CLARUS **Multi-State Regional Demonstration**

CONCEPT OF OPERATIONS

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Version 3.00 - FINAL

Presented by:

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1 SCOPE

This Concept of Operations (ConOps) is presented by the Iowa, Illinois, Indiana, and Ohio Departments of Transportation to articulate business-to-government solutions utilizing *Clarus* observations to supplement existing information.

The ConOps presents two separate business-to-government applications: a Trip Information System and a Construction Weather Archival System.

1.1 Intended Audience

The ConOps is written for use by the United States Department of Transportation (USDOT), Federal Highway Administration (FHWA) Road Weather Management Team to select business-to-government services for development within the *Clarus* Initiative during the *Clarus* Regional Demonstration. The document will also be used by potential contributors to the systems to determine the feasibility of providing data from external sources. The ConOps will be used by stakeholders and consultants in the creation of the requirements for the systems. The document will also be used to communicate to management-level personnel in the stakeholder organizations an understanding of the overall systems proposed and their applications.

1.2 Purpose for Implementing the Services

1.2.1 Trip Information System

The purpose for implementing the proposed Trip Information System is to provide a "one-stop" mechanism for travelers to plan a single or recurring trip. The trip plan will utilize a map-based display and will provide directions and estimated travel times. The selected travel route will have an overlay of information relating to weather observations, incidents, construction, road conditions, link traffic data, and public information that may impact the trip. Transit information will be available to allow travelers to plan multi-modal trips. System subscribers will receive notifications of changing conditions that may affect their specific trip through text messages, emails, and taskbar alerts.

The Trip Information System will collect information from disparate external systems, store the information, perform necessary analyses, and present the information to the user through a website and notifications. The Trip Information System could be deployed as a regional or national system. Envisioned sources of information to the Trip Information System are as follows:

- The *Clarus* system
- National Weather Service (NWS)
- Value-added weather information providers
- Mesonets
- Value-added mapping and routing service providers

- Departments of Transportation (DOT)
- Law enforcement and public safety agencies
- Bus and rail transit agencies
- Vehicle Infrastructure Integration systems
- Probe traffic data systems
- Department of Homeland Security
- Metropolitan Planning Organizations

1.2.2 Construction Weather Archival System

The purpose for implementing the proposed Construction Weather Archival System is to collect, store, and present weather information that relates to specific construction projects. The system will be used by DOT employees for contract management.

The Construction Weather Archival System will collect weather information from disparate external systems, store the information, and present the relevant information to the user through a website and system-generated reports. Envisioned sources of information to the Construction Weather Archival System are as follows:

- The *Clarus* system
- NWS
- Value-added weather information providers
- Mesonets

1.3 Overall Vision of the Clarus Regional Demonstration Services

1.3.1 Trip Information System

The vision of the Trip Information System is to create a tool that allows travelers to assess the effects of static and dynamic events and conditions before and during a trip.

1.3.2 Construction Weather Archival System

The vision of the Construction Weather Archival System is to create a tool for DOT construction management to monitor the effects of weather on specific construction projects.

1.4 Goals and Objectives

1.4.1 Trip Information System

Goals and objectives of the Trip Information System are as follows:

Improve Safety

- Reduce the number of highway-related crashes, injuries, and deaths
- Enhance the dissemination of public safety announcements

Improve Mobility

- Improve the movement of travelers and freight

Improve Efficiency

- Reduce the number of locations that a traveler must visit to obtain information
- Improve traveler awareness of changing conditions by providing notifications en-route

Enhance the Travelers' Experience

- Improve the dissemination of traveler information across state boundaries
- Provide specific, relevant information to travelers through customized subscriptions

1.4.2 Construction Weather Archival System

Goals and objectives of the Construction Weather Archival System are as follows:

Improve Efficiency

- Minimize the effort agency personnel devote to the research and analysis of weather conditions at construction projects

Enhance Contract Management

- Improve evaluation of weather effects on the schedule of construction projects
- Improve ability to analyze the correlation of weather conditions and specific construction tasks in the event of infrastructure failure

Supplement Project Files

- Improve project files by archiving weather information specific to the construction project

1.5 Assumptions and Constraints

1.5.1 Trip Information System

The *Clarus* regional demonstration team is assuming that the data for trip planning, weather, road conditions, incidents, construction, transit, and other travel conditions can be obtained from external sources. The team also assumes that the system will be robust and will be able to process data from legacy systems.

It will be necessary to establish data sharing agreements with external agencies that provide data to the system, either through automated data feeds or through manual data entry using the system operator interface.

The data quality must be checked against an appropriate standard before the data is shown to the system users.

Additionally it is assumed that once the data is obtained and quality-checked, it can be normalized and provided in a consistent manner to the user. The data is assumed to: be available in a form that meets relevant Intelligent Transportation System (ITS) standards; be accurate; and be available in a timely manner.

1.5.2 Construction Weather Archival System

The *Clarus* regional demonstration team is assuming that the data required by this system is available from *Clarus*. The team also assumes that necessary operating agreements can be made with external agencies to obtain additional weather data.

2 REFERENCES

The following documents contain additional information pertaining to this project or have been referenced within this document:

- *Akron-Canton Regional ITS Architecture Home Page*, http://www.consystec.com/ohio/akron/akronintro.htm.
- *Central Ohio Regional Architecture*, http://transportation.morpc.org/its/regITS.html
- *Clarus System User Guide*, Mixon/Hill, Inc.; May 2007.
- *Cleveland Regional ITS Architecture Home Page*, http://www.consystec.com/ohio/cleveland/clevelandintro.htm.
- *Common Alerting Protocol*, v. 1.1 OASIS Standard CAP-V1.1, October 2005.
- *Concept of Operations Outline for the Clarus Multi-State Regional Demonstration*, Noblis, Inc., August 15, 2007.
- *Contract for Professional Services*, Iowa Department of Transportation, October 26, 2007.
- *Generally Accepted Principles and Practices for Securing Information Technology Systems*, National Institute of Standards and Technology Special Publication 800-14, September 1996.
- *IEEE Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document*, IEEE Std 1362-1998, March 19, 1998.
- *Illinois Statewide ITS Strategic Plan and Architecture Technical Assistance Project*, http://www.dot.il.gov/ilits/index.html.
- *Iowa Statewide Intelligent Transportation Systems Architecture*, Version 1.1, URS Corporation, May 2007.
- *Message Sets for Advanced Traveler Information System (ATIS)*, SAE J2354, February 2004.
- *Miami Valley Regional ITS Architecture*, http://www.mvrpc.org/its/MiamiValleyITSRegionalArchitecture.php.
- *NOAA Surface Weather Program and MADIS Transition to Operations*, Jim O'Sullivan, NOAA Surface Weather Program Manager, NWS Office of Climate, Water, and Weather Services, September 20, 2007.
- *Toledo Regional ITS Architecture Home Page*, http://www.consystec.com/ohio/toledo/toledointro.htm.
- *Youngstown-Warren Regional ITS Architecture Home Page*, http://www.consystec.com/ohio/youngstown/youngstownintro.htm.

3 BACKGROUND

This section briefly describes the current situation and the existing operational procedures, as well as their drawbacks and limitations.

3.1 Operational Description of the Current Situation

3.1.1 Trip Information System

Each state DOT has one or more web pages which can be used by the traveler to find route directions, and information about weather, road conditions, incidents, construction, and transit services. Many of these web pages also provide links to non-DOT sites which have additional information. Appendix C shows a summary of the web pages by the project team and by data type.

The envisioned Trip Information System will include many different types of data. The current situation with each data type is discussed individually below.

Mapping Data – When a traveler is planning a trip, one of many mapping websites may be used to obtain directions. Each of these sites accepts origin and destination information. Some sites have advanced options which include the ability to select the shortest time or shortest distance route; to avoid interstate highways; to avoid tolls; or to avoid seasonally closed roads. The websites provide the traveler with an output that includes a map with the route marked, route directions, projected travel time, and the estimated travel distance. During the trip, it is possible for the traveler to modify the route if they have a physical map, navigation system, or if Internet access is available.

Weather Data – During the trip planning stage, the traveler might review the route directions from the mapping data and then research the current and forecasted weather for the area covering the route. This allows the traveler to determine the impact of weather on the selected trip. The sources of this information are as follows:

- DOT websites – Some states have Road Weather Information System (RWIS) information available on their website. Others have general weather information available for the region
- Public/private weather providers
- News media outlets
- State 511 Systems

During the trip, the traveler is able to receive updated weather information from various sources and to adjust his or her route accordingly. These sources of information are as follows:

- News media outlets
- Highway Advisory Radio

- Dynamic Message Signs
- State 511 System
- NWS radio
- Public/private subscription services
- DOT websites

Incident Data - During the trip planning stage, the traveler might review the route directions from the mapping data and then research the incident information for the area covering the route. This information will only have relevance if the trip is starting immediately. This allows the traveler to determine the impact of incidents on the selected trip. The sources of this information are as follows:

- Websites – These websites show current incident information and include the following:
    - DOT websites
    - Regional websites
    - Value-added service providers
- News media outlets
- State 511 Systems

During the trip, the traveler is able receive updated incident information from various sources and is able to adjust his or her route accordingly. These sources of information are as follows:

- News media outlets
- Highway Advisory Radio
- Dynamic Message Signs
- State 511 Systems
- Public/private subscription services
- DOT websites

Construction Data - During the trip planning stage, the traveler might review the route directions from the mapping data and then research the construction information for the selected route. This allows the traveler to determine the impact of construction on the selected trip. The sources of this information are as follows:

- Websites – These websites show current construction information and include the following:
    - DOT websites
    - Regional websites

- Value-added service providers
- News media outlets
- State 511 Systems

During the trip, the traveler is able to receive updated construction information from various sources and to adjust his or her route accordingly. These sources of information are as follows:

- News media outlets
- Highway Advisory Radio
- Dynamic Message Signs
- State 511 Systems
- DOT websites

Transit Data - During the trip planning stage, the traveler might review the route directions from the mapping data and then research the availability of transit services. This allows the traveler to develop a multi-modal trip plan. The sources of transit information are as follows:

- Rail
    - Websites
    - Phone call to a customer service center
- Bus
    - Websites
    - Phone call to a customer service center

During the trip, the traveler is able to receive updated transit information from various sources and to adjust his or her route accordingly. These sources of information are as follows:

- Bus/rail announcements
- Bus/rail Dynamic Message Signs
- Bus/rail subscription alert message
- Phone call to a bus/rail customer service center

Road Condition Data - During the trip planning stage, the traveler might review the route directions from the mapping data and then research the road conditions on the selected route. This allows the traveler to determine the impact of the road conditions on the selected trip. The sources of this information are as follows:

- Websites – These websites show current road condition information and include the following:
    - DOT websites

  - Regional websites
  - Value-added service providers
  - Law enforcement agencies
- News media outlets
- State 511 Systems
- State Road Condition Hotline

During the trip, the traveler is able to receive updated road condition information from various sources and to adjust his or her route accordingly. These sources of information are as follows:

- News media outlets
- Highway Advisory Radio
- Dynamic Message Signs
- State 511 Systems
- DOT websites
- State Road Condition Hotline
- Public/private subscription services

Link Traffic Information Data - During the trip planning stage, link traffic information (speed, volume, and occupancy) may be used by the traveler to determine potential areas of congestion by reviewing average vehicle speeds. The sources of this information are as follows:

- Websites – These websites which show current congestion and vehicle speed information include the following:
  - Regional websites
  - Value-added service providers
- News media outlets
- State 511 Systems

During the trip, the traveler is able to receive this information from various sources and adjust his or her route accordingly. The information is received from the following:

- News media outlets
- Highway Advisory Radio
- Dynamic Message Signs
- State 511 Systems
- Websites

- Public/private subscription services

Public Information Data – This data includes alerts such as public safety, America's Missing Broadcast Emergency Response (AMBER), ozone, and Homeland Security announcements. During the trip planning stage, this information is available from the following:

- Governmental websites
- News media outlets
- State 511 systems

During the trip, the traveler is able to receive this information from the following:

- News media outlets
- Highway Advisory Radio
- Dynamic Message Signs
- State 511 Systems
- Websites
- Public/private subscription services

3.1.2 Construction Weather Archival System

When a construction project is underway, weather directly affects the ability of the contractor to perform its work, and may adversely affect their project schedule. Monetary penalties may apply when a contractor is behind schedule and does not complete the scope of work within the agreed contract period. Many times the contractor will petition the DOT to waive the penalties stating adverse weather as the rationale.

Since weather data is rarely correlated to specific construction projects and then archived, the DOT must perform extensive research to determine the weather conditions during the period of performance at the construction location. This research can be labor intensive and time consuming, and usually involves many different weather information sources. After the weather conditions are retrieved, the DOT must analyze the information to determine if weather was the cause for the delay, or if the delays can be attributed to poor planning by the contractor. Only after this research and analysis is complete can a determination be made as to whether penalties should apply.

3.2 Limitations of the Current Situation

3.2.1 Trip Information System

Mapping Data – The existing trip planning websites do not take into consideration the following items when determining the route:

- Incidents
- Construction
- Congestion
- Road conditions
- Weather

Without accounting for these static and dynamic variables, estimated travel times may be significantly wide of the mark.

Weather Data – The available weather information is not usually based on surface weather observations. The traveler must correlate the weather information to the selected route in order to determine the impact. The existing 511 system provides state-specific information and may not include impacts from bordering states. While traveling, weather updates may be too specific to the immediate area and not provide enough downstream information for travelers to make informed decisions. The traveler may incur a cost in order to subscribe to weather information. Internet coverage may not be available in some locations or the traveler may need to stop in order to access the Internet.

Incident Data – Incidents are, by nature, unpredictable. The traveler must correlate the available incident location information to his trip. The prediction of the impact of an incident on traffic speed and the amount of delay caused by the incident may be provided to the traveler, or, if not, the traveler may need to make a subjective determination of the impact to his trip. The 511 system provides state-specific information and may not include impacts from bordering states. Internet coverage may not be available in some locations or the traveler may need to stop in order to access the Internet.

Construction Data – The traveler must correlate the available construction information to his selected route to determine any potential impacts. The impact of construction is difficult to predict. The delay information provided may be as simple as "expect delays" which provides little guidance to the traveler. The impact is also dependent on the following:

- Type of construction project – a moving striping operation may impact motorists more than a two mile paving project;
- Construction crew present – when the construction crew is present at a construction site and machinery is in operation, motorists tend to divert their attention to the construction activities as opposed to ignoring an inactive construction site;
- Time of day – a construction operation being performed during rush hour traffic or at night (due to high intensity lighting), will have greater impact than at other times.

The 511 system provides state-specific information and may not include impacts of construction from bordering states. Internet coverage may not be

available in some locations or the traveler may need to stop in order to access the Internet.

Transit Data – Currently, it is not easy for the traveler to determine the actual travel times when using transit, and integrate that into an overall trip plan. The traveler may need to correlate information from multiple service providers, covering multiple transit routes, transfer points, transfer times, and schedules with his selected driving route to create a multi-modal trip plan. Not all transit authorities provide the ability to subscribe to update alerts which cover service delays or cancellations. In some cases, the best source of transit information is obtained by calling the customer service centers of the individual transit providers.

Road Condition Data – The road condition information available to the traveler is dependent on the accurate and timely reporting of the information by various agencies such as departments of transportation and law enforcement. In many cases, road conditions are observed by individuals, information is submitted by phone or on-board equipment such as computer-aided dispatch or automated vehicle location systems, and then entered into a database for presentation. Websites display the type of moisture on the pavement surface such as wet, dry, or snow covered. The websites must be kept up-to-date in order to be useful to the traveler. The traveler must also be able to correlate the road condition information to his route in order to determine the impact. The 511 system and the road condition hotline provide state-specific information and may not include impacts from bordering states. Internet coverage may not be available in some locations or the traveler may need to stop in order to access the Internet. The traveler may incur a cost for a subscription service.

Link Traffic Information Data – Information on recurring congestion, such as routine time-of-day delays on commuter routes or at known bottlenecks, is not readily available during the trip planning phase. Travel speeds on roadways are generally presented as ranges such as 0-30 MPH, 31-45 MPH, and >45 MPH, without specifying the actual speed limit. The information is based on the current situation. The traveler must correlate the information to his selected route to determine any potential impacts. The 511 system provides state-specific information and may not include impacts of congestion from bordering states. Internet coverage may not be available in some locations or the traveler may need to stop in order to access the Internet. This information is not available for all routes as all roads are not instrumented.

Public Information Data – While traveling, public information may be too specific to the immediate area and not provide enough downstream information for travelers to make informed decisions. Receiving public information may be dependent on the traveler tuning to the appropriate news media. The 511 system provides state-specific information and may not include public information alerts from bordering states. Internet coverage may not be available in some locations or the traveler may need to stop in order to access the Internet.

3.2.2 Construction Weather Archival System

While there are multiple data sources for atmospheric and surface weather information, there are neither tools nor procedures for DOT personnel to routinely correlate and archive weather observations to specific construction projects. When historic weather information is needed to make contractual decisions, intensive research and analysis is required.

3.3 Justification for and Nature of Changes

3.3.1 Trip Information System

Many trips planned by users of the envisioned system will cross governmental and jurisdictional boundaries. The Trip Information System will provide a single access point for users to accurately and efficiently plan a trip. Users will be able to obtain current transportation-related information, including current weather conditions, incidents, congestion, construction, transit options, road conditions, and alerts that affect any part of their overall trip through the region.

The Trip Information System will also provide a mechanism for travelers to receive transportation-related updates which affect their route during the trip. These updates will give travelers the ability to adjust the trip to compensate for travel delays caused by changing conditions. Travelers may be able to take an alternate route or change their schedule. By giving travelers the knowledge of changing conditions and the ability to determine the impact, travelers will be able to experience more timely and efficient movement through the transportation system.

Determining priorities among the potential changes to the existing situation begins by considering the ways in which the envisioned Trip Information System can respond to the needs of the users. Decisions on changes to be implemented will then be based on these priorities. The viability and risks associated with the potential changes may also be factors in setting priorities.

The highest priorities among the changes will be those that relate to the safety and mobility of travelers. Providing travelers with the ability to plan trips which avoid areas of congestion due to incidents, construction, or weather is important. Providing information which helps prevent accidents and supports free flow of traffic on the highways is of utmost importance.

When considering the availability of transportation-related information for pre-trip planning, the data to be provided can be prioritized as follows:

- Mapping Data – high priority
- Weather Data – high priority
- Incident Data – high priority
- Construction Data – high priority
- Road Condition Data – high priority

- Transit Data – medium priority
- Link Traffic Information Data – medium priority
- Public Information Data
    - Public safety alerts – high priority
    - AMBER alerts – high priority
    - Homeland Security alerts – medium priority
    - Ozone alerts – medium priority

When considering the availability of travel condition updates en-route, the data to be provided can be prioritized as follows:

- Weather Data – high priority
- Incident Data – high priority
- Construction Data – high priority
- Road Condition Data – high priority
- Transit Data – medium priority
- Link Traffic Information Data – medium priority
- Public Information Data
    - Public safety alerts – high priority
    - AMBER alerts – high priority
    - Homeland Security alerts – medium priority
    - Ozone alerts – medium priority

A "one-stop" shop for trip planning and transportation-related information, as envisioned by the Trip Information System, will provide the traveler with an improved experience in the region.

3.3.2 Construction Weather Archival System

A Construction Weather Archival System will make weather data related to specific construction projects more readily available. This information can be used for analyses during the course of a project, so that the impacts of current or recent weather conditions on construction project schedules can be determined. The information can also be used historically to support decisions associated with weather-related claims for construction delays by contractors. The historical information can assist in determining the correlation of weather conditions and specific construction tasks in the event of infrastructure failure.

Determining priorities among the potential changes to the existing situation begins by considering the ways in which the envisioned Construction Weather Archival System can respond to the needs of the users. Decisions on changes to be implemented will then be based on these priorities. The viability and

risks associated with the potential changes may also be factors in setting priorities.

The following priorities have been established for the Construction Weather Archival System:

- Determine the impact of weather on a current construction project - high priority
- Archive weather data for future analyses - high priority
- Ability to analyze the data to determine if the weather adversely impacted the contractor's ability to complete the scope of work on time - high priority
- Ability to analyze the correlation of weather conditions and specific construction tasks in the event of infrastructure failure - high priority

4 OVERVIEW OF *CLARUS* REGIONAL DEMONSTRATION SERVICES

4.1 Boundaries for Clarus Regional Demonstration Services

4.1.1 Trip Information System

The purpose of the Trip Information System is to collect information on events and conditions that affect travel on the region's highway; to present the impacts of these events and conditions in a convenient format to an interested traveler; and to present the information with a geographic context. The system will continuously receive updates from information sources; process the new information; and apply those updates to the planned trips of travelers. Travelers will be informed of changes affecting their planned trips through a variety of communication methods. Email, pagers, and desktop taskbar applications can be used for pushing notifications to travelers, while web browsers and user interfaces at locations such as rest areas will provide a means for travelers to verify trip details on-demand.

The planned capability of the Trip Information System will accept a trip plan from a potential traveler, apply known events and conditions to the planned trip, and provide useful information to the traveler about the planned trip that may include potential delays or suggestions to consider a different route. Available events and conditions that impact travel will include weather and road conditions, congestion, incidents, construction, and emergency alerts. Transit information will also be provided if the traveler plans a multi-modal trip.

The Trip Information System will leverage other existing information systems to perform its services, such as those providing road weather and pavement conditions. People considering travel often look at forecast weather or current area weather conditions, but do not necessarily have the time or experience to determine if, or how, such conditions will impact their travel. Long-distance travelers may not be familiar with their planned travel route, and so may not completely understand the relationship between a distant storm and their route. The Trip Information System bridges this gap.

Figure 1 provides a high-level overview of the interrelated parts of the Trip Information System. The figure highlights the major external systems on which it depends, as well as the output to the traveling public and other traveler information systems. More details on how the Trip Information System accomplishes its tasks are discussed later in this document.

The geographic information service is needed by the Trip Information System to provide the trip planning tools used by travelers to specify their origin and destination and obtain a recommended route, as well as to identify the road segments to which the events and conditions are applied.

Weather information originates from the *Clarus* System, NWS, and other value-added weather providers. The detailed road conditions and area weather are comparable to incident and emergency alert information. They are unplanned,

require managed intervention for resolution, and immediately impact potential travel for varying periods.

Agencies responsible for the management and maintenance of the highways are represented in the figure as DOT Information. They will provide incident information, congestion, construction, and special event details. With the exception of that caused by incidents, congestion is typically recurring and predictable in its location and extent. Similarly, construction and special events are planned and known well in advance. Collectively, this information is useful to help travelers know what to expect during a trip.

Transit agencies can provide route and schedule information for their services, and often have information on service delays, disruptions, and cancellations. This information assists travelers if their plans are public transportation based, or include multi-modal trips. Other public information used by the Trip Information System comes from agencies whose activities affect the transportation system and its users. Law enforcement agencies, metropolitan planning organizations, and the Department of Homeland Security can issue emergency alerts and warnings that affect travel.

As the Trip Information System matures, more travel condition information and geographic area will be made available. Additional, relevant information will increase the usefulness of the system by identifying more events and conditions that have the potential to impact a user's travel plans. It is intended that travelers will not become overwhelmed with information that does not apply to them since the system filters the events and conditions to the context of the traveler's planned trip.

The provided information is combined and processed to determine impacts to user-specified travel routes. The results are formatted to be presented in easily understood forms to the travelers or used by other systems that can benefit from such information.

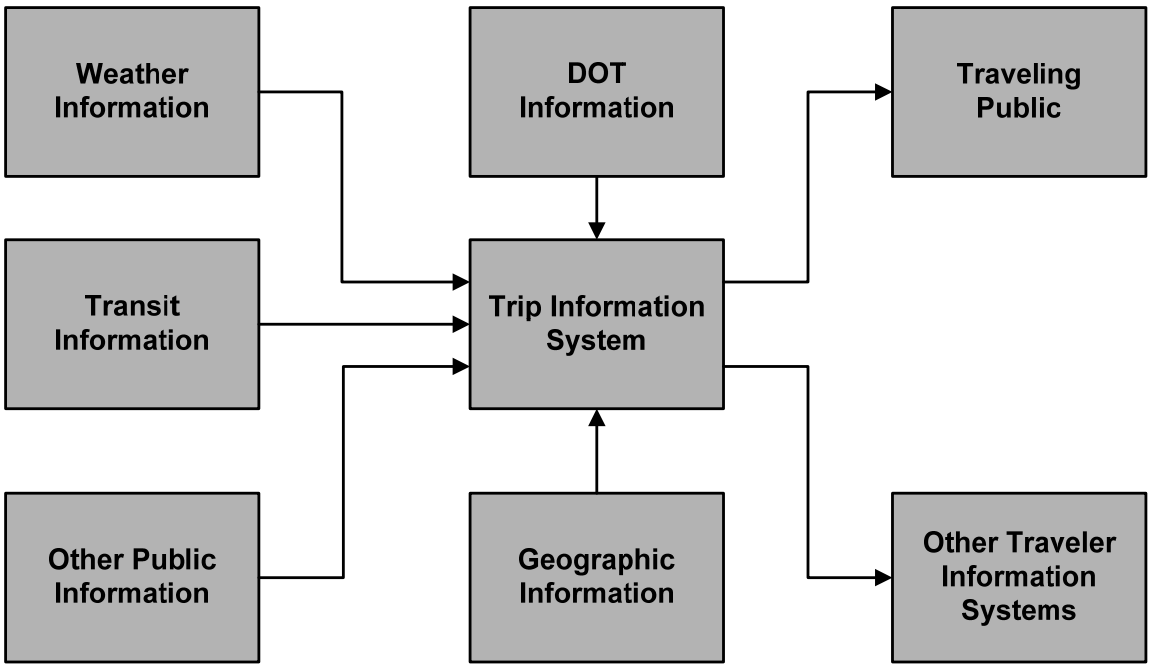

Figure 1 - Trip Information System Overview

The Trip Information System is essentially an information gathering, processing, and dissemination tool, associated with a mapping database and route planning system. There are, however, other external hardware components worth mentioning. A communication and computing infrastructure on which the service resides is needed for the system. Additionally, travelers will use personal computers, mobile telephones, pagers, text messaging, and other Internet-connected devices to plan their trips and receive updates. On the road, user interfaces at locations such as rest areas, truck stops, and even hotels can provide travelers another alternative connection to the system.

4.1.2 Construction Weather Archival System

Construction projects usually have a specified time period in which the project needs to be completed. That timeline is agreed upon by the contractor and the contracting organization. Under normal circumstances, the project can be completed in a timely basis. However, sometimes delays are caused by suppliers missing deadlines, and other times, delays may be caused by adverse weather conditions – such as too much precipitation or humidity, or temperatures outside of a required range to perform a task. The contractor will keep track of conditions causing project delays, and submit the reasons for any delays upon project completion, or as requested by the organization.

Currently, in order to confirm the reasons for the delays, the contracting agency has to rely on manual searches.

The Construction Weather Archival System will provide DOTs with a means for manual input of weather-related data parameters of interest, manual input of weather data at a project site by DOT personnel, and automated retrieval and archiving of specified weather data from *Clarus* and other weather data sources.

After the archiving of the requested weather data, the Construction Weather Archival System will then allow searches and reports of the archived weather records in order to validate the contractor's claims.

The Construction Weather Archival System will enable DOT staff and other authorized users to input a specific date range, project information, or geographic location bounding box, along with the specific weather parameters of interest and then review the reported weather conditions that occurred within the specified geographic and date ranges.

An overview of the Construction Weather Archival System is illustrated in Figure 2 depicting project and weather information entering the system and reports being produced from the system.

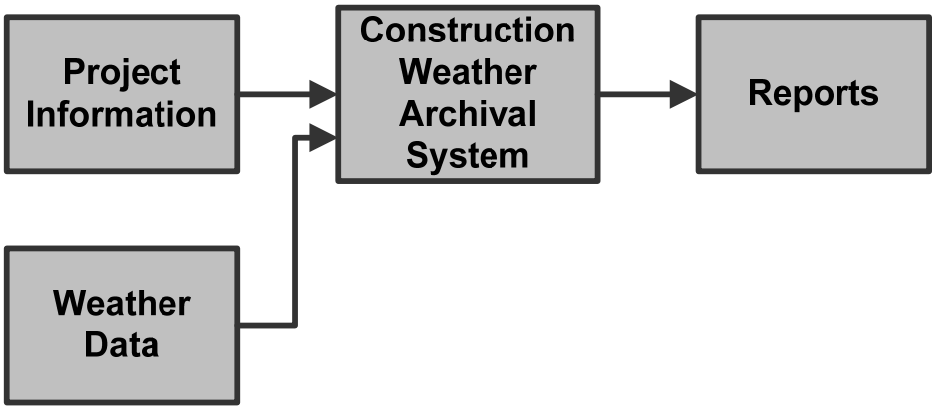

Figure 2 - Construction Weather Archival System Overview

4.2 Stakeholder Roles and Responsibilities

4.2.1 Trip Information System

The complete set of stakeholders for the Trip Information System include anyone who will operate, maintain, build, manage, use, or be affected by its services. The predominant stakeholders will be the traveling public and the providers of the event and condition information.

Travelers use the system to make more informed decisions about their travel plans. When travelers provide their route plans to the system, known events and conditions can be correlated to those routes. Travelers are then informed of potential situations that will affect both their safety and time. Travelers can also use the system to notify them when changes on their planned route occur so that travelers can make more informed decisions even during their journey.

The *Clarus* system and its operators are another stakeholder. As the primary source of road weather information, the *Clarus* stakeholders must consider the requirement for continuous operation and increased demand for information that the Trip Information System will create. The *Clarus* operators will need to allocate the resources necessary to ensure this level of service.

Transportation departments and other government agencies responsible for the highway system will have a similar role to the *Clarus* system operators. For the Trip Information System to work properly, the agencies will need to allocate sufficient resources to provide the level of service required. Where standard information sources are available, the integration with the Trip Information System will be streamlined. Where automated interfaces cannot be implemented, authorized personnel will need to update the Trip Information System through its direct interface.

Maintenance personnel employed by transportation agencies may also be a stakeholder. Since the Trip Information System will contain aggregated weather and road condition data, it could serve as an additional tool to potentially plan maintenance activities. While the maintenance managers are not planning trips like the public user, they can similarly specify particular routes that cover the road segments in which they have an immediate interest.

Transit agency operators can also use the Trip Information System to improve their operations. Not only can they use the system to determine impacts to their transit services, but the system can also serve as an information distribution system that may result in more travelers being made aware of what transit options are available to them. Potentially, this could increase transit service utilization by showing travelers that there are viable trip alternatives.

Other organizations such as law enforcement, metropolitan planning organizations, and the Department of Homeland Security can provide emergency alerts and warnings to the Trip Information System. The system then serves as another means to inform the public of potential hazards and will improve public awareness and safety.

4.2.2 Construction Weather Archival System

Currently, all of the weather providers to be used by the Construction Weather Archival System are separate, distinct entities. Most of them are outside the auspices of the DOTs, with the exception of RWIS information gathered and accessible through the *Clarus* system and some Automated Weather Observing Systems (AWOS).

Any investigation into the weather impacts on a project is currently performed manually. The investigator has to go to each individual weather provider's public records, gather the necessary information from the historical records, tabulate the data, and then analyze the results. This manual effort can take a lengthy amount of time, may not be complete, and is prone to error.

The primary stakeholders in the Construction Weather Archival System are the DOTs, along with their employees, including DOT project managers and their designees, and DOT attorneys. Additional stakeholders would include the weather data providers. A secondary stakeholder would be the contractor whose claims for weather delays are to be confirmed or denied by the Construction Weather Archival System generated reports.

Prior to the start of the project, the DOT project manager or designee will input data pertaining to the project, such as:

- Contact information
- Project name
- Project number
- Location
- Begin and end dates
- Geographic location bounding box encompassing the project boundaries
- Any other necessary project information

While the construction project is underway, weather data corresponding to the location of the project site is automatically gathered from several external providers, and then archived by the Construction Weather Archival System.

Also, whenever a DOT project manager or inspector is at the job site, they can manually input weather data to supplement the archived weather data. This will help benchmark the automated data that may not have been collected at the precise location of the project site.

The project contractor will notify the DOT when a project has been delayed, and also will notify the DOT when the project has been completed.

At any time during the project, the DOT personnel can query the Construction Weather Archival System to determine if weather conditions could possibly be impacting the project's completion. Likewise, after the project is completed, queries can be made to identify weather impacts during the project duration.

When the Construction Weather Archival System is queried, based on the parameters provided, the system will output the requested information.

Additionally, once sufficient historical data has been obtained, the system could be used prior to a contract letting to show local weather trends, and the likelihood of potential weather impacts to the project. That historical information could be used by the DOT and the contractor in generating the construction timeline.

4.3 External Interface

4.3.1 Trip Information System

Multiple external interfaces will be required for the Trip Information System. The anticipated interfaces are shown in Figure 3 and described in the following paragraphs.

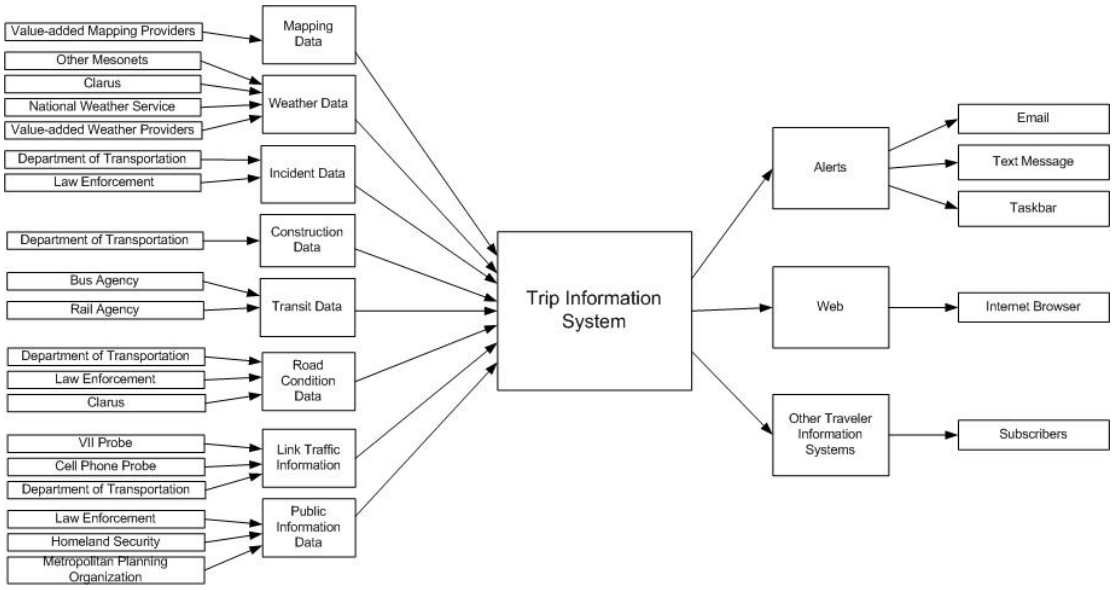

Figure 3 - Trip Information System External Interfaces

The *Clarus* system provides road weather information at regular intervals. It has its own standard format that can deliver the information in either a comma-separated or eXtensible Markup Language (XML) text format. Metadata about the weather observations is also available from the *Clarus* system in a text format. The metadata is needed to apply the appropriate observation types to areas of interest that a route traverses.

NWS observations from its Automated Surface Observing System (ASOS) and AWOS can be used by the Trip Information System. The Common Alerting Protocol (CAP) is an XML text format used to disseminate severe weather watches and warnings from the NWS. Additional weather interfaces may need to be developed as new value-added weather information providers are identified or wish to send their information to the Trip Information system.

Transportation departments can provide their information using two methods. The first method is to use an interface complying with SAE J2354, the message set standard for traveler information. Many existing and upcoming systems employ this standard. Agencies without an automated interface could retrofit their systems to use the J2354 standard when feasible. In the cases where there are no existing systems or the systems cannot easily accommodate an automated interface, the Trip Information System will provide a manual data entry interface, likely through a common Internet web browser.

Additional road condition information may be available from private sector trucking associations. Speed, volume, and occupancy data may also be available from the Vehicle Infrastructure Integration (VII), once the project is completed. The information from either of these sources can be provided by using the same methods as the transportation departments.

The American Public Transit Association (APTA) approved the use of the standard for Transit Communications Interface Profiles (TCIP) to share transit

information among systems. Transit agencies may use this standard to provide transit information to the Trip Information System. Where transit agencies have not adopted the standard or cannot easily retrofit their existing systems, the same transit information can be provided using the same manual data entry interface provided to transportation departments.

Law enforcement, metropolitan planning organizations, and the Department of Homeland Security may provide alerts to the Trip Information System. These types of agencies assisted in the creation of the CAP. Similar to the NWS, emergency alerts can be provided to the Trip Information System using CAP. A human data entry interface will also be available for manually entered alerts.

The Trip Information System will need to integrate a mapping service to provide an interface for travelers to specify their origin and destination. The mapping service then provides the route segments to the Trip Information System through another interface. These route segments are then used by the system to identify applicable travel events and conditions.

Travelers are individual members of the public who use the Trip Information System to plan their trips. Human presentation interfaces can be in the form of text messages sent as email, to pagers, or as pop-up desktop messages. More interactive presentations can be displayed using common web browsers. It is here that the mapping service interface will overlap with the traveler interfaces, serving as a presentation interface to show the user a map.

There are a few outbound interfaces used by the Trip Information System to send its travel planning information directly to travelers or other traveler information systems. Traveler email, pagers, and mobile phones can be sent messages using Simple Mail Transfer Protocol (SMTP). Desktop alert applications and external traveler information systems can use the SAE J2354 and CAP messages as their interface. Web browser interfaces will interact with the system using HyperText Transfer Protocol (HTTP).

4.3.2 Construction Weather Archival System

The Construction Weather Archival System depends on weather data from external sources. The weather interfaces will be similar to the Trip Information System and will encompass the following data sources:

- *Clarus*
- NWS
- Value-added weather providers
- Manual input of weather observations

4.4 Functional Architecture

There are many ways to represent what a system will do and how it will be implemented. Each representation has its own strengths and limitations, but all are intended to create an understanding of the system's boundaries, components, and interactions. Each representation has its own set of basic units and interactions.

One or more of these representations taken together describe the functional system architecture.

The functional architecture of the Trip Information System and the Construction Weather Archival System can be effectively represented as sets of interacting services. Each service has one or more interfaces by which the services interact. This representation is a very natural way of approaching a potentially complex system with a basic repeatable model.

A representation based on services and interfaces inherently leads to a flexible, scalable, and maintainable design. With well-defined interfaces, it is possible to improve the functions of the system by adding services that conform to the interfaces, but which provide new operations. Services do not unnecessarily constrain the physical and computational hardware on which they might be deployed. It is possible to scale the system by adding hardware to support the processing needs of new services as they are developed and deployed. Maintainability can be preserved by being able to update both hardware and software components while the system is running.

The Trip Information System and the Construction Weather Archival System are both based on a service-oriented architecture which will make it flexible, scalable, and maintainable.

4.4.1 Trip Information System

The Trip Information System fulfills a simple purpose: to collect, process, and disseminate information that will affect travel and to inform travelers of potential impacts. As such, the system may not need all of the flexibility its architecture will allow. However, the system does need to be flexible enough to support current and potentially new input providers and map routing services.

Figure 4 is a simple abstract representation of the Trip Information System as a set of services. As shown in the figure, the basic services that comprise the system's functions are input, dynamic data, computational, persistent data, output, presentation, and administrative services. These basic services can be observed in many information systems, but will have specific implementations for the Trip Information System to assure that it meets the intended needs.

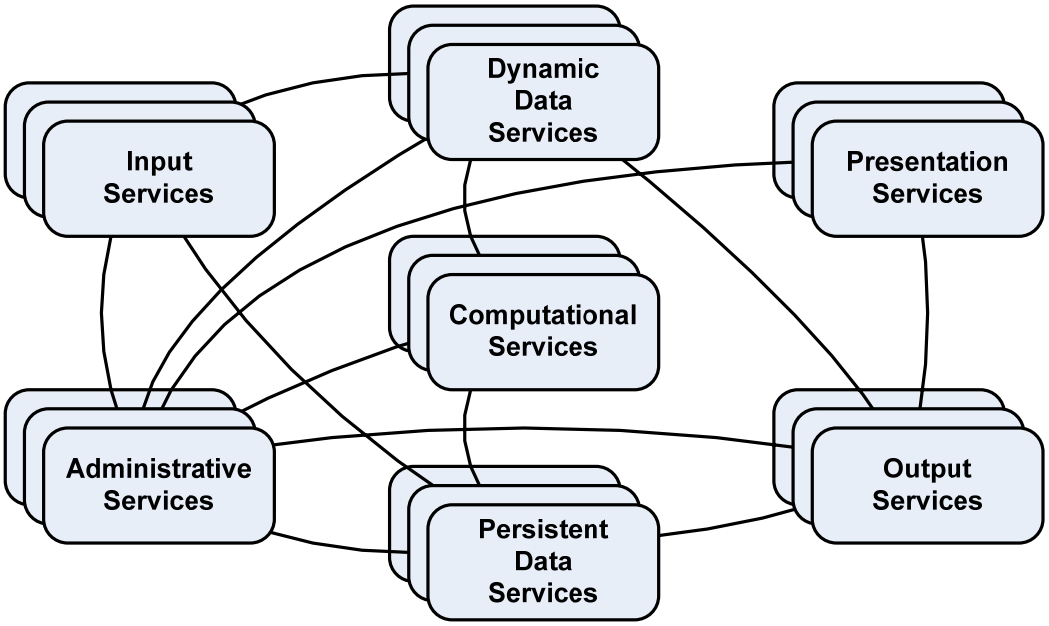

Figure 4 - Trip Information System Services

4.4.1.1 Input Services

Input services provide the ability for the Trip Information System to collect event and condition information that will impact travel from a variety of external systems. These other systems may provide road condition, weather, incident, construction, special event, transit, and emergency alert information. A specific input service will be configured for each information source.

Besides the event and condition information, input services will be needed to accept trip routing information provided by external map and routing services, as well as a traveler's preferred method of receiving updates.

4.4.1.2 Dynamic Data Services

Dynamic data services usually involve relatively short-term information that is rapidly changing and to which fast access is needed. These services can be considered the Random Access Memory (RAM) of the Trip Information System; similar to the purpose of the memory modules in a workstation computer.

Dynamic data services will buffer received traveler information and preserve it long enough for other Trip Information System services to use it. The buffered information is immediately made available to other services, such as those that merge the data into an efficient internal storage format. The dynamic data services will also buffer output information to ensure that the system can deliver notifications in a timely manner.

4.4.1.3 Persistent Data Services

The persistent data services are the long-term memory of the Trip Information System and are intended to provide longer-term storage of information. Archive services, for example, will store subscriber's information relating to their trips,

notification methods, and type of information requested. Other information that may be included in the persistent data services includes the following:

- Contributor information
- Road segments
- Speed limits

Quantitative system data will also be collected by this service for analysis of system performance.

4.4.1.4 Computational Services

Computational services perform the core work for the Trip Information System. Some computational services convert planned trip routes into road segments that the system understands. Other computational services monitor the automated travel information and its impacts to known road segments. In addition, algorithmic calculations will be performed by this service. When planned trips are affected, presentation services are told to create messages that are sent to traveler communication devices informing the travelers of the changes to their routes.

4.4.1.5 Output Services

Output services communicate with the persistent data services to create the necessary information formats so that the received travel information can be used by other services. Output services provide valuable input to other services both within and external to the Trip Information System. J2354 and CAP data formats represent two common output services that interested external systems can use to gather information from the Trip Information System. Additional output information formats can be implemented to support new system needs.

4.4.1.6 Presentation Services

Presentation services support human interpretation of the Trip Information System. Web pages and text messages are created by these services to inform travelers about impacts to their planned trips. Differing message constraints between email, pagers, cell phones, and other mobile devices will be handled by separate presentation services.

Presentation services will also be implemented to create the web browser interfaces for manual entry of traveler, transit, and emergency information where automated interfaces do not exist. New presentation services will be created when new communication devices need to be supported by the Trip Information System.

4.4.1.7 Administrative Services

The Trip Information System uses administrative services to manage and configure other services that make the system operate properly. Administrative services are used to add and remove services, organize the sequence of execution

for the other services, view logging information, configure permissions, and to change the operating modes of the system.

4.4.2 Construction Weather Archival System

The Construction Weather Archival System fulfills the purpose to collect, store, and disseminate project specific weather information for analysis and decision-making. The system should be flexible enough to support current and potentially new input providers and map routing services.

Figure 5 is a simple representation of the Construction Weather Archival System as a set of services. As shown in the figure, the basic services provided by the Construction Weather Archival System are input, persistent data, presentation, and administrative. These basic services are common to all information systems, but will have specific implementations for the Construction Weather Archival System to assure that they meet the needs described in the ConOps.

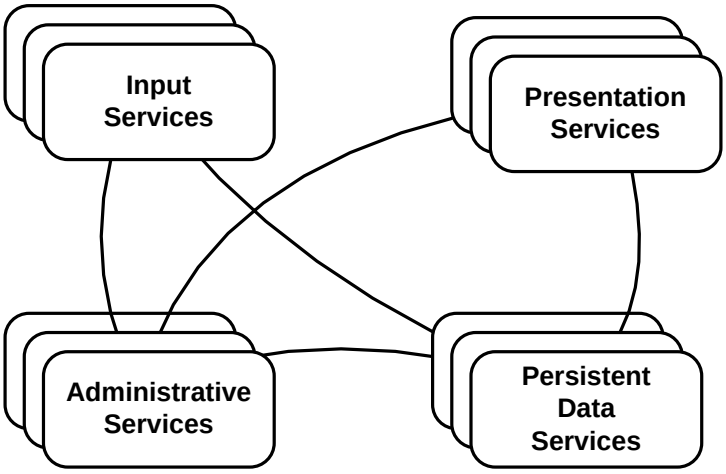

Figure 5 - Construction Weather Archival System Services

4.4.2.1 Input Services

Input services provide the ability for the Construction Weather Archival System to interact with any other system that might have weather data. As described in Section 4.3.2, these other systems could include *Clarus*, NWS, value-added weather providers, and manually input observations.

4.4.2.2 Persistent Data Services

The persistent data services are the long-term memory of the Construction Weather Archival System and are intended to provide longer-term storage of information. Archive services, for example, will store weather observations by contributor and data type. Other information that may be included in the persistent data services includes the following:

- Project Information
- Contributor information

4.4.2.3 Presentation Services

Presentation Services support human interpretation of the Construction Weather Archival System data. Due to the inherent flexibility in modular service implementation, presentation services can be added to the system as needed.

At a minimum, the presentation services will allow a user to request specific weather information by project for output reports. For example, the resident engineer might request the surface temperatures for the life of the project.

4.4.2.4 Administrative Services

The Construction Weather Archival System uses administrative services to manage and configure other services that make the system operate properly. Administrative services are used to add and remove services, organize the sequence of execution for the other services, view logging information, configure permissions, and to change the operating modes of the system.

4.5 Capabilities and Functions

4.5.1 Trip Information System

The majority of the functions performed by the Trip Information System should be automated. Contributing systems should continually send new information as it becomes available. External systems interested in receiving the information should also have an automated interface from which to obtain the information. Very few operating personnel will directly observe the system functions.

The principal component of the Trip Information System is the traveler interface. Travelers will be able to view a map-based interface through which they can select their origin, destination, and travel dates. The map will immediately display current events and conditions based on the traveler's selected filters that will impact their chosen routes, as well as regional forecast weather information. The traveler will also specify how updates are to be received; for example, through an email or text message address. The trip information is stored by the system for future reference.

The Trip Information System will constantly monitor events and conditions that will impact travel and will compare these to the stored traveler trip plans. When there is a match between a planned trip route and a situation update, the system will send an update to the specified address the traveler provided. The traveler will receive the updates en-route if the specified address provided is associated with a mobile phone or pager.

In the case where a traveler does not have an email or text message address or does not want to provide one, there may be user interfaces at locations such as truck stops and rest areas throughout the region. The locations will allow travelers to check their route periodically. These will also allow other travelers who did not set up pre-trip plans to take advantage of the system.

4.5.2 Construction Weather Archival System

The Construction Weather Archival System will provide the user with the ability to select *Clarus* and other weather data for retention based on the dates and location of a specific construction project. The information will be available for future analyses and reporting. User interfaces will provide the ability to define the amount of *Clarus* and other weather observations to be retained for a particular construction project, and to retrieve all or a subset of the archived data and allow the user to generate reports from the data.

4.6 Service Performance

4.6.1 Trip Information System

The selected mapping and routing service will affect the performance of the Trip Information System. Mapping and routing services from commercial providers typically have an upper limit on how many requests can be handled within a 24-hour period using their standard service offerings. 50,000 requests per day is a common limit. This is done so that the service provider can ensure that their capacity and reliability can consistently meet their customer demand. If demand for the Trip Information System is such that additional mapping and routing requests need to be supported, it is anticipated that the service provider will develop a custom pricing package for the system.

Short message service (SMS) limits text message content to two hundred characters. If 50,000 trips are planned daily and each one received one update then the communication bandwidth necessary to successfully deliver all of the messages is approximately 1,000 bits per second (i.e., 200 characters per message * 8 bits per character * 50,000 messages / 24 hours * 3600 seconds per hour). A common communication solution is a T1 data line with a bandwidth of 1.536 million bits per second. This will provide the capability of distributing more than 1,500 alerts per second. If each traveler receives one update for each trip, 1,500 alerts per second can support 130 million travelers throughout a day.

Travelers will make their trips at anytime during the day. Weather and incidents happen without regard to any particular schedule. Consequently, the contributing information systems and the Trip Information System must operate with 100 percent availability. This will be achieved through the use of backup operating hardware. If this level of availability is not achieved, then important information on travel impacts may not be collected or distributed to travelers who need them.

The mapping and routing service does not need to have the same availability. Short duration down-time is tolerable in the case of Internet web browser applications. However, longer-term unavailability may damage positive public acceptance of the Trip Information System.

Received information must be stored long enough to be delivered to impacted travelers. It may also be desired to store the received information for a longer period to conduct performance analyses on the data. Modern electronic storage hardware has extremely large capacities and modular hardware storage solutions

enable nearly unlimited storage. The Trip Information System will have enough storage to handle all of the information provided to it for many years.

Information made available on the Trip Information System should be considered reliable. Data received from other DOT systems and NWS are considered reliable because these systems restrict access to authorized operators and typically have appropriate quality control checks on data before it is published. Similar access control and quality checking measures should apply to manually entered data. Authentication services will ensure that individuals who input data manually are authorized to do so. Policies and procedures will be established for granting data entry privileges and for advising users of their responsibilities for access control and data quality.

Web pages (excluding large graphics and multi-media files) should come up within 5 seconds. Similar performance is required for web pages supporting data entry and system administration.

4.6.2 Construction Weather Archival System

Weather information stored by the Construction Weather Archival System will be provided by *Clarus*, NWS, and other weather providers. *Clarus* maintains its quality checked observations for up to one week and its information can be obtained manually or by subscription services. *Clarus* subscriptions are fulfilled every 20 minutes. The files are placed in a central location for retrieval by the requesting agency or system at their convenience. The files are retained by *Clarus* in the designated location for a minimum of seven days. Data feeds from NWS and other weather providers will need to be collected frequently as those data feeds are constantly updated and mechanisms to retrieve past information are not always available.

The *Clarus* system is designed to accommodate 470 million observations weekly covering all of North America. This equates to 1 TB (terabyte) of information annually. NWS alerts, warnings, and watches for the continental United States consume approximately 3 MB (megabytes) every five minutes. This equates to approximately 308 GB (gigabytes) annually.

A storage requirement estimate for the Construction Weather Archival System will be based on a worst-case scenario: a single state surrounded by eight other states. Using 1.3 TB (1 TB + 308 GB) annually for all of North America, a region of nine states will use about 1/5th of that information or 260 GB annually per state that uses the system. Construction project information is not considered in this calculation as that information is recorded by other systems and can be accessed as needed for the goals of this system.

A good rule-of-thumb, especially where digital storage is concerned, is to double the estimated needed capacity. The initial storage capacity for the Construction Weather Archival System is derived to be 520 GB annually per state. This amount of storage should easily accommodate unknown data volumes received from currently undefined weather information providers.

Since the scope and duration of construction projects are known, and as claim investigations commence, unnecessary weather information can easily be removed from the system. Removing unneeded and/or filtering the collection of weather information based on active and inactive construction projects will greatly reduce the archival system's storage needs. Under these circumstances, the initial 520 GB storage will likely serve the system's purposes for many years.

Actual usage of the archival system will assist in determining future storage expansion needs. 520 GB per state annually is a good starting point. More storage capacity can be added as new states use the system or each state can maintain their own storage.

4.6.3 Modes of Operation

Modes of operation are a way of defining and expressing sets of conditions under which a system is expected to operate. From a system user's perspective, the modes define what can (or cannot) happen while the system is in that mode. From a system developer's perspective, modes prescribe what the system should (or should not) do while the system is in that mode. The modes of operation for the Trip Information and Construction Weather Archival Systems are identical. They are represented in Figure 6 and described below:

- Start – Start is the mode that tells the administrative services to start the dependent processes sequentially as defined. A system in this mode will either transition to Normal mode or to Shutdown mode.
- Normal – Normal is the desired mode for the system. In this mode, the system is ready to receive and process data as designed. From this mode, the system can either go into Abnormal mode, Diagnostic/Repair mode, or Shutdown mode.
- Abnormal – In this mode, the system is still functioning but is also experiencing a problem. From this mode, the system can either go into Diagnostic/Repair mode or Shutdown mode.
- Diagnostic/Repair – In this mode, the system runs diagnostic services in order to attempt a repair. From this mode, the system can either go back into Normal Mode or go into Shutdown mode.
- Shutdown – In this mode, the system is shutting down dependent processes in a predefined sequence. When shutdown is complete, the system will be in Off mode.
- Off – In this mode, the system is completely shutdown. From this mode, the system can go only to Start mode.

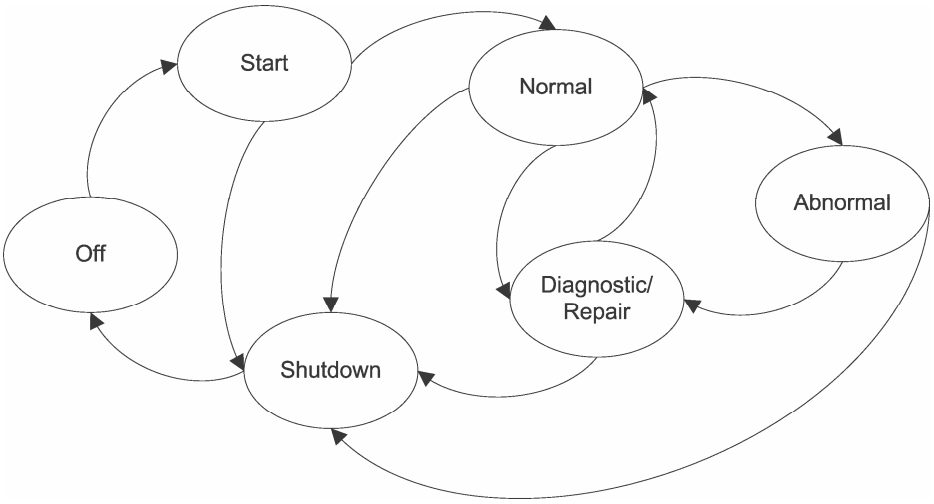

Figure 6 - Modes of Operation

5 OPERATIONAL AND SUPPORT ENVIRONMENT

This section provides a description of the operational and support environment necessary for the Trip Information System and for the Construction Weather Archival System.

5.1 Physical Environment and Facilities

5.1.1 Trip Information System

The system hardware will need to be located in a server environment which includes temperature control, sufficient network bandwidth, physical security, and conditioned power. The actual physical location of the server room is immaterial. Bandwidth requirements will be dependent upon customer acceptance and other design criteria. Existing DOT locations, including traffic management and maintenance facilities, might need additional equipment and network connectivity to support the equipment for this project.

5.1.2 Construction Weather Archival System

The system hardware will need to be located in a server environment which includes temperature control, sufficient network bandwidth, physical security, and conditioned power. The actual physical location of the server room is immaterial. Bandwidth requirements will be dependent upon customer acceptance and other design criteria. Existing DOT locations, including traffic management and maintenance facilities, might need additional equipment and network connectivity to support the equipment for this project.

5.2 Hardware

5.2.1 Trip Information System

The system will be an open system. The hardware will include a minimum of one server to support the Trip Information System. The design, storage, and performance requirements may dictate the need for additional servers. Interfaces to existing equipment will be network-based. Router and firewall security will need to be provided for the system. A conditioned reliable power supply is required and should be commensurate with the availability requirements of the system.

5.2.2 Construction Weather Archival System

The system will be an open system. The hardware will include a minimum of one server to support Construction Weather Archival System. The design, storage, and performance requirements may dictate the need for additional servers. Interfaces to existing equipment will be network-based. Router and firewall security will need to be provided for the system. A conditioned reliable power supply is required and should be commensurate with the availability requirements of the system.

5.3 Software

5.3.1 Trip Information System

The Trip Information System should be designed utilizing an open-system architecture. The operating system and storage software selected does not create a dependency on the design. By selecting an open-system architecture, the impact to future enhancements of the system will be minimized.

Data will be received from a variety of external sources:

- Mapping and routing service providers
- *Clarus* system
- Other public/private weather data providers
- Transit/rail systems
- Other DOT and public sector systems
- Other private sector systems

The system is dependent on each of the external sources for data. The external source must be stable, reliable, and available. The software will need to monitor its own internal and external resources and have the capability to alert staff to resource problems.

The software will need to include web-based graphical user interface (GUI) services so that the traveler can input the specifics of their trip and receive the requested outputs. The GUI interface will need to be appropriately designed for use with both personal computers and mobile computing devices. The software will take data received from external sources and correlate it with the selected route. In this way, the traveler will be provided a comprehensive view of their trip, including directions, weather impacting the route, and other travel conditions which affect the route. The application software will use one or more databases to store and retrieve the data. The application will include monitoring functionality in order to alert the subscriber to changing travel conditions which affect his subscribed route. The software will need to include a downloadable taskbar alert application.

5.3.2 Construction Weather Archival System

The Construction Weather Archival System should be designed utilizing an open-system architecture. The operating system and storage software selected does not create a dependency on the design. By selecting an open-system architecture, the impact to future enhancements of the system will be minimized. The software will need to include a scheduling service so that the appropriate data can be acquired from external sources on a scheduled basis.

Data will be received from a variety of external weather sources. These sources include the following:

- *Clarus* system

- NWS
- Other public/private weather data providers

The system is dependent on each of these sources for data. Therefore, the sources must be stable, reliable, and available. The software will need to monitor its own internal and external resources and have the capability to alert staff to resource problems.

5.4 Personnel

5.4.1 Trip Information System

The personnel needed to support the Trip Information System include

- system administrators;
- operators.

It is expected that the system administrators will possess a high school diploma (college degree preferred) and at least one year of experience as a system administrator. The system administrator will need to be capable of learning new subjects and willing to participate in training to support the new services. The system administrator's working hours need to able to support the desired availability of the system.

It is expected that the operators will also possess a high school diploma and will have experience as operators of software-based traffic operations systems. The operators will need to be experienced in entering data via a manual data entry screen on a computer.

5.4.2 Construction Weather Archival System

The personnel needed to support the Construction Weather Archival System include

- system administrators;
- DOT staff.

It is expected that the system administrators will possess a high school diploma (college degree preferred) and at least one year of experience as a system administrator. The system administrator will need to be capable of learning new subjects and willing to participate in training to support the new services. The system administrator's working hours need to able to support the desired availability of the system.

The DOT staff members who will use the Construction Weather Archival System are the same staff that currently gather and analyze weather information related to construction projects.

5.5 Organizational or Personnel Structures

5.5.1 Trip Information System

Data sharing agreements may be required to allow the Trip Information System to access the desired data from contributing systems. In addition, if a third party vendor wishes to display the information within the Trip Information System, data sharing agreements and possible fees may be needed.

5.5.2 Construction Weather Archival System

Data sharing agreements may be required to allow the Construction Weather Archival System to access the desired data from contributing systems. Since the weather information archived in the system is not anticipated to be redistributed, no other data sharing agreements would apply.

5.6 Operations

5.6.1 Trip Information System

The Trip Information System will be available to the traveler via the Internet. The services will need to be available 24 hours a day and 7 days a week. Since the services are dependent upon external sources of data, the Trip Information System will need to be able to determine when those external systems are not responding as expected and provide appropriate feedback to the system user.

Policies and procedures will be established for the administration, operation, and maintenance of the Trip Information System. As a minimum, these policies and procedures should address system security, access control, and quality control for information received, entered into, and published by the system.

The DOT organizations will need to establish policies and procedures for allowing manual data entry. Policies and procedures within participating agencies should address access control and quality control for information provided to the system.

A system interface specification should be published for the system, identifying the information formats (such as CAP and J2354) used by the system to receive and publish information. This specification should be used as the basis for establishing automated data exchanges with external information systems.

E-mail and text messaging services must comply with the constraints imposed by state and federal anti-spam legislation.

5.6.2 Construction Weather Archival System

The Construction Weather Archival System will need to acquire weather data as scheduled by the responsible DOT personnel. This will result in the need for the system to be available 24 hours a day and 7 days a week. Since the services are dependent upon external sources of data, the system will need to be able to determine when those external systems are not available so that maintenance can be performed.

5.7 Training

5.7.1 Trip Information System

The Trip Information System is intended to be used by the traveling public. Training will be provided through on-line, context-based help files which the user can access to find more information.

The owner of the system will designate Information Technology (IT) personnel to support the system. The IT personnel must be trained in the operation and maintenance of services. This requires the development of consistent plans for training and continuing education for relevant support personnel.

5.7.2 Construction Weather Archival System

Training for the Construction Weather Archival System will be provided by on-line, context-based help files which the user can access to find additional information.

The owner of the system will designate IT personnel to support the system. The IT personnel must be trained in the operation and maintenance of services. This requires the development of consistent plans for training and continuing education for relevant support personnel.

5.8 Maintenance

5.8.1 Trip Information System

The owner of the system will designate IT personnel to support the system. The personnel will need to have training on the various aspects of maintenance of the system. A basic understanding of the interfaces used by the system and application processes will be needed.

Routine maintenance will be performed by the designated IT personnel and will include normal server maintenance, operating system maintenance, and backups/restores of data. Corrective maintenance includes the re-establishment of data interfaces with external data sources. This maintenance will require coordination between the owner's IT personnel and the IT staff at the external data source. Emergency maintenance will be performed by the designated IT personnel and may include system recovery from server failure.

After the initial deployment of Trip Information System, additional functionality may be developed. System upgrades, in both hardware and software, must be deployed in a coordinated fashion to achieve a nationwide scale. This will require procedures for testing and certifying both hardware and software upgrades before they are presented for deployment.

5.8.2 Construction Weather Archival System

The owner of the system will designate IT personnel to support the system. The personnel will need to have training on the various aspects of maintenance of the

system. A basic understanding of the interfaces used by the system and application processes will be needed.

Routine maintenance will be performed by the designated IT personnel and will include normal server maintenance, operating system maintenance, and backups/restores of data. Corrective maintenance includes the re-establishment of data interfaces with external data sources. This maintenance will require coordination between the owner's IT personnel and the IT staff at the external data source. Emergency maintenance will be performed by the designated IT personnel and may include system recovery from server failure.

6 OPERATIONAL SCENARIOS

A scenario is a step-by-step description of how the proposed system will operate and interact with its users and its external interfaces under a given set of circumstances. The following scenarios will allow readers to walk through activities and gain an understanding of how the various parts of the proposed system function and interact. The scenarios will tie together the system, the users, and other entities by describing how they interact.

6.1 The Trip Information System for the Traveler

A traveler is planning a trip for tomorrow from Davenport, IA to Indianapolis, IN. Since the traveler is unfamiliar with the route, the traveler selects the Trip Information System, a web-based application, to obtain directions. The traveler is familiar with the website and has used it previously. The traveler uses his username and password to log in. Once logged in, the traveler creates a new custom trip by inputting the desired origin (Davenport, IA), destination (Indianapolis, IN), and the desired arrival time (tomorrow at 10 a.m.). The traveler also indicates that interstate highways are the preferred route and that a passenger car is the vehicle type. The traveler specifies that a round trip will be needed and that the planned return departure time is 7 p.m.

A trip plan for the best route is returned to the traveler showing a graphical map of the drive, text travel directions with mileage, and a suggested departure time of 5 a.m. from Davenport, IA. The trip plan also provides the traveler with information regarding the weather forecast during the specified trip and states that there are no other travel conditions which affect the trip plan. The traveler is given the option to either accept the plan or to revise the plan. The traveler accepts the plan and the system shows a screen where the traveler can enter information in order to receive updates via an electronic device while on the road. The traveler requests that road condition updates, construction updates, and weather updates be sent to his cell phone for the duration of this trip.

The next day, the traveler leaves Davenport, IA at 5 a.m. As he reaches Bloomington, IL, an alert is received indicating that there is a major road closure at Champaign-Urbana with a predicted 2 hour delay. The traveler decides to stop for breakfast at Bloomington, IL and to let his associates in Indianapolis know that he will be arriving late. While eating breakfast the traveler receives update alerts which indicate that the incident is clearing and eventually receives an alert

stating that two of the three lanes are now opening and the delay is only 10 minutes. The traveler restarts his trip and when he reaches Champaign-Urbana, he encounters only a minor slowdown of traffic. He continues on and arrives in Indianapolis.

At the end of the day, the traveler receives alerts that there are severe weather watches and warnings covering most of Illinois south of Peoria to just west of Indianapolis. An alternate route through Gary, Indiana is suggested. The system also indicates that there is some construction in the Gary, IN area. Accepting the alternative route, the traveler begins his return trip and arrives home safely.

6.2 The Trip Information System for the Commuter

A commuter, who lives near Three Oaks, MI, has taken a new job which is located in downtown Chicago near Millennium Station. The commuter is familiar with the Trip Information System website and has used it previously. The resident uses his username and password to log in. Once logged in, the traveler creates a new custom round trip by inputting the desired origin (Three Oaks, MI), arrival destination (Chicago, IL), desired arrival time (7:45 a.m.), and the desired return time (5:00 p.m.).

A trip plan for the best route is returned to the traveler showing a graphical map of the drive, text travel directions with mileage, and a suggested departure time of 5 a.m. from Three Oaks, MI. Due to the rising costs of fuel, the resident decides to investigate the use of public transit for the majority of his commute. Using the Trip Information System website, the traveler requests a display of transit options in the area. The commuter discovers that the Northern Indiana Commuter Transport District provides public transportation between Michigan City, IN and Chicago, IL. The traveler requests transit information for this commute and requests Parking information. The website returns information that the South Shore Line has a train which leaves at 5:55 a.m. from the 11 Street Station in Michigan City, IN and arrives at Millennium Station with a few minutes to spare. A return trip leaves Millennium Station at 5:10 p.m. The website shows the driving directions from Three Oaks, MI to Michigan City, IN. The information also shows that there is parking available at the 11 Street Station. The commuter accepts the information and subscribes to weekday alerts during his morning commute for the following:

- Weather conditions
- Road conditions
- Incidents
- Parking capacity at 11 Street Station
- South Shore Line train schedule updates
- South Shore Line train capacity updates

He subscribes to weekday alerts for his afternoon commute for the following:

- South Shore Line train schedule updates

- South Shore line train capacity updates
- Incidents
- Road conditions
- Weather conditions

6.3 The Trip Information System for Trucking

A trucking company has many different trucks on the road. The company has a contract to transport goods from Youngstown, OH to Council Bluffs, IA on a daily basis. The trucking company dispatcher has an account on the Trip Information System and has requested travel condition alerts for this route. The truckers leave Youngstown, OH as directed by the dispatcher in the morning. In the late morning, the dispatcher receives a taskbar alert indicating that all of Iowa is experiencing icing conditions and that sections of the interstates are being closed. After reviewing the truck locations, the dispatcher determines that two alternate routes are possible. The dispatcher uses the trip planner tool to verify the feasibility of both routes and discovers that one route has road restrictions which are not acceptable. The truckers are contacted and instructed to divert to the acceptable alternate route. Since the alternate route will extend the travel time, the dispatcher advises the customer that the trucks are still in route but due to the weather, they will arrive later. The dispatcher updates the taskbar alert request to add the alternate routes to his notification list.

6.4 The Trip Information System for Dispatch at Distribution Center

A truck company receives freight at a rail distribution center in downtown Cleveland. The dispatcher at the distribution center monitors the travel conditions of the roads around the distribution center. The dispatcher receives a taskbar alert that Interstate 90 and Interstate 77 are closed in both directions in the downtown area. The dispatcher notifies the trucks currently on-site of the traffic situation and directs them to a temporary parking area. The dispatcher continues to receive taskbar alerts regarding the interstate highways. Once the highways are re-opened, the dispatcher notifies the truck drivers that everything is back to normal.

6.5 The Trip Information System for Law Enforcement Dispatch

In Des Moines, IA, an emergency call is received which indicates that there is an accident with injuries resulting in a vehicle fire at the intersection of Day Street and 22nd Street. Emergency responders needed include police, fire, and ambulance personnel. The emergency response dispatcher uses the automatic vehicle location information from the Computer-Aided Dispatch (CAD) System to determine the locations of available responders. The dispatcher correlates the CAD route information with the data in the Trip Information System to determine if there is any weather or construction affecting routes in the area. The Trip Information System shows that freezing drizzle is falling and the road surface temperatures are below freezing resulting in glazed overpass bridges in the area of the accident. The dispatcher selects police responders who are already on the north side of I-

235 and will not need to use the overpass bridges. The Trip Information System indicates that DOT crews are working on I-235 and have reduced the westbound lanes under the 19th Street overpass to one lane. The dispatcher selects a different route for the fire and ambulance responders and provides the routing information to them. This allows all of the responders to arrive quickly at the accident site.

6.6 The Trip Information System for Transit

Many communities offer transportation services for senior citizens in metropolitan areas. Seniors request the transportation in advance. The dispatcher uses the Trip Information System to determine the best route for the driver to take to provide transportation to the seniors who have scheduled their trips for the next day. The trip plan uses interstate highways and secondary state routes, as well as local streets. The dispatcher requests travel condition alerts for each route he accepts from the system. The driver is provided with the directions in the morning and starts on his route. The weather forecast predicts rain throughout the day and the temperature is dropping. Mid-morning, the dispatcher receives a taskbar alert that the rain is freezing on bridges and overpasses which are part of the driver's route. The dispatcher determines an alternate route and uses the trip planner to verify the feasibility of the route. The dispatcher contacts the driver with the alternate route and the driver is able to avoid the icy bridges and overpasses. The dispatcher continues to monitor the weather and decides that the road conditions are deteriorating. A decision is made to return the seniors safely home and to suspend any additional pickups. A new route is planned and the driver is notified.

6.7 The Trip Information System for the Traveler via User Interface

The driver of a recreational vehicle is traveling from Indianapolis, IN to Columbus, OH on Interstate 70 just before Thanksgiving. The driver realizes that the weather appears to be changing and decides to stop at the Ohio Welcome Center/Rest Area just after he enters Ohio. He finds that an information provider has a user interface available on which he can select a screen for the current weather conditions with the mouse. The graphic interface with radar image shows that he will be driving through some light showers but that the temperature is still above freezing. He notices that there is also a selection available which has construction road conditions. He selects this option and is able to determine that there is no construction between his location and Columbus, OH. The traveler continues his trip after verifying the wipers and lights are working properly on his vehicle.

6.8 Construction Scenario

Prior to the start of a construction project, the DOT and the contractor agree upon a construction timeline, with specific deadlines to be achieved in order to keep the project on schedule. Allowances for adverse weather conditions are built into the agreed upon project deadlines.

Prior to the start of the project, the DOT's project manager will identify a list of specific weather parameters known to affect the project's completion. For

example, on a project that requires pouring concrete, certain temperatures, humidity levels, and rainfall or snowfall conditions may prevent the pour. Additionally, the project manager will gather project-specific information. The weather parameters and project information will be input to the Construction Weather Archival System.

Project-specific information the project manager may provide to the Construction Weather Archival System includes the following:

- Project contact information
- Project name
- Project number
- Project location
- Project start and end dates
- Geographic location bounding box encompassing project boundaries
- Any other necessary project information

Weather parameters that the project manager might be interested in for this particular project include the following:

- High and low daily temperatures
- Precipitation type
- Precipitation amount
- Wind conditions
- Any other necessary weather parameters relating to the project

After the project manager has selected the desired parameters, the Construction Weather Archival System will collect the specified weather parameters from each of its input sources, and store the information in the system's database for future retrieval and use.

Under normal circumstances, the project can be completed in a timely basis. However, sometimes delays are caused by suppliers missing deadlines, sometimes by the contractor allocating his resources to other projects with the expectation that there would still be enough time to shift resources to this specific project, and other times, delays may be caused by adverse weather conditions. The contractor will keep track of conditions causing project delays, and submit the reasons for any delays upon project completion, or as requested by the DOT.

As construction proceeds, the DOT's project manager monitors critical project deadlines, and confers with the contractor to ensure that the project will still be completed within the overall project deadline.

The project manager can also interrogate the Construction Weather Archival System to confirm or deny the contractor's claims regarding project delays.

A situation might take place where the contractor is to perform certain tasks between May and August, and those tasks requiring dry conditions will take 7 weeks to complete. Rather than start those tasks in May or June, the contractor waits until July to begin. During the month of July, rain occurs during three of four weeks impacting the ability of the contractor to perform the scheduled activities. The project is not completed by the end of August.

The contractor complains that they were unable to complete the project on time because of adverse weather conditions at the project site.

The DOT's project manager accesses the Construction Weather Archival System and obtains the weather conditions for the months of May through August at the project location to verify the contractor's claims.

After looking through the output reports from the Construction Weather Archival System, the project manager agrees that the months of July and August were indeed too wet for the project work to be performed. However, the project manager finds that the months of May and June did provide adequate dry conditions to enable the tasks to have been performed and completed within the contract timeframe. Since this was consistent with the agreed project schedule and there is no indication that delays to earlier tasks prevented the work starting in May, the DOT project manager denies the contractor's claim, and may decide to impose penalties on the contractor.

Additionally, after the project is complete, abnormal deterioration of the project infrastructure may occur. With the information contained in the Construction Weather Archival System, the project manager can analyze the weather conditions during specific construction activities to help determine if the execution of the activities was completed within DOT weather specifications.

7 SUMMARY OF IMPACTS OR IMPROVEMENTS

This section includes an analysis of the proposed services and the impacts on each of the stakeholders. It is presented from the viewpoint of each stakeholder, so that they can readily understand and validate how the proposed services will affect their operations.

7.1 Operational Impacts

7.1.1 Trip Information System

The Trip Information System will provide the user with a "one-stop" location to plan a complete trip based on desired route characteristics, and considering the impacts of weather, incidents, construction, and road condition, and transit availability. The system will assist the traveler in identifying risks to both travel safety and travel time.

Travelers will be able to make a more informed decision about their trip. As travelers receive alert updates, they will be able to modify their route during their travel period. The operational impact to this stakeholder group is increased safety and better use of their time.

The *Clarus* system and its operators are the primary source of road weather information. The operational impact to this stakeholder is the need to provide the resources necessary to support increased demand and continuous operation of the system.

Similarly, the transportation departments and other government agencies that are responsible for the transportation infrastructure, and whose systems will be sources of information will need to provide the resources necessary to support the level of service required of their systems.

Maintenance managers may find the Trip Information System to be a useful tool when planning maintenance. The system will be able to provide an overview of the events and conditions on identified road segments.

Transit operators will be able to use the system to improve their operations. The operational impact to this stakeholder will be the ability to assess the effectiveness of routes and to determine potential improvements.

The operational impact to the stakeholder group of public safety and planning organizations is that the system will provide an additional mechanism to inform the public of potential hazards and will improve public awareness and safety.

7.1.2 Construction Weather Archival System

The Construction Weather Archival System will provide the user with a mechanism to gather construction project-related weather data in a single location. This will allow the investigation of weather impacts on a project to be performed in a more efficient manner.

The primary stakeholders in this system are the DOT employees and their designees who are assigned the task of investigating a contractor's claim of construction delays due to weather. The operational impacts to this group of stakeholders are as follows:

- Improve the accuracy of claim validation
- Increase the efficiency of data queries
- Reduce the amount of time necessary for analyses

The weather data providers, including the *Clarus* system and its operators, are the source of weather information. The operational impact to this stakeholder is the need to provide the resources necessary to support the increased demand and continuous operation of the system.

The project contractor whose claims of construction delays due to adverse weather will know that weather data is gathered by the Construction Weather Archival System. The operational impact to this stakeholder will be a more expedient claim resolution.

7.2 Effectiveness Evaluation

Measures of effectiveness can be difficult to define. The effectiveness of any particular system is dependent on the purpose of that system. Baseline statistics about a new system do not exist and effectiveness is gauged against known system limits or expectations of the stakeholders. Once baseline operational statistics have been gathered, it is easier to determine the meaning of effectiveness and the management directions or system modifications that need to be taken to improve that effectiveness.

As an example, perhaps a new signal timing system has been installed. Before the new signal timing system was deployed, 400 cars per hour are detected on a particular roadway segment. With the new signal timing system, 1800 cars per hour are detected on the same segment.

In this scenario, the measure of effectiveness could be defined as the number of vehicles per hour within a specified length of roadway. The goal of installing a new signal timing system is logically to improve resource—in this case the roadway—utilization. Baseline statistics were known from previous observations and it is clear that the new signal timing system was successful within the context for the defined measure of effectiveness.

The following subsections will briefly describe the purposes of the Trip Information System and Construction Weather Archival System, what those systems affect, and the methods by which their effectiveness will be assessed.

7.2.1 Trip Information System

The Trip Information System's purpose is to collect information about events and conditions that impact travel and to notify travelers of those impacts when they will affect planned trips. Travelers are the direct focus of the Trip Information System and its effectiveness directly correlates to the number of users of the

system. Regardless of the comprehensiveness of the information made available through the system, if there are no users, then the system would not be considered very effective.

The number of users and the total number of repeat users are two methods to directly gauge effectiveness. After a short period, in the range of one week to one month, baseline usage can be established. Subsequent periods can then be used to gauge improvement or decline in usage.

If there is little change in usage, it is possible that additional publicity about the Trip Information System is needed. Lack of increased usage is not always an indication that the system is not effective, but that the system is unknown to potential users. There are many ways to notify potential users about the system such as media outlets or flyers in motor vehicle registration packets.

The system itself could offer feedback options through its user interface. If email addresses are provided for planned trips, as a recurring email address is detected, simple questions could be presented to see if the user likes the system or would tell others about the system. A direct method to leave comments could also be provided.

Surveys external to the system could be offered to both ad-hoc and registered users. These surveys can be used as additional marketing materials. Measuring the automated system usage against planned marketing can also be used to measure the value of the information campaign.

Another method of evaluating the Trip Information System is to ask the question of whether or not the system is doing what is expected. The collected traveler information is stored for analysis. It is possible for a person to quality check the system by randomly selecting trips and comparing the impacts that were communicated to a traveler to the impacts that should have been communicated. This exercise may discover that system algorithms or routing metadata need to be updated to improve notifications to travelers. Independent quality verification will ensure that the system is meeting as many traveler needs as possible.

7.2.2 Construction Weather Archival System

The Construction Weather Archival System affects the timeliness and thoroughness of the investigation of contractor claims of schedule delay due to weather. The financial penalties collected or not collected by the owning agency, as well as the time invested to determine claim validity, can represent significant swings in revenue. Consequently, the effectiveness of this system can be based on expense.

The number of contractor claims, the number of significant weather events, the amount of time spent investigating contractor claims, and the amount of revenue gained or lost from those claims are all recorded and are known historical quantities. All of this information can be summarized as the ratio of money recovered to money spent. If that measure increases more than the cost of deploying and maintaining the system, then the system is successful.

8 OTHER CONSIDERATIONS

It is anticipated that data sharing agreements will be needed between external data providers and the DOT owners of the Trip Information and Construction Weather Archival Systems.

Travelers who use the Trip Information System will need to read and accept privacy and terms of use statements which may include disclaimers.

As a web-based government information service, the system may be a target of malicious tampering. The security for the system should meet the minimum security standards for a General Support System as described in the *Generally Accepted Principles and Practices for Securing Information Technology Systems*, National Institute of Standards and Technology Special Publication 800-14. The system should also meet the security requirements for participating DOT's computer systems.

Risk factors for success of the system include both too much and too little interest within the identified community of potential users of the Trip Information System.

The community could show too little interest in the system if the coverage and quality of information do not meet user expectations. The system must acquire and deliver enough useful information to capture and keep the interest of the user community. Users who are disappointed with a web site's content will rarely return for subsequent visits.

There are also risks associated with being too successful, particularly with the subscription services. There may be several dozen incidents and construction/maintenance related lane closures during any given day. If users do not set filters to keep the number of messages down to a useful volume, the number of messages received from the system can turn from a useful flow of information into a constant flow of interruptions. Email systems may be especially sensitive to large volumes of email originating from the system and may blacklist the site as a spam source unless generally accepted anti-spam conventions are followed. Users must always be given an easy way to filter or stop the subscription messages when they might be inconvenient.

Initially, risks associated with content quality are relatively low. Since information is already available to the public through other sources, users should be able to verify questionable incidents. However, it may be appropriate to require subscription users to read and acknowledge a statement that the information provided is accurate to the best of the provider's knowledge, and that the state accepts no liability for the accuracy or timeliness of the information. Users of the taskbar broadcast service should be required to acknowledge a software users license for the taskbar software and acknowledge the same disclaimer for the information.

APPENDIX A: DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

The following table provides the definitions of all terms, acronyms, and abbreviations required to properly interpret this Concept of Operations.

Term	Definition
511	Nationwide traffic information telephone number
AMBER	America's Missing Broadcast Emergency Response
APTA	American Public Transit Association
ASOS	Automated Surface Observing System
ATIS	Advanced Traveler Information System
AWOS	Automated Weather Observing System
CAD	Computer-Aided Dispatch
CAP	Common Alerting Protocol – an open, non-proprietary standard data interchange XML format that can be used to collect all types of hazard warnings and reports locally, regionally and nationally, for input into a wide range of information-management and warning dissemination systems.
Clarus	The *Clarus* (which is Latin for "clear") System is an integrated surface transportation weather observing, forecasting and data management system.
ConOps	Concept of Operations
DOT	Department of Transportation
FHWA	Federal Highway Administration
GB	Gigabyte
GUI	Graphical User Interface
HTTP	HyperText Transfer Protocol
HVAC	Heating, ventilation, and air conditioning
IEEE	Institute of Electrical And Electronic Engineers, Inc.
IT	Information Technology
ITS	Intelligent Transportation Systems
J2354	SAE standard message protocol for the Advanced Traveler Information System, which describes the format of messages for travel conditions and traffic events.

Term	Definition
Link Traffic Information	Link Traffic Information refers to speed, volume, and occupancy.
MADIS	Meteorological Assimilation Data Ingest System
MB	Megabyte
MPH	Miles per Hour
NOAA	National Oceanic & Atmospheric Administration
NWS	National Weather Service
OASIS	Organization for the Advancement of Structured Information Standards
RAM	Random Access Memory
RWIS	Road Weather Information System - a unique system consisting of many meteorological stations strategically located alongside highways that allow the state Departments of Transportation to make more informed decisions during storms; specialized equipment and computer programs monitor air and pavement temperature to make forecasts regarding how the weather impacts the operation and maintenance of the highways.
SAE	An organization formerly known as Society of Automotive Engineers, now known as SAE International
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
TB	Terabyte
TCIP	Transit Communications Interface Profiles
USDOT	United States Department of Transportation
VII	Vehicle Infrastructure Integration
XML	eXtensible Markup Language

APPENDIX B: NEEDS FOR THE SYSTEMS

B.1 Trip Information System Needs

1. Need to acquire mapping data
2. Need to acquire surface weather and atmospheric information
3. Need to acquire weather forecasts
4. Need to acquire weather alerts (NWS watch and warning)
5. Need to acquire incident information
6. Need to acquire traffic information
7. Need to acquire travel time
8. Need to acquire congestion forecasts
9. Need to acquire road condition information
10. Need to acquire transit information
11. Need to acquire parking lot information
12. Need to acquire link traffic information
13. Need to acquire public information alerts
14. Need to process surface weather and atmospheric information
15. Need to process weather forecasts
16. Need to process weather alerts using CAP
17. Need to process incident information
18. Need to process traffic information
19. Need to process travel time
20. Need to process congestion forecasts
21. Need to process road condition information
22. Need to process transit information
23. Need to process parking lot information
24. Need to process link traffic information
25. Need to process public information alerts
26. Need to publish requested information on GUI
27. Need to provide requested information formatted for printing on user's printer
28. Need to publish data required via subscription to user using email
29. Need to publish data required via subscription to user using text messages
30. Need to publish data required via subscription to user using taskbar alerts

31. Need to display graphical overview map of route
32. Need to display graphical detail map of route
33. Need to display graphical map of route with weather data
34. Need to display graphical map of route with construction data
35. Need to display graphical map of route with incident data
36. Need to display graphical map of route with road condition data
37. Need to display graphical map of route with transit data
38. Need to display graphical map of route with link traffic information data
39. Need to display graphical map of route with public information data
40. Need to present text directions for route
41. Need to present text directions for route with weather data
42. Need to present text directions for route with construction data
43. Need to present text directions for route with incident data
44. Need to present text directions for route with road condition data
45. Need to present text directions for route with transit data
46. Need to present text directions for route with link traffic information data
47. Need to present text directions for route with public information data
48. Need to provide GUI interface for use with personal computer
49. Need to provide GUI interface for use with mobile computing device
50. Need to provide GUI interface for use with mouse
51. Need to provide ability to cycle through a set of web pages without mouse for use by other information providers at their location
52. Need to provide graphical map of transportation system for use by other information providers at their location
53. Need to provide zoom capability of graphical displays with mouse for use by other information providers at their location
54. Need to provide graphical map of road conditions for use by other information providers at their location.
55. Need to provide graphical map of road construction for use by other information providers at their location
56. Need to provide weather radar map for use by other information providers at their location
57. Need to provide a web page with system-wide alerts for use by other information providers at their location
58. Need to provide standard method of representing surface weather data

59. Need to provide standard method of representing atmospheric weather data
60. Need to provide standard method of representing road construction
61. Need to provide standard method of representing road conditions
62. Need to provide standard method of representing incidents
63. Need to provide standard method of representing link traffic information data
64. Need to provide standard method of representing transit data
65. Need to provide standard method of trip planning
66. Need to provide standard method of determining construction impact
67. Need to provide standard method of determining road condition impact
68. Need to provide standard method of determining incident impact
69. Need to provide standard method of determining travel time.
70. Need to provide a standard message set for subscribed alerts
71. Need to present context-based help files for GUI user
72. Need to provide GUI interface which allows user to define a customized trip
73. Need to provide GUI interface which allows the user to subscribe to available alerts
74. Need to provide GUI operator interface
75. Need to provide GUI operator interface for data entry
76. Need to provide GUI administrator interface
77. Need to provide printed administrator reports
78. Need to provide on-screen administrator reports
79. Need to provide interface to receive information from each external system
80. Need to provide data store for transportation-related data
81. Need to provide data store for user account information
82. Need to provide data store for system configuration information
83. Need to provide data store for alert information
84. Need to provide security for stored data
85. Need to manage and validate users
86. Need to manage administrators/operators
87. Need to manage user groups
88. Need to provide backup/restore tools
89. Need to provide workstation backup/restore tools
90. Need to provide anti-virus software

91. Need to provide downloadable taskbar alert software
92. Need to provide intrusion detection
93. Need to provide firewall protection
94. Need to provide ability to schedule subscription alerts
95. Need to quality check information
96. Need to meet industry standards for ITS system
97. Need to meet existing legal constraints
98. Need to provide operating agreements defining conditions for receiving data
99. Need to provide operational procedures
100. Need to maintain high availability
101. Need to meet performance requirements
102. Need to provide a maintenance plan
103. Need to provide a system security plan
104. Need to monitor system status
105. Need to provide an event log which records system events
106. Need to publish system status information via log files
107. Need to provide GUI method for administrators to monitor system
108. Need to provide method for administrators to monitor system and network security
109. Need to provide administrators with notification of system errors
110. Need to have a competent and well-trained staff
111. Need to provide system documentation
112. Need to provide system operator manuals
113. Need to provide system administrator manuals
114. Need to provide system maintenance manuals.
115. Need to provide system training for operators
116. Need to provide system training for administrators
117. Need to provide physical security for system
118. Need to provide network infrastructure
119. Need to provide reliable power supply
120. Need to provide heating, ventilation, and air conditioning (HVAC) infrastructure

B.2 Construction Weather Archival System Needs

1. Need to input project information through GUI
2. Need to input project geographic limit information through GUI
3. Need to input desired input sources through GUI
4. Need to input desired project weather observations through GUI
5. Need to acquire weather observations by push, pull, and manual input methods
6. Need to acquire weather forecasts by push and pull input methods
7. Need to acquire weather alerts (watches and warnings)
8. Need to provide for new input services
9. Need to provide for new users
10. Need to identify authorized users with access to project information
11. Need to store project information
12. Need to log users who attempt to access unauthorized data
13. Need to manage and validate users
14. Need to manage administrators / operators
15. Need to manage user groups
16. Need to store weather observations for each project by input source.
17. Need to provide GUI-based project selection list for generating reports
18. Need to provide GUI-based project parameter list for generating reports
19. Need to provide GUI-based project geographic limit selection for generating reports
20. Need to provide GUI-based time-period selection for generating reports
21. Need to provide GUI-based input source selection list for generating reports
22. Need to provide for reporting functionality
23. Need to provide for new types of output reports
24. Need to provide security for stored data
25. Need to provide backup / restore tools
26. Need to provide workstation backup / restore tools
27. Need to provide anti-virus software
28. Need to provide intrusion detection
29. Need to provide firewall protection
30. Need to present context based help files for GUI user

31. Need to provide GUI administrator interface
32. Need to provide security for stored data
33. Need to manage and validate users
34. Need to manage administrators / operators
35. Need to manage user groups
36. Need to provide offline storage and archival tools
37. Need to provide backup / restore tools
38. Need to provide workstation backup / restore tools
39. Need to provide anti-virus software
40. Need to provide intrusion detection
41. Need to provide firewall protection
42. Need to meet industry standards for ITS system
43. Need to meet existing legal constraints
44. Need to provide operating agreements defining conditions for receiving data
45. Need to provide operational procedures
46. Need to meet performance requirements
47. Need to provide a maintenance plan
48. Need to provide a system security plan
49. Need to monitor system status
50. Need to provide method for administrators to monitor system
51. Need to provide method for administrators to monitor system security
52. Need to provide administrators with notification of system errors
53. Need to have a competent and well-trained staff
54. Need to provide system documentation
55. Need to provide system operator manuals
56. Need to provide system administrator manuals
57. Need to provide system maintenance manuals
58. Need to provide system training for operators
59. Need to provide system training for administrators
60. Need to provide physical security for system
61. Need to provide network infrastructure
62. Need to provide reliable power supply
63. Need to provide HVAC infrastructure

APPENDIX C: DOT WEBSITES

The Iowa, Illinois, Indiana, and Ohio DOTs provide information to the traveling public through multiple websites. The following four tables provide the DOT links to their respective websites based on the type of data.

Table 1 - Iowa Available Information

Type of Data	Iowa Department of Transportation Web Links
Weather Data	RWIS and AWOS Observations http://www.weatherview.dot.state.ia.us/ NWS Forecasts and Road Conditions http://www.iowaroadconditions.org/default.asp?display=weather&area=IA_statewide&textOnly=False
Incident Data	Major Delays including Accidents, Alerts, and Difficult Driving Conditions http://www.511ia.org/default.asp?display=critical&area=IA_statewide&textOnly=False
Construction Data	Road Work & Maintenance Activities By Month http://www.511ia.org/default.asp?display=construction&area=IA_statewide&textOnly=False
Link Traffic Information	Des Moines Area Traffic Speed Map and Cameras http://www.511ia.org/DM_Metro_tripGuide.asp
Transit Data	Office of Public Transit http://www.iatransit.com/
Road Condition Data	Road Conditions and NWS Forecasts http://www.iowaroadconditions.org/roadConditions.asp?area=IA_statewide&textOnly=False

Table 2 - Illinois Available Information

Type of Data	Illinois Department of Transportation Web Links
Mapping Data	Driving Directions in Illinois http://www.gettingaroundillinois.com/getdirections.aspx
Weather Data	RWIS http://www.gettingaroundillinois.com/default.aspx?ql=rwis
Incident Data	Sign up for Traffic Alerts in Illinois via Email http://www.iltrafficalert.com/
Construction Data	Road Construction http://www.gettingaroundillinois.com/default.aspx?ql=const
Transit Data	Amtrak http://dot.state.il.us/amtrak/amtrak.asp DOT Operated Ferries http://dot.state.il.us/ferries.html
Road Conditions	Statewide Road Conditions http://wrc.gettingaroundillinois.com/winterroadconditions/

Table 3 - Indiana Available Information

Type of Data	Indiana Department of Transportation Web Links
Weather Data	RWIS http://netservices.indot.in.gov/rwis/
Incident Data	Central Indiana http://pws.indot.org/ipws/ci/ Northwest Indiana http://pws.indot.org/pws/nw/
Construction Data	Central Indiana http://pws.indot.org/ipws/ci/ Northwest Indiana http://pws.indot.org/pws/nw/
Link Traffic Information	Northwest Indiana http://pws.indot.org/pws/nw/

Table 4 - Ohio Available Information

Type of Data	Ohio Department of Transportation Web Links
Weather Data	RWIS http://www.buckeyetraffic.org
Incident Data	Incident Information Provided under Road Activity http://www.buckeyetraffic.org
Construction Data	Road Construction http://www.buckeyetraffic.org
Road Condition Data	Statewide Road Conditions http://www.buckeyetraffic.org