North/West Passage Clarus
Multi-state Regional Demonstration

prepared for
North/West Passage Clarus Initiative

prepared by
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This document contains the scenario descriptions that will be included in the Clarus Concept of Operations document. The Concept of Operations report will include a background section (setting the stage for the Clarus Multi-state Regional Demonstration), Clarus vision and goals, stakeholders, and user needs, as well as discussion of technical and institutional issues. All this information will be included in the later versions of this report. This draft document has been prepared only for discussions of the Use Case Scenarios and will be refined more fully as development and discussion of the Use Cases unfold.

Section 1 of this document briefly describes the scenarios developed for Clarus. Section 2 describes in detail the North/West Passage Clarus Regional Demonstration use case scenarios. In all the scenarios the Clarus functionality is described at a high concept level.

**Representative Clarus Operational Scenarios**

The North/West Passage Clarus Regional Demonstration must satisfy the operational requirements within multiple user communities (maintenance, construction, emergency management, traveler information, commercial services, general public, etc.). The operational requirements are driven by the types of information and services each of these user communities utilize to support their operational decision-making or that they provide to their constituents. Thus, different user communities view how Clarus System data is best utilized from different perspective and assess requirements from slightly different perspectives. The utilization of Clarus System data is primarily a low-level function performed by the weather service provider and surface transportation weather service provider communities. The remainder of the stakeholders who utilize Clarus System data do so through these two provider communities. An exception to this will be interested parties within the state transportation agencies who have the responsibility for operating and maintaining environmental sensor data (ESS) for their particular agency or state. These entities will utilize the quality checking information provided by the Clarus System to support the maintenance of system data integrity. In some limited situations, direct access of Clarus System data by other user stakeholders will occur, but these are viewed as being limited in extent and are only briefly captured in the North/West Passage Clarus Regional Demonstration Concept of Operations.

The technique chosen to evaluate the commonalities and the unique requirements of the various user communities are Use Case and Sequence diagrams of operational scenarios for each of the selected operational scenarios being considered by the North/West Passage Clarus Regional Demonstration. Since different scenarios contain substantial redundancy, the discussion presents the common framework of the scenario and then highlights the unique features of specific stakeholders in separate discussions.

Each specific scenario is described in narrative text from an operations perspective and contains one or more specific actors that are generalized at the framework level. Use Case and Sequence diagrams are based on the UML standard. The Use Case Diagrams are used to describe the outwardly visible operations of a system and in this Concept of Operations they define the system boundary. The Use Case Diagrams in this section have four primary elements: actors, use cases, associations and depedencies.

- Actors, represented by the stick figures, represent any external operator or system interfacing with a use case, system or package.
• Use cases, represented by ovals, describe the things the actors want the system to do, such as querying the ESS in order to retrieve data from an ESS Data Collector.

• The lines connecting actors with use cases are associations. Associations indicate that there is some sort of interaction between the actor and the use case. The Use Case Diagrams are based on the narrative text of the scenario.

• The dashed lines, which are attached to an open triangle symbol, depict dependency relationships. Dependencies are relationships whereby the two use cases are joined through a mutual use of data or services.

Use Case Diagrams reflect scenarios from each actor’s point of view. Even though the symbol for the actor is a stick figure, an actor can represent a person, agency, or system. The sequence diagram portrays a typical sequence of operation between the actors and the systems found within the scenario. The sequence diagram contains vertical dashed lines with a label at the top representing the same actors and systems (packages) from the use case diagram for that scenario. Time begins at the top of the sequence diagram and goes down to the bottom of the diagram.

Use case and sequence diagrams are part of an iterative process and should be continued in more detail past the Concept of Operations phase of the North/West Passage Clarus Regional Demonstration Concept of Operations development. The representative use case and sequence diagrams in this document have been developed at a level of detail sufficient for broad stakeholder review and do not contain the rigorous detail that would be found in a system design/system develop.
Section 1. Summaries of Scenarios

The Use Case Scenarios presented address specific user needs identified during the stakeholder assessment of this project. Although the focus of this project is meant to emphasize how Clarus System data can be used to improved road weather utilization, the scenarios attempt to define advancements in various aspects of the transportation system and transportation system utilization through improved application of weather data and information within a roadway environment. This latter effort is the basis for the Clarus Initiative, which is to utilize Clarus System data to lead to improved mobility, safety and reliability during periods of challenging road weather conditions.

**Scenario A – Interstate Advisory and Control Strategy Coordination and Communications Function**

The scenario for the interstate advisory and control strategy coordination and communications function explores the utilization of a centralized data warehouse of active and anticipated advisory and control across the North/West Passage to improve interstate transportation efficiencies. The vision of use case scenario is that implementation of advisory and control road weather management strategies will be aided through enhanced monitoring and prediction of road and road weather conditions afforded by use of Clarus System data. The availability of interstate advisory and control strategies are expected to improve coordination of travel and winter maintenance planning activities near state borders.

**Scenario B – Integrated Corridor-Wide 511 System Information Function**

The scenario for the integrated corridor-wide 511 system information function explores the processes required to extend the availability of 511 and other advanced traveler information system data along multi-state highway corridors. Consolidation of traveler information for the eight North/West Passage states will provide seamless pre- and en-route planning actions and will move the Nation closer to the goal of achieving a seamless accessibility of 511 information. The presence of weather as a major component for all present and pending 511 systems from Wisconsin to Washington, including the Interstate 90 and Interstate 94 corridors, emphasizes the importance of reliable current and forecast weather and road condition information. The Clarus Initiative provides a catalyst for moving forward to address the significant technical challenges associated with constructing an integrated 511 system spanning all North/West Passage states.

**Scenario C – Regional Road Condition/Road Weather Reporting and Forecasting System Function**

The scenario for the regional road condition / road weather reporting and forecasting system function explores the implementation of a database and distribution system whereby road condition information presently collected in individual states is aggregated and made more broadly available to stakeholders across the entire North/West Passage region and beyond. The road condition information includes the full range of information that affects highway travel including incidents, construction, and pavement / driving conditions. An extension of the typical road condition reporting system is also being made to facilitate the incorporation of predictive components of the pavement / driving conditions. This is a logical extension as the construction events already include a projection forward in time and, as such, have established the precedence of including projected information within the road condition reporting system.
database. The users of this system are a broad collection including state transportation decision makers, the traveling public, commercial vehicle operators, state patrol, and emergency managers.

**Scenario D – Automated Alert and Notification System Function**

The scenario for the automated alert and notification system function explores the use of the concept of information push technologies to provide surface transportation weather stakeholders with information in a proactive manner. The growth in information technologies in the past decade have resulted in more of an ‘any time – any where’ process of providing information that is readily incorporated into the road weather ITS setting. The automated alert generation involves responding to individuals when predesignated thresholds for conditions have been exceeding that exist within either a temporal or spatial boundary of interest to the given stakeholder. The identification of these thresholds and the individuals/agencies/organizations who receive the information is performed through a subscription-based model whereby the consumer of the information must take the lead effort in registering for the alert notification and providing the appropriate threshold settings and methods of desired notification. The automated notification method follows the preferred method whether this is electronic notification via such methods as cellular text messages or Internet email or perhaps through a voice message to a designated telephone number. The stakeholders for this function span the state transportation operations and decision makers to the traveling public and commercial vehicle operators. For example, a winter maintenance operator might receive an automatic notification when predefined pavement conditions for a specific maintenance route are projected to result in a level of service less than desired and a commercial vehicle operator might receive a notification for the same location when it is a defined route where he/she is planning to travel.
Section 2. Clarus Scenarios

Scenario A – Interstate Advisory and Control Strategy Coordination and Communication Function

Representative Scenario Description

Sam and Sarah Smith had just spent the last eight hours inside the gymnasium at the Tri-State Wrestling tournament where their son, Tony, had participated. The weather was beautiful when they entered the gymnasium earlier that Saturday morning. But as they stepped out, storm clouds had already begun to gather in advance of a major winter storm moving northeastward from eastern Colorado. They knew it was going to be a long trip from Alexandria (MN) back to Pierre (SD). As they stopped to fill up with gasoline and get a quick late afternoon meal, there was a National Weather Service special weather announcement on the diner’s television noting that a winter storm watch had just been issued from Nebraska northward through much of South Dakota. Concerned about the possible difficulties returning home, the discussion over their meal was nervous and full of questions as to the best route home.

The 5:00 p.m. shift change at the South Dakota Statewide Traffic Operations Center (TOC) had just finished and Walter Jones was deep in thought as he scanned the large wall displays providing situational information on the unfolding winter storm now moving into central and eastern South Dakota. Already snow was falling at several inches per hour making for limited visibility and difficult driving conditions in many parts of the eastern third of the state, and the road weather forecast for the remainder of the evening was depicting considerable heavy snow continuing mainly through the northeastern portion of the state. Reports were already coming in from law enforcement officials in Day and Roberts Counties that I-29 was nearly impassable and no travel was advised. Elsewhere across the state, roads were in good to moderate winter driving condition, but Walter’s concern was just how long it would be before more routes would become difficult and resulting in the need for road closures. After a short briefing with the rest of the TOC staff, Walter began his hourly update of the North/West Passage Interstate Advisory and Control Communication (IACC) database to inform adjacent states of the active advisory and control road weather management strategies across the state.

As the Smith family pulled back onto I-94 heading west from Alexandria towards Fargo (ND), light snow was beginning to fall and their travel plan apprehensions continued to grow. Normally, they would follow I-94 to Fargo, then turn south on I-29 towards South Dakota. It was nearing 7:30 p.m. as they approached within 30 minutes of Fargo and they knew they must make a decision soon. Meanwhile, Walter Jones had just updated the IACC database with the latest information that I-29 northbound from Watertown in northeastern South Dakota had been closed due to heavy snow. Susan Wieble, shift manager at the North Dakota Statewide Traffic Operations Center, acknowledged the notice of the new controls placed on I-29 by South Dakota Department of Transportation almost instantly. Susan knew immediately that the procedure was to notify the North Dakota DOT Maintenance Office in Fargo and to post the information on the Dynamic Message Signs along I-94 and I-29 that travel southbound into South Dakota was not possible due to heavy snow. Thus, when the Smiths reached Fargo and noticed that southbound on I-29 into South Dakota was closed, they knew they had to alter their travel plans. With the late hour and the long distance yet to go, they collectively decided to stop in Fargo for the evening and continue their journey when the weather improved.
Technical Description

During stakeholder meetings situations cited by state department of transportation operations personnel described closing a road in a neighboring state that resulted in significant impacts on the transportation actions in their state, such as long lines of vehicles waiting for roads to re-open or travelers needing lodging. Having information in advance or at the time of imposing these controls would provide an effective means of both informing the public of travel delays or a need for detours, as well as improve the maintenance coordination across state borders.

The uses of advisory and control road weather management strategies are a routine process for state departments of transportation (DOT) when road conditions deteriorate during hazardous winter weather. However, the imposition of advisories and controls often is not well communicated with adjacent states, which can result in travel impacts as traffic stalls in areas that are not well prepared to handle the influx of stranded motorists. The development of a process to communicate in a timely manner the changes in road status would permit officials in adjacent states the opportunity to take proactive mitigation steps to reduce the impact on travelers.

Often, the precursor weather events leading to eventual advisory and/or control actions can be discerned from close monitoring of observed weather conditions in adjacent states. This becomes one of the first steps in raising awareness of potential road condition problems in an adjacent state. This brings to bear the value of Clurus System environmental sensor (ESS) data, as it is a mechanism that will permit individuals in any state the opportunity to monitor pavement and weather conditions in nearby states. The availability becomes one of the first activities in the awareness of road weather management strategies in surrounding states. The extension of the ESS data, through a combination with other weather observations, provides the DOT decision makers with added information on trends in expected road weather conditions and becomes an asset in the decision-making process. Using field observations from reliable field sources, such as state patrol and/or maintenance personnel, adds to the ESS data to provide a picture of current and expected road conditions.

The responsibility for establishing advisories and controls will vary by agency policies and procedures and is not expected to be the same for all North/West Passage states. In some situations, state patrol will have a significant voice in the process where other situations the responsibility will exist more with maintenance and/or traffic management staff. However, once an advisory or control action has been performed, it is necessary to transmit this information to a common repository or data warehouse where the information from all states can be stored and made available for posting to appropriate channels of information dissemination to appropriate interested stakeholders, including state agencies, travelers, and traveler-related interests.

A major challenge in the exchange of information will be establishing common protocols and formats for information transmittal and storage. The communications coordinator will have oversight for the collection of individual state advisory and control information will required to populate the multi-state advisory and control actions database.

The information that follows provides a step-by-step flow of activities and depicts a general scenario for how an advisory and control coordination and communication system function would occur. Figure 1 provides a Use Case Scenario diagram associating the individuals, agencies, and organizations (actors) that perform the actions (use cases) leading to outputs to the end users (actors). A listing of all the actors and use cases, including a brief technical description found within the Use Case Scenario diagram, follows Figure 1. Figure 2 depicts the Use Case Scenario in a time sequence of use cases from the collection of ESS data to the final delivery of end-user products and services. Following this figure is a
description of activities and requirements associated with this sequence of use cases. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity (actor) responsible for each is noted on the line before each set of bullets.

Figure 1. Use Case Diagram based upon the functionality defined for the Advisory/Control Coordination and Communications Function.

**Interstate Advisory / Control Coordination Actors:**

Interstate Advisory / Control Coordination

*Type:* public **Actor**  
*Package:* Interstate Advisory/Control Communications

The Interstate Advisory / Control Coordination actor performs the communications and coordination of the collection, compilation, and distribution of road weather management advisory and control strategies.
Clarus System Operator

**Type:** public Actor  
**Package:** Clarus System

The Clarus System Operator actor manages the collection, integration and dissemination of all data within the Clarus System.

Commercial Vehicle Operations

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Commercial Vehicle Operations actor provides the capability for commercial drivers and fleet managers to receive weather information and to monitor the safety and security of their commercial vehicle drivers and fleet.

ESS Data Collector

**Type:** public Actor  
**Package:** General North/West Passage Actors

The ESS Data Collector actor collects ESS measurement data from the ESS Equipment actor.

ESS Equipment

**Type:** public Actor  
**Package:** General North/West Passage Actors

The ESS Equipment actor represents the Environmental Sensor Stations collecting environmental data.

Maintenance Operator

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Maintenance Operator actor monitors and manages roadway infrastructure winter maintenance activities. Representing both public agencies and private contractors that provide these functions, this actor manages fleets of winter maintenance, or special service vehicles (e.g., snow and ice control equipment). The actor receives a wide range of status information from these vehicles and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment. This actor manages equipment at the roadside, including environmental sensors and automated systems that monitor and mitigate adverse road and surface weather conditions. This actor manages the repair and maintenance of both non-ITS and ITS equipment including the traffic controllers, detectors, dynamic message signs, signals, and other equipment associated with the roadway infrastructure. Additional interfaces to weather information providers (the weather service and surface transportation weather service providers) provide current and forecast weather information that can be fused with other data sources and used to support advanced decision support systems that increase the efficiency and effectiveness of winter maintenance operations.
Media

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Media actor represents a major consumer of road weather information for the support of a broad array of stakeholders ranging from travelers to the general public.

Recreation Facility Operators

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Recreation actor uses the facilities of the outdoors, such as those provided by state or national parks. This actor uses data from traveler information systems to enhance its safety in a vulnerable outdoor environment.

State Patrol

**Type:** public Actor  
**Package:** General North/West Passage Actors

The State Patrol actor is responsible for overseeing and enforcing traffic safety compliance on roads and highways. This actor will often be the first responder to incidents that may be affected by significant weather impacts. This actor will monitor and report damage to or poor conditions of roads.

Surface Transportation Weather Service Provider

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Surface Transportation Weather Service Provider actor receives data from the Clarus System and provides value-added weather and surface transportation data integration and interpretation to the Weather Information User Community.

TOC / TMC Operator

**Type:** public Actor  
**Package:** General North/West Passage Actors

The TOC/TMC Operator actor monitors and controls traffic and the road network. It represents centers that manage a broad range of transportation facilities including freeway systems, rural and suburban highway systems, and urban and suburban traffic control systems. This actor monitors and manages traffic flow and monitors the condition of the roadway, surrounding environmental conditions, and field equipment status.
Travelers

Type: public Actor
Package: General North/West Passage Actors

The Travelers actor collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The actor can play several different roles in an integrated ITS. In one role, the Traveler actor provides a general data warehousing function, collecting information from transportation system operators and redistributing this information to other system operators in the region and other ISPs. In this information redistribution role, the Traveler actor provides a bridge between the various transportation systems that produce the information and the other ISPs and their subscribers that use the information. In a second role, a Traveler actor is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories including weather, traffic and road/route conditions, transit schedule information, yellow pages information, ride matching information, and parking information. In a third role, the Traveler actor may be dedicated to, or even embedded within, the dispatch system.

Traveler Support Services

Type: public Actor
Package: General North/West Passage Actors

The Traveler Support Services actor provides a bridge between the various transportation support systems that provide assistance to travelers, both general travelers and commercial vehicle operators through the provision of lodging and traveler services. The Traveler Support Services actor often delivers traveler information to customers and often provides assistance during inclement weather and driving conditions.

Weather Observing Equipment

Type: public Actor
Package: General North/West Passage Actors

The Weather Observing Equipment actor represents environmental sensing equipment that provides weather observation data from stations not included in the Clarus System.

Weather Service Provider

Type: public Actor
Package: General North/West Passage Actors

The Weather Service Provider actor provides data to the Clarus System based on its weather observation equipment. The Weather Service Provider integrates, transforms and interprets general weather data including data from the Clarus System for dissemination to the Weather Information User Community.
**Interstate Advisory / Control Coordination Use Cases:**

**Collect Regional Advisory Information**

*Type:* public UseCase  
*Package:* Interstate Advisory/Control Communications

The Collect Regional Advisory Information use case performs the actions associated with assimilating road weather management advisory strategies implemented by North/West Passage states. The collection of information incorporates the use of appropriate ITS and affiliated communications protocols.

**Collect Regional Control Information**

*Type:* public UseCase  
*Package:* Interstate Advisory/Control Communications

The Collect Regional Control Information use case performs the actions associated with assimilating road weather management control strategies implemented by North/West Passage states. The collection of information incorporates the use of appropriate ITS and affiliated communications protocols.

**Distribute Advisory & Control Information**

*Type:* public UseCase  
*Package:* Interstate Advisory/Control Communications

The Distribute Advisory and Control Information use case is the action to promote the utilization of regional advisory and control information by state decision makers and a range of stakeholders outside of state organizations who use the information to promote greater safety, mobility and productivity. The information is an aggregation of the advisory and control road weather management strategy information generated by the North/West Passage states. The compilation of regional advisory information is maintained in a relational database.

**ESS Data Collection**

*Type:* public UseCase  
*Package:* Clarus System

The ESS Data Collection use case is part of the Clarus System Framework. This use case is responsible for transferring the collected ESS data from the ESS Data Collector actor to the Clarus System Operator.

**ESS Data Serving**

*Type:* public UseCase  
*Package:* Clarus System

The ESS Data Serving use case is part of the Clarus System Framework. This use case is responsible for transferring the processed ESS data, quality control flags, and pertinent metadata to the Weather Service Provider, Surface Transportation Weather Service, the state transportation decision maker actors, and
potentially other interested stakeholders. The Clarus operator has the capability to specify critical ESS information processing priorities for the Clarus System.

**ESS Quality Checking**

*Type:* public **UseCase**  
*Package:* Clarus System

The ESS Quality Checking use case is part of the Clarus System Framework. This use case is responsible for checking and flagging the collected ESS data. The Clarus quality control process will check for observed values that exhibit out-of-tolerance limits and other data characteristics that require flagging and will set quality exception flags where necessary. The process will notify the ESS Data Collector actor of observed values that consistently report quality exception flags.

The ESS Quality Checking use case will rely upon current ESS metadata provided by the ESS Data Collector actor that include configuration and operational status information.

**Acquire External Weather Data**

*Type:* public **UseCase**  
*Package:* General North/West Passage Use Cases

The Acquire External Weather Data use case is external to the Clarus System Framework. This use case is responsible for collecting the external weather data from the Weather Observing Equipment actor, which includes products and services generated by NOAA, Environment Canada, and various weather data service providers. These may include numerical weather depiction guidance, forecasts, and public or private environmental sensor data from sensors not directly connected to Clarus. The use case delivers the information to the Weather Service Provider actor and the Surface Transportation Weather Service Provider actor.

**Observer Current Road Conditions**

*Type:* public **UseCase**  
*Package:* General North/West Passage Use Cases

The Observer Current Road Conditions use case performs the actions to acquire current road condition system information. This information includes incident, construction, and weather-related pavement conditions.

**Perform Advisory Actions**

*Type:* public **UseCase**  
*Package:* General North/West Passage Use Cases

The Perform Advisory Actions use case conducts the actions necessary to determine and apply road weather management advisory strategies.
Perform Control Actions

Type: public UseCase
Package: General North/West Passage Use Cases

The Perform Control Actions use case conducts the actions necessary to determine and apply road weather management advisory strategies.

Provide ESS Measurement

Type: public UseCase
Package: General North/West Passage Use Cases

The Provide ESS Measurement use case covers the process wherein the ESS Equipment actor facilitates the observation of road and weather conditions from environmental sensor stations.

Provide Surface Transportation Weather Analysis & Forecast

Type: public UseCase
Package: General North/West Passage Use Cases

The Provide Surface Transportation Weather Analysis and Forecast use case covers the process wherein the Surface Transportation Weather Service Provider actor integrates weather information from the Acquire External Weather Data, ESS Data Serving, and Regional Road Condition Reporting System use cases, generates analyses and forecasts of both weather and pavement conditions, and disseminates the information to the Weather Information Consumer Community. The Weather Information Consumer Community actors include state decision makers who incorporate the resulting weather information to support their decision-making processes.

Provide Traveler Information

Type: public UseCase
Package: General North/West Passage Use Cases

The Provide Traveler Information use case conducts the needed actions to distribute traveler information to a wide array of stakeholders. The primary instantiation of this action is through the use of 511 ATIS methods and the use of the World Wide Web.

This use case includes state decision makers who incorporate the resulting weather information to support their decision-making processes.

Provide Weather Analysis & Forecast

Type: public UseCase
Package: General North/West Passage Use Cases

The Provide Weather Analysis and Forecast use case covers the process wherein the Weather Service Provider actor integrates weather information from the Acquire External Weather Data and ESS Data Serving use cases, generates analyses and forecasts of weather and disseminates the information to the
Weather Information Consumer Community. The Weather Information Consumer Community actor includes state decision makers who incorporate the resulting weather information to support their decision-making processes.

Figure 2. Sequence diagram for the Integrated Advisory / Control Communications and Coordination Function

ESS MEASUREMENT – TRANSPORTATION AGENCY

- Weather and pavement values measured in field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field ESS as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION – TRANSPORTATION AGENCY

- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

CONSOLIDATION - CLARUS

- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date and time and location reference
QUALITY ASSURANCE CHECK - CLARUS
• External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
• Quality assurance check is run on the time and location sorted data
• Observations deviating from expected value by a specified amount are flagged as potential errors
• Clarus stores the error flags with the data
• Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS
• Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER
• The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
• The Service Providers acquire forecast guidance products to complement the observed data
• Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
• The observed and forecasted data are composed into weather forecast products
• The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER (WEATHER AND SURFACE TRANSPORTATION WEATHER)
• Meteorological data are run through a pavement condition model that transforms the weather forecast components into projection of pavement temperatures and road conditions
• Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
• Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

ADVISORY GENERATION – STATE AGENCY (TRAFFIC MANAGER, STATE PATROL, MAINTENANCE OPERATOR)
• Assess service provider weather forecast data to determine extent and persistence of current road weather conditions
• Updates road condition reports to provide latest available status of pavement conditions
• Monitors current road conditions and trends in forecast road conditions to develop awareness of potential need for road advisory generation
• Generates appropriate advisory messages as needed following standard practices

CONTROL GENERATION - STATE AGENCY (TRAFFIC MANAGER, STATE PATROL, MAINTENANCE OPERATOR)
• Assess service provider weather forecast data to determine extent and persistence of current road weather conditions
• Updates road condition reports to provide latest available status of pavement conditions
• Monitors current road conditions and trends in forecast road conditions to develop awareness of potential need for road control generation
• Generates appropriate control actions, messages, and dissemination as needed following standard practices
ADVISORY / STRATEGY COORDINATION – STATE AGENCY or SERVICE PROVIDER

• Assimilate advisory action messages from participating state agencies
• Assimilate control action messages from participating state agencies
• Index messages within a database for ease of retrieval
• Maintain coordination with all states to maintain timeliness and reliability of submitted data

ADVISORY / STRATEGY COMMUNICATION – STATE AGENCY or SERVICE PROVIDER

• Facilitate access to advisory / control database
• Maintain communications protocols and network accessibility to data
• Service external queries and provide user support assistance as needed
• Provide routine communications with state entities to maintain operational lines of communications

TRAVEL INFORMATION – STATE AGENCY or SERVICE PROVIDER

• Access latest advisory / control information
• Fuse advisory / control information with routine traveler information message content
**Scenario B – Integrated Corridor-Wide 511 System Information Function**

**Representative Scenario Description**

Two days after Christmas, Michael Roberts, a 39-year-old resident of Madison, WI gets ready to set upon a new life adventure. After three years of law school, he has accepted what he believes to be his dream job in Seattle, WA with a national law firm. Accepting the position, he agreed to be in place and ready to begin work by January 10\textsuperscript{th}. With his pregnant wife, two children, two vehicles and one trailer, Michael embarks upon his most important trip, a new life for his family 1927 miles across the country, in the middle of the winter across the Great Northern Plains and Rocky Mountains.

Michael, a former Air Force fighter pilot, understands the importance of flight planning and approached his trip with the same search for intelligence on the best travel route. In planning the trip, Michael remembered a debate in law school. The issue was liability of state government and among the many issues that surfaced was one referencing a telephone traveler information system known as 511. The discussions focused on the detail and reliability of information for the traveler, particularly if the state sources were the best available. He recalled that the class investigation of the system highlighted actual current road and weather conditions from sensors across the region.

This sensor information, verified and quality-checked for use from a system known as Clarus, was then incorporated in current condition reports as well as integrated into high resolution weather and road condition models. These models were then analyzed by trained meteorologists to produce a highway travel-planning tool with a level of dependability that had never been seen or experienced before. Michael remembered that this information was included in what had become known as an “All Hazards” report for all state routes within a number of states. These “All Hazards” report integrated this quality-checked information of current conditions, forecasted conditions, accidents, closures, construction, and any number of events that are key to travel planning. With this knowledge, Michael plans his route and prepares a secondary route as a backup plan.

Michael and Lori, with their children, Ken (8) and Julie (4), pack the cars and trailer at 8 o’clock Tuesday morning, and focus on their plan. The plan called for specific checks of highway conditions along the route and alternate choices should conditions become restrictive across the primary route. Michael calls 511 to determine the current and forecasted conditions at the first two key points along the first leg of the trip: the I-90/I-94 junction in Wisconsin, forecasted weather and road conditions for I-90 across South Dakota, and I-94 across North Dakota. With a storm moving out of Colorado into Nebraska and South Dakota that could close highway systems, Michael and Lori decide to take I-94 across North Dakota with the goal of making it to Fargo, ND about the time the storm is moving across I-94 in Minnesota. The next morning, the plan calls for checking I-94 and US Highway 2 across North Dakota and Montana. A storm front moving across the southern border of North Dakota and Montana closed I-94 along the state line, leaving the couple with concerns on when the questionable road conditions along I-94 will be cleared. Choosing their alternate route, Michael and Lori decide to drive north to US Highway 2 to enter Montana and continue west.

By Friday morning, Michael and Lori prepare to leave Havre, MT, checking US 89 to I-15 and I-90 into Idaho. The planned routes now provide for I-15 to I-90 across Idaho, or continue on US Highway 2 to I-90 into Washington. With clear road conditions reported across both routes, Michael and Lori decided to take the southern route on US 89 to I-15 and I-90 to avoid US Highway 2 through the mountains with a trailer, arriving in Spokane, WA Friday night. Their trip is almost complete, with only one more day until
their new life begins. Starting their trip on Saturday morning, the only remaining points of interest along the route include pass conditions across the State of Washington and if they will have stop along the way. Both current and forecasted conditions are clear and the future is in sight...

Technical Description

Present 511 systems have limited capabilities to access information across borders and are limited to the exchange of information with adjacent states. Providing mechanisms to permit the data warehousing of traveler information, including current/forecast road conditions and weather conditions would provide a framework enhancing traveler decision support along full highway corridors spanning multiple states.

To enable 511 to become a ubiquitous source for traveler information the barriers to information should not be at state borders. This function has a focus to provide accessibility to 511 content beyond a caller’s present state location and even beyond that of an adjacent state. Long-distance travelers can be faced with route planning challenges during inclement weather where a decision to proceed can be based upon knowing not the present road and weather conditions but those anticipated at the time of arrival. The challenges in supporting this longer-range information capability go beyond physical challenges of predicting the future. They include overcoming 511 system data/information standardization and communications protocols. Presently, systems are largely limited to accessibility to information for their present state in which they are calling. If the 511 system has the capability of spanning across a state border it is often due to the same 511 service provider supporting both states. North/West Passage has made some initial strides in overcoming this barrier through development efforts to link the 511 system in Minnesota to that found in North Dakota and South Dakota. However, no present system does there exist a capability to extend 511 service coverage along an entire Interstate or US Highway reaching beyond two states. As such this ‘reach’ limitation places restrictions on a more optimal usage of 511 for long distance travel planning.

In this function, the vision is to provide a mechanism to facilitate the accessibility of 511 information for any Interstate or US Highway across the eight-state North/West Passage Pooled Fund Transportation Study. The essence of the activity is to pool information resources in use by each state for access by each state’s 511 service provider for delivery over the width of the corridor.

As weather and road conditions form the basis for 511 services in the North/West Passage states, the use case follows the premise that quality road weather and road condition information is a priority that will be enhanced by the greater accessibility to all ESS observations within the North/West Passage domain. Hence, the early aspects of the use case scenario has a functionality that is consistent with that found within present and pending 511 services for the eight North/West Passage states.

The information that follows provides a step-by-step flow of activities and depicts a general scenario for how an integrated corridor-wide 511 information system function would occur. Figure 3 provides a Use Case Scenario diagram associating the individuals, agencies, and organizations (actors) who perform the actions (use cases) leading to outputs to the end users (actors). A listing of all the actors and use cases including a brief technical description found within the Use Case Scenario diagram follows Figure 3. Figure 4 depicts the Use Case Scenario in a time sequence of use cases from the collection of ESS data to the final delivery of end-user products and services. Following this figure is a description of activities and requirements associated with this sequence of use cases. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity (actor) responsible for each is noted on the line before each set of bullets.
Integrated Corridor-Wide 511 Information System Actors

Integrated 511 System Operator

Type: public Actor

Package: Integrated Corridor-Wide 511

The Integrated 511 System Operator actor collects, processes, stores, and disseminates transportation information to system operators and the traveling public. Information provided includes weather information, basic advisories, traffic and road/route conditions, transit schedule information, yellow pages information, ridematching information, and parking information. The Integrated 511 System Operator can utilize both basic one-way (broadcast) and personalized two-way information communication. The entity provides the capability for an informational infrastructure to connect providers and consumers across the Interstate and National Highway System North/West Passage region.
Clarus System Operator

**Type:** public Actor  
**Package:** Clarus System

The Clarus System Operator actor manages the collection, integration and dissemination of all data within the Clarus System.

Commercial Vehicle Operations

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Commercial Vehicle Operations actor provides the capability for commercial drivers and fleet managers to receive weather information and to monitor the safety and security of their commercial vehicle drivers and fleet.

ESS Data Collector

**Type:** public Actor  
**Package:** General North/West Passage Actors

The ESS Data Collector actor collects ESS measurement data from the ESS Equipment actor.

ESS Equipment

**Type:** public Actor  
**Package:** General North/West Passage Actors

The ESS Equipment actor represents the Environmental Sensor Stations collecting environmental data.

Maintenance Operator

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Maintenance Operator actor monitors and manages roadway infrastructure winter maintenance activities. Representing both public agencies and private contractors that provide these functions, this actor manages fleets of winter maintenance, or special service vehicles (e.g., snow and ice control equipment). The actor receives a wide range of status information from these vehicles and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment. This actor manages equipment at the roadside, including environmental sensors and automated systems that monitor and mitigate adverse road and surface weather conditions. This actor manages the repair and maintenance of both non-ITS and ITS equipment including the traffic controllers, detectors, dynamic message signs, signals, and other equipment associated with the roadway infrastructure. Additional interfaces to weather information providers (the weather service and surface transportation weather service providers) provide current and forecast weather information that can be fused with other data sources and used to support advanced decision support systems that increase the efficiency and effectiveness of winter maintenance operations.
State Patrol

*Type:* public Actor  
*Package:* General North/West Passage Actors

The State Patrol actor is responsible for overseeing and enforcing traffic safety compliance on roads and highways. This actor will often be the first responder to incidents that may be affected by significant weather impacts. This actor will monitor and report damage to or poor conditions of roads.

Surface Transportation Weather Service Provider

*Type:* public Actor  
*Package:* General North/West Passage Actors

The Surface Transportation Weather Service Provider actor receives data from the Clarus System and provides value-added weather and surface transportation data integration and interpretation to the Weather Information User Community.

TOC / TMC Operator

*Type:* public Actor  
*Package:* General North/West Passage Actors

The TOC/TMC Operator actor monitors and controls traffic and the road network. It represents centers that manage a broad range of transportation facilities including freeway systems, rural and suburban highway systems, and urban and suburban traffic control systems. This actor monitors and manages traffic flow and monitors the condition of the roadway, surrounding environmental conditions, and field equipment status.

The Traveler Support Services

*Type:* public Actor  
*Package:* General North/West Passage Actors

The Traveler Support Services actor provides a bridge between the various transportation support systems that provide assistance to travelers, both general travelers and commercial vehicle operators through the provision of lodging and traveler services. The Traveler Support Services actor often delivers traveler information to customers and often provides assistance during inclement weather and driving conditions.

Travelers

*Type:* public Actor  
*Package:* General North/West Passage Actors

The Travelers actor collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The actor can play several different roles in an integrated ITS. In one role, the Traveler actor provides a general data warehousing function, collecting information from
transportation system operators and redistributing this information to other system operators in the region and other ISPs. In this information redistribution role, the Traveler actor provides a bridge between the various transportation systems that produce the information and the other ISPs and their subscribers that use the information. In a second role, a Traveler actor is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories including weather, traffic and road/route conditions, transit schedule information, yellow pages information, ridematching information, and parking information. In a third role, the Traveler actor may be dedicated to, or even embedded within, the dispatch system.

Weather Observing Equipment

**Type:** public Actor

**Package:** General North/West Passage Actors

The Weather Observing Equipment actor represents environmental sensing equipment that provides weather observation data from stations not included in the Clarus System.

Weather Service Provider

**Type:** public Actor

**Package:** General North/West Passage Actors

The Weather Service Provider actor provides data to the Clarus System based on its weather observation equipment. The Weather Service Provider integrates, transforms and interprets general weather data including data from the Clarus System for dissemination to the Weather Information User Community.

**Integrated Corridor-Wide 511 Information System Use Cases**

Collect Regional Road Conditions

**Type:** public UseCase

**Package:** Integrated Corridor-Wide 511

The Collect Regional Road Conditions use case performs the actions to acquire and store the data from statewide road conditions reporting systems supported in the corridor-wide 511 system.

Collect Route-Specific Road Weather Conditions

**Type:** public UseCase

**Package:** Integrated Corridor-Wide 511

The Collect Route-Specific Road Weather Conditions use case performs the actions to assimilate current and future road conditions from state agency resources including those obtained by the state agencies through the surface transportation weather services providers. This use case stores the data collected in a database providing capabilities for querying by the 511 system distribution.

Distribute Traveler Information

**Type:** public UseCase
Package: Integrated Corridor-Wide 511

The Distribute Traveler Information use case provides the external accessibility to 511 information services. This interface is generally supported through a combination of computer telephony and web-based delivery methods.

Support Regional Road Condition Reporting System

Type: public UseCase
Package: Integrated Corridor-Wide 511

The Support Regional Road Condition Reporting System use case performs the functions supporting the querying and updating of the regional road condition database by state decision makers and the stakeholders who assimilate the information into their information dissemination efforts i.e. 511.

ESS Data Collection

Type: public UseCase
Package: Clarus System

The ESS Data Collection use case is part of the Clarus System Framework. This use case is responsible for transferring the collected ESS data from the ESS Data Collector actor to the Clarus System Operator.

ESS Data Serving

Type: public UseCase
Package: Clarus System

The ESS Data Serving use case is part of the Clarus System Framework. This use case is responsible for transferring the processed ESS data, quality control flags, and pertinent metadata to the Weather Service Provider, Surface Transportation Weather Service, the state transportation decision maker actors, and potentially other interested stakeholders. The Clarus operator has the capability to specify critical ESS information processing priorities for the Clarus System.

ESS Quality Checking

Type: public UseCase
Package: Clarus System

The ESS Quality Checking use case is part of the Clarus System Framework. This use case is responsible for checking and flagging the collected ESS data. The Clarus quality control process will check for observed values that exhibit out-of-tolerance limits and other data characteristics that require flagging and will set quality exception flags where necessary. The process will notify the ESS Data Collector actor of observed values that consistently report quality exception flags.

The ESS Quality Checking use case will rely upon current ESS metadata provided by the ESS Data Collector actor that include configuration and operational status information.
Acquire External Weather Data

Type: \textit{public UseCase}
Package: General North/West Passage Use Cases

The Acquire External Weather Data use case is external to the Clarus System Framework. This use case is responsible for collecting the external weather data from the Weather Observing Equipment actor that includes products and services generated by NOAA, Environment Canada, and various weather data service providers. These may include numerical weather depiction guidance, forecasts, and public or private environmental sensor data from sensors not directly connected to Clarus. The use case delivers the information to the Weather Service Provider actor and the Surface Transportation Weather Service Provider actor.

Provide ESS Measurement

Type: \textit{public UseCase}
Package: General North/West Passage Use Cases

The Provide ESS Measurement use case covers the process wherein the ESS Equipment actor facilitates the observation of road and weather conditions from environmental sensor stations.

Provide Surface Transportation Weather Analysis & Forecast

Type: \textit{public UseCase}
Package: General North/West Passage Use Cases

The Provide Surface Transportation Weather Analysis and Forecast use case covers the process wherein the Surface Transportation Weather Service Provider actor integrates weather information from the Acquire External Weather Data, ESS Data Serving, and Regional Road Condition Reporting System use cases, generates analyses and forecasts of both weather and pavement conditions, and disseminates the information to the Weather Information Consumer Community. The Weather Information Consumer Community actors include state decision makers who incorporate the resulting weather information to support their decision-making processes.

Provide Weather Analysis & Forecast

Type: \textit{public UseCase}
Package: General North/West Passage Use Cases

The Provide Weather Analysis and Forecast use case covers the process wherein the Weather Service Provider actor integrates weather information from the Acquire External Weather Data and ESS Data Serving use cases, generates analyses and forecasts of weather and disseminates the information to the Weather Information Consumer Community. The Weather Information Consumer Community actors include state decision makers who incorporate the resulting weather information to support their decision-making processes.
ESS MEASUREMENT – TRANSPORTATION AGENCY
- Weather and pavement values measured in field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field ESS as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION – TRANSPORTATION AGENCY
- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

CONSOLIDATION - CLARUS
- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date and time and location reference

QUALITY ASSURANCE CHECK - CLARUS
- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time and location sorted data
- Observations deviating from expected value by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur
DATA TRANSFER - CLARUS
- Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER
- The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
- The Service Providers acquire forecast guidance products to complement the observed data
- Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
- The observed and forecasted data are composed into weather forecast products
- The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER (WEATHER AND SURFACE TRANSPORTATION WEATHER)
- Meteorological data are run through a pavement condition model that transforms the weather forecast components into projection of pavement temperatures and road conditions
- Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
- Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

511 SERVICE PREPARER – STATE AGENCY or SERVICE PROVIDER
- Acquires surface transportation weather service provider forecast for route-specific locations within the state for which the service is being provided
- Updates road condition reports to provide latest available status of pavement conditions
- Updates incident and construction information found within the road condition reporting system to provide the latest available status in 511 message
- Transforms the content of available information into content specific to the information delivery format or the 511 system being used
- At a designated schedule the state’s 511 content is posted to the multi-state integrated 511 database

INTEGRATED MULTI-STATE 511 – STATE AGENCY or SERVICE PROVIDER
- Manages data acquisition from each North/West Passage state
- Transforms each state’s 511 data into common format for database insertion
- Indexing of database to provide access by each state’s 511 service provider
- Provides system management and administration to integrated 511 database
- Maintains open dialog and communications with each state participants 511 coordinator

TRAVEL INFORMATION PROVIDER – STATE AGENCY or SERVICE PROVIDER
- Access integrated 511 database to retrieve required data to satisfy end-user query
- Fuse out-of-state 511 information, where requested by the end user, with traveler information message content from the in-state 511 system
Scenario C – Regional Road Condition/Road Weather Reporting and Forecasting System Function

Representative Scenario Description

In October 2009, Lt. Robert Fischer of the Montana State Highway Patrol was traveling in northwestern Montana along Interstate 90 westbound towards the Idaho state line with a new member of the division, Patrolman John Wilson. Standard department procedure requires a newly assigned patrolman to ride with a veteran during the first six months of evaluation.

Along the way, Robert explains certain duties and responsibilities that they handle in the field that may or may not be specifically taught at the academy. An hour into the shift, the team was advised that Idaho closed I-90 at the border to prevent traffic from entering the state because a blizzard was reducing visibilities down to zero in some places. John asked, “How is that going to affect our shift? Will we head towards the state line now to monitor conditions as vehicles start to backup into the state?” Robert calmly stated, “Well, if this was two years ago, you would be right. Idaho closing I-90 would create a backup of traffic along this interstate to the point where you would think you’re in a mall parking lot. Without a way to share the information and provide advanced warnings, cars and trucks would just keep traveling until they reach the closure point. Holding trucks at the state line and ensuring everyone has water and food when the hotels and motels are full would become our primary responsibility.”

Robert then explained that in 2007 several Departments of Transportation began a research program known as Clarus. One of the many focuses of the program was to integrate road and weather data across state lines. After the states worked together to integrate multi-state road reporting systems, people traveling in Montana, not to mention North Dakota or Minnesota traffic, can now be informed that the border of Idaho and Montana is closed. This information can allow traffic to choose an alternate route or change their travel plans and destinations long before they reach the state line and get stuck with no place to rest.

“Remember that Dynamic Message Sign you saw earlier?” Robert asks. “By now, that sign is warning travelers of the road closure ahead so they can adjust their travel plans. This program established a multi-state road condition reporting system that allows states within a given region to communicate road conditions and status to each other. This information is then shared with a number of traveler information systems, hotels, gas stations, and official services along the route to facilitate services and travel planning. If someone calls 511, sees a Dynamic Message Sign en-route, or visits a road reporting website before starting their trip, the information is provide directly to them so they can change or adjust their plans.”

“The big advantage to us has been that instead of taking on a “babysitting” role during these events, we are now available to continue to do our jobs of serving and protecting the public,” explains Robert. “Now, if someone gets stranded in a storm, we can go assist in that situation instead of being tied up monitoring border conditions.” John then asks, “Well then, since the weather and road conditions have no effect on our patrol, where are we headed to tonight?”

Technical Description

Under the current SAFETEA-LU federal transportation act Section 1201 the ITS Architecture and Standards Rule/Policy requires state and local governments are required to address information needs and data exchange associated with highway information and monitoring. Many of the North/West Passage states have addressed this in their ITS architectures to provide an integrated (statewide) road condition...
reporting system. However, the utility of the information within a statewide road condition reporting system frequently extends beyond the boundaries of a given state and serves as a useful planning and decision-making tool for users from winter maintenance personnel to travelers.

Considering the current efforts toward statewide road condition reporting systems in the North/West Passage states, the technical areas associated with this function involve the collection of content from the participating state agencies, maintaining the content in a relational database that incorporates the varying content among the states, and providing distribution methods for user access of the database. The data collection efforts are largely establishing the communications protocols and access methods to state agency road condition reporting system databases. The extraction of content from the state information flows can be addressed by adhering to ITS data standards when aggregating data from differing road condition reporting systems. Establishing an appropriate database schema that incorporates the desired system content would initially be a composite of present fields within the state databases. However, the addition of predictive fields for pavement and driving conditions will require new categories of information within the regional database where the majority of this information will require the coordination with the surface transportation weather service provider.

The distribution of information will involve database query methods that will be either client-side applications or web-based queries. The client-side applications will be lightweight applications that are platform independent providing the capability of data viewing and input. The input capabilities will be limited by authorization privileges granted to the end-user. The client-side applications may also be configured to provide a large access ‘sweep’ of the database to permit value-added providers access to information for incorporation into further product application requiring the road condition reporting system information. An example of this latter application would be the incorporation of the current regional road condition reporting system information into the Pooled Fund Study Maintenance Decision Support System, which would then use the information to define the current state of the regional road network for pavement condition forecasting and to display the information for maintenance personnel.

The web-based access of the regional road condition reporting system would support a broader, less technical stakeholder base of users. This web access would either be provided as a new web portal for regional road condition information or provided by an individual state agency using their existing web support for traveler information.

The information that follows provides a step-by-step flow of activities and depicts a general scenario for how a regional road condition system function would occur. Figure 5 provides a Use Case Scenario diagram associating the individuals, agencies, and organizations (actors) that perform the actions (use cases) leading to outputs to the end users (actors). A listing of all the actors and use cases including a brief technical description found within the Use Case Scenario diagram follows Figure 5. Figure 6 depicts the Use Case Scenario in a time sequence of use cases from the collection of ESS data to the final delivery of end-user products and services. Following this figure is a description of activities and requirements associated with this sequence of use cases. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity (actor) responsible for each is noted on the line before each set of bullets.
The coordinating agent with the Regional Road Weather and Condition Reporting Function to ensure that the State Road Condition Reporting System Operator actor manages the coordination and communications to facilitate a regional generation and utilization of a regional reporting system.

Regional Road Weather and Condition Reporting System Actors

Regional Road Weather and Road Condition Reporting Operator

Type: *public Actor*

Package: Regional Road Weather and Conditions

The Regional Road Weather and Road Condition Reporting Operator actor represents the coordination and communications to facilitate a regional generation and utilization of a regional reporting system.

State Road Condition Reporting System Operator

Type: *public Actor*

Package: Regional Road Weather and Conditions

The State Road Condition Reporting System Operator actor manages the coordination and communication of road condition information collection and compilation. The actor is also designated as the coordinating agent with the Regional Road Weather and Condition Reporting Function to ensure that
the state's road condition information is made available to the regional system. The actor has oversight for reception of regional road weather and condition reports for use within the state's operations.

Integrated 511 System Operator

**Type:** public Actor  
**Package:** Integrated Corridor-Wide 511

The Integrated 511 System Operator actor collects, processes, stores, and disseminates transportation information to system operators and the traveling public. Information provided includes weather information, basic advisories, traffic and road/route conditions, transit schedule information, yellow pages information, ridematching information, and parking information. The Integrated 511 System Operator can utilize both basic one-way (broadcast) and personalized two-way information communication. The entity provides the capability for an informational infrastructure to connect providers and consumers across the Interstate and National Highway System North/West Passage region.

Clarus System Operator

**Type:** public Actor  
**Package:** Clarus System

The Clarus System Operator actor manages the collection, integration and dissemination of all data within the Clarus System.

ESS Data Collector

**Type:** public Actor  
**Package:** General North/West Passage Actors

The ESS Data Collector actor collects ESS measurement data from the ESS Equipment actor.

ESS Equipment

**Type:** public Actor  
**Package:** General North/West Passage Actors

The ESS Equipment actor represents the Environmental Sensor Stations collecting environmental data.

Maintenance Operator

**Type:** public Actor  
**Package:** General North/West Passage Actors

The Maintenance Operator actor monitors and manages roadway infrastructure winter maintenance activities. Representing both public agencies and private contractors that provide these functions, this actor manages fleets of winter maintenance, or special service vehicles (e.g., snow and ice control equipment). The actor receives a wide range of status information from these vehicles and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment. This actor manages equipment at the roadside, including environmental sensors and automated systems that
monitor and mitigate adverse road and surface weather conditions. This actor manages the repair and maintenance of both non-ITS and ITS equipment including the traffic controllers, detectors, dynamic message signs, signals, and other equipment associated with the roadway infrastructure. Additional interfaces to weather information providers (the weather service and surface transportation weather service providers) provide current and forecast weather information that can be fused with other data sources and used to support advanced decision support systems that increase the efficiency and effectiveness of winter maintenance operations.

**Media**

*Type:* public **Actor**  
*Package:* General North/West Passage Actors

The Media actor represents a major consumer of road weather information for the support of a broad array of stakeholders ranging from travelers to the general public.

**State Patrol**

*Type:* public **Actor**  
*Package:* General North/West Passage Actors

The State Patrol actor is responsible for overseeing and enforcing traffic safety compliance on roads and highways. This actor will often be the first responder to incidents that may be affected by significant weather impacts. This actor will monitor and report damage to or poor conditions of roads.

**Surface Transportation Weather Service Provider**

*Type:* public **Actor**  
*Package:* General North/West Passage Actors

The Surface Transportation Weather Service Provider actor receives data from the Clarus System and provides value-added weather and surface transportation data integration and interpretation to the Weather Information User Community.

**TOC / TMC Operator**

*Type:* public **Actor**  
*Package:* General North/West Passage Actors

The TOC/TMC Operator actor monitors and controls traffic and the road network. It represents centers that manage a broad range of transportation facilities including freeway systems, rural and suburban highway systems, and urban and suburban traffic control systems. This actor monitors and manages traffic flow and monitors the condition of the roadway, surrounding environmental conditions, and field equipment status.
Weather Observing Equipment

*Type:* public **Actor**
*Package:* General North/West Passage Actors

The Weather Observing Equipment actor represents environmental sensing equipment that provides weather observation data from stations not included in the Clarus System.

**Regional Road Condition Reporting System Use Cases**

**Collect Forecasted Regional Road Conditions**

*Type:* public **UseCase**
*Package:* Regional Road Weather and Conditions

The Collect Forecasted Regional Road Conditions use case performs the actions to assimilate the projected future weather-related pavement conditions.

**Collect Regional Road Conditions**

*Type:* public **UseCase**
*Package:* Regional Road Weather and Conditions

The Collect Regional Road Conditions use case performs the required assimilation of road condition data from states in the region.

**Distribute Regional Road Condition Information**

*Type:* public **UseCase**
*Package:* Regional Road Weather and Conditions

The Distribute Regional Road Condition Information use case performs the dissemination of existing and predicted road and weather information to a diverse community of users dealing with transportation-related programs.

**Generate Geospatial Representation of Road Condition Reports**

*Type:* public **UseCase**
*Package:* Regional Road Weather and Conditions

The Generate Geospatial Representation of Road Condition Reports use case conducts the geospatial actions to associate road conditions to site-specific road network locations.
Generate Statewide Road Condition Report

Type: public UseCase
Package: Regional Road Weather and Conditions

The Generate Statewide Road Condition Report use case prepares a summary of all incidents, construction activities and current and/or future road conditions due to changing weather conditions and as altered by road weather management treatment strategies. The statewide nature of the system provides a systemic approach to consolidation of the above road conditions.

Implement a Maintenance Treatment Strategy

Type: public UseCase
Package: Regional Road Weather and Conditions

The Implement a Maintenance Treatment Strategy use case is a process within the Maintenance Personnel actor analyzes the pavement conditions, the forecasted weather conditions, the available resources, and agency policies to perform the best treatment option. This use case is managed by the Maintenance Operator for each agency.

Maintain Road Condition Database

Type: public UseCase
Package: Regional Road Weather and Conditions

The Maintain Road Condition Database use case performs the management activities to store all regional road condition data in a relational database following a schema that corresponds to the various data types defined in the schema.

Observer Current Road Conditions

Type: public UseCase
Package: General North/West Passage Use Cases

The Observer Current Road Conditions use case performs the actions to acquire current road condition system information. This information includes incident, construction, and weather-related pavement conditions.

Utilize Maintenance Decision Support System

Type: public UseCase
Package: Regional Road Weather and Conditions

The Utilize Maintenance Decision Support System use case incorporates a decision-making process designed to utilize current and projected road, weather conditions, resource utilization plans to effect the desired level of service associated with winter maintenance activities. The maintenance decision support system is referred to in general terms as defined and advocated by the AASHTO TIG.
ESS Data Collection

Type: public UseCase
Package: Clarus System

The ESS Data Collection use case is part of the Clarus System Framework. This use case is responsible for transferring the collected ESS data from the ESS Data Collector actor to the Clarus System Operator.

ESS Data Serving

Type: public UseCase
Package: Clarus System

The ESS Data Serving use case is part of the Clarus System Framework. This use case is responsible for transferring the processed ESS data, quality control flags, and pertinent metadata to the Weather Service Provider, Surface Transportation Weather Service, the state transportation decision maker actors, and potentially other interested stakeholders. The Clarus operator has the capability to specify critical ESS information processing priorities for the Clarus System.

ESS Quality Checking

Type: public UseCase
Package: Clarus System

The ESS Quality Checking use case is part of the Clarus System Framework. This use case is responsible for checking and flagging the collected ESS data. The Clarus quality control process will check for observed values that exhibit out-of-tolerance limits and other data characteristics that require flagging and will set quality exception flags where necessary. The process will notify the ESS Data Collector actor of observed values that consistently report quality exception flags.

The ESS Quality Checking use case will rely upon current ESS metadata provided by the ESS Data Collector actor that include configuration and operational status information.
Figure 6. Sequence diagram for the Regional Road Weather and Condition Reporting Function

ESS MEASUREMENT – TRANSPORTATION AGENCY
- Weather and pavement values measured in field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field ESS as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION – TRANSPORTATION AGENCY
- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

CONSOLIDATION - CLARUS
- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date and time and location reference

QUALITY ASSURANCE CHECK - CLARUS
- External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
- Quality assurance check is run on the time and location sorted data
- Observations deviating from expected value by a specified amount are flagged as potential errors
- Clarus stores the error flags with the data
- Clarus sends notification to the data provider when suspect data occur
DATA TRANSFER - CLARUS
• Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER
• The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
• The Service Providers acquire forecast guidance products to complement the observed data
• Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
• The observed and forecasted data are composed into weather forecast products
• The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER (WEATHER AND SURFACE TRANSPORTATION WEATHER)
• Meteorological data are run through a pavement condition model that transforms the weather forecast components into projection of pavement temperatures and road conditions
• Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
• Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

PROVIDE ROAD CONDITIONS – STATE AGENCY (TRAFFIC MANAGER, STATE PATROL, MAINTENANCE OPERATOR)
• Assess service provider weather forecast data to determine extent and persistence of current road weather conditions
• Updates road condition reports to provide latest available status of pavement conditions
• Monitors current road conditions and trends in forecast road conditions to develop awareness of potential need for road advisory generation
• Generates appropriate advisory messages as needed following standard practices

REGIONAL ROAD CONDITIONS - STATE AGENCY or SERVICE PROVIDER
• Collect and store assorted statewide road conditions from participating regional states
• Collect and store assorted statewide route-specific road weather conditions and forecast conditions
• Monitors road condition database for quality and consistency in information
• Generates geospatial representation of road condition information using acceptable geospatial database and display standards
• Provide query methods to mine use required and requested road condition data
• Support database transactions with the regional 511 information system
• Provide road condition information back to statewide road condition systems as requested and/or required to support participating state needs

REGIONAL ROAD CONDITION DISTRIBUTION – STATE AGENCY or SERVICE PROVIDER
• Provide web-based information dissemination methods for data query transactions
• Maintain coordination with all states to maintain timeliness and reliability of submitted data
511 SYSTEM COMMUNICATIONS – STATE AGENCY or SERVICE PROVIDER
- Facilitate access to regional road condition database via 511 communications protocols
- Fuse appropriate road condition information with routine traveler information message content
- Maintain communications protocols and network accessibility to data
- Service external queries and provide user support assistance as needed
- Provide routine communications with state entities to maintain operational lines of communications

BROADCAST ROAD CONDITION INFORMATION – MEDIA
- Access latest regional road condition information
- Provide information on current and projected road conditions to viewers
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Scenario D – Automated Traveler Alert and Notification System Function

Representative Scenario Description

Mike, 46, has lived in Minnesota all of his life. He is all too familiar with the winters across the Northern Great Plains. Since 1995, when he began his regional transport company, his winter weather experience has expanded across to the Rocky Mountains. In the early years of his business, he noticed a marked difference between weather reports from the Weather Channel, the National Weather Service, and the local television stations. Many times Mike would turn to his neighbor, Roger, who works for the state Department of Transportation to see what weather information he acquired through state resources.

In 2009 with the growth of his business across six northern plain states, Roger’s current weather information was not enough to plan ahead to alter routes for delivery. This fact was discussed between them one morning in Mike’s front yard. Roger explained about a new system called Clarus that for a small monthly fee, would provide data not only of weather events across the region at specific locations along given routes, but would quality control the information, and provide current and forecasted weather and road conditions derived from this same information. This information would come directly from state owned weather sensors, and would update on a regular basis. If desired, the system could provide pre-selected automated alerts to e-mail, cell phone, or PDA systems as conditions change. He explained to Mike that if he pre-selected his routes, time of day, and criteria of alerts on a webpage, the system would notify him of the selected changes as they occur or forecasted to occur. Roger explained that key decision makers use both in-state and out of state alerts for key sensors and routes to plan and track specific weather events in an effort to maximize their limited manpower and resources with their primary focus on keeping the roads open.

Mike was excited about this opportunity and signed up, programming the company’s routine routes and some alternate routes they had been forced to use in the past. A week later, Mike was able to inform two trucks traveling across North Dakota into Montana and Wyoming of a storm front and expected changing conditions across Northern Wyoming (I-90) and Southern Montana (I-90/I-94). With the anticipation of delays, Mike was able to send the Wyoming shipment south on US 85 in South Dakota to reach Wyoming, and the Montana shipment north on US 85 to US 2 to complete the delivery to Harve, MT.

Meanwhile in Montana, the same storm front is affecting travel within the state as well. Jackie, a single mother of two, was preparing to travel with the local basketball team, which her son was the star player, to the state basketball championships in Billings, MT. Jackie had learned of the Clarus Automated Alert Notification system through her work at the Montana Department of Transportation in Helena. Knowing how the supervisors across the state received early warnings of events along specific routes coupled with the forecasted weather and road conditions alerts had saved the state over-time and resource costs in planning, she had signed up for the service two days earlier.

With the 12-hour advanced forecasted warning she received for the Billings area and all points between, Jackie advised the team and other parents to get started early and chose an alternate route to head north to Billings. She was relieved that the team and fans arrived about one hour before the storm hit the area. Fortunately, the players for the other team were able to make it to the game but however they were no match for Jackie’s son and his team.
Technical Description

The growth in consumer use of information technology and the availability of site-specific road weather information provides an excellent opportunity to merge these capabilities to provide a proactive delivery of site-specific road weather information. The technical requirements to do this are largely contained within the existing infrastructures of the road weather community and those within the telecommunications community. The additional technical requirements to complete the automated alert and notification system function is the fusing of these technologies such that information flows can be established from creation to delivery. The requirements to complete this function will be the construction of a database of information for delivery, a system of communication methods for distribution of information from the database, a set of end-user requirements describing what data is desired along with where and when the information is needed, and a database monitoring and mining capability to apply the end-user requirements that would trigger the extraction, packaging and delivery of the appropriate information.

The database of information will be comprised of regional information found elsewhere in this North/West Passage Clarus Regional Demonstration Concept of Operation. Specifically, these data include the regional advisory and control road weather management strategy information, the regional road condition information, and the road weather information contained within the integrated 511 traveler information system. A schema describing the structure and content of the database will be required that defines the data available for the alert and notification provision. Query methods will be required that provide access to the database elements that are specified in the end-user alert and notification configuration. Algorithms to identify the geospatial and temporal fields in the database against the end-user’s requirements will be needed to select appropriate data that can be checked as to whether a threshold value has been exceeded. With such a threshold exceeded the method or methods of data delivery will need to be evaluated and used to prepare the appropriate packaging of the information to the device or instrument where the user will be receiving the information.

This system is anticipated to be a business-public agency relationship as the nature of the information is across state borders and the method of delivery will be fee-based. It is possible that this endeavor could be supported under a pooled fund program such as the North/West Passage, however the cost recovery mechanisms would need to be identified. No matter the manner of business model chosen for implementation, the function would require access to multi-state information resources as a routine, operational framework and a end-user subscription method need to be developed. This subscription method could be located on state agency and/or private sector provider traveler information web pages for subscription by the traveling public or commercial subscribers. The subscription system within state agencies i.e., winter maintenance, traffic managers, could be located on either a state agency’s surface transportation weather web page or a unique web page for the automated alert and notification system, which could be provided either by the state agency or the private sector provider of the service.

The end users of this function are likely to be as much state agencies as travelers. State agency personnel such as winter maintenance professionals would use this system to identify to occurrence or pending occurrence of road weather situations requiring their decision or actions. Travelers, general motorists and commercial vehicle operators, would use this system to alert them to changing driving conditions that might require their alteration in travel actions or plans. The extent into the future the system would provide forecasted conditions would be dependent upon the length of forecast information inherent in other aspects of road weather data generated in other functions (packages) found within this Concept of Operations.
The information that follows provides a step-by-step flow of activities and depicts a general scenario for how a regional alert and notification system function would occur. Figure 7 provides a Use Case Scenario diagram associating the individuals, agencies, and organizations (actors) that perform the actions (use cases) leading to outputs to the end users (actors). A listing of all the actors and use cases including a brief technical description found within the Use Case Scenario diagram follows Figure 7. Figure 8 depicts the Use Case Scenario in a time sequence of use cases from the collection of ESS data to the final delivery of end-user products and services. Following this figure is a description of activities and requirements associated with this sequence of use cases. Each successive heading and set of bullets constitutes the next stage of activities with a general flow of time increasing as the list progresses. The entity (actor) responsible for each is noted on the line before each set of bullets.

Figure 7. Use Case Diagram based upon the functionality defined for the Automated Alert Notification Service Function
**Regional Alert and Notification System Actors**

**Notification Service Operator**
*Type:* public Actor  
*Package:* Multi-State Automated Alert and Notification Service

The Notification Service Operator actor provides oversight to the functional activities of the automated alert notification service function.

**Clarus System Operator**
*Type:* public Actor  
*Package:* Clarus System

The Clarus System Operator actor manages the collection, integration and dissemination of all data within the Clarus System.

**Commercial Vehicle Operations**
*Type:* public Actor  
*Package:* General North/West Passage Actors

The Commercial Vehicle Operations actor provides the capability for commercial drivers and fleet managers to receive weather information and to monitor the safety and security of their commercial vehicle drivers and fleet.

**ESS Data Collector**
*Type:* public Actor  
*Package:* General North/West Passage Actors

The ESS Data Collector actor collects ESS measurement data from the ESS Equipment actor.

**ESS Equipment**
*Type:* public Actor  
*Package:* General North/West Passage Actors

The ESS Equipment actor represents the Environmental Sensor Stations collecting environmental data.

**Maintenance Personnel**
*Type:* public Actor  
*Package:* Multi-State Automated Alert and Notification Service

The Maintenance Personnel actor monitors and manages roadway infrastructure winter maintenance activities. As used in this instantiation of the Maintenance Operator, this actor represents both public agencies and private contractors that provide these functions and a generalization of Maintenance
Operators across jurisdictions. This actor manages fleets of winter maintenance, or special service vehicles (e.g., snow and ice control equipment). The actor receives a wide range of status information from these vehicles and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment. This actor manages equipment at the roadside, including environmental sensors and automated systems that monitor and mitigate adverse road and surface weather conditions. This actor manages the repair and maintenance of both non-ITS and ITS equipment including the traffic controllers, detectors, dynamic message signs, signals, and other equipment associated with the roadway infrastructure. Additional interfaces to weather information providers (the weather service and surface transportation weather service providers) provide current and forecast weather information that can be fused with other data sources and used to support advanced decision support systems that increase the efficiency and effectiveness of winter maintenance operations.

**Surface Transportation Weather Service Provider**

*Type:* public Actor  
*Package:* General North/West Passage Actors

The Surface Transportation Weather Service Provider actor receives data from the Clarus System and provides value-added weather and surface transportation data integration and interpretation to the Weather Information User Community.

**Travelers**

*Type:* public Actor  
*Package:* General North/West Passage Actors

The Travelers actor collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The actor can play several different roles in an integrated ITS. In one role, the Traveler actor provides a general data warehousing function, collecting information from transportation system operators and redistributing this information to other system operators in the region and other ISPs. In this information redistribution role, the Traveler actor provides a bridge between the various transportation systems that produce the information and the other ISPs and their subscribers that use the information. In a second role, a Traveler actor is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories including weather, traffic and road/route conditions, transit schedule information, yellow pages information, ridematching information, and parking information. In a third role, the Traveler actor may be dedicated to, or even embedded within, the dispatch system.

**Weather Observing Equipment**

*Type:* public Actor  
*Package:* General North/West Passage Actors

The Weather Observing Equipment actor represents environmental sensing equipment that provides weather observation data from stations not included in the Clarus System.
Weather Service Provider

Type: public Actor
Package: General North/West Passage Actors

The Weather Service Provider actor provides data to the Clarus System based on its weather observation equipment. The Weather Service Provider integrates, transforms and interprets general weather data including data from the Clarus System for dissemination to the Weather Information User Community.

Regional Alert and Notification System Use Cases

Configure Alert Notification Criteria

Type: public UseCase
Package: Multi-State Automated Alert and Notification Service

The Configure Alert Notification Criteria use case provides the actions associated with the setting of threshold values and geospatial locations desired in the various types of road weather elements for which an automated alert notification is available.

Distribute Alert

Type: public UseCase
Package: Multi-State Automated Alert and Notification Service

The Distribute Alert use case provides the actions associated with the delivery of road weather information to an end-user subscriber. These services are provided through a subscription process where system users provide pre-configured information request profiles.

Monitor Alert Criteria

Type: public UseCase
Package: Multi-State Automated Alert and Notification Service

The Monitor Alert Criteria use case provides the actions associated with the processing of threshold mechanisms in the alert notification profile that matches the criteria corresponding to those set by the end-user. This end-user may be an individual motorist or an individual in a transportation organization charged with making operational decisions that are road weather dependent.

Trigger Alert

Type: public UseCase
Package: Multi-State Automated Alert and Notification Service

The Trigger Alert use case generates an action leading to a distribution of an automated alert when processing of the trigger mechanisms in the alert notification profile matches the criteria as determined after a scan of the desired thresholds exceeded in the system's road weather database. This service has a dependency in a multi-jurisdictional implementation where the cross-jurisdictional data are acquired from the database generated from contributions from all North/West Passage states.
ESS Data Collection

Type: public UseCase
Package: Clarus System

The ESS Data Collection use case is part of the Clarus System Framework. This use case is responsible for transferring the collected ESS data from the ESS Data Collector actor to the Clarus System Operator.

ESS Data Serving

Type: public UseCase
Package: Clarus System

The ESS Data Serving use case is part of the Clarus System Framework. This use case is responsible for transferring the processed ESS data, quality control flags, and pertinent metadata to the Weather Service Provider, Surface Transportation Weather Service, the state transportation decision maker actors, and potentially other interested stakeholders. The Clarus operator has the capability to specify critical ESS information processing priorities for the Clarus System.

ESS Quality Checking

Type: public UseCase
Package: Clarus System

The ESS Quality Checking use case is part of the Clarus System Framework. This use case is responsible for checking and flagging the collected ESS data. The Clarus quality control process will check for observed values that exhibit out-of-tolerance limits and other data characteristics that require flagging and will set quality exception flags where necessary. The process will notify the ESS Data Collector actor of observed values that consistently report quality exception flags.

The ESS Quality Checking use case will rely upon current ESS metadata provided by the ESS Data Collector actor that include configuration and operational status information.

Acquire External Weather Data

Type: public UseCase
Package: General North/West Passage Use Cases

The Acquire External Weather Data use case is external to the Clarus System Framework. This use case is responsible for collecting the external weather data from the Weather Observing Equipment actor that includes products and services generated by NOAA, Environment Canada, and various weather data service providers. These may include numerical weather depiction guidance, forecasts, and public or private environmental sensor data from sensors not directly connected to Clarus. The use case delivers the information to the Weather Service Provider actor and the Surface Transportation Weather Service Provider actor.

Provide ESS Measurement

Type: public UseCase
Package: General North/West Passage Use Cases
The Provide ESS Measurement use case covers the process wherein the ESS Equipment actor facilitates the observation of road and weather conditions from environmental sensor stations.

Provide Surface Transportation Weather Analysis & Forecast

**Type:** public UseCase  
**Package:** General North/West Passage Use Cases

The Provide Surface Transportation Weather Analysis and Forecast use case covers the process wherein the Surface Transportation Weather Service Provider actor integrates weather information from the Acquire External Weather Data, ESS Data Serving, and Regional Road Condition Reporting System use cases, generates analyses and forecasts of both weather and pavement conditions, and disseminates the information to the Weather Information Consumer Community. The Weather Information Consumer Community actors include state decision makers who incorporate the resulting weather information to support their decision-making processes.

Provide Weather Analysis & Forecast

**Type:** public UseCase  
**Package:** General North/West Passage Use Cases

The Provide Weather Analysis and Forecast use case covers the process wherein the Weather Service Provider actor integrates weather information from the Acquire External Weather Data and ESS Data Serving use cases, generates analyses and forecasts of weather and disseminates the information to the Weather Information Consumer Community. The Weather Information Consumer Community actors include state decision makers who incorporate the resulting weather information to support their decision-making processes.
ESS MEASUREMENT – TRANSPORTATION AGENCY
- Weather and pavement values measured in field Environmental Sensor Station (ESS)
- Weather and pavement values stored in field ESS as current report
- Aggregated weather and pavement values stored in field ESS as a series of reports

ESS COLLECTION – TRANSPORTATION AGENCY
- ESS Data Collector polls ESSs and transfers new stored reports in stored series from each ESS
- ESS Data Collector stores reports in database

CONSOLIDATION - CLARUS
- Clarus server directly collects data from the ESS Data Collector and Vehicle Data Collector
- Collection process performs quality control checks on incoming data and flags obvious errors
- Clarus server stores the data with quality control flags
- Clarus server accepts and stores External Weather data for quality assurance check
- Data from multiple sites is sorted into data sets having common date and time and location reference

Figure 8. Sequence diagram for the Automated Alert Notification Service Function
QUALITY ASSURANCE CHECK - CLARUS
• External Weather data is compared with Clarus data for the purpose of data validation and quality assurance processing
• Quality assurance check is run on the time and location sorted data
• Observations deviating from expected value by a specified amount are flagged as potential errors
• Clarus stores the error flags with the data
• Clarus sends notification to the data provider when suspect data occur

DATA TRANSFER - CLARUS
• Data in the Clarus database are acquired by public and private members of the Service Provider community based on timeframe and location

DATA INTEGRATION – SERVICE PROVIDER
• The Service Providers collect, store, and consolidate the Clarus data with observed meteorological data from various other sources
• The Service Providers acquire forecast guidance products to complement the observed data
• Observed data are consolidated and composed into presentations showing the data from various sites displayed on a GIS background
• The observed and forecasted data are composed into weather forecast products
• The forecasts are organized into text and graphical presentations

DATA TRANSFORMATION – SERVICE PROVIDER (WEATHER AND SURFACE TRANSPORTATION WEATHER)
• Meteorological data are run through a pavement condition model that transforms the weather forecast components into projection of pavement temperatures and road conditions
• Pavement conditions are computed for segments of a given highway having relatively uniform physical and environmental characteristics
• Computed pavement temperatures and road conditions are organized into tabular and graphical representations of current and forecasted pavement conditions

ALERT GENERATION – STATE AGENCY (NOTIFICATION SERVICE OPERATOR)
• Assess service provider weather forecast data to determine extent and persistence of current road weather conditions
• Updates road condition reports to provide latest available status of pavement conditions
• Monitors current road conditions and trends in forecast road conditions to develop awareness of potential need for road advisory generation
• Generates appropriate alert messages as needed following user-defined alert configurations
• Distributes alert notifications using pre-defined telecommunications methods

ALERT NOTIFICATION RECEPTION – STATE AGENCY
• Pre-defined locations, times and data sources for monitoring by alert notification system
• Provides devices or Internet resources for reception of alert notifications
• Applies alert notification information to relevant decision-making processes

ALERT NOTIFICATION RECEPTION – TRAVELER or COMMERCIAL VEHICLE OPERATOR
• Pre-defined locations, times and data sources for monitoring by alert notification system
• Provides devices or Internet resources for reception of alert notifications
• Applies alert notification information to travel actions and/or planning process
Section 3. Summary

The Use Case Scenarios presented in the preceding section provide the foundation for the North/West Passage Clarus Regional Demonstration. They are high-level descriptions of the actions to be conducted and the entities involved in the actions. As developed, these scenarios provide a piece of the final Concept of Operations development. Upon feedback and approval by the North/West Passage Project Team, these scenarios will be refined to include additional functional requirements, internal and external interfaces required, and a description of the resources anticipated to be required to conduct an operational demonstration of the scenarios. Given the high degree of interaction associated with the scenarios, it is anticipated that the operational demonstration will include virtually all four of the scenarios with the possible exclusion of the automated alert and notification system.