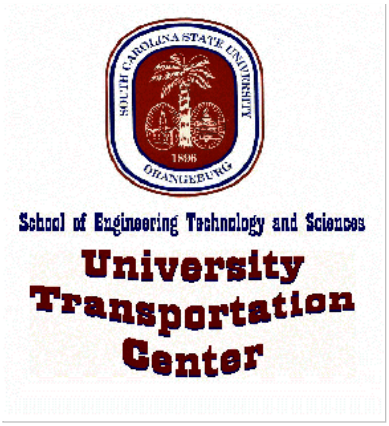
Intelligent Transportation Systems for the Rural Highway System of South Carolina

Clarence W. Hill and
Terence K. Thomas



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ABSS INC.

ABSS, Inc.
Benjamin H. Burgis III
4 Monckton Boulevard
Suite 200
Forest Acres, SC 29206

Phone 803 787-5666
Fax 803 787-4008

Rural ITS Requirements Document

Lower Savannah Region

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1.0 Overview

This document is used to specify the understanding of requirements between the Stakeholders and SCSU Research Principal Investigators for the purpose of implementing a Rural ITS Solution for the Lower Savannah Region to meet the following objectives:

- Improve transportation safety
- Improve transportation security

The document is divided into three parts:

- Project Objects
- General requirements and constraints
- Specific requirements and constraints.

1.1 Intelligent Transportation Systems (ITS)

1.1.1 National ITS Architecture

The National ITS Architecture was developed for the US Department of Transportation (USDOT) as the framework for implementing modern transportation operations systems.

The national ITS Architecture provides a common structure for the design of intelligent transportation systems. It defines the framework around which different design approaches can be developed, each one specifically tailored to meet specific regional requirements, while

maintaining the benefits of a common architecture within current (legacy) and planned systems.

The National Architecture can provide short-term benefits by saving time and money in the development of a project from its inception through its implementation, since it:

- Correlates requirements and problems to services that must be performed, thus providing trace ability for a project to overall transportation needs.
- Illustrates efficiencies that can be gained by eliminating redundant implementations of similar functions.
- Provides a view into the future to identify services and functionality that may not have been initially considered, currently needed, or even feasible. This provides a checklist of future capabilities that could be planned for now in anticipation of future requirements.
- Provides an extensive list of the transportation agencies (by matching the functions they perform with the corresponding subsystem names in the National ITS Architecture) that an agency should consider talking to during initial planning of an implementation.
- Defines the kind of information one should consider sharing among these agencies. The agency can use this information as a checklist in planning the project and in discussions with other stakeholders to show how they can participate through sharing of the information.
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1.2 Current State of ITS in South Carolina

The following information was obtained from the South Carolina Department of Transportation website.

1.2.1 Advanced Traffic Management / Incident Management

- A fog mitigation system that monitors visibility conditions is in operation on I-526 near the Cooper River in Charleston.
- Closed circuit television cameras are being utilized on the Grace Memorial and Pearman bridges in Charleston to detect roadway traffic incidents.
- The South Carolina Department of Transportation (SCDOT) is in the process of developing a traffic surveillance system\motorist information system on Interstates 26 and 1-26 in Columbia, and I-85 in Spartanburg.
- The SCDOT and various Metropolitan Planning Organizations (MPO) have implemented a motorist assistance program. This program is being used in many urban areas within the State. The name of the program is “State Highway Emergency Patrol” (SHEP).
- An ITS study has been proposed by the Central Midlands Regional Planning Council of Columbia.
- SCDOT has made a significant investment in upgrading traffic signal systems throughout the state.

1.2.2 Commercial Vehicle Operations (CVO)

- South Carolina is a participant with other Southeastern states in developing a commercial vehicle operations (CVO) institutional issues study
- A pilot "One Stop Shop" for CVO permitting has been implemented in Columbia

1.2.3 Electronic Toll Collection

The SCDOT, working with the FHWA Division Office, selected Lockheed Martin IMS for the private operation and maintenance of a toll system on the Cross Island Parkway in Hilton Head. The 7.5-mile Cross Island Parkway has one toll plaza with 14 lanes and two ramps with two lanes apiece. ITS technologies to be included in the system will consist of, but not be limited to, electronic toll collection, electronic fare payment, automatic vehicle identification (AVI) and video enforcement. Lockheed Martin is responsible for the equipment design and installation as well as operation of the state's first toll facility. ETC is also planned for the state's second toll facility in Greenville.

1.2.4 Planning for ITS

- The Greenville\Spartanburg ITS early deployment planning study is complete and the Charleston study is still underway. Implementation of methods, identified in the Greenville\Spartanburg study, to reduce traffic congestion is underway.
- The City of Greenville is in the process of developing a parking management system that will be used to alleviate traffic congestion created by special events at a new arena in the commercial business district.
- The Spartanburg MPO has implemented a motorist assistance patrol, and is in the process of implementing a motorist information system along the I-85\I-85 Business couplet in Spartanburg.

2.0 Project objective

Determine most cost effective way to provide or enhance the South Carolina Rural Highway system (Savannah Region and Orangeburg County) using ITS capabilities.

Focus on the following aspects as it relates to ITS capabilities:

- Real-time control and monitoring

- Safety and security

The approach being used to accomplish the above is as follows:

- Review current Rural ITS implementations either completed or being implemented by South Carolina and other states.
- Develop Rural ITS capability requirements document based on the US DOT National ITS Standards and Architecture.
- Publish Requirements Document for review by stakeholders. Once reviewed by the stakeholders all feedback will be incorporated into the final version.
- Develop high-level Design Architecture Document
- Develop high-level Project Plan for Implementation. The project plan will describe in detailed the ITS requirements to be implemented and how. The project plan will also include detailed information on the infrastructure needed to support the implementation, on-going support and maintenance of all ITS components.

2.1 References

2.2.1 US Ten-Year ITS Program Plan Addresses Advanced Intelligent Vehicle-Highway Systems

2.2.2 National ITS Program Plan, Five-Year Horizon, August 2000

2.2.3 California Rural ITS Projects website

2.2.4 Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in Charleston Report, July 2001

2.2.5 ITS in South Carolina website

2.2.6 ITS: an evolving technology (21st Century Service) Article, September 1998

2.2.7 Promoting And Improving Safety – Serving Rural America – FHWA

2.2.8 ITS – Intelligent Transportation Systems, CE 3201 NOTES, by J.D. Jones

2.2.9 ITS Deployment Tracking, 2000 Survey Results

2.2.10 Developing ITS Using the National ITS Architecture, An Executive Edition for Senior Transportation Managers, July 1998, USDOT

2.2.11 ITS Resource Guide, FHWA, 2001

2.2.12 ITS Joint Program Office website (www.its.dot.gov)

2.2.13 ITS Electronic Library (www.its.dot.gov/itsweb/welcome.htm)

2.2.14 ITS Newsletter (www.nawgits.com/cdn.html)

2.2.15 Operations/ITS Help line, (866) 367-7487

2.2.16 ITS Peer-to-Peer Program, (888) 700-PEER

2.2.17 What Have We Learned About ITS? (FHWA-OP-01-006), 2000

2.2.18 Department of Transportation's ITS Projects Book, 2001

2.2.19 ITS Benefits and Costs Database

2.2.20 ITS Deployment Tracking Database

2.2.21 Rural ITS Users Needs Document

3.0 GENERAL REQUIREMENTS

3.1 General Capabilities

All specific user requirements must be mapped to fit within the standard User Service solutions outlined in the ITS Program Plan. This will ensure that all user requirements to be implemented will fit within the standards and guidelines outlined by National ITS Program Plan and Architecture.

3.2 General Constraints

All requirements outlined in this document will be mapped to the published User Services

3.4 Assumptions and Dependencies

The scope for all user requirements is to support the project objectives for the Lower Savannah Region only.

4.0 Specific Requirements

4.1 Emergency Service

Emergency Services address the response to an individual incident such as a traffic collision and to more widespread events such as natural disasters.

These services can be in the form of ambulances and medical care, police, fire, tow trucks, and other vehicle assistance, etc.

The user requirements in the area of Emergency Services should focus on measures designed to improve the emergency response process, from reducing incident detection and verification times through the process of selecting the most appropriate response. Requirements in this area should include the need for emergency notification or warning in the event of natural disasters or terrorist attacks.

4.1.1 Response Information

4.1.1.1 Incident Notification

- Include information to assist emergency services personnel/agencies with operational responsibility for potentially large geographic areas and types of terrain when incident occurred. The information required is as follows:
  - Incident location
  - Incident type and classification
  - Incident severity
  - Information source, and confirmation of who is on-scene to establish protocols for appropriate response.

4.1.1.2 Response Vehicle Location

- Provide location of emergency vehicle to appropriate emergency management agency to facilitate dispatch and guidance of emergency vehicles to incident site.
- Location/routing system needs to should include identification of all highway-rail intersections.
- Determine location of destinations not available through existing/traditional sources and disseminates directions. Requires: uniform naming system and capability to cross reference latitude/longitude data with traditional local addresses. (Should follow/be consistent with FCC's work to locate cellular 911 calls.

4.1.2 En-route Services Information

4.1.2.1 En-Route Directions

- Provide emergency vehicle drivers with information (e.g., congestion, travel time, incidents, etc.) and directions while en-route, which will allow alternative routes to their destination to be chosen.

4.1.2.2 Emergency Centers/Medical

- Provide location and availability of hospitals, clinics, emergency care centers, etc within a predefined range. Information also includes level of service of a facility (e.g., full trauma center or urgent care with no surgical services available).

4.1.2.3 Shelters/Red Cross (Weather)

- Provides location and availability of sites designated as shelters during/following natural disasters and other emergency events within a predefined area or based on vehicle location.

4.1.2.4 Tow Services

- Provides location and availability information for tow services in the area. Information would also include the type of tow services (e.g., industrial) available.

4.1.2.5 Trauma Systems Development Plan

- Plans would include information on hospital communications protocols to include: how the hospitals communicate with each other, their dispatch process (what, when and how), and information sharing needs.

4.1.3 Emergency assistance

4.1.3.1 Crash Information (Data, Voice)

Ability to relay information through multiple path communications

Common data set format and terminology

Automatic or manual distress signal system to disseminate traveler vehicle location and crash characteristics needed by emergency services with operational responsibility for potentially large geographic areas and types of terrain (e.g., mountains). Required information includes: crash kinematics, delta-v, occupant information, if/when airbags deployed, vehicle characteristics (such as HAZMAT information), information on local weather conditions to determine wind direction/speed for HAZMAT information, such as provided by CAMEO model, and medical patient data in an encrypted or safeguarded format.

4.1.3.2 Emergency Notification/Response

Ability to automatically transmit information from traveler vehicle about occurrence of crash to include vehicle location and extent of crash damage from a variety of terrain environments to appropriate agency(s).

4.1.3.3 Vehicle Location

Provides location of vehicle involved in crash/incident over potentially large geographic areas and types of terrain (e.g., mountains) to appropriate emergency management agency.

4.1.4 System operational effectiveness

4.1.4.1 Inter-Agency Coordination (Emergency Services)

A system or set of systems designed to facilitate coordination of emergency response between traffic management and other agencies and emergency service providers in a wide range of geographic settings. Coordination should include:

- Data linkage to allow evaluation
- Standard format for data entry forms
- Uniform incident identification codes
- USDOT ID number for HAZMAT loads
- Private centers (ONSTAR)
- Process for verification information

4.1.4.2 Automatic Billing

Must have the ability of emergency services to electronically process transactions with toll authorities, hospitals, and customers. Includes data linkage to facilitate evaluation, driver's license information; transmit a patient care report/registration from vehicle to hospital, and ability to safeguard information.

4.1.4.3 System Expansion

Must have the ability to add new agencies/providers to the coordination system. Should include: services/systems such as ITS, Mayday, incorporate statewide planning prior to implementation.

4.2 Tourism and Travel

The user requirements in the Tourism and Travel area include the need to provide information and mobility services to tourists and destination locations, since many times visitors have little choice of mode (no auto) and require special services. Knowing where desired destinations are, how to get to them, and conditions along the way adds to the mobility and convenience of an area. Likewise, travelers must be aware of destinations before they can visit them. Many rural areas are characterized by long distances between tourist destinations and diverse landforms including mountainous areas, forests and deserts, complicating information delivery to travelers in the region. Alternative modes of transportation such as shuttle buses may or may not be available from gateway communities further limiting information dissemination opportunities.

Providing services to tourists and others unfamiliar with the rural surroundings enhances the economic vitality of the area. In addition, once in a resort area, tourists often are hindered due to lack of a vehicle.

Tourism may also be a concern in any rural setting during major events and festivals. At these events the traffic, local population, and transportation problems of the participants, local residents, and emergency services swell to many times their average levels. Event logistics, traffic and parking management, and provision of emergency communications are crucial to the success of these events, and yet must be temporary in nature, and in most cases understandable to volunteers.

The main focus of user requirements identified to date in this area is access to/dissemination of information. This includes information typically associated with electronic yellow pages, as well as weather and condition forecasting, route advisory information, information dissemination in hotels, roadside, wide band radio, etc. Tourism and travel needs also include the need for mobility through transit, para-transit, and Global Positioning Systems (for rental cars.

4.2.1 Advisory Information

4.2.1.1 Pre-Trip Information

Provides route-based information that focuses on destinations to include directions, estimated travel time and traffic conditions. Information would be tailored to include information of interests to hikers or bicyclists in areas such as national parks.

4.2.1.2 En-Route Directions

Provides travelers with information and directions (e.g., congestion, travel time, incidents, etc.) while en-route for route selection.

4.2.1.3 Roadway Traffic Conditions

Information to travelers describing effect of weather (e.g., visibility during snow storms), construction operations and other information (e.g., congestion near destination locations) affecting roadway operations.

4.2.1.4 Multimodal Route Information/Guidance

Disseminate information regarding routing and scheduling of various modes of transport in the area. It also includes location of system entry points (e.g., terminals).

4.2.1.5 Service Facility Availability

Disseminate information regarding the availability of traveler services or attractions such as those listed in a "Yellow Pages" traveler information service (e.g., hotel vacancies, 24 hour service stations, restaurants) within predefined area or range or based on vehicle location. Information would provide hours of operation.

4.2.1.6 Rural Addressing

Determine location of destinations not available through existing/traditional sources and disseminates directions.

4.2.1.7 Incident Warning

Provides notification and information concerning incidents to vehicle drivers, agencies, and information providers. Information would include incident severity and estimated duration.

4.2.2 En-Route Services Information

4.2.2.1 Yellow Pages

Will provide information regarding traveler services in predefined area or based on vehicle location.

- Gas/Service Stations
- Lodging/Reservations
- Food/Restaurants
- Sites/Attractions
- Shopping Areas
- Rest Areas

4.2.2.2 Emergency Centers/Medical

Provides location and availability of hospitals, clinics, emergency care centers, etc within a predefined range. Information also includes level of service of a facility (e.g., full trauma center or urgent care with no surgical services available).

4.2.2.3 Shelters/Red Cross (Weather)

Provides location and availability of sites designated as shelters during/following natural disasters and other emergency events within a predefined area or based on vehicle location.

4.2.3 Emergency Assistance

4.2.3.1 Crash/Incident Information (Data, Voice)

Automatic or manual distress signal system disseminates vehicle location and crash/incident characteristics to appropriate management agency.

4.2.4 Transit Information

4.2.4.1 Transit Schedules

Disseminate information regarding scheduled transit services such as hours of operation, headways, fares, etc. Information should include specialized services such as shuttles serving major attractions in the area.

4.2.4.2 Public Transportation Routes/Services

Information regarding specific transit routes (to include transfer/connection information) and destinations as well as services (e.g., dial-a-ride) offered by area transportation providers.

4.2.4.3 Bus/Taxi Vehicle Location/Status

Information describing location of transit vehicles/taxis and anticipated arrival times.

4.2.5 Economic Development

4.2.5.1 Business Viability

Systems/practices designed to improve local transportation system operations, improved access to interstates, ports, dissemination of services to travelers, etc. This should also include customized information for business operators, CVO operators, and tourist travelers.

4.2.5.2 Trip Enhancement

Systems that allows travelers to access information through a variety of media regarding (fixed and mobile sources) regional tourist attractions and traveler services.

4.2.5.3 Electronic/Multiple-Use Payment Device

Card or other payment media that can be used to pay for transit and other services (e.g., retail).

4.2.6 Data Sharing

4.2.6.1 Market Data

Provide Systems that collects information related to or which can be used to develop marketing strategies for regional business community.

4.3 Traffic Management

Travelers in rural areas are often faced with traffic congestion and excessive delays when traveling through construction areas or near seasonal or cyclical attraction areas such as ski areas, beaches, national parks, etc. Although congestion is less frequent than in urban areas, the lack of alternate routes in rural areas often results in traffic congestion as severe as that experienced in urban areas, creating costly and lengthy delays. Incident-related delay, exacerbated by the longer response times typical in rural areas and the high rate of fatal crashes (nearly twice that of urban areas) also contributes to traffic congestion and traveler delay along rural roadways. In addition, sudden, or unexpected areas of congestion may also contribute to secondary incidents and additional traveler delay.

4.3.1 Advisory Information

4.3.1.1 Pre-trip and En-Route Directions

Provides information (e.g., congestion, travel time, etc.) and directions prior to a trip or while en-route for route selection. This information needs to be conveyed to vehicle drivers, commercial vehicle operators, tourists, emergency services, and transit users. Information may have to be provided across large geographic areas and types of terrain such as mountains.

4.3.1.2 Roadway Traffic Conditions

Information describing levels of congestion on area roadways such as volume and speed data. . Information may have to be provided across large geographic areas and types of terrain such as mountains.

4.3.1.3 Vehicle Location

Location of vehicles serving as mobile probes to provide data on travel times for congestion information. Vehicle location needs to specify a common mapping system. There is a need to have regional agreement on consistent naming and addressing. There is a need to automatically know the location of a vehicle calling in an incident, as travelers/users don't always know where they are. A consistent means of showing rural addresses on electronic maps is needed. In addition, information may have to be provided across large geographic areas and types of terrain such as mountains.

4.3.1.4 Multimodal Route Information/Guidance

Disseminate information regarding routing and scheduling of various modes of transport in the area. It also includes location of system entry points (e.g., terminals).

4.3.1.5 Incident Information

There is a need to communicate among all agencies involved or potentially involved of the status of incidents. The information related to roadway closures and alternates need to be communicated with drivers (pre-trip or en-route) in a variety of geographic settings.

4.3.1.6 Emergency Evacuation Routes

There is a need to maintain locations of emergency management/ evacuation routes, and staging areas for disaster recovery. There is also need to determine whether a HAZMAT incident is by rail or heavy truck and to correlate the rail/truck routes for short term and long term alternative routing and evacuation.

4.3.1.7 Construction Information

Advisory Information needs to include road construction, schedule for construction, and whether construction is actually taking place or not. For the commercial vehicle and transit community, information needs to be provided in advance to make routing choices. Additional information to be provided to commercial vehicle and transit operators includes spring weight restrictions for vehicles, and over height restrictions.

4.3.1.8 Natural Road Closures

There is a need to have a category of incident that covers natural road closures. This includes: heavy rains, slides (mud, rock, and snow), weather (fog, sleet, etc.), earthquakes, wildfires, and road conditions (black ice, etc.).

4.3.2 Traffic Control

4.3.2.1 Road Surface-Dynamic Warning/VSL

Systems designed to monitor and detect changes in roadway surface conditions affecting drivability. These systems would alert drivers of driving conditions and reduce posted (electronic) speed limits to speed consistent with roadway conditions.

4.3.2.2 Work Zone Intrusion

Systems are to monitor traffic activity on the vicinity of work zones and to provide advice and warnings to maintenance and construction crews. System to advise or warn drivers as they approach work zones.

4.3.2.3 Work zone management

There is a need to help engineers design work zones according to accepted industry practices. There is a need to implement lane closure management to more smoothly merge lanes.

4.3.2.4 Speed Warning

Need to notify users of their own speed using visual warning device such as a VMS.

4.3.2.5 Reduced Speed Ahead

Need to notify users to reduce speed. The speed reduction may be to prevent rear-end collisions with slow moving vehicles such as farm vehicles.

4.3.2.6 Bridge Warning

There is a need to notify users of draw bridge up.

4.3.2.7 Signal Coordination

Systems, which provide traffic management agencies with capability to adjust, signal timing to efficiently manage periodic congestion. These types of systems include adaptive signal control systems and systems with self-timing capabilities for small communities.

4.3.2.8 Road Closure Management

Systems designed to enable remote closure of swing gates at road closure points and monitoring/signage on roads leading up to closure points so that remote closures can be done safely.

4.3.2.9 Seasonal Delays

Systems designed to manage delays associated with specific seasons such as flooding of certain areas in the spring or road and bridge icing during the winter (e.g. portable traffic management systems, weather information systems, etc.).

4.3.2.10 Seasonal Events

Systems designed to address conditions associated with seasonal/annual events such as higher than usual numbers of farm equipment on roads during harvest season or high levels of congestion due annual events such as rodeos, fairs ski season, hunting season (e.g., portable traffic management systems, etc.).

4.3.2.11 Incidents

Systems designed to provide a coordinated response to incidents in the area (which may cover a variety of landforms and significant distances). System capabilities would include ability to anticipate and plan, detect, verify, and assess incident/crash severity.

4.3.2.12 Incidents

Multiple jurisdictions (over potentially large geographic areas with various types of terrain) need to know whether they are the only agency or one of many agencies responding.

4.3.2.13 Inter-Agency Coordination (O&M)

Systems designed to facilitate coordination of O&M activities with traffic management and other related agencies (e.g., maintenance vehicle tracking, shared operations, 24/7 operations, anticipated delays, roadways affected, etc.). In addition, not all rural areas have the resources to maintain or operate systems. Therefore, there is a need to share in O&M cost of utilities, and infrastructure. There is a need to leverage existing public-public partnerships to maintain ITS and other critical devices in rural areas.

4.3.2.14 Inter-Agency Coordination (Alternate Routes)

It is critical to determine alternative routes and information sharing needs between agencies and stakeholders. Stakeholders must include traditional public agencies, but also private sector such as restaurants, hotels, and gas stations.

4.3.2.15 Data Collection

System designed to facilitate collection of real-time traffic data. There is a need to collect historical traffic data for planning purposes. There is a need to be able to collect information from the private sector without that information becoming part of the public domain.

4.3.2.16 Remote monitoring and maintenance

There is a need to monitor and have system malfunctions transmitted from remote location (over potentially large areas and terrain types).

Systems need to track equipment malfunctions and failure from remote maintenance sites.

4.3.2.17 Statewide/Regional TOC

The need to coordinate and share information and operations.

Sharing of control is also needed to allow functions of a TOC to take place across agencies when and where necessary.

4.3.2.18 Virtual TOC

Remote maintenance site could be used as a temporary TOC if needs warranted.

This need also extends to the use of mobile command centers (i.e. van).

4.3.2.19 Entrance Fee Collection

Systems to enable use of technologies such as toll tags for collecting entrance fees at national parks and other attractions generating large traffic volumes/queues.

4.3.2.20 Communications System Redundancy

A need exists that cell phones, and communications in general, have a backup capability, i.e. no single point of failure for communications (over potentially large areas and terrain types).

4.3.3 Enforcement

4.3.3.1 Speed Enforcement

Systems designed to enhance law enforcement's ability to effectively enforce speed limits in the area.

4.3.3.1 Unsafe Driving for Conditions

Systems designed to identify unsafe driving.

4.3.3.3 Remote Monitoring of Sites

Systems designed to provide video monitoring of key sites.

4.3.4 Economic Development/Environmental Protection

4.3.4.1 Reduce High Emission (Acceleration & Deceleration)

Systems designed to provide traffic conditions that reduce areas characterized by frequent acceleration and deceleration (e.g., bottlenecks, major arterials with poorly coordinated signal systems, etc.).

4.3.4.2 Reduce Vehicle Trips (Emissions)

Systems or practices designed to reduce SOV trips (e.g., ridesharing programs, multi-use zoning, transit promotions, etc.)

4.2.4.3 Reduce VMT (Emissions)

Systems or practices designed to reduce VMT (e.g., transit promotions, multi-use zoning, parks, etc.)

4.3.5 Data Sharing

4.3.5.1 Market Data

System that collects information related to or which can be used to assess effectiveness of traffic management strategies (e.g., traffic conditions, regional traveler information, planning information, and other centers).

4.4 Transit and Mobility

As the nation ages, the need for accessible mobility services will become much more important. This is especially true for rural areas where neighbors are often miles apart, trip distances are long, and travel to common origins and destinations are infrequent.

Rural user needs in the area of rural transit focus on providing and having access to traditional fixed-route transit, flexibly routed transit, demand-responsive Para transit, and other services associated with the ability to make a desired trip. Identifying those who need services, determining what types of services are needed; and determining how to provide the needed services in an efficient and effective manner, are key elements in defining rural transit user needs from the transit agency perspective. Further, there are additional factors that must be considered, including: the needs of agencies to identify special non-transit services (nursing, meals on wheels, hospital out patient, etc.); and the needs associated with coordination and communication between the many providers of services that may be involved (such as transit agencies and social service providers). From the customer's perspective, the needs include services that go where and when customers need to travel; access to accurate, real-time information regarding arrivals and departures; and better customer service.

4.4.1 Transit Management

4.4.1.1 Vehicle Location

Determines location of vehicles and provides display in dispatch (or alternate locations) of appropriate agencies. Specific information needs/capabilities include:

- The display of real-time or near real-time vehicle location at a central management facility and for the general public should be considered
- Vehicle location should be linked to automated scheduling
- Vehicle location data can support safety-related decisions, such as those involving bad weather

- Vehicle location data can support recording revenue and non-revenue vehicle time and mileage, which is used to determine budget compliance
- Vehicle location data can assist in the preparation of the National Transit Database data
- Vehicle location data can support the investigation of fraud issues, such as eligibility, safety and payroll
- Vehicle location technology can support a silent alarm feature, which can notify dispatch in the event of an incident on-board the vehicle
- Vehicle location technology will support using transit vehicles as "probes" to identify certain roadway conditions for transportation management centers and/or traffic operations centers

4.4.1.2 Automated Scheduling

Provides vehicle schedules for all transit services and provides input to dispatching. Specific information needs/capabilities include:

- Automated call taking and scheduling for demand-responsive service;
- Customer-generated ride request via a telephone and/or personal computer;
- Dynamic/adaptive scheduling, including feedback between vehicle locations and scheduling functions.

4.4.1.3 Computer Aided Dispatch (CAD)

Provides schedule adherence; route adherence; communications among dispatch, vehicle operators, road supervisors and maintenance; and computer-aided service restoration. Specific information needs/capabilities include:

- This need should be fulfilled across all modes;
- CAD should support retaining the history of operations
- Access to a communication system is an absolute necessity for effective CAD
- CAD, along with two-way communication, should facilitate identifying no shows, and subsequently dispatching a vehicle for another piece of work
- CAD should assist in maintaining ridership
- CAD should provide a link between the transit agency and emergency services
- CAD should provide information to vehicle operators, such as wind speed, which is important when handling wheelchair passengers

4.4.1.4 Geographic Information

Computerized database management in which geographic databases are related to one another via a common set of location coordinates. Geographic information should be provided on-board vehicles for drivers and at all dispatch locations.

4.4.1.5 Advanced Communications

Communication systems (voice and data) are capable of covering large rural areas and various types of terrain (e.g., mountains). Reliable and redundant communications for transit are a must. The communications infrastructure should be a common infrastructure, integrated with other transportation entities, such as a transportation management center (TMC), highway maintenance, emergency services, State highway patrol, etc.

4.4.1.6 En-Route Directions

Provides vehicle drivers with driving directions to destinations while enroute.

This requirement will support determining the accessibility of particular addresses (e.g., house has ramp for wheelchair), and will support transit maintenance (e.g., sending a maintenance vehicle to a particular location for a road call).

4.4.1.7 Roadway Conditions

Provides vehicle operators and dispatchers with information describing roadway conditions.

4.4.1.8 Rural Addressing

Provides location of destinations not available through existing/traditional sources including tribal lands.

4.4.2 Traveler Information

4.4.2.1 Pre-Trip Traveler Information

Information regarding transit routes, maps, schedules, fares, park-and-ride lot locations, points of interest, traffic conditions, weather, etc. provided through various media. Both real-time and static information are needed. Specific needs include:

Itinerary planning for regional trip making (using multiple modes/systems), information on intermodal connections; and notification of vehicle status and/or arrival time (e.g., beeping someone when the vehicle that is picking them up is five minutes from their home).

4.4.2.2 In-Terminal/Wayside Traveler Information

Similar to pre-trip information, but provided to traveler as he/she make his/her trip. Needs include en-route real-time information about connections/transfers (including intermodal connections); estimated time of arrival; and real-time arrivals and departures. Information needs would also include disability accessibility information, security information, language translation capabilities, and for transfer locations, information about services available within close proximity to these locations (e.g., local shopping, ATM machines, etc.)

4.4.2.3 In-Vehicle Traveler Information

Information on real-time arrivals and departures, and connections/transfers (including intermodal connections), stop announcements, security information; and language translation capabilities.

4.4.2.4 Vehicle Location and Estimated Time to Arrival

Provides location of vehicle and estimated arrival time to travelers.

4.4.2.5 Multimodal Traveler Information/Guidance

Information regarding routes, schedules and itineraries for various modes of transport in the region. Also includes location of stations and/or terminals

4.4.2.6 Automatic Callback

Notification from service provider to customer confirming trip and indicating when vehicle will arrive.

4.4.2.7 Emergency Trip Cancellation

Communication between the transit agency and the traveler in case of emergency. Intended for the traveler who experiences an emergency and is unable to communicate such to the vehicle operator before the operator arrives at the traveler's pick-up location (and would otherwise consider the traveler a no-show).

4.4.2.8 Emergency Driver Communication

Communication between dispatch and the vehicle operator in case of emergency.

4.4.3 Electronic Fare Payment

4.4.3.1 Electronic Fare Payment

Non-cash fare payment (e.g., using magnetic stripe card, contactless smart card, etc.). There should be a linkage between this need and automated billing.

4.4.3.2 Multiple-Use Payment Device

Card that could be used to pay for transit and other services (e.g., retail). There should be a linkage between this need and automated billing.

4.4.4 System Operational Effectiveness

4.4.4.1 Service Coordination

System to coordinate services among transit providers to enhance transit service (e.g., nearest vehicle to service)

4.4.4.2 Service Planning and Evaluation

Measures or systems designed to facilitate expansion of transit services in the region (e.g., customer needs, business development tracking, housing development tracking, demographic tracking, etc.), and system services/modes simulation capabilities. The simulation of new services/modes would be based on historical data about existing services, travel patterns, etc. (e.g., "SIMBUS") Automated Billing – Ability of transit agencies to automatically generate third-party billing.

Should have capability for linkage to Electronic Fare Payment and Multiple-Use Payment Device systems.

4.4.4.3 Trip Reliability

Systems designed to improve the schedule adherence of transit vehicles Information for Traveler Requests - The use of real-time information to respond to traveler requests. For example, this need would support investigating a complaint that the transit vehicle never arrived at a traveler's home for pick-up, or would support a request for an estimated time to arrival for a pick-up. Further, the real-time information could be used as input to the planning and scheduling process to better serve customers' needs.

4.4.4.4 Transit Maintenance

Transit maintenance refers to those activities associated with scheduled, preventative and unscheduled/corrective maintenance of transit vehicles and associated equipment. Transit maintenance is linked to needs previously described in the Transit management category, such as vehicle location, automated scheduling and computer-aided dispatch.

4.4.4.5 Training

Training is a need that becomes more significant as technology is added to various aspects of a transit agency's operations. Specific training is needed to describe current state-of the art technology that may help solve specific service, maintenance, and customer-related problems.

4.4.5 Data Sharing

4.4.5.1 Roadway Conditions

Two-way exchange of data, such as congestion levels and roadway travel times, between transit agency and traffic management center(s).

4.4.5.2 Regional Traveler Information

Exchange of data between transit agency, and regional traveler information providers and agencies.

4.4.5.3 Planning Information

Exchange of data between transit agency and local/regional planning organization to facilitate modifying, adding or deleting transit service. This exchange would include design elements of developments to facilitate transit-friendly design.

Other Data Exchanges - Other organizations that transit agencies would share data with include:

- State DOT
- State tourism bureau
- State department of health and human services and commission(s) on aging
- Economic development agencies and chambers of commerce
- Emergency management
- Intercity transportation providers
- Other major transit providers
- “Main St. Network Groups” to promote appropriate development

4.5 Crash Prevention and Security

Within rural transportation settings, the type, rate, and severity of incidents/accidents have been repeatedly identified as one of the most serious problems that need to be addressed. For example, accidents per-vehicle-mile-traveled are higher in rural settings than in urban areas and tend to be more severe because of higher vehicle operating speeds and longer travel times for emergency service response.

Rural ITS User Needs for Crash Prevention and Security focus on preventing crashes before they occur, reducing the severity of the crashes that do take place, and safeguarding other users of the transportation system (i.e., transit riders). These identified User Needs center around improving a driver's ability to operate a vehicle safely in rural settings. Therefore, they address the following:

The three (3) main components of vehicle crashes: the driver, the vehicle, and the roadway. These User Needs further attempt to reduce the factors that influence a crash: for example, diminishing driver alertness, roadway obstructions (e.g., animals, debris), poor roadway conditions (e.g., weather, visibility, roadway geometrics).

Other Rural ITS User Needs in this category involve increasing the security (both actual and perceived) of travelers during their trip. For example, a traveler may be injured even though he or she has not been involved in a vehicular accident (i.e., transit patron assaulted while waiting for a bus). Thus, providing a secure environment through remote monitoring of key transportation sites, the presence of silent alarms, and automated vehicle location (AVL) systems are also included.

4.5.1 Collision Avoidance

4.5.1.1 Collision Avoidance

Systems designed to alert driver of impending situations that are inconsistent with safe vehicle movements and speeds on the roadway.

4.5.1.2 Foreign Objects/Obstructions in the Roadway

Systems designed to alert driver to impending situations that are inconsistent with safe headways or impending collisions with obstructions in the roadway (e.g., slow moving/stopped vehicles, large rocks/debris, pedestrians, animals, etc.).

4.5.1.3 Perimeter Detection

System designed to alert driver to presence of foreign objects (e.g., vehicles, pedestrians, etc.) in areas around car (i.e., blind spots).

4.5.1.4 Animal Deterrence

Systems designed to deter animals from entering roadway.

4.5.1.5 Terrain Hazard Advisory

Systems designed to detect inconsistencies in a driver’s transient surroundings and provide static and dynamic information provided to travelers regarding hazards (e.g., falling rocks/rock slides, mud slides, floods, etc.).

4.5.1.6 Roadway Traffic Conditions

Information describing levels of congestion on area roadways.

4.5.1.7 Roadway Enhancement/Shoulder Detection

Systems designed to improve driving characteristics of roadway and alert driver when within defined distance of shoulder.

4.5.1.8 Driver Status

System designed to monitor status of driver's ability to operate vehicle within defined parameters (e.g., alcoholic consumption, etc.). Includes systems designed to monitor alertness of driver and provide warning if level of alertness falls outside defined parameters.

4.5.1.9 Driver Enhancement

Systems designed to augment vehicle operator's capabilities (e.g., vision enhancement to see pedestrians and hazardous situations during periods of poor driving visibility, steering enhancements, speed-control enhancements, etc.).

4.5.2 Roadway Geometrics

Roadway Geometrics refers to systems designed to alert driver of areas where roadway geometrics affect driver safety (e.g., area with reduced site distance, sharp bends, curves, steep downgrades, etc.).

4.5.3 Roadway/Weather Information Systems (RWIS)

4.5.3.1 Roadway/Weather Information Systems (RWIS)

Includes elements to monitor and detect weather conditions that affect driver safety [e.g., visibility (snow/fog/sand), slippery roadway conditions (ice/snow/water), etc.).

4.5.3.2 Road Surface Dynamic Warning [Variable Speed Limit (VSL)]

Systems designed to monitor and detect changes in roadway surface conditions affecting drivability. These systems would alert drivers of driving conditions and actuate system designed to reduce posted (electronic) speed limits to speed consistent with roadway condition.

4.5.3.3 Speed Enforcement of Unsafe Driving Conditions

System designed to enhance law enforcement's ability to effectively identify and enforce unsafe driving conditions and driver behavior (e.g., speeding, weaving, etc,) to facilitate enforcement activities.

4.5.4 Work Zone Control/Advisory System

4.5.4.1 Work Zone Control/Advisory Systems

Systems designed to inform drivers of upcoming work zones, anticipated travel delays, and provide physical barriers to prevent vehicles from entering.

4.5.5 Highway-Rail Intersection (HRI) Crossings

4.5.5.1 Overall Category Definition

Systems designed to warn vehicle operators of train proximity and provide barrier to prevent vehicle from entering rail/roadway intersection (i.e., crash avoidance).

4.5.5.2 Rail/Vehicle Conflict Advisory & Control

Systems designed to alert approaching drivers of vehicle presence at a rail/roadway intersection.

4.5.5.3 Train Detection/Notification

Systems designed to detect approaching train and to alert drivers within defined distance of roadway/rail intersection of approaching train.

4.5.5.4 Rail Crossing

Provides traffic control of highway and rail traffic for at-grade highway-rail intersections.

4.5.6 Vehicle Pre-Emption

Vehicle pre-emption systems designed to allow for safe passage of vehicles through signalized intersections:

- Emergency Vehicles
- Warnings to Non-Emergency Vehicles

4.5.7 Security

4.5.7.1 Overall Category Definition

Systems designed to provide remote monitoring (e.g., video, audio, vehicle presence, etc.) of an area or vehicle to a 3rd party in order to enhance site safety.

4.5.7.2 Remote Monitoring of Sites

System designed to provide monitoring at key locations (e.g., inside bus, rest area, bus stop, transit terminals, etc.).

4.5.7.3 Vehicle Location

Systems designed to provide location of vehicles to the driver and the appropriate management agency.

4.5.7.4 Individual Location

Systems designed to provide location of a particular individual (e.g., hiker/ranger in National Park, etc.) to the appropriate agency.

4.5.7.5 Silent Alarms

Systems designed to provide system users with access to silently activated alarms.

4.5.7.6 Roadway Throughput

Systems designed to track vehicle at specific roadway intervals in order to detect when a potential roadway hazard or event may have occurred (e.g., 100 vehicles pass Point A on mountain road but none pass Point B 5-miles down the road a possible avalanche, etc.).

4.5.8 Data Sharing

Data Sharing refers to sharing of appropriate information with other agencies that will assist in their mission/operations.

Shared with the appropriate regional traffic management agencies:

- Terrain Hazard Advisory
- Roadway Traffic Conditions
- Roadway/Weather Information System (RWIS)
- Road Surface Dynamic Warning [Variable Speed Limit (VSL)]
- Vehicle Presence at Intersection Notification
- En-Route Directions
- Train Detection/Notification
- Rail Crossing
- Remote Monitoring of Sites
- Vehicle Location
- Silent Alarms

Shared with the appropriate railway organizations:

- Train Detection/Notification
- Rail Crossing

Shared with the appropriate transit management centers:

- Remote Monitoring of Sites
- Vehicle Location
- Silent Alarms
- Terrain Hazard Advisory
- Roadway Traffic Conditions
- Roadway/Weather Information System (RWIS)
- Road Surface Dynamic Warning [Variable Speed Limit (VSL)]
- Vehicle Presence at Intersection Notification
- En-Route Directions
- Train Detection/Notification
- Rail Crossing

Shared with insurance carriers:

- Insurance-Actuarial Data (e.g., vehicle miles traveled (VMT), vehicle safety records, etc.)

Shared with safety planning agencies:

- All information collected to support every User Need (Archived Data)

Potential sharing with 3rd party enforcement agencies:

- Road Surface Dynamic Warning [Variable Speed Limit (VSL)]
- Driver Status
- Alertness

4.6 Operations and Maintenance

The isolation, distances involved, and the large number of rural roadway miles make the operation and maintenance of the rural transportation infrastructure both challenging and costly. Low traffic volumes on these roads also make the detection of problems and condition a concern. Similarly, operations and maintenance activities are difficult for rural public transportation service providers, which are frequently small, dispersed, and which lack adequate human and financial resources.

Operations and maintenance of rural roads and their associated infrastructure are typically the responsibility of public agencies at the state, county or city and township level. Their responsibilities include monitoring, maintaining, and improving the physical condition of the infrastructure; maintaining the condition of public vehicle fleets; ensuring safe operation of the system, especially under adverse travel conditions, such as winter weather, or during construction and other work zone activities; and ensuring the efficient operation of the system, including the use and maintenance of various traffic management and traffic control devices.

4.6.1 Infrastructure management

4.6.1.1 Infrastructure Inventory and Condition Monitoring

Systems to collect, disseminate, and maintain information about the location, types, and condition/integrity of physical roadway infrastructure, including the pavement, bridges, materials, structures, signs, and other roadway devices, and the condition, and operations and maintenance needs of each, and about roadway closures and restrictions. Information should cover multiple agencies, and should support data sharing between agencies. Information should be accessible to field crews responsible for operations and maintenance. Consequently, the system should be appropriate for skill levels found in small maintenance sections many of which may be located in widely dispersed locations.

4.6.1.2 Work Zone Location Information

Systems designed to gather, store, and disseminate information about work zones and construction activities, such as locations, alternate routes, and anticipated delays, for short-term and long-term activities. These systems should support internal operations and maintenance needs, should be available to support commercial vehicle routing activities, and be suitable for providing information to traveler information systems and travel service organizations. Data should be collected in real-time and accessible information should be up-to-date. These systems should be capable of correlating planned activities with actual work in the field and they should support both pre-trip and at-site applications.

4.6.1.3 Portable System Resource Management

Systems to monitor the location and usage of portable assets (over widely separated locations and terrain types) such as portable traffic management and work zone management systems, and to manage the scheduling, delivery, setup, operation, and return of such devices.

4.6.2 Roadway condition monitoring

4.6.2.1 Roadway Traffic Conditions

Systems to monitor traffic levels on roadways, and to provide information regarding the impacts that certain traffic levels would have on alternate roadways in the event of re-routing due to operations and maintenance activities.

4.6.2.2 Roadway Surface and Atmospheric Conditions

Systems to monitor and detect changes in roadway surface conditions and other weather and atmospheric conditions affecting drivability, and to alert agencies (potentially located in widely separated locations) of such changes.

Conditions to be monitored would include ice, precipitation, fog, wind, blowing dust, and potentially air quality. Roadway surface condition information should also include a determination of coefficient of friction. It could also actuate systems to advise or warn drivers of these conditions as well as automatic de-icing systems.

4.6.3 Safety management

4.6.3.1 Smart Work Zones

Systems to monitor, control, and direct traffic activity in the vicinity of work zones with the objective of enhancing the safety of maintenance and construction crews.

These systems should be incorporated in work zone set-up procedures without increasing the burden on the crews. Ideally the se systems would be accompanied by increased police enforcement in the work zone. Could also actuate systems to advise or warn drivers as they approach work zones.

4.6.4 System maintenance effectiveness

4.6.4.1 Winter Weather Maintenance

Systems to enhance the efficiency of pre-treatment and plowing operations, such as providing up-to-date information on weather and roadway surface conditions, location of nearest maintenance vehicle, time of last treatment or plowing per segment, or type of treatment or chemicals applied. It should also include systems on-board the maintenance vehicles that provide vehicle location, the ability for automated environmental recording, and automated recording of operational data (e.g., spreader on/off).

4.6.4.2 Winter Weather Maintenance Safety

Systems installed on-board snowplows and other winter maintenance vehicles to assist the operator in lane following and detecting obstructions.

4.6.4.3 Infrastructure Maintenance

Systems to facilitate efficient use and scheduling of resources to perform routine infrastructure maintenance, such as striping, patching, installation, and other repairs. It should also include systems on-board maintenance vehicles for automated logging of observed maintenance needs.

4.6.5 System Operations Effectiveness

4.6.5.1 Inter-Agency Coordination

Systems to facilitate coordination of operations and maintenance activities within and between agencies, such as sharing information about affected roadways and anticipated duration, or sharing resources.

4.6.5.2 Asset Management

Systems to facilitate management of operations and maintenance assets, such as the type, location, failure rates, and maintenance schedules of equipment, infrastructure, and the roadway. These systems should provide predication of when failures will occur so that preventative maintenance can be performed.

4.6.5.3 Natural Events Management

Systems to support enhanced allocation, dispatch and use of operations and maintenance resources during natural events or disasters, such as roadway icing, flooding, avalanches, and mud slides.

4.6.5.4 Seasonal and Planned Events Management

Systems to support operations and maintenance activities, such as dispatching and pre-positioning of equipment and resources during seasonal events, such as agricultural equipment movements during harvesting or traffic conditions during ski season, or during planned special events, such as traffic conditions around fairs or cultural events. It should include coordination with the private sector, such as event operators, where appropriate.

4.6.5.5 Incident Management

Systems to detect, verify and assess incident severity, and to provide a coordinated response to incidents. Approach should emphasize inter-agency coordination and communications and should consider emergency situations, such as hazardous material spills.

4.6.6 Public fleet management

4.6.6.1 Real-Time Information

Systems to provide vehicle operators and dispatchers with real-time routing information, for example, relating to congestion, incidents, or fixed and temporary roadway restrictions, and real-time information relating to predicted equipment failures. Could also support other traveler information systems.

4.6.6.2 Vehicle Location and Status

Systems to provide information on the location and status of vehicles in public fleets operating in various types of terrain such as mountains, including information about predicted failures of the vehicle or its on-board equipment.

4.6.6.3 Computer-Aided Dispatching

Systems to support route planning, scheduling and dispatching of vehicles in public fleets. They should include inter-agency communications (e.g., for a highway patrol officer responding to a crash and finding the roadway icy to request a gritting truck).

4.6.6.4 Rural Addressing

Information on destination locations, such as remote rural residences, that are not available through existing, traditional sources, used to support a variety of systems.

4.6.7 Security

4.6.7.1 Remote Monitoring of Sites

Systems to provide video monitoring of activities at remote sites (potentially located at widely dispersed areas), such as rest areas.

4.6.7.2 Silent Alarms

Systems to provide operators of vehicles with silently activated alarms to use in emergency situations.

4.6.8 Data collection and sharing

4.6.8.1 Performance and Planning Data

Systems to collect and store data on a variety of applications for subsequent analysis and distribution. Systems should be used as the basis of information dissemination applications

4.6.8.2 Infrastructure Information

Systems to provide access to databases necessary for assessing right-of-way, as-built drawings, and other CAD information. Should be updated regularly (e.g., to include information from recent bridge inspections).

4.7 Surface Transportation Weather

Rural areas represent a diverse variety of terrain types ranging from mountainous areas to desert areas located below sea level. Weather conditions for rural travelers reflect this variety of characteristics. Some rural areas include such extreme differences in terrain and variability of weather within a single corridor, even within the same time frame. Weather-related crashes and delays represent a chronic problem for some rural areas prone to abrupt changes in conditions, terrain induced variability, and even seasonal occurrences such as spring and summer rainstorms creating flash flood conditions. Steep mountain grades combined with icy conditions present significant problems for commercial vehicle operators (as well as other travelers). Long response times of emergency services in these conditions delay vitally needed medical care, and further exacerbate travel delays due to secondary incidents.

Rural user needs in the area of Weather focus on support to decision making prior to trip initiation, monitoring roadway weather conditions for trips and operations that are underway, and communicating this information to system users. Rural user needs in this area also include providing service information to travelers who are not able to continue their trips due to hazardous conditions.

4.7.1 Advisory Information

Weather Warnings/Advisories:

Information regarding roadway and bridge surface conditions and timing that could affect travel conditions and operating speeds in the area (e.g., snow, icing, standing water, etc.)

Information regarding weather conditions and timing that could affect travel conditions in the area (e.g., fog, freezing precipitation, thunderstorms, snow, tornadoes, visibility, etc.)

Education of weather information users and providers re: the effects of weather on travel improve the outcome of decisions for weather-impacted activities.

Needs are addressed by need category (e.g., Traffic Management).

Some particular needs include:

4.7.1.1 Emergency Services

- Forecasts for short term planning and observations of current weather to determine the maximum safe speed and routing available to responders, duration of closures, and mode choice. Surface and air responses have differing requirements.
- All scales of information required, temporal and spatial—historical, prospective, short-term forecast, and current conditions. There is a moving domain of interest, starting with large area during early planning, forecasts for each geographical and functional areas of interest, small areas for near-term and instant case. Weather information detail varies from synoptic (winter storm, for example) to mesoscale (thunderstorm).
- Customers include emergency response team and emergency operations centers, victims, responders, trauma centers, and analysts.
- Decision making and weather information development and dissemination processes may be similar among users; but details of the information vary.

4.7.1.2 Tourism/Traveler

- Some parameters of interest, forecast and observed, include: road conditions, wind speed and direction, visibility, hazardous and severe weather.
- General weather conditions for tourist enjoyment, regional and national scale depending on trip length.
- Road conditions deriving from weather effects on terrain, such as falling rock, mud and rockslides, avalanches.
- Traveler's advisory usually has a short horizon for trips. Combine weather, road, and traffic information to provide travel information. Formats should be simple for lay-travelers, and focused on their route of travel. Weather information may be most useful when embedded in broader indicators such as Level of Service (LOS).
- There is a subtle conflict between the desire of recreation/destination operators to have weather portrayed in the most attractive light, and the need of tourists/travelers for targeted decision support.

4.7.1.3 Traffic Management

- Same as previous two tracks
- Weather effects on crew and staff scheduling are important.
- Forecast and observed weather impacts on traffic flow.

- Inputs to drafting of interagency agreements; e.g. permissible alternate routes necessitated by weather variations, and what, when, where and severity effects on traffic management actions.
- Duration and spatial extent of weather event; effect on designation of alternate routing.
- Weather observations and forecasts as input to traffic models.

4.7.1.4 Transit and Mobility

- Much like Traffic Management track
- Forecasts and observations focused on routes of particular importance. Fixed route service removes alternate routing and schedule flexibility as options.
- Storm effects on roadway, rail, and pedestrian needs (passengers approaching, waiting, loading, unloading/departing).
- Thermal effects on trackage; icing on third-rail supplies.
- Snowfall rate, accumulation, drifting.
- Rain and hydrology, flash flooding and scouring.
- Crash Prevention
- Road and bridge surface conditions, and their effects on speed.
- Visibility.
- Spot warning.
- Operator education regarding the effects of weather on crash occurrence.

4.7.1.5 Operations and Maintenance

- Forecasts of conditions likely to produce avalanches, mudslides.
- Weather to affect work zone scheduling, material and its delivery, construct ability, equipment. Climatology for planning, forecasts for scheduling, observations for reactive changes.
- Effects on facilities: power supply (lightning), chemical storage, and resource protection.

4.7.1.6 Terrain Hazard Advisory

Dynamic information for travelers regarding hazards such as falling rocks/rock slides, mudslides, avalanches, etc., pertains to all development tracks.

4.7.2 System Operational Effectiveness

Weather forecast and other systems providing appropriate information regarding weather conditions and timing which could potentially affect transportation system operations; and transportation user safety and efficiency.

Some particular needs include:

- Weather information requirements should be defined by each agency's (user) LOS standards. LOS usually depends on functional classification of roadways.
- Information gaps need to be filled to get sufficient observations both for diagnostic and forecast meteorology, and for operational use; and tailoring and synergistic (decision maker and meteorologist) integration are important.
- Cooperative agreements are needed to provide weather information for long and short range planning support resource management.
- Dissemination formats must have the user in mind.
- Forecast weather/solar effects on communications (e.g., microwave, high frequency).

4.7.3 En-Route Services Information

Shelters/Red Cross (Weather) – Determine location and availability of sites designated as shelters during/following natural disasters such as flooding and other emergency events within predefined area or based on vehicle location.

Some particular needs include:

- Very small-scale weather impacts, spot conditions, affecting driving safety and travel time for both "traveler's" intended route and alternates.
- Current and arrival time destination weather conditions.
- Observations and forecasts to support stop and restart "what if" evaluations.
- Lead time for determining when to activate shelters for emergencies.

- Current and forecast temperature and humidity for managing livestock stresses during travel.
- Consistency of language, format, and accessing of weather information across political boundaries.

4.7.4 Leveraging Weather Information to Cost Containment, Profitability, and Safe Operations/Travel

Weather Information Leveraging – Provide weather impact information on predetermined thresholds affecting cost and safety, with dissemination methods and formats tailored to various transportation users/stakeholders. Includes determining availability of suitable weather products and services, and/or taking actions to make them available.

Some particular needs include:

- Corridor orientation, especially for very long trips, to facilitate route selection/optimization.
- Climatology to minimize vulnerability to flooding, pavement deterioration, avalanche, etc.

Also should optimize facilities placement.

- Weather forecasts for “just in time” and stocking logistical practices.
- Forecasts as the point of departure in anti-icing snow and ice control practices.
- Descriptive weather information to support economic development.

4.7.5 Data Sharing

Support to weather analysis and prediction for surface transportation:

- Systems to enhance and share weather and road surface condition historical records and current observations from multiple sources to support accurate and definitive weather forecasts for surface transportation.
- Identify any need to archive surface transportation generated weather data, and its value in the marketplace.