can then flow through the Vehicle Data Translator and the *Clarus* System to decision-support tools that address the IntelliDrive[SM] goals of increasing safety and mobility, while reducing environmental impact. As an option, the data may also be transmitted to an IntelliDrive[SM] Data Capture data environment for storage and additional dissemination.

The following table summarizes the five steps.

Step #	Step Title	Responsible Party	Deliverables
Step 1	Data Acquisition	Selected State DOTs or multi-state consortia, e.g. Clear Roads, Aurora, AASHTO IntelliDrive, or MDSS Pooled Fund Study	• Design and implementation plan for collecting weather, road condition, and vehicle status data on fleet vehicles(sub-step 1.1) • Design and implementation plan for transmitting the collected data to the DOT using the J2735 standard, and transmitting data from the DOT to VDT and/or the *Clarus* System. (sub-step 1.2) • Demonstration of the capabilities planned in the previous two deliverables (prior to sub-step 1.3)
Step 2	Data Synthesis	National Center for Atmospheric Research (NCAR)	• Design plan for VDT Version 3.0 to process weather, road condition, and vehicle status data (sub-step 2.1) • Implementation plan for transmitting weather, road condition, and vehicle status data from one or more DOTs into VDT (sub-step 2.2) • Definitions of open source algorithms to be developed for processing ingested weather, road condition, and vehicle status data (sub-step 2.3) • Documentation and code for completed data processing algorithms (sub-step 2.3) • Monthly status reports describing progress toward building VDT Version 3.0 (sub-steps 2.1 – 2.3) and operating it (sub-step 2.4)

Step #	Step Title	Responsible Party	Deliverables
Step 3	Processing by the *Clarus* System	Mixon/Hill Inc. (MHI)	• Design and implementation plan for ingesting, processing, and disseminating data from mobile sources in the *Clarus* System (sub-steps 3.1 and 3.2) • Design and implementation plan for transmission of data from mobile sources into the *Clarus* System from the VDT and from one or more state DOTs (sub-step 3.3) • Monthly status reports describing progress toward fulfilling sub-steps 3.1 – 3.3 • Demonstration of the capabilities planned for sub-steps 3.1 – 3.3
Step 4	Plan Integration into IntelliDrive[SM] Applications	Same as Step 1	For each application that uses weather and road condition observations: • Concept of Operations for using mobile weather data in the application (sub-steps 4.1 and 4.2) • System Requirements for ingesting mobile data into the application and enhancing the application to use the data (sub-steps 4.1 and 4.2) • Plan and schedule for implementing the enhanced capabilities • Plan for evaluating the benefit achieved through the addition of mobile data, including quantifiable performance measures (sub-step 4.3)
Step 5	Implementation and Operation	Same as Step 1	For each participant and for each application that uses weather and road condition observations:

Step #	Step Title	Responsible Party	Deliverables
			• Lessons learned with respect to data collection on the vehicles • Lessons learned with respect to transmission of the data to the DOT, using wireless technologies and ITS standards • Lessons learned with respect to ingesting the mobile data into the application • Results of the evaluation to assess the extent to which the addition of mobile data to the application provided benefits to the participant (sub-step 5.3)

Figure 1

The top portion of Figure 1 shows the transmission of data in J2735 probe messages to a State DOT via currently available wireless systems (Step 1). The central part shows the transmission to the VDT and processing by the VDT (Step 2). The next section shows the transmission of the data from the VDT and directly from State DOTs to the *Clarus* System and ingestion of the data by *Clarus* (Step 3). The bottom portion of Figure 1 shows that the project feeds road weather data through *Clarus* to one or more IntelliDrive[SM] applications or decision support tools used by State DOT operations and maintenance personnel and Traffic Management Centers. The road weather data variables used by MDSS, MMS, and the *Clarus* System and regional demonstration are well established. The road weather variables used by other IntelliDrive[SM] applications are not well established. Some use of weather and road condition observations by IntelliDrive[SM] applications may be prototyped by this project.

Schedule

Each of Steps 1-3 has two parts. The first part is the preparation and establishment of a capability. The second part is the execution of the capabilities during the operation of the project test. The first part of each step may run concurrently since each step does not depend extensively on the others. The second part of the step requires all the steps to function simultaneously. Step 4 consists entirely of planning, and may be done concurrently with the development portions of Steps 1-3. After the completion of Step 4, FHWA may assess the results to determine which application(s) to pursue in Step 5.

It would be preferable to run the project during times when adverse weather (e.g. precipitation, wet pavement, or icy pavement) is anticipated in the participating states.

Appendix A – Description of *Clarus* Regional Demonstration Use Cases

- *Clarus* is intended to facilitate and improve the value of road weather information that is provided by both the public and private weather enterprise to the breadth of transportation users and operators. *Clarus* and participation by US State and Canadian Province transportation departments creates robust data assimilation, quality checking, and data dissemination system that can provide near real-time atmospheric and pavement observations from the collective public Departments of Transportation's investments in Road Weather Information Systems (RWIS), Environmental Sensor Stations (ESS) and participating DOT vehicles (via cellular communications).

- Regional Demo, Use Case #1 – Enhanced Road Weather Forecasting Enabled by *Clarus*: Throughout the duration of the *Clarus* Initiative, the FHWA Road Weather Management Program has been demonstrating that the investments made in deploying Environmental Sensor Stations (ESS) go beyond just site-specific winter maintenance operations. *Clarus* seeks to remove restrictive network borders, making quality checked, near real-time observation data available to all transportation agencies and promote the use of data (mobile and point observation data) as input to enhanced road weather forecasting service providers and the greater weather enterprise. In this scenario, *Clarus*-based data has been enhancing (atmospheric and pavement) forecasting for surface transportation. Enhanced surface transportation forecasting can come from many different types of services. This first scenario provides a foundation for working on any of the remaining scenarios, as well as improving road weather forecasting capabilities within the weather enterprise.
    - Enhanced forecasts support more accurate MDSS input
    - Enhanced forecasts support Decision-making support tools for both State DOT operations and Operations at Traffic Management Centers.

- Regional Demo Use Case #2 – Seasonal Weight Restriction Decision Support Tool: Based upon the Alaska/Canada Team concept of operation, this tool describes a decision support tool that analyzes the sub-pavement conditions given near real-time *Clarus* ESS observations, historical weather and historical pavement conditions (and other elements as necessary) to provide estimates of road segment locations and time periods where vehicle weight restrictions are necessary. Observations from the *Clarus* System (e.g., air temperature, pavement temperature, subsurface temperature, etc.) are used as input, along with other available observations, into a data analysis, meteorological and pavement modeling decision support tool to support transportation agency control strategies during critical freeze/thaw periods. The resulting output will be recommendations to transportation agency personnel (and by extension commercial vehicle operators) on where and when seasonal weight restrictions may be imposed. As a road weather control strategy, this Seasonal Weight Restriction Tool will be based on agency rules of practice and user needs.
    - Enhanced forecasts support Decision-making support tools for both State DOT operations and Operations at Traffic Management Centers.

  Montana, North Dakota, and South Dakota DOTs are participating in this regional demonstration.

- Regional Demo Use Case #3 – Non-Winter Maintenance and Operations Decision Support Tool: Based primarily on the concepts of operation from the Alaska/Canada Team and the Aurora Team, this tool is intended to take a broader look at expanding decision support activities, beyond snow and ice control. Specifically, this scenario focuses on how *Clarus* data can be used to assist in decision making for road maintenance scheduling decisions, especially those activities that affect

traffic flow and mobility (e.g., lane closures for striping or pothole filling), and construction-related scheduling decisions such as for pavement applications, curing, and inspections.

- This tool leverages the work that has already been performed in the creation of the winter Maintenance Decision Support System (MDSS). Transportation agency members can assess their needs, and document their rules of practice so that operationally based recommendations can be generated by the tool and presented to the agency. These recommendations provide assistance in step planning and scheduling for year-round maintenance and construction operations. This decision support system uses *Clarus* data along with other weather, route and local information as input into weather and pavement condition forecasts. These forecasts are fed into customized algorithms that provide scheduling recommendations for operational transportation agency personnel. The analyzed weather data is based on the weather-related practices established for the activity. (i.e., airTemp > 70) The planner can display available times to perform the activity. notify users when observations are outside the weather-related practice range, and give decision makers three options: reschedule activity, cancel activity, or keep original schedule.
- Activity planning information support decision-making efforts for both State DOT operations and Operations at Traffic Management Centers.

Illinois, Indiana, and Iowa DOTs are participating in this regional demonstration.

- Regional Demo Use Case #4 – Multi-State Control Strategy Tool: Based on the concepts of operation of the Northwest Passage Team and the Aurora Team, this tool takes a highway control action, once it has been performed, and facilitates the transmission of this information to a common repository or data warehouse where the information from all jurisdictions can be stored and made available for posting to appropriate channels of information dissemination. Interested parties could include transportation agencies, law enforcement agencies, fleet managers, information service providers, travelers, and traveler-related interests.
  - Closing a road along a transportation corridor at or just beyond the border in the next state or province can result in significant impacts on transportation agencies along with potential hardships on travelers. One effect might be congestion, as long lines of vehicles wait for roads to re-open at a state border. In extreme cases, travelers may need lodging or in extreme cases even require the National Guard to be mobilized to deliver blankets or food to stranded travelers. Having information in advance or at the time controls are imposed provides an effective means of informing the public of travel delays, detours or closures, as well as improve agency coordination across jurisdictional borders.
  - The use of control strategies (e.g., lane/road/bridge closures, contraflow operations, detours, etc.) is a well-documented process for transportation agencies when road conditions deteriorate during adverse weather. However, there is the need for improved coordination within states as well as with adjacent states with respect to the imposition of controls and dissemination of associated advisories. These actions can result in significant travel impacts as traffic stalls in areas that are not well prepared to handle the influx of stranded motorists. The development of a timely process to communicate changes in road status would permit officials in adjacent areas the opportunity to take proactive steps to mitigate the impact on travelers. Such actions include rerouting travelers prior to a blockage in areas that have better infrastructure to handle lodging, fueling and dining.
  - This tool is a data management system that combines (but is not limited to) *Clarus* data (mobile and point observations) and road condition data for input into a decision support

tool to support agency (DOT operations and Operations at Traffic Management Centers) control strategies within and across multiple states or provinces.

Illinois, Indiana, and Iowa DOTs are participating in this regional demonstration.

- Regional Demo Use Case #5 – Enhanced Road Weather Content for Traveler Advisories: In this scenario, improved content related to enhanced road weather advisories is provided for traveler information systems such as dynamic message signs (DMS), highway advisory radio (HAR) broadcasts, 511 telephone services, related websites or "push" technologies (e.g., text messages, personal digital assistants [PDAs], really simply syndication [RSS] alerts, e-mail messages, etc.). This scenario enhances the pooling of informational resources already in use and improves their accessibility and content by each State's service provider for improved data, advisory and forecast delivery over the width of a corridor. This includes interstate, route-specific weather forecast information, road condition data, and the ability to provide actual atmospheric and pavement conditions and advisories enabled through use of the *Clarus* System.
    - This tool is a service that provides transportation agencies and/or private sector partners with accurate and concise information about pavement and weather conditions for use in disseminating traveler information - A new visualization display to show the value of *Clarus* data in real time, integrated with other relevant data as a tool for both transportation agencies and travelers.
    - Content for Traveler Advisories support Decision-making support tools for both State DOT operations and Operations at Traffic Management Centers.

  Montana, Minnesota, Idaho, North Dakota, and South Dakota DOTs are participating in this regional demonstration.