

Intelligent Transportation Systems Applications
To Ski Resorts in New England

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The New England Transportation Consortium
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Project No. 02-8

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16. Abstract <p>Ski areas present transportation professionals with a host of challenging problems, including heavy seasonal peak traffic demands, the rural nature of the surrounding road networks, and the inclement weather conditions under which travel to ski resorts often occurs. The current study was undertaken with the purposes of: (1) understanding winter recreation travel problems in New England; and (2) assessing the applicability of Intelligent Transportation Systems (ITS) to address these problems. To quantify the transportation challenges, different stakeholders were contacted and interviewed, and site visits were made to a number of ski resorts. With the information compiled, the study proceeded to develop a "toolkit", designed to help select appropriate ITS applications for addressing the transportation challenges associated with ski resort travel. To provide further guidance on ITS applicability, a case study, focused on the Vermont Route 103/100 Corridor which includes a number of ski resorts, was selected and a high-level ITS architecture was developed for the region. The report concludes by summarizing the main conclusions derived from the study and making recommendations for future research.</p>					
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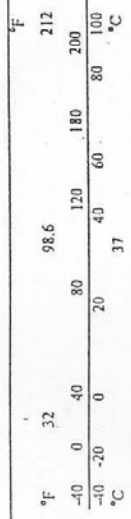


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1. INTRODUCTION

1.1 Introduction

Ski resorts have long been regarded as a major source of income to most, if not all, of the New England states and northeastern New York State. From a transportation standpoint, however, ski areas present a host of challenging problems to transportation professionals that require close attention. Ski areas are characterized by heavy seasonal peak traffic demands, especially on weekends and during holidays. This seasonal demand severely strains the highway network system surrounding these areas, causing many road segments to operate at a level that is very close to capacity.

With traffic volumes approaching capacity, and given the rural nature of many of the road networks around ski resorts, any minor disruption of traffic operations, in the form of an accident or inclement weather for example, immediately results in excessive congestion and huge travel delays. Moreover, in many cases, travel to ski resorts occurs under adverse weather conditions, such as snowstorms, icy roads and low visibility conditions. These conditions, when combined with the rural nature of many of the roads around ski resorts with their steep grades and sharp curves, present a real challenge to travelers, and a real threat to their safety.

In recent years, there has been a great interest within the transportation community in applying information technologies to improve the efficiency and safety of the transportation system. This effort, which is now generally referred to as the Intelligent Transportation Systems (ITS) program, includes several applications, among which are advanced transportation management systems, adaptive traffic control systems, traveler and roadway weather information systems, incident management systems and fleet optimization systems.

While ITS has been proven to help solve some of the nation's most challenging transportation problems, there have been few studies that have focused on using ITS to specifically address the transportation problems associated with ski resort areas. However, as this report will demonstrate, there is significant potential for ITS to alleviate long-standing transportation concerns in ski resort communities and travel corridors.

This document is the final report for a research project sponsored by the New England Research Consortium (NETC) entitled "Intelligent Transportation Systems (ITS) Applications to Ski Resorts in New England" (NETC Project #02-8). The study was funded by the six participating Departments of Transportation of the NETC member states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont), as well as the New York Department of Transportation, which shares similar needs and concerns.

1.2 Project Goals and Objectives

The principle goal of this project is to explore how Intelligent Transportation Systems (ITS) can be utilized to address the needs of ski resort transportation in the Northeast. This includes the needs of visitors to ski resorts (day visitors and overnight guests) as well as employees, commercial/freight transporters, and others in ski regions that are either positively or adversely affected by resort-generated trips. In essence, the study examines existing rural and large-scale ITS applications to determine their applicability to the unique needs of this travel segment.

The objectives of the project include:

- Defining transportation needs and issues associated with ski resorts, resort communities, and ski travelers in the northeastern states;
- Identifying ITS concepts and strategies that address these needs;
- Applying general ITS concepts to a specific case study region in the project area;
- Identifying opportunities for public-private cooperation for ITS deployment and operation
- Assessing ITS costs and benefits on a broad level; and
- Exploring implementation strategies, deployment considerations, and future research needs.

1.3 Study Area

The study area for this project (Exhibit 1-1) consists of seven northeastern ski states, incorporating all of the ski regions of New England as well as northeastern New York (i.e., the Adirondack and Catskill Mountains). Each of the seven states included in the study has at least one ski area, representing a diverse range of resort sizes, locations, and transportation characteristics.

The more urbanized areas of southern and coastal New England, as well as New York and Albany, serve as origins for a significant number of long-distance, ski-related trips over the transportation network. Because the needs of ski travelers begin before leaving home (e.g., determining pre-trip weather information), it is important to look beyond the resort regions themselves to understand ski travel needs. Additionally, the southern New England states and New York metropolitan area contain substantial existing and planned investments in ITS that could be leveraged to address ski travel needs, if such a purpose was defined in a systematic way.

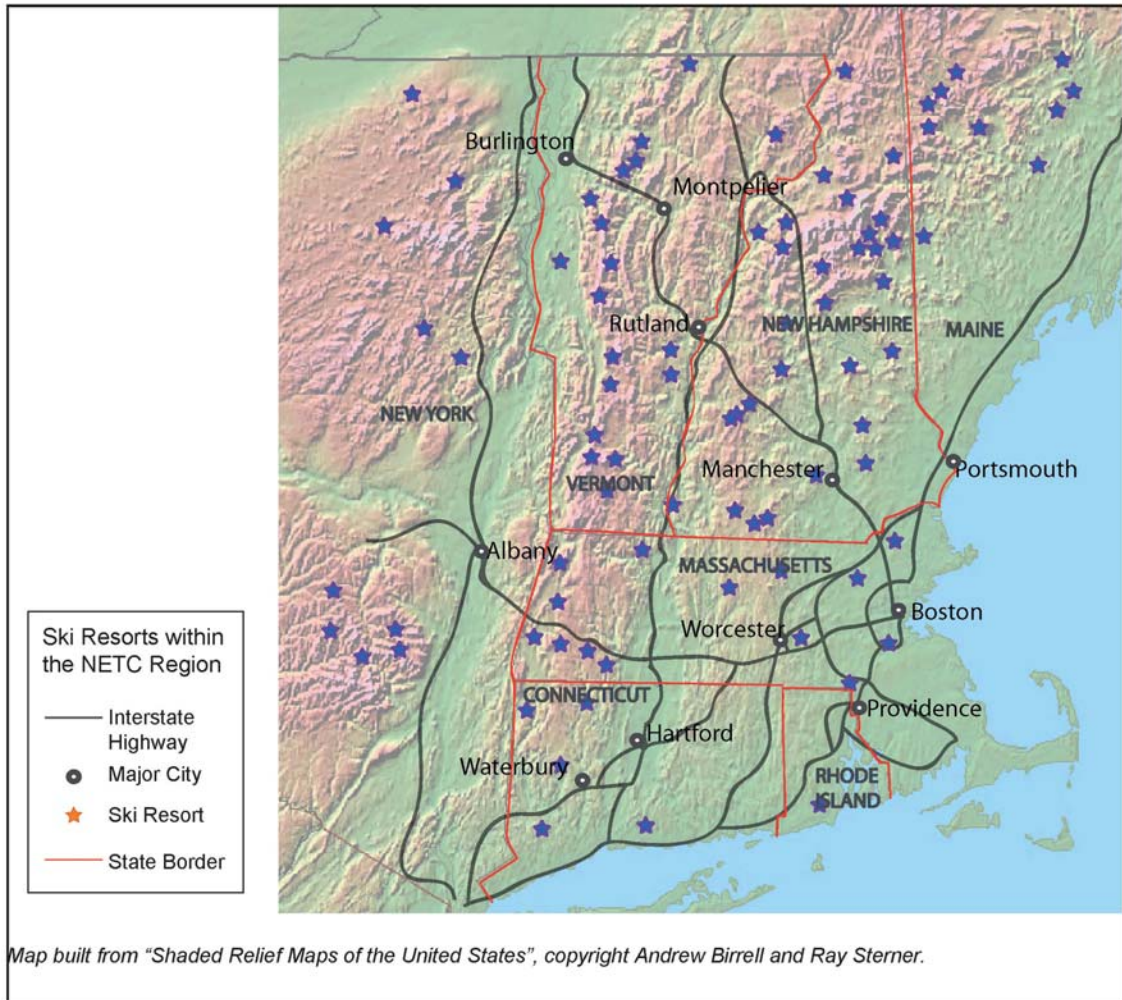


Exhibit 1-1: Major Ski Areas of the Northeast

1.4 Characteristics of Ski Transportation

There are several reasons why the application of ITS to ski resort travel deserves specific attention. First, ski transportation is a fundamental component of the rural transportation landscape in the northeastern states owing to the volumes and characteristics of skier travel. Some of the unique attributes of ski resort transportation include:

- Seasonality of travel (late fall, winter, and early spring);
- Recreation as the primary motivation;
- Higher probability of travel during inclement weather (e.g., snowstorms and icing)

- Reliance on rural interstates and secondary highways;
- High peaking of demand, esp. weekend afternoons;
- Potential for localized, recurrent congestion in resort areas, gateway communities, and key intersections;
- Significant role of large private and quasi-private entities (ski resorts, chambers of commerce) in traffic generation and mitigation;
- Ties to the local economy through traveler and tourism services.

Safe and convenient travel to ski resorts, is also important to the economic health of New England and New York mountain regions. Moreover, it has secondary impacts for the well being of all inhabitants of northeastern ski regions, both positive (economic) and negative (traffic congestion).

The participation of private ski resorts in the transportation management landscape poses both a challenge and opportunity to ITS deployment. In many cases, private ski resorts are already working with (sometimes antagonistically) with local, regional, and state authorities to develop, implement, and finance transportation management measures. Ski resorts also own or manage real transportation assets, including roads, parking lots, and shuttle fleets, and may pay for other public improvements through impact fees. Leveraging the vested interests of ski resorts in efficient transportation may allow for expedited deployment of ITS in ski regions, as well as provide suitable arrangements for financing, maintenance, and ongoing operations support.

The transportation characteristics and needs of ski resorts are diverse. As will be discussed later, the size, location, and market of each ski resorts determines its particular combination of transportation characteristics. Most resorts experience some combination of the following trip patterns:

- Long-distance skier travel (from urbanized areas)
- Circulation to, from, and within neighboring communities (local residents, lodging, and visitor services) by auto or shuttle
- Parking/lodging shuttle circulation within the resort itself
- Employee transportation to/from the resort
- Commercial and/or charter motor coach services
- Connections to regional bus, rail, and airport facilities
- Commercial freight delivery

Ski resort transportation patterns place urban-style peak demands on a predominantly rural transportation network whose roads are subject to significantly

lighter demands during other times of the day and in other seasons of the year. ITS, already a proven approach in urban regions, is therefore a good tool to ensure safety and efficiency on the rural transportation network in these areas, as well as to promote continued economic development in ski regions. Thus it is relevant to address ski-related transportation issues using transportation management strategies such as ITS. In fact, a number of such transportation management programs are already in use (often with partial or total funding contributions by the resorts) in New England and beyond, as illustrated by the following table.

Program	Location	Intended Impact
Stowe Trolley System	Stowe, VT	-Reduce congestion on Resort Entrance Road -Encourage use of Park-and-Ride -Discourage overnight guests from driving to resort from lodgings in town
“Sunday Solution” Half-Day Lift Ticket	Okemo, VT	-Encourages skiers to leave mountain before peak Sunday evening travel time
MOOver Transit Shuttle	Deerfield Valley, VT (Mount Snow)	-Provides alternative travel mode for employees and visitors
Peak Hour Traffic Management Plan	Killington, VT	-MOA with local municipalities to provide traffic officers at key intersections during periods, based on threshold conditions
Carpooling Incentives	Arapahoe Basin, CO	-Lift ticket discounts for carpools with at least 4 occupants
Lodging Incentives	Keystone Resort, CO	-Friday and Sunday night lodging incentives to discourage peak period travel
Dial-A-Ride	Beaver Creek Resort, CO	-Free door-to-door shuttle service for employees and visitors using vans and sedans

Exhibit 1-2: Examples of Existing Transportation Management Strategies for Selected Ski Resorts

For example, traveler information, for example, is an ITS particularly important to ski travelers. Because of the inherent nature of skiing, many travelers will venture long distances in severe weather conditions to take advantage of snow conditions, or because their travel plans are constrained by pre-existing lodging reservations. As a result, it is important to convey accurate road condition and weather information to aid in trip planning and promote roadway safety. Furthermore, since out-of-area visitors may be unfamiliar with traveler services and alternative transportation options, it would be useful for ski regions to provide ready access to this information for visitors at key decision points and en route.

While this study focuses on ski travel, many of its findings are extensible to other forms of rural transportation, including event-driven, tourism-driven, and/or seasonal travel patterns such as:

- Fall foliage season;
- Coastal, lake, and mountain resort areas;
- Large-scale special events (concerts, fairs, festivals, etc.); and

- Other events that place periodic strains on rural transportation networks significant enough to compel transportation management strategies.

1.5 Research Methodology

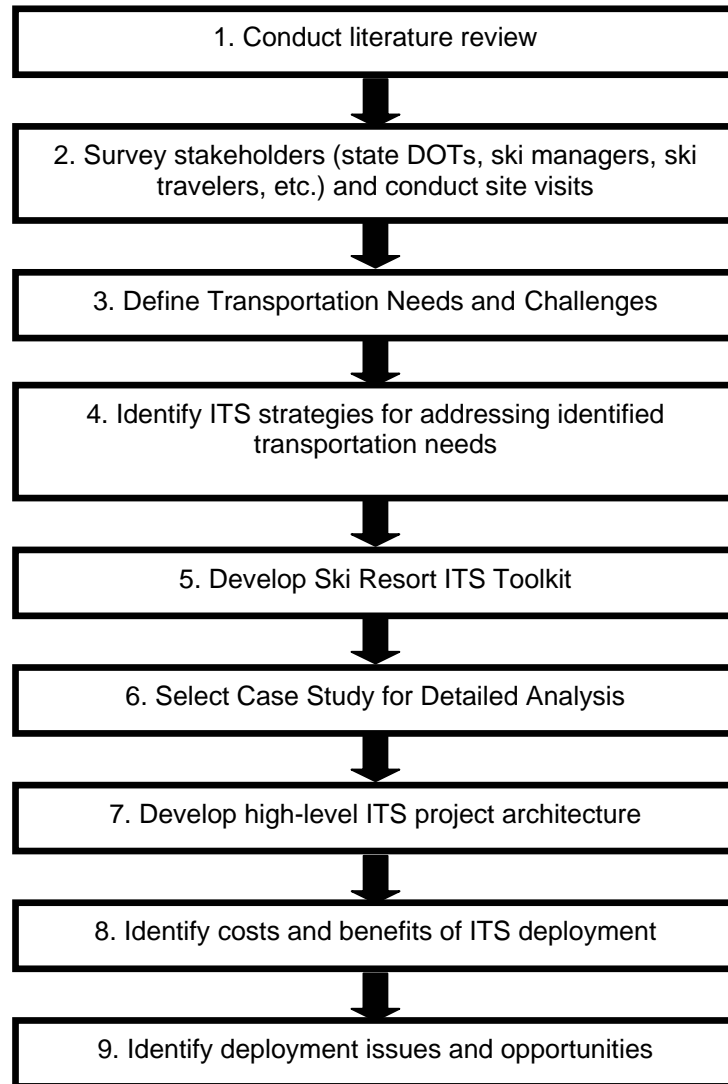


Exhibit 1-3: Study Methodology

This project was organized into nine tasks as illustrated in Exhibit 1-3. A brief description of each of these tasks is given below.

Task 1 - Conduct Literature Review: This task involved conducting a review of the literature in an effort to gather information that would support the various tasks of the project. Specifically, the literature review focused on identifying previous national, as well as international, research efforts that have focused on :

1. The transportation challenges associated with ski resort travel;
2. The travel and information needs of ski resort travelers; and
3. ITS strategies to improving the safety and efficiency of ski resort travel;

Task 2 - Survey Stakeholders and Conduct Site Visits: The first step in this task was to identify the different groups with stakes in ski resort travel. Among the groups identified were:

4. Ski associations;
5. Ski resort managers;
6. State departments of transportation;
7. State and local police;
8. Tourism agencies;
9. Transit/shuttle operators; and
10. Ski resort travelers.

With the different stakeholders identified, the study team proceeded to survey these different groups in an effort to identify their transportation needs and challenges. The basic philosophy behind the surveys was to inquire about general transportation needs in the hopes of avoiding the common trap of “technology searching for a problem”. A combination of survey questions and informal conversations were employed with each respondent. The surveys were augmented by a series of site visits to a number of ski resorts in New England in order to gather information regarding the characteristics of the surrounding roadway network and the general driving environment. One-on-one surveys with skiers were also conducted during these site visits.

Task 3 – Define Transportation Needs: The focus of this task was synthesizing the data collected from the literature review, the surveys conducted under task 2, and the site visits in order to define the transportation needs and challenges associated with ski resort travel. Our analysis indicates that different stakeholders have different needs, and that transportation challenges vary depending upon the location and the size of the resort, as well as the characteristics of the access network.

Task 4. Identify ITS Strategies for Addressing the Identified Problems: The focus of this task was identifying ITS strategies and solutions for the problems

identified in the previous tasks. The study team screened the ITS Market Packages defined in the National ITS Architecture (a market package can be generally defined as a collection of ITS functionalities, which are required to work together to provide a particular transportation service, or to solve a particular transportation problem). An ITS technology review was also conducted to identify any ITS applications that are not, as of yet, a part of the National Architecture, but that may still be useful for addressing the identified problems associated with ski resorts travel.

Task 5. Develop Ski Resort ITS Toolkit: In this task, the study team developed a “toolkit” designed to allow transportation professionals to select appropriate ITS applications for addressing the transportation challenges and needs associated with ski resort travel. The “toolkit” looks at the different stages of a typical trip to or from a ski resort and identifies the appropriate ITS applications for each stage. A brief description of each application is included, along with a discussion of the issues associated with its deployment. Guidance is also provided on the most cost-effective applications to be deployed based upon ski resort size and characteristics.

Task 6. Select Case Study for Detailed Analysis: To serve as a case study for the feasibility and benefits of using ITS strategies to address ski resort transportation challenges, the study team, in collaboration with the project’s technical committee, selected the Vermont Route 103/100 Corridor which includes a number of ski resorts. Background information regarding the selected corridor was compiled from previous study reports as well as from Geographic Information Systems (GIS) coverage. A meeting was also held at the Okemo Ski resort to solicit information from the major stakeholders in the region regarding the different transportation problems and challenges that they face. Attending the meeting were representatives of the Okemo ski resort, the Vermont Agency of Transportation, the Regional Planning Commission, the towns of Ludlow and Chester, and the Federal Highway Administration.

Task 7. Develop High-level ITS Project Architecture: This task, then developed a high-level ITS project architecture for the selected corridor based on the data collected during the previous task. The architecture was developed in a fashion consistent with the national ITS architecture, in order to ensure national and regional interoperability, and made use of the Turbo Architecture software tool recently developed by ITERIS for the FHWA.

Task 8. Identify the Cost and Benefits of ITS Deployment: This task focused on roughly estimating the costs of deploying the proposed ITS system for the selected corridor, as well as on predicting the anticipated benefits of the proposed deployment in terms of their impact on travel efficiency and safety. These cost and benefits estimates were largely based on the data compiled by Mitertek in the Benefit-Cost database. This database is available on the Internet at: <http://www.benefitcost.its.dot.gov/>.

Task 9. Identify Deployment Issues and Opportunities: This task focused deployment issues and opportunities associated with ITS for ski resorts. Because of the current involvement of many private ski resorts in transportation management arrangements with local officials, there is an encouraging precedent for public-private cooperation in ITS deployment, funding, and operations.

1.6 Project Team

This project took place under the direction of the following NETC Project Manager and Steering Committee:

1.6.1 NETC PROJECT MANAGER

Karen Songhurst
Vermont Agency of Transportation

1.6.2 NETC PROJECT STEERING COMMITTEE

Jim Bush, Federal Highway Administration (VT Section)
Harold Decker, Connecticut Department of Transportation
William Thompson, Maine Department of Transportation
Russell Bond, Massachusetts Highway Department
Subramanian Sharma, New Hampshire Department of Transportation
Rick Zabinsky, New York Department of Transportation
Joe Schall, Rhode Island Department of Transportation

The University of Vermont has teamed with consulting firm IBI Group to conduct this study. The team combines research and ITS planning expertise with the intention of producing study results that have immediate real-world applicability.

1.6.3 PRINCIPLE INVESTIGATOR

Dr. Adel W. Sadek
Associate Professor
Department of Civil and Environmental Engineering
The University of Vermont

1.6.4 CONSULTANT TEAM

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Director
IBI Group
Boston, MA

Randy J. Knapick, AICP
Associate
IBI Group
Boston, MA

1.7 Project Meetings

The following meetings/videoconferences were held during the course of the project:

- Steering Committee Meeting #1: November 18, 2002
- Steering Committee Meeting #2: May 5, 2003
- Case Study Stakeholder Workshop: September 22, 2003
- Steering Committee Meeting #3: October 20, 2003

- Steering Committee Meeting #4: February 19, 2004

1.8 Report Organization

This report is organized in nine sections, as follows:

Chapter 1 Introduction: This chapter lists the study's objectives, and briefly outlines the methodology followed to achieve the research objectives. The section also describes the organization of the report and the contents of each section.

Chapter 2 Literature Review: This chapter highlights the major conclusions derived from the review of the literature conducted under task 2.

Chapter 3 Defining Transportation Needs: This chapter describes the survey procedures followed in order to identify the transportation needs of the different ski resorts' stakeholders, and summarizes the important conclusions derived from these surveys.

Chapter 4 Application of ITS to Ski Travel Zones: In this chapter, a concept of "Ski Travel Zones" is introduced in order to identify ITS strategies that can help address the identified transportation needs and challenges.

Chapter 5 Identifying Applicable ITS Technologies: This chapter examines market packages in the National ITS Architecture to identify those applications that are relevant to the ski traveler needs identified earlier.

Chapter 6: ITS Ski Resort Toolkit: This chapter describes the ITS Ski Resort Toolkit, which was developed to allow transportation professionals select appropriate ITS applications for addressing the transportation challenges and needs associated with ski resort travel.

Chapter 7: ITS Costs and Benefits: This chapter discusses the expected costs and benefits of deploying ITS for the selected corridor.

Chapter 8: ITS Case Study: This chapter focuses on the Vermont Route 103/100 Corridor case study, which was conducted to evaluate the feasibility and benefits of using ITS strategies to address ski resort transportation challenges.

Chapter 9: Conclusions and Recommendations: This chapter summarizes the main conclusions derived from the study, and makes some recommendations for future work.

2. LITERATURE REVIEW

The focus of this task was to conduct a literature review in an effort to gather information that would support the various tasks of the project. While few examples of ITS deployment specifically designed for ski resorts could be found in the literature, the study team, nevertheless, was able to find several studies that are quite relevant to the purposes of the current project. For example, there is a wealth of information available in the literature regarding the transportation challenges of rural travel, the information needs of travelers, and the applicability of ITS applications for addressing some of the transportation challenges of rural tourism areas and National Parks. In this section, we briefly summarize the main results derived from our literature review. These results are organized under the following three categories: (1) rural transportation challenges; (2) information needs of travelers; and (3) ITS for rural tourism areas and for National Parks.

2.1 Rural Transportation Challenges

Since ski resorts are located in remote and rural areas, our first focus in this task was to better understand the major transportation challenges associated with travel in rural areas. The major challenges we have identified are summarized below [1,2].

Design Standards - Rural highways are designed to much lower standards than their urban counterparts. For example, it is very common for rural highways to have steep grades, blind corners, a lot of curves, few passing lanes, few navigational signs, etc. All these characteristics complicate driving on rural roads.

Existing Infrastructure - Rural areas have less existing infrastructure per square mile compared to urban areas. As a result, we find that there are much fewer convenient detour options available in rural environments. This is also the case with public transportation. Public transportation is very limited or non-existent in many rural areas. Presently, 38% of the nation's rural residents live in areas with no public transportation whatsoever, and another 28% in areas with limited service. Given the dispersed nature of rural transportation systems, the unit costs for service delivery, maintenance and operations are typically quite high.

Safety - Statistics show that the frequency of accidents per vehicle miles traveled is higher in rural areas. In addition, accidents are more severe and more often fatal (this might be attributed partly to the fact that the response time to incidents is higher in rural areas than in urban areas). In fact, about 60 percent of traffic fatalities and 55 percent of work zone fatalities occur in rural areas.

Adverse Weather and Road Surface Conditions - Adverse weather conditions, such as snow storms, fog and icy roads, present a real challenge to rural travelers and a real threat to their safety.

Recreational Travel - Recreational travel represents a significant portion of rural travel; this implies that a number of drivers in rural areas are unfamiliar with their surroundings, and hence, are in need for traveler information.

2.2 Information Needs of Travelers

A number of studies have been conducted in order to understand the information needs of travelers, in particular, rural travelers. Among the well-documented of these studies is one recently conducted by the Western Transportation Institute as a part of the Northern California/Southern Oregon Rural ITS Area-wide Travel and Safety Improvement Project (COATS) [3]. The study's objective was to determine *what* types of information the rural traveler needs, *where* he/she would like this information presented, and through what *medium*. This was accomplished by surveying a total of 1040 general travelers at 14 different locations distributed along the corridor. The survey inquired about their general transportation challenges, their information needs, and their willingness to use advanced technologies. Among the main results of the study were:

Perceived Transportation Problems: The most cited concern was for passing trucks and heavy vehicles which relates to clearance and visibility issues. This was followed by concern about road conditions, such as ice, snow, rain or fog. Exhibit 2-1 below ranks the perceived transportation problems using a 4-point Likert scale, which rates the frequency of the problem encountered as never, occasionally, frequent and always (with a 1 referring to "never" and a 4 referring to "always").

Transportation Problem	Average Score
Passing trucks and other heavy vehicles (clearance/visibility)	2.48
Road conditions like ice, snow, rain or fog	2.40
Driving through construction zones	2.33
Debris, objects or animals on the roadway	2.18
Driving on hills or curves	2.14
Encountering slow moving vehicles like snowplows, farm equipment or R.V.s	2.13
Lack of information from signs along the roadway	2.03
Running off the roadway	1.83

Exhibit 2-1: Ranking of Perceived Problems from the COATS Study [3]

Information Needs: With respect to information needs, travelers indicated that it was important for them to know, before they started their trip, the following: weather conditions; the best route to their destination, locations of traveler services such as rest stops, distances to destinations, and locations of traffic delays. Exhibit 2-2 ranks the importance of these different information types to travelers starting with the most important type, on a scale of 1 to 4 (with 4 referring to the most important).

Information Type	Average Score
Weather conditions	3.08
The best route to destination	3.06
Location of traveler services (rest stops)	2.94
Distance to destination	2.83
Location of traffic delays due to special events, road closures, etc.	2.83
Location of accidents or incidents	2.81
Tourist attractions (parks/recreation/historical)	2.64
Knowing trip-planning assistance is available from rest stops	2.62

Exhibit 2-2: Ranking of Information Needs from the COATS Study [3]

When asked when or where they would like to receive tourism and traveler information, 30.7% of the respondents mentioned that they would like to receive the information before they start their trip, 9.3% would like to receive it while on the road, 53.9% would like to receive it before and during the trip, and 6.1% mentioned that they do not need it.

ITS Device Usage: The survey also asked respondents to rate the likelihood of their usage different ITS devices and services to obtain traveler information or to aid in driving, once again on a scale of 1 – 4, with 4 indicating most likely. The results are as shown in Exhibit 2-3.

ITS Device	Average Score
Warning signs for speed, curves & animal presence that change with conditions	3.33
A telephone number to report an incident or accident	3.12
A special radio channel for road conditions, accidents, etc.	2.97
Changeable message signs	2.95
A telephone number for road conditions	2.81
A cellular phone	2.79
An in-vehicle device to enhance driving capabilities in low visibility situations	2.78
An in-vehicle device to help you avoid collisions or running off the roadway	2.75
A special radio channel for tourist information	2.70
Small, computerized information centers (or kiosks) at convenient locations	2.52
A local TV channel with continuously updated tourist and traveler information	2.26

Exhibit 2-3: Likelihood of ITS Device Usage [3]

2.3 ITS for Rural Tourism Areas and National Parks

Ski resorts share a number of features with other rural tourism areas, as well as with National Parks. Accordingly, this section reviews some of the major ITS field operational tests (FOTs) to evaluate the degree to which ITS applications could address the transportation challenges of National Parks.

2.3.1 ITS FOR RURAL TOURISM AREAS

In the area of rural tourism areas, two of the better known Field Operation Tests are: (1) the Branson Travel and Recreational Information Program (Branson TRIP) in Branson, Missouri; and (2) the I-40 Traveler and Tourist Information System (I-40 TTIS) in northern Arizona.

Branson, Missouri ITS System: In recent years, Branson, Missouri region has grown to become known as the “live entertainment capital of the world.” The annual visitor population to the region is estimated to be over 6 million visitors, and the majority of that traffic enters and leaves using one or two highways. In an effort to address the resulting traffic congestion, the Branson TRIP ITS system was proposed. The system was designed to take advantage of the existing ITS infrastructure in the region and to develop a comprehensive regional traveler information system that provides information on tourist attractions, weather, traffic, and road construction in the area.

Exhibit 2-4 shows the overall design of the system. As can be seen, the system receives input from a wide variety of sources including traffic detectors, police reports, Closed Circuit TV cameras (CCTV), attraction information databases, FORETELL (a privately operated weather information system) and construction work schedules information from transportation agencies. All this information is compiled in the central traveler information center, located at the City of Branson Police Department’s 911 Center. The compiled information is then disseminated using various information dissemination devices such as Variable Message Signs (VMS), Highway Advisory Radio (HAR), an Interactive Voice Response (IVR) phone system, the Internet and various kiosks.

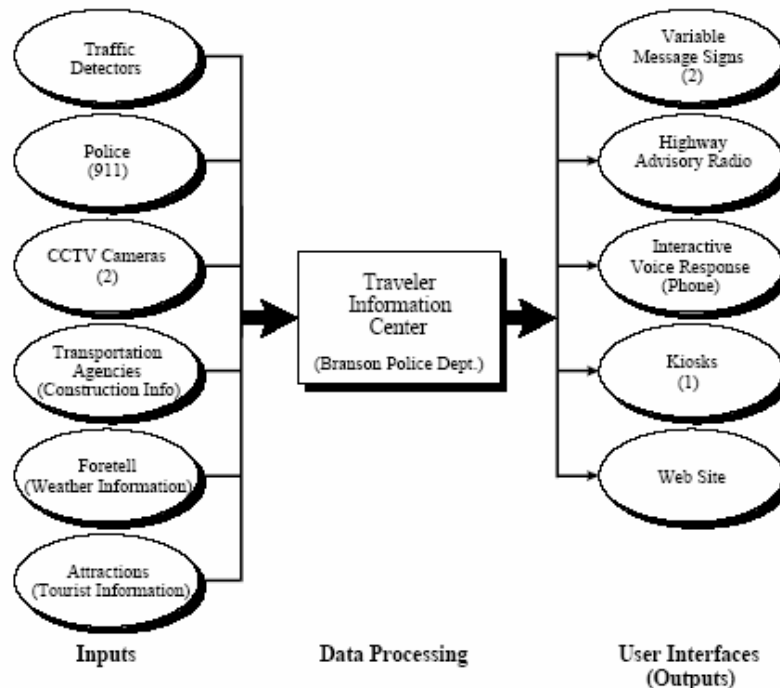


Exhibit 2-4: Overall System Design for the Branson TRIP ITS System [4]

The I-40 Traveler and Tourism Information System (TTIS): The rural segment of I-40 crossing Arizona is a major east-west route serving Arizona and its adjoining states. Traffic volumes on this section of interstate approach 25,000 vehicles per day, approximately 40 percent of which are commercial vehicles. The route serves as a major feeder to more than 25 national parks, national monuments, and major tourist attractions. The I-40 TTIS was designed with the goals of providing up-to-date traveler information and improved safety, particularly given the high volumes of commercial traffic using the corridor and the diverse weather conditions experienced. Exhibit 2-5 shows the overall design of the system.

As can be seen, the design is quite similar to the Branson, Missouri system. Input is received from a wide variety of sources including road/weather sensors, CCTV cameras, Arizona DOT crews, police patrols, pre-pass transponders, as well as from a distributed network of 13 workstations, where a number of agencies can enter and access information. The Highway Closure and Reporting System (HCRS), located in the Phoenix Traffic Operations Center, serves as the central information system of the I-40 TTIS, where the I-40 corridor information is combined with metropolitan Phoenix area information. The information is then disseminated to the public using a wide variety of public and private user interfaces, including VMS, the Internet, kiosks, and an IVR phone system.

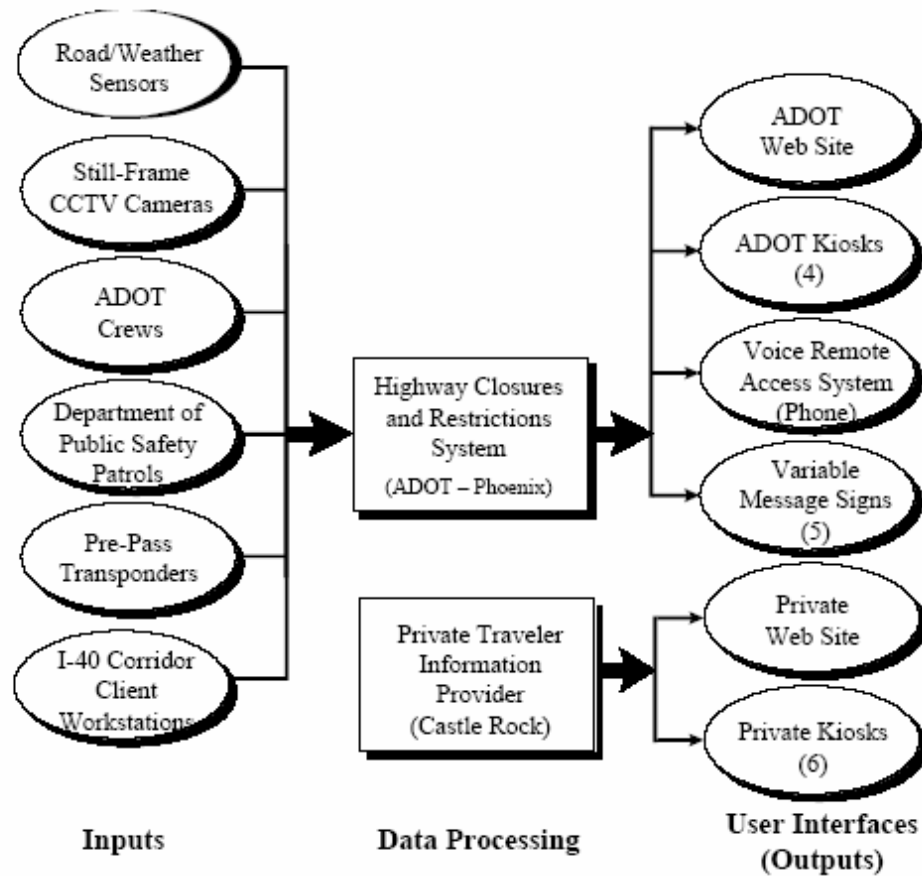


Exhibit 2-5: Overall System Design for Arizona I-40 TTIS [4]

Evaluation Results: In 1999, under a contract with the U.S. Department of Transportation's ITS Joint Program Office, an evaluation of the Branson, Missouri and the I-40 projects was conducted by Battelle. The evaluation addressed the following five goals: mobility, access, congestion, economic development and safety, and was primarily based upon tourist intercept surveys and qualitative interviews and focus groups. Unfortunately, the systems at the time of the evaluation did not contain the real-time processing capabilities that the original design had called for, which meant that the impact of the systems on travelers' behavior was limited. With this limitation, the evaluation focused on recording tourists' reactions to the deployed ITS systems and on assessing their general attitudes toward ITS.

The evaluation study revealed that a significant percentage of tourists were aware of at least one of the deployed Advanced Traveler Information System (ATIS) components. Furthermore, about 45 and 48 percent of those surveyed in Arizona and Branson were users of at least one component. A significant percentage of the surveyed tourists also reported that the travel information they received from one of the deployed ATIS components helped them save time and avoid traffic congestion, as well as made it easier to get to the site. From a safety standpoint, a majority of tourists in both Branson and in Arizona agreed that the highways in the area were safe. The perception of safety did not vary by awareness or use of ATIS in Arizona, but varied to some extent by awareness and use of ATIS in Branson.

2.3.2 ITS FOR NATIONAL PARKS

The real transportation challenge associated with travel to and from National Parks stems from the need to balance the dual purpose of preserving the natural and cultural resources while providing visitors with a meaningful and pleasant experience. A good example of ITS deployments geared toward addressing the transportation needs of National Parks is the Acadia National Park ITS field test in Maine. Acadia is one of the most-visited National Parks, especially during the summer months of July and August. More than 95% of the trips visiting the park are done using a private car, which strains the capacity of the road system and parking areas. This in turn has resulted in serious roadway congestion, parking problems, traffic delays, as well as noise and air pollution issues. The Acadia ITS FOT was intended to evaluate the extent to which ITS could help address some of these problems. The overall ITS system is comprised of nine interrelated components that represent the following three general areas of ITS applications: (1) Travel and Traffic Management; (2) Public Transportation Management; and (3) Emergency Management. The clusters of applications are shown in Figure 2-4.

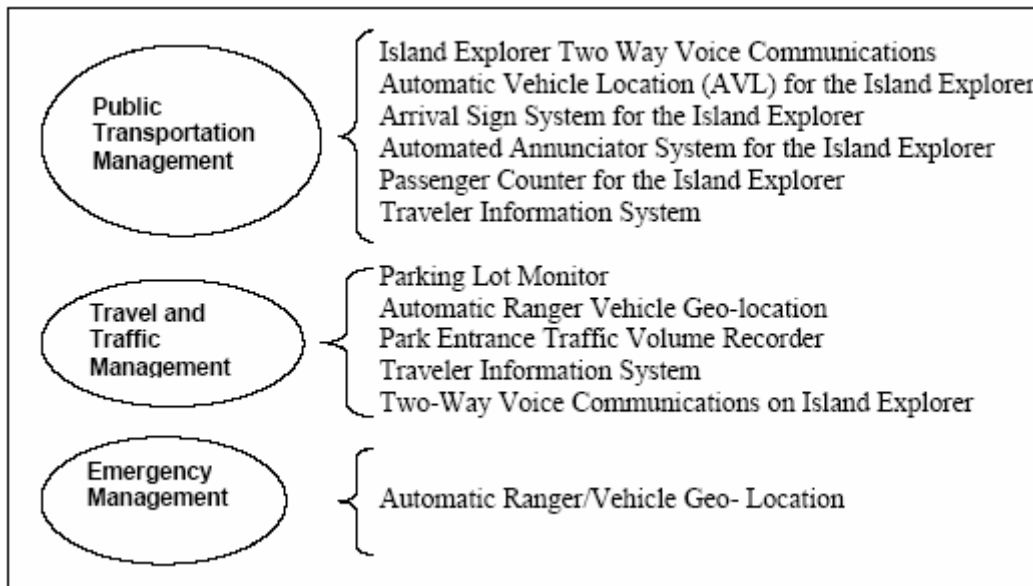


Exhibit 2-6: ITS Applications Deployed for the Acadia ITS FOT [5]

2.3.3 EARLY-WINNER ITS APPLICATIONS FOR RURAL AND TOURISM TRAVEL

The final part of the literature review focused on identifying what could be regarded as “early-winner” ITS applications for rural and tourism travel. This was intended to help guide the study in selecting appropriate ITS strategies for addressing the ski resort transportation problem, since, as previously mentioned, ski resort travel shares a number of features with rural and tourism travel. In 1999, the Western Transportation Institute, as a part of COATS project previously alluded to in this paper, conducted a ranking exercise in which various project participants ranked candidate early-winner projects [6]. From this analysis, the top 12 infrastructure-type applications were identified. These were:

1. Regional Incident Management Plan (RIMP)
2. Road Weather Information Systems (RWIS)
3. Highway Advisory Radio (HAR)
4. Closed-Circuit Television Cameras (CCTV)
5. Touch Screen Interactive Kiosks (TSIK)
6. Automated Flood Warning (AFW)
7. Dynamic Warning Variable Message Signs (DWVMS)
8. Advisory Television (AT)
9. Variable Message Signs (VMS)
10. 1-800 Travel Advisory Telephone Hotline (TATH)
11. Motorist-Aide Call Boxes (MACB)
12. Automated Visibility Warning (AVW)

A more detailed description of these ITS applications will be given later in this report.

Evaluation Results: An independent evaluation of the Acadia ITS FOT was undertaken by Battelle from 2000 through 2003. The evaluation focused on customer satisfaction and mobility, as the two top goals. Other goals included safety, efficiency, productivity, economic vitality, energy and the environment. To assess the impact of the deployed ITS system, a number of methods were used including a mail survey of visitors, a mail survey of businesses, interview with the Park's staff and other stakeholders, direct observation of visitor parking patterns, and operational data from the deployed system components. Among the main conclusions of the evaluation study are [7]:

- (1) ITS can help improve visitors' experience and help increase visitors' willingness to use transit (i.e. the Island Explorer Bus) rather than their own vehicles. Increased use of transit in turn results in improvements in air quality and possibly reductions in traffic and motor vehicle crashes;
- (2) Visitors who use ITS traveler information tend to be those most concerned about travel and transportation problems. For those visitors, ITS helps alleviate the perceived problems;
- (3) Although only three signs were deployed for real-time parking information as a part of the Acadia FOT, the signs have helped reduce excess parking at the two most popular destinations in the Park;
- (4) ITS appears to be useful from an economic development standpoint. Users of the Island Explorer and the ITS components associated with it tended to stay longer and spend more than other types of visitors.

A detailed analysis of the businesses survey results revealed that the majority of business managers recognize the importance of tourism to their business and community. However, they are concerned about transportation problems including parking, congestion, air quality and safety [8]. Most of the business managers were aware of the ITS technologies associated with the Island Explorer bus system, and, in particular, the electronic bus departure signs. In addition, managers perceived many benefits associated with the ITS, such as making it easier for tourists to get around, reducing parking and congestion problems, relieving uncertainty regarding bus arrival time, and improving the overall travel experience.

The Acadia FOT also revealed an interesting point regarding the challenge of marrying the interests of the business community with those of travelers [8]. During the course of the FOT evaluation, the Maine Department of Transportation (DOT) was getting ready to launch a statewide 511 telephone service. Given this, it seemed logical to include the Acadia Park's information (i.e. bus departure time and parking conditions) in the 511 service. However, when Maine DOT turned on their service in May of 2003, they were faced with an immediate backlash from the tourism industry. The tourism industry was concerned about the potential of losing some customers who would call and find the parking lots full. As a compromise, it was decided to keep the Acadia parking information in the 511 system, but not to "headline" it in the introductory message to the Acadia section of the 511 service.

2.4 Literature Review Conclusions

The following conclusions regarding ITS and ski resort travel can be made based upon the literature review conducted as a part of this study.

- (1) Travelers to ski resorts often face the challenges associated with rural travelers, including low design standards, limited infrastructure, safety concerns, and adverse weather conditions.
- (2) From a traveler information needs standpoint, information regarding weather conditions, the best route to a traveler's destination, locations of traveler services and locations of traffic delays are most useful to travelers.
- (3) ITS has a potential to address a number of the transportation challenges associated with ski resort travel. ITS should be expected to help improve customer satisfaction, improve mobility and accessibility, reduce congestion and delays, enhance safety, and reduce parking problems.
- (4) In designing traveler information systems for ski resorts, care should be taken to avoid the conflict between the interests of resort managers and travelers. Information should be provided in such a way that it avoids discouraging skiers from traveling to the resort.
- (5) Examples of potential ITS applications for ski resorts include traveler information systems, road weather information systems, variable message signs and highway advisory radio, incident management systems, parking management systems, and advanced public transportation systems.

3. DEFINING TRANSPORTATION NEEDS

In order to define the transportation needs and challenges of ski resort travel, a wide variety of stakeholders were surveyed for this project:

- Ski resort associations;
- Ski resort managers;
- Tourism agencies;
- State and Local Police;
- Transit/shuttle operators; and
- Ski resort travelers.

The basic philosophy behind the surveys was to inquire about general transportation needs and challenges. A combination of survey questions and informal conversations were employed in completing the surveys. These surveys were augmented by a series of site visits to a number of ski resorts in New England, in order to gather information regarding the characteristics of the surrounding roadway network and the general driving environment. One-on-one surveys with skiers were also conducted during these site visits. The following sections highlight the important information derived from surveying each of the afore-mentioned stakeholders.

Due to the small sample sizes and the informal nature of the interview process, the results presented herein are not statistically valid but do provide insight into the broad range of stakeholder concerns.

3.1 Ski Associations

In this case, the survey was administered over the phone. Among the main concerns that our discussion with the Vermont ski association revealed were:

- The need for improved signage and way-finding to ski resorts;
- The need for improved public transportation service from airports and Amtrak stations to ski resorts;
- The need for rest areas and welcome centers for to be open all the time.

The ski association was also asked to rate the transportation challenges of ski resort travel on a scale of 1 to 5, with 5 indicating most severe, and 1 indicating not really a problem. Exhibit 3-1 below shows the results obtained. As can be seen, public transportation and way-finding appear to be the two top concerns for the ski association.

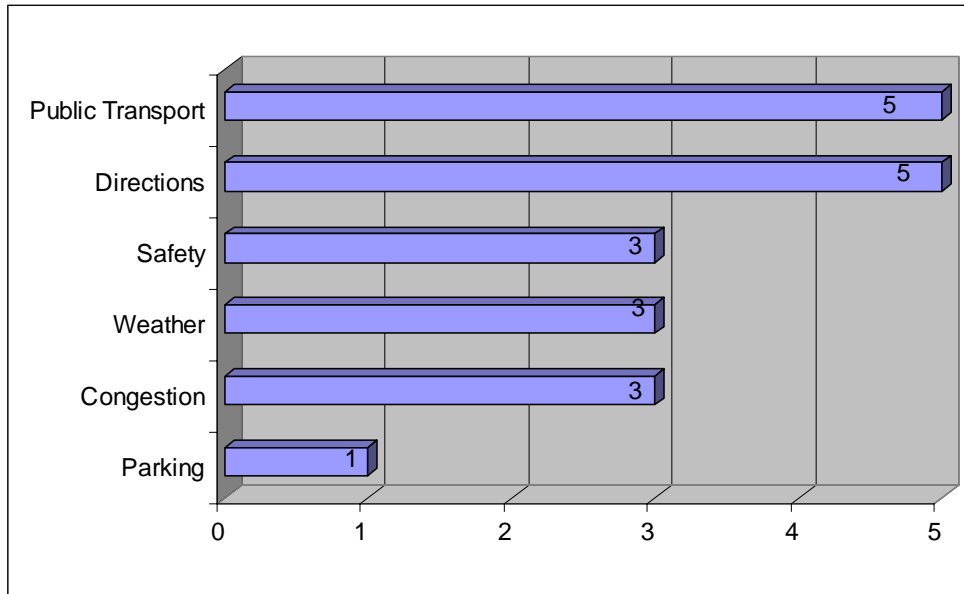


Exhibit 3-1: Ski Association Rating of Transportation Challenges

3.2 Ski Resort Managers

A number of ski resorts throughout New England were contacted, and a phone interview was conducted (the survey form used to conduct the telephone interview is included in Appendix A of this report). Among the ski resorts surveyed were: Middlebury Snow Bowl, VT; Killington, VT; Pat's Peak, NH; Gunstock, NH; Loon Mountain, NH; and Attitash/Bear Peak, NH. Some of the main concerns that came out of the ski resort managers' surveys were:

- Providing information to customers regarding transit and shuttle services;
- Information on parking availability and guidance, in particular for the larger resorts during holidays and weekends;
- Alleviating congestion during the peak period;
- Weather information is useful, but should be presented in such a way so as not to scare customers away; and
- Improved signage and way-finding to resorts, although this was not perceived as severe by ski resort managers compared to the ski association.

Ski resort managers were also asked to rate the transportation challenges they face on a scale of 1 to 5, with 5 indicating most severe, and 1 indicating not really a problem. Exhibit 3-2 below shows the average score obtained for each transportation challenge.

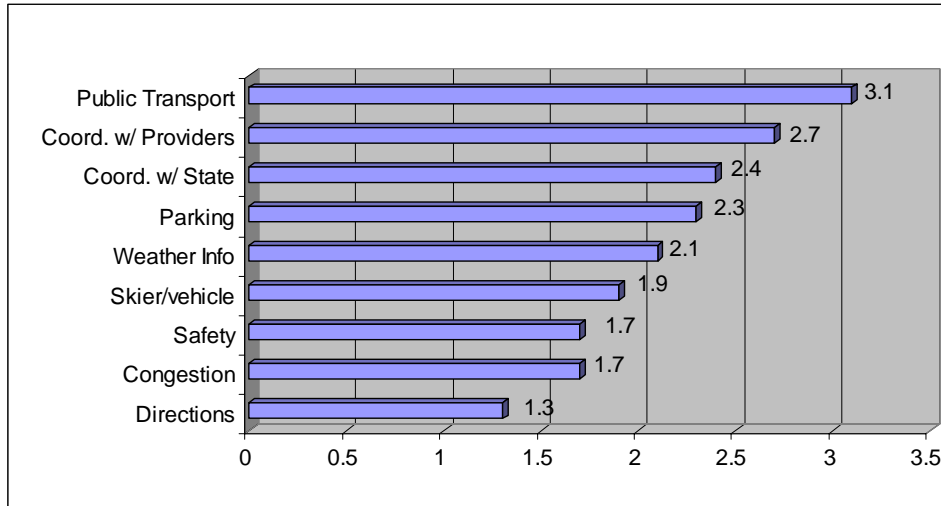


Exhibit 3-2: Ski Resort Managers Rating of Transportation Challenges

Another interesting point that came out of these surveys is the fact that ski resort managers view mitigation of transportation problems as vital for: (1) obtaining permits for future development; (2) showing good environmental stewardship; and (3) projecting a positive image with the local community.

3.3 State and Local Police

State and local police are involved in roadway safety, enforcement, and joint traffic management operations related to ski resort travel. Officers of the Massachusetts State Police (Shelburne Falls Barracks) and the Town of Princeton Police Department (near Wachusett Mountain, MA) were interviewed for this study.

The Massachusetts State Police cited ski-related congestion on major arterials through the region, including MA Route 2 (major east-west arterial between Boston and the resorts in the Berkshires) and Interstate 91 (major north-south arterial between southern New England and Vermont/New Hampshire resorts). Inclement weather contributes to safety concerns and accident frequency during the ski season. Reckless driving, including driving too fast for roadway conditions, is a major concern of the State Police in this region. Occasionally citizens inquiring about the latest roadway conditions during inclement weather contact the police barracks for information.

The Princeton Police similarly cite congestion concerns on the two-lane roads serving the Wachusett resort, though there are few alternatives as the system is near saturation. Inclement weather inevitably increases the severity of congestion, as well as the accident rate. Preemptive planning and coordination between the police department and the resort has occurred to develop a road maintenance and traffic management plan. Coordination with other municipalities has been discussed in order to better improve severe congestion issues.

3.4 Tourism Agencies

Staff representing two tourism agencies were interviewed for this study. One location was the MassHighway Visitors Center located in Greenfield, Massachusetts at the intersection of Interstate 91 and Mass. Route 2, and operated by the Franklin County Chamber of Commerce. The other location was the Vermont State Visitors Center located on Interstate 91 Northbound in Guilford, Vermont.

Both locations revealed that the primary questions asked by ski travelers include, in order of frequency:

- Information on weather/roadway conditions ahead;
- Directions to ski resorts (wayfinding information);
- Information on en route services such as lodging, gas, and food.

Additionally, the visitor centers, particularly the Vermont location, serve as rendezvous points for separate parties traveling from urban centers to the south and east. Thus, they provide a rare en-route location where traveler information can be disseminated in stationary devices (e.g., kiosks) as opposed to in-vehicle or mobile devices.

3.5 Transit/Shuttle Operators

Shuttle arrangements at northeastern ski resorts vary depending on resort size, location, and configuration, but typically involve one or more of the following functions:

- Intra-resort shuttle;
- Parking shuttle;
- Resort-gateway community visitor shuttle;
- Intermodal shuttle (e.g., to a nearby train station); and/or
- Employee shuttle.

These services are either provided by the resorts themselves or through local public transportation districts, often with financial support from the resorts served. Ski resort transit services include both free and pay-per-ride services.

Operators of resort shuttle services were interviewed at Stowe, VT; Waterville Valley, NH; and Gore Mountain, NY. Transit is considered to provide a valuable service in the resort setting by reducing congestion, providing transportation options for minors, reducing employee parking requirements at the resorts, providing job access, and improving the quality of the mountain environment. All interviewees indicated that resort transit services are subject to surges in demand during the

morning and afternoon peak periods, with considerably lighter utilization at other times.

Key transit needs cited by the interviewees include:

- Improving schedule adherence and headway management, particularly when the system is stressed due to weather or demand surges;
- Improving public awareness of available transit services, including routes, hours of operation, fare structure, etc.;
- Faster fare collection (on paid services) to reduce dwell times during peak periods;
- Increasing incentives to ride public transportation targeting overnight guests in particular; and
- Encouraging the use of park-and-ride facilities served by transit shuttles to alleviate access road and base lodge congestion.

3.6 Ski Resort Visitors

Informal interviews were conducted with a range of ski resort visitors during the course of the 2002-2003 skiing season. Interviews were conducted at the following locations: Loon Mountain, NH; Cannon Mountain, NH; Attitash/Bear Peak, NH; Killington, VT; Mount Snow, VT; and Bellayre Mountain, NY.

The skiers interviewed represented a wide range of travel characteristics, including day trip visitors from major urban areas, overnight guests in rental, time-share, or second home accommodations, and visitors from local towns near ski resorts.

Roadway congestion, weather information, and parking inconvenience were major concerns for those interviewed. Roadway congestion in the vicinity of resorts and on major access routes frustrates drivers and reduces the length of time and the perceived quality of the recreation experience. Some travelers are dismayed that “getting away from it all” in the mountain resorts means can mean contending with traffic jams and angry drivers. Short of eliminating these traffic jams, being aware of travel delays and potential alternate routes would provide positive benefits to ski travelers.

One characteristic trait of ski travel is that visitors are motivated to travel in sometimes severe weather in order to reach the best winter sports conditions at the resorts. There is also a significant degree of inelasticity in skier travel—skiers who wish to maximize their length of stay on weekends will inevitably travel during peak Friday evening and Sunday afternoon periods. Also, the fact that overnight guests in particular may have non-refundable lodging reservations can compel skiers to journey to a resort during poor weather conditions when travel is not advisable.

As with many large destinations, skiers interviewed cited the convenience of resort parking as a major concern. Visitors look for parking that is as close as possible to the ski lodges and lifts to minimize walking and shuttle travel time. The emergence

of valet and paid parking at some resorts illustrates that at least some visitors are willing to pay a premium for the most convenient parking. Visitors also look for clear signage and direction when parking lots are full to minimize the amount of time spent searching for parking.

Shuttle services received generally positive marks from interviewees; though the most common concern related to knowing when the next shuttle vehicle was due to arrive at a given location. This knowledge would lessen the uncertainty of relying on transit services and could potentially reduce the amount of time spent waiting outdoors in cold weather for the arrival of the next vehicle.

Many interviewees were familiar with Intelligent Transportation Systems from experiences in more urbanized areas. In particular, the skiers interviewed saw the value of improved real time traveler information related to congestion and weather conditions. For example, this information would allow skiers to time their return journeys based upon knowledge of deteriorating roadway conditions due to weather (or lead them to stay overnight instead). Similarly, time wasted in peak-hour or accident-related congestion could be better spent in après-ski activities or dining at the resort area if this traffic information was available before leaving the resort area.

Ultimately, the need to return home for the start of the work week or similar external constraints will compel most visitors to depart at a given time in spite of congestion or weather conditions. In such cases, the most important factors are assisting in route choice to minimize delays, and to ensure the safety of the journey.

3.7 Summary of Stakeholder Concerns

The following table summarizes the concerns of stakeholders that were expressed during the survey process.

Stakeholder	Expressed Transportation Needs
Ski Associations	<ul style="list-style-type: none"> • Improved signage and way-finding to ski resorts • Improved public transportation service to ski resorts
Resort Managers	<ul style="list-style-type: none"> • Improved public transportation service to ski resorts • Better coordination with transportation providers • Parking for some of the bigger resorts • Traveler information (improved signage, weather information – but not to scare skiers off) • Congestion on some of the main arterials
State DOTs	<ul style="list-style-type: none"> • Winter road maintenance is the primary concern • Congestion is the most prevalent problem • Safety/Accident prevention
State and Local Police	<ul style="list-style-type: none"> • Congestion (resort area; main vs. secondary roads; sporadic vs. constant) • Weather concerns (reckless driving for road condition; accident rates)
Tourism Agencies	Traveler Information (Weather, Services, Directions)
Transit/Shuttle Operators	<ul style="list-style-type: none"> • Schedule/headway adherence (adverse weather, demand surges) • Passenger information outreach (available service, real-time service information) • Fare collection/incentives (speed up collection; cooperative programs with lodging and resorts)
Ski Travelers	<ul style="list-style-type: none"> • Traffic congestion • Locating convenient parking • Information on road incidents and weather conditions • Local transportation options (shuttles and park-and-ride lots) • Information about services (Lodging, food, etc.)
Gateway Communities	<ul style="list-style-type: none"> • Traffic congestion • Economic development/tourism services

Exhibit 3-3: Summary of Stakeholder Concerns

4. APPLICATION OF ITS TO SKI TRAVEL ZONES

For purposes of this study, the research team has broken a typical ski traveler home-to-resort journey into six “Ski Travel Zones” (Figure 4-1). Each of these travel zones identifies a stage of a traveler’s journey with unique functional and/or geographic characteristics. This is in recognition of the fact that the needs of the traveler, the characteristics of the transportation network, and the applicable ITS systems or deployment systems vary throughout each of the zones.

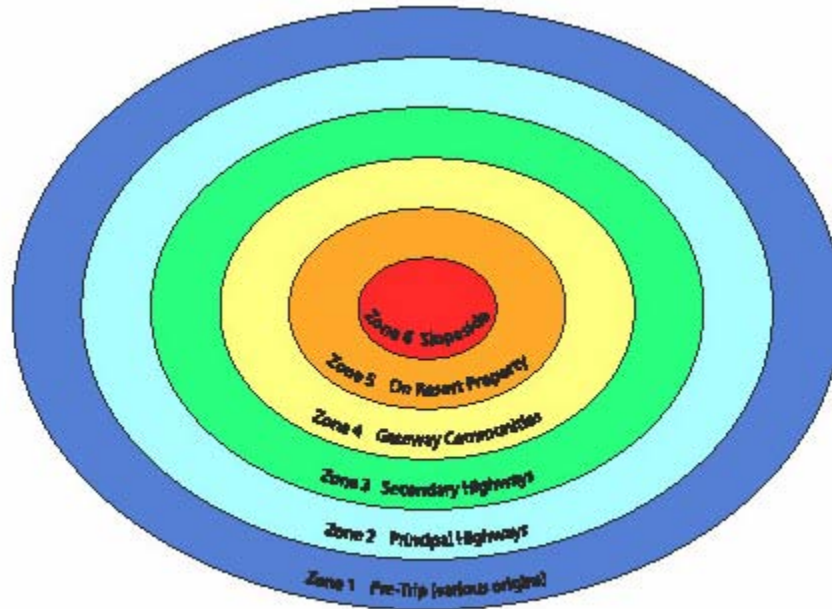


Exhibit 4-1: Ski Travel Zones

The six ski travel zones that have been developed for this study are as follows:

- Zone 1: Pre-Trip Planning
- Zone 2: Principal Highways
- Zone 3: Secondary Highways
- Zone 4: Gateway Community
- Zone 5: On Resort Property
- Zone 6: Slopeside

These ski travel zones will be referenced throughout the remainder of this report. Note that the zones do not have strict geographic definitions—for example, pre-trip planning may take place in a distant urban center as well as in a place of lodging very close to a resort. A common set of traveler needs, rather than precise

geographic boundaries, is the most important characteristic defining each of the ski travel zones.

4.1 Definition and Analysis of Ski Travel Zones

The following is a description of transportation characteristics in each of the six travel stages described above:

4.1.1 ZONE 1 - PRE-TRIP PLANNING

4.1.1.1 Description

This zone encompasses trip-planning activity that occurs prior to departure for the ski resort (e.g., home). However the pre-trip planning phase can also refer to locations closer to the ski resorts (e.g., resort lodging) where local trips originate during the course of skiers' visits.

For the pre-trip stage, travelers' needs are typically focused on gathering pertinent travel information for the trip being planned. For a ski resort trip, this information could include the following:

1. Obtaining directions to the resort of choice;
2. Identifying traveler services available at this resort or en route;
3. Determining alternative modes of transportation to travel to or around the resort;
4. Real-time or forecast weather and road surface conditions for the planned travel period;
5. Real-time or forecast traffic conditions; and
6. Planned construction and maintenance activities along the route to the resort.

4.1.1.2 Transportation Needs Suited to ITS

- Pre-trip travel planning information
- Real-time roadway and weather conditions
- Real-time weather, accident, and congestion advisories

4.1.1.3 Issues

- Path of travel is likely to involve several state jurisdictions in both urban and rural areas; need to access information conveniently from out of state locations.

4.1.2 ZONE 2 - PRINCIPLE HIGHWAY NETWORK

4.1.2.1 Description

This zone describes the en-route phase of travel that utilizes principal travel Interstate and other limited access highways with high throughput. These major travel routes tend to have the highest levels of traveler amenities as well as ITS instrumentation (e.g., dynamic message signs, weather sensors, traffic flow monitoring). Travelers use the principle highway network to bridge the long

distances between urban centers and the rural regions where major ski resorts are located.

4.1.2.2 Transportation Needs Suited to ITS

- Traveler information on available services
- Real-time weather, accident, and congestion advisories
- Updated route guidance information

4.1.2.3 Issues

- Interstate coordination may be required to communicate information to travelers on the regional highway network that are across state boundaries.

4.1.3 ZONE 3 - SECONDARY HIGHWAY NETWORK

4.1.3.1 Description

This stage describes the network of secondary highways (state, county, and local routes) that provide access to ski resorts from the primary highway network. More than one secondary route may service a given ski resort, providing dynamic routing/diversion opportunities in the event of an incident, though the capacity of these routes tends to be limited and severely stressed at peak ski travel periods.

4.1.3.2 Transportation Needs Suited to ITS

- Traveler information on available services
- Real-time weather, accident, and congestion advisories
- Updated route guidance information

4.1.3.3 Issues

- Secondary network typically has much lower design standards than freeway networks, incorporating steep grades and sharp curves.
- Secondary highways reach into rugged, mountainous terrain and are subject to increasingly severe weather conditions.
- Heavy seasonal demands of ski resorts travel may exceed the available capacity of these secondary networks, which raises some congestion and traffic management issues.
- Widespread ITS deployment along all secondary routes may be impractical due to large size and limited travel density.
- Winter maintenance on secondary networks is often a responsibility shared among state, city and town officials, which raises issues related to coordination and management of winter maintenance operations

4.1.4 ZONE 4 - GATEWAY COMMUNITY

4.1.4.1 Description

This zone encompasses resort towns, villages, or other developed areas surrounding ski resorts that feature services, lodging, employee residences, and other activities related to, or affected by, ski resort activities. Examples include: Ludlow, VT; Stowe, VT; and North Conway, NH.

This zone also includes communities that are not in the immediate vicinity of ski resorts but which are subject to the detrimental effects of “pass-through” traffic, and/or are subject to secondary ski-induced transportation or economic activity.

This zone begins to introduce end-of-trip parking considerations, and alternative transportation options (transit/shuttle services, park-and-ride) that may be available.

4.1.4.2 Transportation Needs Suited to ITS

- Management of traffic congestion on local roads and secondary highways
- Parking guidance, management, and payment in commercial areas
- Transit management, payment, and information
- Traveler information on available visitor services
- Traveler information on available parking and alternative transportation

4.1.4.3 Issues

- Heavy seasonal demands of ski resort travel may exceed the available capacity of roadways in gateway communities, which raises congestion and traffic management issues.
- Cooperation between state agencies, local municipalities, and resort personnel is required for traffic management and winter roadway maintenance in this zone.

4.1.5 ZONE 5 - ON-PREMISES (RESORT PROPERTY)

4.1.5.1 Description

This zone includes all transportation activities that occur within the boundaries of the resort itself. Typically this land, whether privately owned or leased from a public agency, is privately managed and includes significant parking capacity as well as shuttle services, pedestrian activity, and freight delivery. The roadway network is geared primarily towards access to resort facilities rather than through movement of traffic.

4.1.5.2 Transportation Needs Suited to ITS

- Management of traffic congestion on access roadways

- Parking management, dynamic parking guidance, and parking payment
- Transit shuttle management, payment, and information

4.1.5.3 Issues

- Typically a non-public infrastructure (road and transit) on resort property
- Critical need for resort support of transportation investment, and operations and maintenance.
- Weighing resorts' costs and benefits of ITS traffic and parking management systems will be an important criterion and potential incentive for resort operators

4.1.6 ZONE 6 - SLOPESIDE

4.1.6.1 Description

Pre-trip travel decision phase for trips departing the ski resort, lodging, or other major points of departure. This zone includes individuals who are planning trip departure time, mode, or route; those who are interested in learning about available traveler and tourism services; as well as those who are waiting at transit or shuttle stops for pick-up.

4.1.6.2 Transportation Needs Suited to ITS

- Provision of real time congestion, weather, and accident information for travelers' return journeys
- Traveler information on available visitor services
- Transit management, payment, and information

4.1.6.3 Issues

- Critical need for resort buy-in, investment, and operations and maintenance support in this zone.
- Placement, reliability, and user friendliness of ITS systems will substantially impact their effectiveness, particularly in pedestrian settings.

5. IDENTIFYING APPLICABLE ITS TECHNOLOGIES

5.1 Introduction

Intelligent Transportation Systems (ITS) can be defined as the application of advanced technologies and communications systems to address transportation needs. The goal of ITS is to obtain increased operational efficiency, safety, reliability, and economic benefit from existing transportation infrastructure. These benefits can often be achieved at a fraction of the cost of conventional infrastructure expansion (i.e. road building), and are particularly effective in locations where such expansion is financially, environmentally, and/or politically infeasible.

ITS technologies are applicable to virtually any mode of transportation, including highway, transit, rail, commercial vehicle operations, marine transportation, airports, and intermodal systems. Examples of ITS systems include:

- Roadway surveillance (CCTV cameras and electronic flow detection)
- Real-time traveler information (Internet, telephone, dynamic message signs)
- Electronic tolling and fare collection (e.g., E-Z Pass, smart cards)
- Transit Management (vehicle tracking, schedule adherence)
- Traffic signal coordination

In its early years, ITS was seen primarily as a solution for congested transportation networks in large metropolitan areas. ITS studies and deployments in recent years illustrate that ITS can play a serious role outside of the major urban centers. A few examples of rural ITS applications in the New England region include:

- Acadia National Park ITS Field Test (transit and traveler information), Maine
- VT-NH-Maine TRIO (event reporting system)
- Franklin County, MA, MassCountryRoads.com (traveler and tourism information)
- Cape Cod ITS (transit and parking management)
- UMass Regional Traveler Information Center (telephone/web travel time info, video, event reporting)
- Rutland, VT ITS system (traffic management, weather information, and traveler information)

ITS systems, in themselves, do not immediately, and independently, solve transportation problems. Rather, when thoughtfully designed and implemented, they serve as tools to address transportation problems, often in concert with more traditional transportation management strategies.

ITS technologies often introduce new forms of interagency and public-private collaboration, particularly in the realm of ITS operations. These considerations are equally important, if not more important, as the successful planning and design of the technologies themselves.

5.2 Market Package Screening

In order to identify applicable ITS strategies for ski resorts, the first step was to screen the ITS market packages defined in the National ITS architecture against the transportation needs and challenges, which were identified from both the surveys, as well as from the needs analysis of the different stages of a ski resort trip discussed in the previous section. A *market package* is a collection of ITS equipment capabilities that satisfy a certain market need or help solve a particular transportation problem. *Market packages* were defined by the National ITS Architecture development team to provide for an accessible, service-oriented perspective to the National ITS Architecture. The packages do not, however, specify the specific technology that will be deployed. Version 4.0 of the National Architecture contains a total of 75 market packages organized under 8 service areas. Exhibit 5-1 below shows the screening results.

		Traveler Info				Traffic Management										Maintenance				Transit				
		Broadcast Traveler Information	Interactive Traveler Information	ISP-Based Route Guidance	Yellow Pages and Reservation	Network Surveillance	Probe Surveillance	Surface Street Control	Traffic Info Dissemination	Regional Traffic Control	Incident Management System	Traffic Forecast/Demand Manag.	Virtual TMC/Probe Data	Parking Facility Management	Regional Parking Management	Reversible Lane Management	Speed Monitoring	Maintenance Vehicle Tracking	Road Weather Data Collection	Weather Info. Processing/Distribution	Winter Maintenance	Transit Vehicle Tracking	Transit Fixed-route Operations	Transit Traveler Information
Ski associations	Improved signage and way-finding			X				X																
	Improved public transportation service																							
Ski resort managers	Improved public transportation service																							
	Better coordination with transportation providers																X	X	X	X				
	Parking for some of the bigger resorts												X	X										
	Traveler information (improved signage, weather information)	X	X					X										X	X					
	Congestion on some of the main arterials	X				X	X	X	X	X	X	X			X									
State DOTs	Winter road maintenance is the primary concern																X	X	X	X				
	Congestion is the most prevalent problem	X				X	X	X	X	X	X	X		X										
	Travel safety, particularly during inclement weather							X	X						X		X	X	X					
State and Local Police	Congestion (resort area; main vs. secondary roads; sporadic vs. constant)	X	X			X	X	X	X	X	X	X		X			X	X	X	X				
	Weather concerns (reckless driving; accident rates; maintenance responsibility)							X	X		X				X	X	X	X	X					
Tourism Agencies	Traveler information (directions to resorts; weather; services in the vicinity)	X	X	X	X			X									X	X						
Transit/Shuttle Operators	Schedule/headway adherence (adverse weather, demand surges)																				X	X		
	Passenger information outreach (available service, real-time service)	X	X																		X		X	
	Fare collection/incentives																							X
	Demand management (Park-and-ride lots)										X	X	X								X	X	X	
Skiers	Traffic congestion, especially on local and secondary roads	X	X			X	X	X	X	X	X	X	X		X									
	Locating convenient parking												X	X										
	Information on road incidents and weather conditions	X	X			X	X		X		X						X	X						
	Local transportation options (shuttles, and Park-and-ride lots)																							
	Information about services (Lodging, food, .. etc.)				X																			
Gateway Communities	Traffic congestion is a primary concern	X	X					X	X	X	X	X		X										
	Information outreach about available services				X																			

Exhibit 5-1: ITS Market Packages Screening

As can be seen, a total of 24 market packages were identified. In the following paragraphs, we give a brief description of each of these market packages.

5.2.1 TRAVELER INFORMATION:

Broadcast Traveler Information: This market package collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, roadway maintenance and construction information, air quality and weather information, and broadly disseminates this information through existing infrastructures and low cost user equipment. The information may be provided directly to travelers or provided to merchants and other traveler service providers so that they can better inform their customers of travel conditions. The package is applicable to stages 1, 2, 3, 4, 5 and 6 of the ski resort trip.

Interactive Traveler Information: This market package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, roadway maintenance and construction, transit services, ride share/ride match, parking management, detours and pricing information. A range of two-way, wide-area wireless and fixed-point to fixed-point communications systems may be used to support the required data communications between the traveler and Information Service Provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone via a 511-like portal, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. This market package also allows value-added resellers to collect transportation information that can be aggregated and then available to their personal devices or remote traveler systems to better inform their customers of transportation conditions. The package is applicable to stages 1, 2, 3, 4, 5 and 6 of the ski resort trip.

ISP-Based Route Guidance: This market package offers the user pre-trip route planning and potentially turn-by-turn route guidance services. The package includes two-way data communications and, optionally, also equips the vehicle with the databases, location determination capability, and display technology to support turn-by-turn route guidance. The package is applicable to stages 1, 2, 3, and 4 of the ski resort trip.

Yellow Pages and Reservation: This market package provides yellow pages and reservation services to the user. These additional traveler services may be provided using the same basic user equipment used for Interactive Traveler Information. This market package provides multiple ways for accessing information either while en route in a vehicle, using wide-area wireless communications, or pre-trip via fixed-point to fixed-point connections. The package is applicable to stages 1, 2, 3, 4, 5, and 6 of the ski resort trip.

5.2.2 TRAFFIC MANAGEMENT:

Network Surveillance: This market package includes traffic detectors, other surveillance equipment, the supporting field equipment, and fixed-point to fixed-point communications to transmit the collected data back to the Traffic Management Subsystem. The package provides the real-time monitoring of the status of the

transportation system needed for the implementation of a large number of ITS applications. With respect to ski resorts applications, the package is particularly applicable to stages 2, 3, and 4 of the ski resort trip.

Probe Surveillance: This market package provides an alternative approach for surveillance of the roadway network. The package enables traffic managers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. One way to implement this package is through wide-area wireless communications between the vehicle and Information Service Provider to communicate current vehicle location and status. The package is applicable to stages 2, 3 and 4 of the ski resort trip.

Surface Street Control: This market packages aims at optimizing the operations of traffic signal control systems a traveler to a ski resort may encounter along his/her trip. The package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this market package ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. The package is applicable to stages 3 and 4 of the ski resort trip.

Traffic Information Dissemination: This market package provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic and road conditions, closure and detour information, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. Careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. The package is applicable to stages 2, 3, 4, 5 and 6 of the ski resort trip.

Regional Traffic Control: This market package provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. Several levels of coordination are supported by the sharing of information through sharing of control between traffic management centers. For ski resort application, coordination through information sharing will likely be the predominant mode. The package is applicable to stages 2, 3 and 4 of the ski resort trip.

Traffic Incident Management System: This market package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The market package includes incident detection capabilities through roadside monitoring devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers, as well as event promoters. The package supports traffic operations personnel in developing an appropriate response to confirmed incidents, which may include traffic control strategy modifications or resource coordination between center subsystems. Incident response also includes presentation of information to affected travelers through both

pre-trip as well as en-route travel information dissemination devices. The package is particularly applicable to stages 2 and 3 of the ski resort trip.

Traffic Forecast and Demand Management: This market package includes advanced algorithms that support historical evaluation, real-time assessment, and forecast of the roadway network performance. This includes the prediction of travel demand patterns to support better linked travel time forecasts. The market package provides data that supports the implementation of TDM programs, and policies managing both traffic and the environment. The package can potentially collect information on vehicle pollution levels, parking availability, usage levels, and vehicle occupancy to support these functions. For ski resorts, the package has the potential to aid in spreading out the peak traffic volume that typically occurs on Sunday afternoons by providing incentives to travelers (e.g. lower ticket fares, free refreshments, ... etc.) to encourage them to change their departure time. The package is applicable to stages 1, 2, 3, 4, 5 and 6 of the ski resort trip.

Virtual TMC and Smart Probe Data: This market package is specifically geared toward rural road systems. Instead of a central TMC, the traffic management is distributed over a very wide area (e.g., a whole state or collection of states). Each locality has the capability of accessing available information for assessment of road conditions. The package can use vehicles as smart probes that are capable of measuring road conditions. The package is particularly applicable to ski resorts, since many of them are located in rural areas, and is particularly applicable to stages 1, 2 and 3 of the ski resort trip.

Parking Facility Management: This package assists in the management of parking operations, coordinates with transportation authorities, and could potentially support electronic collection of parking fees. The package is particularly applicable to stages 4 and 5 of the ski resort trip.

Regional Parking Management: This market package supports coordination between parking facilities to enable regional parking management strategies. Similar to the parking facility management market package, this package is applicable to stages 4 and 5 of the ski resort trip.

Reversible Lane Management: This market package provides for the management of reversible lane facilities. Given the directional distribution nature of ski resort travel, this package may be quite useful in managing traffic on Sunday afternoons and during holidays. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. It also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events. The package is particularly applicable to stages 3, 4 and 5 of the ski resort trip/

Speed Monitoring: This market package monitors the speeds of vehicles traveling through a roadway system. If the speed is determined to be excessive, roadside equipment can suggest a safe driving speed. Environmental conditions may be monitored and factored into the safe speed advisories that are provided to the motorist. The package is particularly suited to ski resort travel, which often occurs

on roads with lower design standards and during inclement weather. The package is particularly applicable to stages 2 and 3 of the ski resort trip.

5.2.3 MAINTENANCE AND OPERATIONS:

Maintenance and Construction Vehicle Tracking: This market package will track the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities. These activities can include ensuring the correct roads are being plowed and work activity is being performed at the correct locations. The package is particularly applicable to the ski resort environment where winter maintenance is of prime importance, and specifically to stages 2, 3, 4, and 5 of the ski resort trip.

Road Weather Data Collection: This market package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. In addition to fixed sensor stations at the roadside, sensing of the roadway environment can also occur from sensor systems located on Maintenance and Construction Vehicles. The package is applicable to stages 2, 3, 4, and 5 of the ski resort trip.

Weather Information Processing and Distribution: This market package processes and distributes the environmental information collected from the Road Weather Data Collection market package. The package uses the environmental data to detect environmental hazards so that system operators and decision support systems can make decisions on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination market package, and aid operators in scheduling work activity. The package is applicable to stages 2, 3, 4, and 5 of the ski resort trip.

Winter Maintenance: This market package supports winter road maintenance including snow plow operations, roadway treatments (e.g., salt spraying and other anti-icing material applications), and other snow and ice control activities. The package monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response, and track and manage response operations. The package is applicable to stages 2, 3, 4, and 5 of the ski resort trip.

5.2.4 PUBLIC TRANSPORTATION:

Transit Vehicle Tracking: This market package monitors current transit vehicle location using an Automated Vehicle Location System. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the Information Service Provider. For ski resorts, this package can provide for more

efficient management of bus shuttles between the resort and the gateway community, or between the resort and off-site parking facilities. The package is applicable to stages 4, 5 and 6 of the ski resort trip.

Transit Fixed-route Operations: This market package performs vehicle routing and scheduling, as well as automatic operator assignment and system monitoring for fixed-route and flexible-route transit services. This service determines current schedule performance using AVL data and provides information displays at the Transit Management Subsystem. Static and real time transit data is exchanged with Information Service Providers where it is integrated with that from other transportation modes to provide the public with integrated and personalized dynamic schedules. The package is applicable to stages 4, 5 and 6 of the ski resort trip.

Transit Traveler Information: This market package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop announcement, imminent arrival signs, and real-time transit schedule displays that are of general interest to transit users. The package is applicable to stages 4, 5 and 6 of the ski resort trip.

5.3 Mapping of Market Packages to Ski Travel Zones

The identified market packages were mapped against the six zones or stages of a ski resort trip. The results are shown in Table 5 below. This table can aid in identifying applicable ITS strategies or market packages for each trip stage, as well potential participating stakeholders.

		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Traveler Information	Broadcast Traveler Information	X	X	X	X	X	X
	Interactive Traveler Information	X	X	X	X	X	X
	ISP-Based Route Guidance	X	X	X	X		
	Yellow Pages and Reservation	X	X	X	X	X	X
Traffic Management	Network Surveillance		X	X	X		
	Probe Surveillance		X	X	X		
	Surface Street Control			X	X		
	Traffic Info Dissemination		X	X	X	X	X
	Regional Traffic Control		X	X	X		
	Incident Management System		X	X			
	Traffic Forecast/Demand Manag.	X	X	X	X	X	X
	Virtual TMC/Probe Data	X	X	X			
	Parking Facility Management				X	X	
	Regional Parking Management				X	X	
	Reversible Lane Management			X	X	X	
Speed Monitoring		X	X				
Maintenance	Maintenance Vehicle Tracking		X	X	X	X	
	Road Weather Data Collection		X	X	X	X	
	Weather Info. Processing/Distribution		X	X	X	X	
	Winter Maintenance		X	X	X	X	
Transit	Transit Vehicle Tracking				X	X	X
	Transit Fixed-route Operations				X	X	X
	Transit Traveler Information				X	X	X
	Transit Passenger/ Fare Management				X	X	X

Exhibit 5-2: Mapping of Market Packages and Trip Zones

5.4 Advanced Traveler Information Systems for Ski Regions

Virtually all of the ITS Market Packages identified as relevant to ski region transportation needs are components of an advanced traveler information infrastructure. ITS systems can serve as *information dissemination tools* (through telephone hotlines, the Internet, kiosks, etc.), or they can serve as information and data sources providing the *content* that these traveler information systems require to be useful and effective.

For the average traveler, the perceived value of Intelligent Transportation Systems hinges on the availability and quality of traveler information. While there are many other ITS benefits that are less apparent but equally important (e.g., more efficiency transit services; improved incident management), advanced traveler information systems form the “public face” of ITS and allow the average traveler to take advantage of shared real-time information. Because of this, the role of applicability of ITS traveler information technologies to ski region ITS applications deserves specific mention.

Important considerations in ski region traveler information provision include:

- **Information Content:** What information should be delivered to the traveler in order to be meaningful?
- **Trip Stage:** What information is relevant to travelers in different stages of the ski travel journey?
- **Geographic Location:** Where are travelers located when the information they require needs to be delivered?
- **Customization:** Is the information a general bulletin for all travelers (e.g., weather alert), or is the information specific to a given user query (e.g., lodging details)?
- **Responsibility:** What entity or entities are responsible for provision, upkeep, and/or verification of traveler information availability and accuracy?
- **Information Delivery:** What is the best technology for delivering information to the traveler given the content, level of detail, traveler location, and urgency of the message?

Information needs of travelers are specific to the travelers’ trip stage or travel zone, as are the technologies suitable for reaching travelers in a particular trip stage. For example, an interactive kiosk is a poor choice for disseminating real-time weather advisories to travelers in their vehicles. A better technology for this application is a dynamic message sign that is immediately accessible to all travelers without specifically searching for this information.

The choice of information dissemination technology is critical to the success and penetration rate of an advanced traveler information system. Exhibit 5-3 illustrates the applicability of several common traveler information dissemination technologies for ski traveler information needs.

Traveler Information	Traveler Information Technology								
	Internet	Mobile Internet Device	511 Phone IVR	VMS	Kiosk	HAR/LPFM	Cable TV	In-Vehicle	Public Address
Real-time traffic information for ski travelers	X	X	X	X	X	X	X		
Real-time Traffic Information for local residents/others	X	X	X	X	O	X	O	O	
Real-time roadway condition information	X	X	X	X	O	X	O	O	
Advanced information on weather/approaching storms	X	X	X	X	O	X	O	O	
Advice on route selection based on travel conditions	X	X	X	X	O	X	O	X	
Transit and shuttle information-real time	X	X	X	X	X	X	X	X	X
Transit and shuttle information-trip planning	X	X	X		X		O		
Real-time parking availability and location			X	X		X		O	
Parking reservation	X	X	X		O				
Available Traveler and Tourism Services	X	X	X	X	X	O	O	O	O
Alternative Long-Distance Travel Modes (Air, Rail, Motorcoach)	X	X	X	O	X	O	O	O	

X = primary technology to address need
O = Secondary Technology to address need

Exhibit 5-3: Applicability of Technologies for Specific Ski Traveler Information Needs

5.5 Summary

The preceding analysis demonstrates that a majority of the ITS Market Packages identified in the National ITS Architecture are relevant to the transportation needs of ski travelers, ski resorts, and ski region communities. Intelligent Transportation Systems provide the capability of real-time transportation network monitoring and control, as well as instantaneous distribution of traveler information based upon dynamic network conditions. Ski region transportation characteristics, which blend rural and urban transportation system management needs, are by no means exempt from reaping these benefits.

The Architecture and its components provide a general framework for ITS planning in ski regions, though a more in-depth examination of the specific design and operational issues related to ski region ITS deployments is required. The remainder of this document will examine the nuances of ski region ITS in greater detail to better define the functional requirements and strategic considerations relevant to these unique environments.

6. INTELLIGENT TRANSPORTATION SYSTEMS (ITS) TOOLKIT

The User Services, Market Packages, and Equipment Packages outlined in the National ITS Architecture, and discussed in previous chapters provide a general framework for the development of rural ski region ITS systems. However, the National ITS Architecture applies to both large metropolitan and rural areas, and is purposely designed to avoid mention of specific ITS technologies. Thus, it is necessary for the research team to develop a more focused description of ITS systems as they pertain to specific ski region transportation needs.

The Project Steering Committee endorsed the development of an “ITS Toolkit,” which is presented in this chapter. The toolkit provides tangible ideas and guidelines for ITS applications that address particular transportation issues and ski resort characteristics. The intent of the toolkit is to demonstrate that there are ITS systems available today which can be used to improve ski region transportation and to complement existing traffic mitigation programs in place at Northeastern ski resorts.

The toolkit section addresses other issues that are not part of the National ITS Architecture or the general literature on rural ITS Deployment, namely:

- The relationship of ITS systems to the ski travel zones (1-6) introduced earlier in this report, which in turn describe traveler needs and ITS deployment issues;
- The public and private entities which will play a major role in ITS deployment and operations in a ski region setting;
- Descriptions of ski resort transportation characteristics for which each ITS application is suited;
- Identification of ITS deployment issues or opportunities unique to ski regions; and
- Identification of opportunities for involvement of private ski resorts in ITS funding, deployment and operations.

Note that the toolkit does not provide a “design” or architecture” for specific ITS projects. Indeed, the needs of each individual resort need to be examined in depth to determine the suitability of an ITS application for a particular setting. Furthermore, existing ITS and communications infrastructure need to be evaluated to fully understand the potential for ITS deployment in a given area for a given purpose.

The toolkit is organized into six application areas, in which several specific ITS applications are discussed:

Advanced Traveler Information Systems

- Pre-Trip Traveler Information

- En-Route Traffic and Weather Information
- Traveler and Tourism Services Information

Advanced Traffic Management Systems

- Highway Traffic and Incident Management Systems
- Advanced Traffic Signal Systems

Operations and Maintenance

- Road Weather Information Systems
- Maintenance Vehicle Management Systems

Rural ITS Safety Systems

- Variable Speed Limit Systems
- Dynamic Curve and Downhill Speed Warning
- Motorist Warning Systems

Advanced Public Transportation Systems

- Computer-Aided Dispatch (CAD)/Automatic Vehicle Location (AVL)
- Dynamic Transit/Shuttle Passenger Information
- Transit Electronic Fare Collection

Parking Management Systems

- Dynamic Parking Guidance Systems
- Parking Reservation Systems

Each toolkit entry contains the following descriptive information:

- ITS System Name;
- Description: Provides an overview of the purpose and functionality of the ITS system;
- Ski Travel Zones: Indicates which of the six ski travel zones described earlier in this report are applicable to this particular technology;

- **Typical Lead Agency:** Describes the entity (public or private) which is likely to spearhead implementation of this technology (can vary based upon local conditions);
- **Other Key Stakeholders:** Describes other entities (public or private) that play a key role in the planning, deployment, and/or operations of the technology;
- **Ski Resort Partnership Opportunities:** Identifies specific ways in which private ski resorts may become involved in the planning, deployment, and/or operations of the technology;
- **Transportation Needs Addressed:** Drawing from the needs analysis described earlier in the report, this section lists ski-related transportation issues that are addressed by this technology;
- **Example Deployments:** Provides real-world illustrations of this technology in use. Where possible, New England area and/or rural projects have been cited;
- **Complementary ITS Systems:** Describes other ITS systems that work synergistically with this technology to enhance benefits and/or functionality;
- **Ski Region Deployment Issues:** Identifies any special considerations for the use of this technology in a ski region application; and
- **Applicable Resort Characteristics:** Indicates any specific resort characteristics (size, location, configuration, etc.) that influence the effectiveness or deployment approach for this technology.

6.1 Advanced Traveler Information Systems

(NOTE- Transit and Parking Traveler Information applications are discussed separately in subsequent sections of the toolkit)

Advanced Traveler Information Systems (ATIS) deliver real-time or static information to travelers related to traffic, transit, weather conditions, accidents, user services, or other areas of relevance to motorists. Many ITS applications generate data that can be of great benefit to travelers if it can be provided to motorists in a useful format and at the appropriate time through an ATIS system.

6.1.1 PRE-TRIP TRAVELER INFORMATION

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Static Pre-Trip Traveler Information	1,6	<ul style="list-style-type: none"> • State DOT • Ski Resort or Regional Coalition 	<ul style="list-style-type: none"> • Transit Providers • Tourism Agencies • Weather Information Providers • Ski Industry Associations • Emergency Management Agencies • DOTs in Adjacent States 	<ul style="list-style-type: none"> • Hardware and Systems Deployment • System Operations • Information/Data Provision

6.1.1.1 Description

Pre-trip traveler information systems provide static and/or real-time information for use in travel planning, determining current traffic and weather conditions, selecting travel mode, determining a travel route, identifying available traveler services services, etc. Pre-trip traveler information differs from en-route traveler information in the timing and nature of information required, as well as the media available for information dissemination.

6.1.1.2 Transportation Needs Addressed

- Pre-trip travel planning
- Identification of available transportation options to, from, and around the resort
- Peak-hour traffic mitigation (shifting departure times/modes)

6.1.1.3 Example Deployments

- Vermont TRIO (TRaveler Information Online) Event Reporting System (<http://www.aot.state.vt.us/Travelinfo.htm>)
- UMass Regional Traveler Information Center (RTIC) website (<http://www.coolidgeinfo.com>)
- MassCountryRoads.com Traveler and Tourism Information System, Franklin County, MA

6.1.1.4 Complementary ITS Systems

- Other Traveler Information Services
- Real-Time Traffic, Weather, Transit Detection (as a data source for information systems)

6.1.1.5 Applicable Resort Types/ Characteristics

- All Resorts

6.1.1.6 Ski Region Deployment Issues

- Because many ski travelers consult internet sites to check weather and ski conditions, and also to locate and book accommodations prior to departure, there is an existing precedent for providing static and real-time traveler information over this medium as well.
- Resorts are sensitive to traveler advisories (weather/traffic) that may “scare away” potential customers. This fact must be taken into consideration when designing pre-trip traveler information systems and messages.

6.1.1.7 Ski Resort Partnership Opportunities

- Potential opportunities to link to existing ski resort web pages, telephone hotlines, etc. as means of distributing traveler information.
- For certain types of information (parking, shuttles, tourism information), ski resorts may serve as the primary source of information.

6.1.2 EN-ROUTE TRAFFIC AND WEATHER INFORMATION

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
En-Route Traffic and Weather Information	2,3,4,5	<ul style="list-style-type: none"> • State DOT • Ski Resort or Regional Coalition 	<ul style="list-style-type: none"> • Transit Providers • Tourism Agencies • Weather Information Providers • Ski Industry Associations • Emergency Management Agencies • DOTs in Adjacent States 	<ul style="list-style-type: none"> • Hardware and Systems Deployment • System Operations • Information/Data Provision

6.1.2.1 Description

As opposed to pre-trip traveler information systems, the purpose of en-route information dissemination is to inform travelers who have left their origin and are on their way to their destinations. The information provided could include:

- Information about incidents and alternate routes
- Information about congestion and delays
- Information about weather and road surface conditions
- Speed advisory messages

While some the information provided by en-route travel information dissemination systems is similar to that provided by pre-trip systems, other information is quite different in terms of time-sensitivity and purpose. Often, real-time information is most useful in the en-route phase when the information is fresh and travelers are in a position to react to it through route selection.

En-route information dissemination technology options are varied and may include:

- Highway Advisory Radio (HAR) or low-power FM
- Variable Message Signs
- 511 Service
- Kiosks at Welcome centers and rest stops

6.1.2.2 Transportation Needs Addressed

- Congestion mitigation
- Improved traffic management

- Improved traffic safety

6.1.2.3 Example Deployments

- “511” Interactive Voice Response (IVR) telephone information, Vermont, New Hampshire and Maine
- Variable Message Signs, I-84, I-91 and Route 2 corridors, Hartford, CT

6.1.2.4 Complementary ITS Systems

- Other Traveler Information Systems
- Real-Time Traffic, Weather, Transit Detection (as a data source for information systems)

6.1.2.5 Applicable Resort Types/ Characteristics

- All Resorts

6.1.2.6 Ski Region Deployment Issues

- Real-time weather/roadway conditions information is particularly relevant to ski resort travel given the season and terrain involved
- Rural communications infrastructure limitations may restrict options for delivering en-route information to travelers
- Resorts are sensitive to traveler advisories (weather/traffic) that may “scare away” potential customers. This fact must be taken into consideration when designing pre-trip traveler information systems and messages

6.1.2.7 Ski Resort Partnership Opportunities

- Ski resorts may serve as a primary source for some type of en-route information (e.g. parking availability)

6.2 Traveler and Tourism Services Information

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Traveler and Tourism Services Information	1,2,3,4,5,6	<ul style="list-style-type: none"> • State/Local Tourism Agency • DOT 	<ul style="list-style-type: none"> • Tourism Agencies • Chamber of Commerce/ Business Community • DOT 	<ul style="list-style-type: none"> • Information Provision • Infrastructure Provision

6.2.1.1 Description

An electronic version of the familiar blue services signs along interstate corridors, these systems provide information on traveler services and tourism attractions in the vicinity of a trip, such as lodging, restaurants, fuel, sightseeing, and public services. They can provide very customized information to a user through the internet, kiosks, or telephone information systems, including lodging reservations.

6.2.1.2 Transportation Needs Addressed

- Increasing traveler convenience and access to services
- Promote secondary economic benefits of ski resort travel

6.2.1.3 Example Deployments

- MassCountryRoads.com Traveler and Tourism Information System, Franklin County, MA
- *ConnectVermont* Traveler Information System, Vermont

6.2.1.4 Complementary ITS Systems

- Other Traveler Information Systems

6.2.1.5 Applicable Resort Types/ Characteristics

- All Resorts

6.2.1.6 Ski Region Deployment Issues

- These systems promote positive economic benefits for ski regions and gateway communities who are otherwise adversely affected by traffic impacts of ski travelers

6.2.1.7 Ski Resort Partnership Opportunities

- The resorts themselves may be significant contributors of content for such traveler and tourism information systems.

6.2.2 ADVANCED TRAFFIC MANAGEMENT SYSTEMS

Advanced Traffic Management Systems (ATMS) utilize traffic detectors and surveillance, combined with personnel observations from the field, to monitor and maintain smooth traffic flow. ATMS systems are particularly beneficial when used to reduce the impact of traffic incidents, and/or to provide real-time traffic information to the traveling public.

6.2.2.1 Highway Traffic and Incident Management Systems

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Highway Traffic and Incident Management Systems	2,3,4	<ul style="list-style-type: none"> • State DOT 	<ul style="list-style-type: none"> • State Police • City or Town • DOTs in Adjacent States • Ski Resorts 	<ul style="list-style-type: none"> • Information Dissemination Hardware Deployment

6.2.2.2 Description

Incident management systems (which include the use of CCTV, service patrols, and incident detection algorithms) are mainly designed to deal with non-recurrent congestion, which is the result of unusual or abnormal occurrences, such as freeway accidents, stalled vehicles, work zone land closures or special events. Incident management, which is typically one of the primary functions of a freeway management, is concerned with reducing the time needed for incident detection and verification, incident response, incident clearance and recovery, in order to allow for restoring normal operations in the most efficient fashion possible. Incident management systems, therefore, have the potential to aid in managing the traffic and congestion problems associated with ski resort travel.

6.2.2.3 Transportation Needs Addressed

- Congestion mitigation
- Improved traffic management
- Improved traffic safety

6.2.2.4 Example Deployment

- The State of Massachusetts has 3,174 arterial miles and 394 freeway miles covered by free cellular phone call to a dedicated number, 580 arterial miles and 333 freeway miles covered by service patrols, 80 freeway miles covered by CCTV, and 10 freeway miles covered by incident detection algorithms.

- In New Haven, Connecticut, there are 664 arterial miles and 136 freeway miles covered by free cellular phone call to a dedicated number and 136 freeway miles covered. There are 22 freeway miles covered by CCTV. There are 30 freeway miles covered by service patrols.

6.2.2.5 Complementary ITS Systems

- Traffic monitoring system
- Traveler Information systems
- Road weather information systems

6.2.2.6 Applicable Resort Types/ Characteristics

- All resorts, but particularly those that are prone to incident-related congestion or which have multiple access routes among which diverted traffic may be distributed.

6.2.2.7 Ski Region Deployment Issues

- These systems may only operate during specific peak travel periods, increasing the operational feasibility in rural regions

6.2.2.8 Ski Resort Partnership Opportunities

- Ski resorts may be significant contributors in terms of operations and data provision (anticipated travel demand based on ticket sales)

6.3 Advanced Traffic Signal Systems

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Advanced Traffic Signal Systems	3,4	<ul style="list-style-type: none"> • State DOT • City or Town 	<ul style="list-style-type: none"> • State DOT • City or Town 	<ul style="list-style-type: none"> • Providing demand information for activation of peak period signal timing plans.

6.3.1.1 Description

Advanced arterial traffic control systems (or Adaptive Traffic Control Systems) are adaptive control systems that depend upon the use of a digital computer and sophisticated computer algorithms for controlling the operation of a system of signals along an arterial. The basic idea is to take advantage of the power of digital computers to control many signals, along an arterial or in a network, from one central location, and to allow for coordinated signal operations.

6.3.1.2 Transportation Needs Addressed

- Congestion mitigation
- Improved traffic flow
- Improved Safety

6.3.1.3 Example Deployments

- Advanced Signal Systems are widely deployed throughout the country. The specific capabilities of the deployed systems vary, however, from simple signal coordination schemes to highly adaptive traffic control systems.

6.3.1.4 Complementary ITS Systems

- Road Weather Information Systems

6.3.1.5 Applicable Resort Types/ Characteristics

- Resorts with significant traffic and where a number of signalized intersections, with congestion problems, are encountered en-route to the resort.

6.3.1.6 Ski Region Deployment Issues

- These systems may only operate during specific peak travel periods, increasing the operational feasibility in rural regions

6.3.1.7 Ski Resort Partnership Opportunities

- Ski resorts may be significant contributors in terms of operations and data provision (anticipated travel demand based on ticket sales)

6.4 Operations and Maintenance

6.4.1 ROAD WEATHER INFORMATION SYSTEMS

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Road Weather Information System	1,2,3,4,5,6	<ul style="list-style-type: none"> • State DOT 	<ul style="list-style-type: none"> • Weather Information Providers • Tourism Agencies • Ski Industry Associations • DOTs in Adjacent States 	<ul style="list-style-type: none"> • Hardware and Systems Deployment (e.g. deployment of kiosks on the ski resort premises) • Information/Data Provision

6.4.1.1 Description

The purpose of these systems is to provide travelers with comprehensive, integrated, road weather information. Systems typically allow users to access current and predicted road weather conditions on an interactive map, or via 511 service. The objective of these systems is to allow the public to make more informed travel decisions (regarding departure time, route selection, .. etc.) than can be made with less specific road weather information. Road weather information systems receive their input from a wide range of sources including Environmental Sensor Stations (ESS), the National Weather Service (NWS) Doppler Radar, NWS satellite data, Federal Aviation Administration surface weather observations, as well as field reports from DOT and State Patrol personnel.

6.4.1.2 Transportation Needs Addressed

- Pre-trip travel planning
- Improved travel safety during inclement weather

6.4.1.3 Example Deployments

- Vermont, New Hampshire and Maine TRIO project and in particular the FORETELL weather prediction component (<http://www.aot.state.vt.us/Travelinfo.htm>)

6.4.1.4 Complementary ITS Systems

- Road Weather Information Systems (RWIS)
- Variable Message Signs and Highway Advisory Radio

- Other Traveler Information Services

6.4.1.5 Applicable Resort Types/ Characteristics

- All Resorts

6.4.2 MAINTENANCE VEHICLE MANAGEMENT SYSTEM

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Maintenance Vehicle Management System	2,3,4,5	<ul style="list-style-type: none"> • State DOT • City or Town • Ski Resort 	<ul style="list-style-type: none"> • Weather Information Providers • Tourism Agencies • Ski Industry Associations • DOTs in Adjacent States 	<ul style="list-style-type: none"> • Hardware and Systems Deployment (e.g. deployment of kiosks on the ski resort premises) • Information/Data Provision

6.4.2.1 Description

These systems monitor the real-time location of agency vehicles during maintenance activities, and can also monitor the activities that occur on the vehicle (e.g., determining the amount of chemicals applied to each lane and ensuring that the amount of chemicals applied is appropriate to the road surface conditions). Smart Plows can be equipped with location technologies, vehicle status monitoring (plow up/down, rate of chemical application) and communicated back to a central management point. Additionally, vehicle-mounted sensors can detect the conditions of the road surface, and apply the appropriate amount of chemicals or sand to treat the condition of the roadway.

6.4.2.2 Transportation Needs Addressed

- Increased efficiency of maintenance operations
- Improved travel safety during inclement weather

6.4.2.3 Example Deployments

- Advanced Technologies Highway Maintenance Vehicle program undertaken by Iowa, Michigan and Minnesota
- MnDOT “Smart” Snow Plow

6.4.2.4 Complementary ITS Systems

- Road Weather Information Systems (RWIS; to predict icing conditions)

6.4.2.5 Applicable Resort Types/ Characteristics

- All Resorts, particularly bigger resorts

6.5 ITS Rural Safety Systems

These systems are designed to improve the safety of rural travel, which often takes place during adverse weather and road surface conditions and on infrastructure with lower design standard compared to their urban counterparts. These systems are thus quite appropriate for addressing some of the challenges associated with ski resorts travel.

6.5.1 VARIABLE SPEED LIMIT SYSTEMS

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Variable Speed Limit Systems	2,3	<ul style="list-style-type: none"> • State DOT 	<ul style="list-style-type: none"> • State Police • DOTs in Adjacent States 	none

6.5.1.1 Description

The purpose of these systems is to reduce the severity and frequency of winter-related accidents. The systems typically combine environmental sensor stations with radar speed detectors. Advisories are then posted on Variable Message Signs to advise drivers of the safe driving speed for the prevailing weather and road surface conditions. The decision to reduce the speed limit is often based on feedback from multiple weather stations, snowplow operators and State Patrol.

6.5.1.2 Transportation Needs Addressed

- Improved travel safety during inclement weather

6.5.1.3 Example Deployments

- The Snoqualmie Pass (Travel Aid) System, Washington State
- The “Fuzzy Variable Speed Limit” System, Northern Arizona

6.5.1.4 Complementary ITS Systems

- Road Weather Information Systems (RWIS)
- Variable Message Signs and Highway Advisory Radio

6.5.1.5 Applicable Resort Types/ Characteristics

- All resorts, but particularly those that rely on secondary mountain highways with a history of severe weather, poor geometric characteristics, and/or high accident rates.

6.5.2 DYNAMIC CURVE AND DOWNHILL SPEED WARNING

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Dynamic Curve and Downhill Speed Warning Systems	2,3	<ul style="list-style-type: none"> • State DOT 	<ul style="list-style-type: none"> • State Police • DOTs in Adjacent States 	none

6.5.2.1 Description

These systems are typically intended to improve the safety of travel on sharp curves and steep downhill slopes. They typically use a Variable Message Sign in conjunction with a speed measurement and vehicle classification device. Based upon the measured speed of the detected vehicle, advisory messages are then posted on the Variable Message Sign. These advisories could include recommended speed, sharp curve or steep grade warning, and a recommendation for using a low gear on steep downhill grades.

6.5.2.2 Transportation Needs Addressed

- Improved travel safety, and especially during inclement weather

6.5.2.3 Example Deployments

- The Downhill warning system deployed along a 19 km segment with a 7 percent grade west of the Eisenhower Tunnel on I-70. in Colorado
- The Sacramento River Canyon Curve Warning System in California

6.5.2.4 Complementary ITS Systems

- Road Weather Information Systems (RWIS)
- Variable Message Signs

6.5.2.5 Applicable Resort Types/ Characteristics

- All resorts, but particularly those that rely on secondary mountain highways with a history of severe weather, poor geometric characteristics, and/or high accident rates.

6.5.3 MOTORIST WARNING SYSTEMS

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Motorist Warning Systems	2,3	<ul style="list-style-type: none"> • State DOT 	<ul style="list-style-type: none"> • State Police • DOTs in Adjacent States 	none

6.5.3.1 Description

The purpose of these systems is to warn drivers of any condition that would pose a hazard to safe driving. These conditions could include low visibility, drifting snow, high winds, fog, animals in the roadway, etc. The systems typically employ a combination of environmental sensors, visibility sensors and traffic detectors. Warning messages are typically posted on Variable Message Signs.

6.5.3.2 Transportation Needs Addressed

- Improved travel safety, and especially during adverse conditions

6.5.3.3 Example Deployments

- The Idaho Storm Warning System
- The I-40 Fog Detection and Early Warning System, North Carolina

6.5.3.4 Complementary ITS Systems

- Road Weather Information Systems (RWIS)
- Variable Message Signs and Highway Advisory Radio
- Traveler Information Systems

6.5.3.5 Applicable Resort Types/ Characteristics

- All resorts, but particularly those that rely on secondary mountain highways with a history of severe weather, poor geometric characteristics, and/or high accident rates.

6.6 Advanced Public Transportation Systems

Advanced Public Transportation Systems (APTS) are intended to increase the efficiency, reliability, and attractiveness of mass transportation modes. Advanced Public Transportation Systems are applicable to both publicly owned and operated transit systems in resort areas, as well as shuttle systems owned and operated by the ski resorts themselves. Because of the importance of high-quality transit services to ski resort traffic mitigation programs, several APTS applications show promise in ski resort settings.

6.6.1 COMPUTER-AIDED DISPATCH (CAD)/AUTOMATIC VEHICLE LOCATION (AVL)

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Computer-Aided Dispatch (CAD)/ Automatic Vehicle Location (AVL)	5,6	<ul style="list-style-type: none"> Transit/Shuttle Provider Ski Resort 	<ul style="list-style-type: none"> Transit/Shuttle Provider Ski Resort 	<ul style="list-style-type: none"> Infrastructure provision Funding Operations

6.6.1.1 Description

These systems provide integrated on-board equipment and central computing software to provide a number of advanced transit management capabilities. Global Positioning Systems (GPS) can be used to track the real-time location of transit vehicles and correlate this information with static timetables to obtain schedule adherence information. In addition to automating a number of “back office” tasks such as driver scheduling, CAD/AVL systems can be used to feed real-time transit information to passengers through bus-stop message boards, automated telephone systems, websites, etc. (see *Dynamic Transit/Shuttle Passenger Information*).

6.6.1.2 Transportation Needs Addressed

- Increasing efficiency and reliability of transit
- Promoting the use of alternative travel modes

6.6.1.3 Example Deployments

- Island Explorer, Acadia National Park, Maine
- Montachusett Regional Transit Authority (MARTA), Fitchburg, MA

6.6.1.4 Complementary ITS Systems

- Dynamic Transit/Shuttle Passenger Information (as an outlet for information generated by the system)

6.6.1.5 Applicable Resort Types/ Characteristics

- Resorts with public/private transportation or shuttle services

6.6.1.6 Ski Region Deployment Issues

- Ski resort transit/shuttle systems tend to be small in scale, often with fewer than ten vehicles in the fleet. The benefits of the “back-office” scheduling, personnel, fleet management functions of CAD/AVL systems are probably secondary to the benefits to passengers from real-time vehicle location and arrival information generated by these systems.

6.6.1.7 Ski Resort Partnership Opportunities

- At resorts where transit/shuttle fleets are funded, owned and/or operated by the resorts themselves, there is an opportunity to leverage private investment in these systems as part of a transportation mitigation program.

6.6.2 DYNAMIC TRANSIT/SHUTTLE PASSENGER INFORMATION

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Dynamic Transit/Shuttle Passenger Information	5,6	<ul style="list-style-type: none"> • Transit/Shuttle Provider • Ski Resort 	<ul style="list-style-type: none"> • Transit/Shuttle Provider • Ski Resort 	<ul style="list-style-type: none"> • Infrastructure provision • Funding • Operations

6.6.2.1 Description

Dynamic transit/shuttle information systems provide real-time “where is my bus?” information for transit riders. This information can take the form of estimated arrival times, display of vehicle locations on interactive web/television maps, onboard announcement of upcoming stops, and other service-related bulletins (e.g., delays, special services). Dynamic transit/shuttle information may be distributed through bus stop or onboard dynamic message signs, as well as other traveler information dissemination media (telephone 511, kiosks, internet, etc.).

6.6.2.2 Transportation Needs Addressed

- Provision of transit traveler information
- Increasing efficiency and reliability of transit
- Promoting the use of alternative travel modes

6.6.2.3 Example Deployments

- Island Explorer, Acadia National Park, Maine
- Tri-Met Bus Shelter Real-Time Passenger Information Systems, Portland, OR

6.6.2.4 Complementary ITS Systems

- Computer-Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) (a real-time data source)
- Other Traveler Information Systems

6.6.2.5 Applicable Resort Types/ Characteristics

- Resorts with public/private transportation or shuttle services

6.6.2.6 Ski Region Deployment Issues

- From the perspective of the traveling public, providing real-time transit information is one of the most beneficial ITS investments to increase comfort and familiarity of potential riders with the system. In ski country, real-time transit information could be broadcast directly into hotel/condo rooms, along with static “how to ride” information, via resort community cable TV channels.

6.6.2.7 Ski Resort Partnership Opportunities

- At resorts where transit/shuttle fleets are funded, owned and/or operated by the resorts themselves, there is an opportunity to leverage private investment in these systems as part of a transportation mitigation program.

6.6.3 TRANSIT ELECTRONIC FARE COLLECTION

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Dynamic Transit Passenger Information	5,6	<ul style="list-style-type: none"> • Transit/Shuttle Provider • Ski Resort 	<ul style="list-style-type: none"> • Transit/Shuttle Provider • Ski Resort 	<ul style="list-style-type: none"> • Infrastructure provision • Funding • Operations

6.6.3.1 Description

Electronic Fare Collection (EFT) utilizes any of a number of non-cash fare media to expedite passenger boarding and simplify back office cash handling. Typical electronic fare media include magnetic stripe tickets and “smartcards” with very robust data storage capabilities. Fare payment systems can be combined with other electronic ID’s (e.g., employee ID cards, season passes, parking passes), to simplify transit access and payment.

6.6.3.2 Transportation Needs Addressed

- Increasing efficiency of transit services
- Promoting the use of alternative travel modes

6.6.3.3 Example Deployments

- University of Vermont/Chittenden County Transportation Authority Student ID Integration, Burlington, VT.
- VISA Cash Smartcard Transit Integration for 1996 Olympics (MARTA), Atlanta

6.6.3.4 Complementary ITS Systems

- Other Advanced Public Transportation Systems
- Electronic Parking Payments/Integrated, Multi-Function Resort Payment Cards or Passes

6.6.3.5 Applicable Resort Types/ Characteristics

- Resorts with public/private transportation or shuttle services for which a fare is charged, or another type of pass is required (e.g., valid lift ticket) in order to ride.

6.6.3.6 Ski Region Deployment Issues

- The use of electronic, contactless smartcards for lift access at some resorts provides an ideal platform for transit/shuttle applications at ski resorts. Integration of transit applications with employee or season pass IDs and other relevant opportunities in ski resort settings.

6.6.3.7 Ski Resort Partnership Opportunities

- At resorts where transit/shuttle fleets are funded, owned and/or operated by the resorts themselves, there is an opportunity to leverage private investment in these systems as part of a transportation mitigation program.

6.7 Parking Management Systems

Parking Management Systems are intended to optimize the use of available parking resources. As a secondary benefit, these systems can reduce traffic circulation in congested areas related to the search for parking, and in some cases, create new opportunities revenue generation.

6.7.1 DYNAMIC PARKING GUIDANCE SYSTEMS

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Dynamic Parking Guidance Systems	4,5	<ul style="list-style-type: none"> City or Town Ski Resort 	<ul style="list-style-type: none"> State DOT 	<ul style="list-style-type: none"> Hardware and Systems Deployment System Operations Information/Data Provision

6.7.1.1 Description

Dynamic Parking Guidance Systems use sensors to record the number of vehicles entering and exiting a parking lot in order to determine the number of current, available parking spaces. The information can then be provided to drivers, typically through variable message signs, to direct drivers to the nearest available spaces. Dynamic parking guidance systems were pioneered in the urban centers in Europe to reduce unnecessary traffic circulation related to the search for parking. More recently, these systems have seen increased application in North America, particularly at major trip attractors such as airports and special events venues.

6.7.1.2 Transportation Needs Addressed

- Parking Management
- Congestion Mitigation-Base Area and Gateway Community

6.7.1.3 Example Deployments

- Acadia National Park Parking Management System, Maine
- MBTA Rapid Transit Commuter Park-and-Ride Garages, Boston
- Logan Airport Central Parking Facilities, Boston

6.7.1.4 Complementary ITS Systems

- Other Traveler Information Systems
- Electronic Parking Payment
- Parking Reservation Systems

6.7.1.5 Applicable Resort Types/ Characteristics

- Resorts with significant parking demand, limited parking availability, and/or base area/gateway community congestion
- Resorts with remote park and ride facilities for spillover parking demand

6.7.1.6 Ski Region Deployment Issues

- Parking management issues at ski resorts tend to revolve around a few peak periods of the day when large numbers of visitors are arriving or leaving, which will result in different cost/benefit analysis, design, and operations planning as compared to applications in urban centers.

6.7.1.7 Ski Resort Partnership Opportunities

- Because most ski resort parking management issues occur on the resort property, the ski resorts are likely to be the lead entities in deployment and operation of these systems.

6.7.2 PARKING RESERVATION SYSTEMS

ITS System	Ski Travel Zones	Typical Lead Agency	Other Key Stakeholders	Ski Resort Partnership Opportunities
Parking Reservation Systems	5,6	<ul style="list-style-type: none"> Ski Resort or Local Municipality 	<ul style="list-style-type: none"> Ski Resort or Local Municipality 	<ul style="list-style-type: none"> Infrastructure provision Funding Operations

6.7.2.1 Description

These systems allow resort visitors to reserve a preferred parking space (potentially for a fee) prior to arrival at the ski resort via an internet or telephone reservation service.

6.7.2.2 Transportation Needs Addressed

- Parking Management
- Congestion Mitigation-Base Area and Gateway Community

6.7.2.3 Example Deployments

- University of Minnesota Guest Parking Reservation System

6.7.2.4 Complementary ITS Systems

- Other Traveler Information Systems
- Electronic Parking Payment
- Parking Reservation Systems

6.7.2.5 Applicable Resort Types/ Characteristics

- Resorts with significant parking demand, limited parking availability, and/or base area/gateway community congestion
- Resorts which operate or are considering “preferred” or valet pay parking in a location that is very convenient to the base lodge(s)

6.7.2.6 Ski Region Deployment Issues

- Some ski resorts (e.g., Loon Mountain, NH) have existing valet or preferred parking programs that could be improved through the use of an online parking reservation system.

- Parking management issues at ski resorts tend to revolve around a few peak periods of the day when large numbers of visitors are arriving or leaving, which will result in different cost/benefit analysis, design, and operations planning as compared to applications in urban centers.

6.7.3 SKI RESORT PARTNERSHIP OPPORTUNITIES

- Because most ski resort parking management issues occur on the resort property, the ski resorts are likely to be the lead entities in deployment and operation of these systems.

7. ITS BENEFITS AND COSTS

7.1 Introduction

Estimating the expected or realized benefits from ITS deployment is a challenging task. For the ITS strategies the current study has proposed for ski resorts, five general types of benefits are to be expected. These are: (1) Mobility benefits; (2) Accessibility benefits; (3) Congestion Mitigation benefits; (4) Economic Development benefits; and (5) Safety benefits. Exhibit 7-1 below lists some of the performance measures and procedures that can be used to evaluate the realized benefits once a system is deployed. This table is largely based upon the framework that was used to evaluate the Branson, Missouri and I-40 Traveler Information systems, as well as the Acadia National Park Field Operations Test.

Focus Area	Direct Measures	Evaluation Procedures
Mobility of Travelers	<ul style="list-style-type: none"> • Travel time • Travel convenience • Ski traveler satisfaction 	<ul style="list-style-type: none"> • % of survey respondents who perceive ITS helped increase the convenience of their travel experience • % of survey respondents who report ITS applications helped save time • Perceived satisfaction of travel experience • Number of stops to ask for directions
Accessibility (Destination)	<ul style="list-style-type: none"> • Awareness of available travel options 	<ul style="list-style-type: none"> • % of ski travelers indicating use of alternative route • % of ski travelers indicating that they visited attractions not previously known, as a result of ITS deployment
Congestion	<ul style="list-style-type: none"> • Number and nature of delays • Level of Service 	<ul style="list-style-type: none"> • Traffic volume and throughput • Average travel time or speed • Reported number and severity of delays • Number of accidents • Incident response time • % of ski travelers indicating that congestion was avoided
Economic Impact	<ul style="list-style-type: none"> • Increased visitation • Increased revenue • Increased awareness of available attractions and services 	<ul style="list-style-type: none"> • Duration of stay • Estimated expenditures during the stay • Intent to return • Utilization of available information dissemination resources
Safety of Travelers	<ul style="list-style-type: none"> • Accidents • Injuries, fatalities 	<ul style="list-style-type: none"> • Accident analysis • % of travelers responding to safety advisory messages • Travelers perception of safety • Amount of information regarding safety that is available before and after ITS deployment

Exhibit 7-1: Benefits Evaluation Framework

7.2 Anticipated Benefits from ITS Deployments

The framework defined above in Exhibit 7-1 can only be used to evaluate the benefits from an ITS system that already is in operation. For planning applications, however, there is still a genuine need for at least making reasonable and sound

estimates of such benefits. At the current time, the common practice for making such estimates is to look for similar ITS applications and systems that have been deployed elsewhere and have had their impact evaluated. One would then assume that similar benefits would be realized for the project at hand. To facilitate this process, the United States Department of Transportation's Intelligent Transportation Systems Joint Program Office has been actively collecting information regarding the benefits and costs of ITS since December of 1993. This information is contained with the ITS Benefits and Costs Database available on-line at:

<http://www.mitretek.org/its/benecost.nsf>

Mitretek regularly publishes reports highlighting the information contained within this database. The most recent of these reports, entitled ITS Benefits and Costs: 2003 Update, represents a culmination of nearly a decade of DOT's active data collection on the impact of ITS projects on surface transportation and the cost of implementing them.

In addition, the Federal Highway Administration (FHWA) has recently sponsored the development of a sketch planning analysis tool for estimating the benefits and costs of ITS deployment called the ITS Deployment Analysis System (IDAS). IDAS,, which was developed by Cambridge Systematics for the FHWA. It operates as a post-processor to traditional planning models based on the four-step planning process, and is designed to evaluate several traditional, as well as non-traditional, ITS benefits. The tool, however, is geared more toward evaluating Metropolitan ITS deployments than rural applications.

7.3 Benefits of Ski Resorts ITS Applications

Given the fact that IDAS requires a transportation planning model, and is more geared to Metropolitan ITS applications, the tool could not be directly used for the purposes of this project. Instead, the project team decided to consult the ITS Benefits and Costs Database, and to extract information regarding the benefits that have been reported for deployed ITS systems which are similar to the ITS applications and strategies the current study proposed for ski resorts. This information is summarized below.

7.3.1 TRAVELER INFORMATION

Pre-trip Traveler Information: A simulation study of the Washington, DC, metropolitan area found that individuals using traveler information services could improve their on-time reliability by 5-16% while reducing the risk of running late. In San Francisco, California, 45% of the travelers receiving information from the Travel Advisory Telephone System changed their travel plans, and 81% of travelers receiving specific route information from the Travelinfo Internet site changed their travel behavior. In addition, modeling studies in a number of US cities have shown slight improvements in corridor capacity with the provision of traveler information.

Tourism-oriented Traveler Information Systems: Surveys taken in popular vacationing destinations of Branson, Missouri, and along Interstate 40 in Arizona

found that over 50% of travelers in the areas felt that information from the recently installed traveler information systems saved them time.

7.3.2 TRAFFIC MANAGEMENT

Advanced Signal Control Systems: Several studies report significant benefits for signal coordination and advanced signal control systems projects. For example, a study has shown that the implementation of signal coordination along 76 corridors in California cities has reduced vehicle delay along these corridors by 25%. Other studies reveal productivity benefits, environmental benefits (in terms of fuel consumption), as well as safety benefits (reduction in crash risk).

En-route Information Dissemination: A number of studies have demonstrated that drivers are willing to change behavior in response to en-route travel information. For example, several European studies found that 30%-90% of travelers pay attention to dynamic message signs, and that 40% of drivers change route as recommended by dynamic message signs.

Using simulation, an evaluation study of the en-route information dissemination system deployed on the John C. Lodge freeway in Detroit, Michigan, showed that HAR and dynamic message signs in combination with ramp metering could reduce vehicle delay by up to 22%. On the other hand, In San Antonio, Texas, modeling results indicate that a traveler using traveler information could reduce his/her delay by around 8.1%.

Incident Management Systems: A study in Maryland revealed that this state's incident management program helped reduce incident durations by 57% in 2000. Reductions in incident-related delay also lead to fuel savings and reductions in fuel-related emissions.

Parking Management: While parking management systems are not yet widespread in the U.S., experience with parking management systems in Europe indicate a 25% reduction in downtown traffic volumes related to the search for parking. In addition, the parking management system deployed as a part of the Acadia ITS FOT in Maine has helped reduce excess parking at the two most popular destinations in the Park.

7.3.3 ITS RURAL SAFETY SYSTEMS

Variable Speed Limit Systems: An evaluation study of a variable speed limit system implemented in the Netherlands to control traffic during foggy conditions revealed that the system managed to reduce average speeds by about 10 kph, with a slight increase in speed variability.

Dynamic Curve and Downhill Speed Warning Systems: An advanced curve warning system installed along a mountainous portion of I-5 in rural California was found to reduce truck speeds on downgrades by more than 5%. Another dynamic truck downhill speed warning system in Colorado decreased truck accidents by 13%.

Motorists Warning Systems: An Idaho DOT study found significant speed reductions when weather-related warnings were posted on dynamic message signs. During periods of high winds and snow covered pavement, vehicle speeds dropped

35% to 35 mph when warning messages were displayed, compared to a 9% drop to 44 mph without the dynamic message signs.

7.3.4 MAINTENANCE AND OPERATIONS

Road Weather Information Systems: In Finland, it was estimated that the use of road weather information systems would allow for reducing the duration of slippery road conditions by between 10 to 30 minutes. In Wisconsin, it was found that using these systems would help improve planning for work schedules and would allow for reducing labor-hours by up to 4 hours per person during a significant storm.

7.3.5 TRANSIT MANAGEMENT

Transit Tracking and Scheduling Systems: In Kansas City, Missouri, the use of transit tracking and scheduling systems helped reduce the size of the vehicle fleet by up to 10% with no reduction in customer service. In Denver, Colorado, the use of transit tracking technologies has resulted in a 21% decrease in late arrivals.

Transit Information: A survey in Finland showed that 95% of those surveyed found in-terminal, real-time transit information displays to be quite useful. The most desirable features were displays of remaining wait time and knowing if an expected vehicle had already passed.

7.4 ITS Costs

7.4.1 FACTORS INFLUENCING SKI REGION ITS DEPLOYMENT AND OPERATIONS COSTS

Intelligent Transportation Systems are, by definition, “systems” comprised of various field hardware, communications, and central headend components/software. The costs of these systems comprises both deployment capital costs (including design, software development, and/or system integration) as well as ongoing operating costs (including maintenance technicians, operators, administration, etc.)

The National ITS Cost/Benefit Database introduced earlier in this chapter provides empirical ITS deployment and operations costs for a wide range of ITS applications deployed in urban and rural regions throughout the United States. The database includes “unit” costs for individual ITS components as well as “systems” costs for total deployments involving representative combinations of hardware, communications, and systems costs.

While there is an understandable desire to develop ITS cost rules of thumb for a given application, the reader is cautioned that the development of ITS cost estimates in the absence of an in-depth analysis and design for a specific application can be very misleading. It is as impossible to develop, for example, an abstract “traveler information” cost estimate as it is to develop an abstract estimate for “good transit service.” Both examples require a greater definition of location-specific variables and design parameters.

From a project financing perspective, there are opportunities in ski region deployments for cost sharing among public agencies and private ski resort operators as part of a traffic mitigation program. Public-private funding partnership opportunities are discussed in greater detail under specific applications in the ITS Toolkit, as well as in the Conclusions chapter of this report.

Once the basic parameters of an ITS deployment project are defined, tools such as the National ITS Cost/Benefit Database can be used to obtain an order-of-magnitude estimate of that project's costs, provided the reference data involves circumstances similar to the proposed deployment. The extensive literature on Rural ITS deployment and funding provides an additional resource for ski region ITS costing and financing information.

That said, it is possible to discuss generally some factors that will influence ITS deployment costs in ski region applications:

7.4.2 DEPLOYMENT (CAPITAL) COSTS

- **Leveraging Existing Regional/Statewide ITS Infrastructure:** Perhaps the greatest single cost-effectiveness strategy is to take advantage of existing ITS investments (statewide 511, event reporting systems, freeway traffic management) for ski region ITS requirements. Often great benefits to the ski region can be obtained through low-cost modifications to the operating plan, field infrastructure, and/or central software systems. This strategy is discussed further in the Conclusions chapter.
- **Ski Region Communications Availability:** Because communications between remote hardware to fixed control centers, and communication from fixed center to fixed center depends upon reliable communications, the type and capacity of available communications infrastructure has a dramatic impact on the feasibility and cost of ITS systems deployment. In rural ski regions with limited services and mountainous terrain, communications infrastructure limitation may have a detrimental impact on project costs. This is particularly true if new, dedicated infrastructure (e.g., fiber optic links)
- **Scale of Deployment:** ITS project cost structures are not linear, and there are some economies of scale to be realized in larger ITS deployments. This is particularly true of headend systems and software which are less cost elastic than hardware items costed on a per-unit basis (e.g., CCTV camera installations). Some agencies have combined their ITS procurements in order to obtain more favorable pricing for equipment and software development.

7.4.3 OPERATIONS COSTS

- **System Hours of Operation:** Most major urban ITS systems operate 24 hours a day, 7 days a week. In ski region applications, it is more

likely that intensive use of the ITS infrastructure will only be utilized during a few peak travel hours per week. Thus, the labor costs associated with ski region ITS deployments could be significantly lower for a “desktop” transportation management system that is operated only on an as-needed basis.

- **Systems Automation:** Many ITS applications (web cameras, roadway weather information systems, roadway safety systems) can operate in an automated or semi-automated state, particularly in smaller deployments with limited functional requirements. Use of such systems in smaller ski region deployments can reduce the overall operations costs associated with labor (though ongoing maintenance costs still must be considered).
- **Joint Operations Agreements:** Control of ski region ITS infrastructure, particularly during off-peak hours, can be shared with other regional ITS systems through cooperative operations agreements. For example, in the case study region, operations of the Ludlow/Okemo corridor could be combined with the Rutland area rural ITS deployment to leverage the similar staffing and operations requirements of that system. Additionally, off hours control could be transferred to a state police barracks or a statewide traffic management center for overnight operations, for the occasional instances when this infrastructure may be needed well outside of peak operating periods.

8. CASE STUDY: OKEMO/LUDLOW, VT AREA

8.1 Introduction

A case study region was selected in order to further develop ski region ITS concepts against realistic conditions at an actual resort in the Northeast. The objective of the case study is to apply the concepts developed thus far to a realistic situation in a ski resort area that typifies the transportation needs of a large number of northeastern ski areas.

The Okemo/Ludlow region of south-central Vermont was chosen for the case study in consultation with the project Steering Committee. This region is representative of a number of challenges faced by a wide cross-section of ski resort areas in the seven states of the study area, and thereby provides lessons that can be applicable to a multitude of settings. The complexity of the challenges in this area, as well as the context provided by other ITS deployments in the region, provides an ideal testing ground for new ski region ITS applications.

Noteworthy characteristics of the Okemo case study region include:

- Complex transportation needs involving on-resort, local, regional, and interstate transportation;
- Peak hour-congestion issues which strain the local road network and impact regional economic development;
- Adverse traffic impacts on “gateway” communities such as Ludlow and Chester;
- Adverse impacts from through traffic from other resorts;
- Reliance on secondary highways for resort access;
- Multiple interstate access corridors from several neighboring states;
- Mixed draw of skier traffic from local and far-away destinations;
- On-resort and in-town parking management issues;
- Local transit and shuttle services are present;
- Existing transportation management programs are in place to encourage the use of alternate modes and to shift peak-hour demand.

Transportation and economic development in the Okemo region are inextricably linked, because resort growth is constrained by the ability of the roadway network to absorb additional traffic. Expansion of the Okemo Mountain Resort is subject to a development review process under Act 250, a Vermont statewide development review process that links development approval to evaluation and mitigation of potential adverse impacts. Through Act 250 and an associated Memorandum of

Agreement, Okemo is obligated to provide 1-for-1 mitigation of any new traffic demand resulting from resort expansion.

On September 22, 2003, the research team held a stakeholder workshop at the Okemo Mountain Resort to identify transportation needs, existing transportation management strategies, and existing/planned ITS investments in the corridor. The following entities were represented at the workshop:

- Vermont Department of Transportation (State and District Level)
- Federal Highway Administration (VT Division)
- Okemo Mountain Resort
- South Windsor County Regional Planning Commission
- Town of Ludlow
- Town of Chester
- Town of Cavendish

Findings from this workshop are presented throughout the discussion below.

8.2 Overview of the Okemo Region

The Okemo Mountain Resort (“Okemo”) is located to the east of the village of Ludlow, Vermont, in the Green Mountain region southeast of the Town of Rutland and northeast of the Town of Brattleboro. The resort is typical of the larger New England ski resorts with 601 acres of skiable terrain, and a visitor draw from the larger metropolitan areas of southern New England and New York. The resort attracts significant numbers of both day-trip skiers (from local and distant origins) as well as overnight guests who stay in commercial lodgings and condominium developments in the Okemo Valley.

The Okemo Mountain Resort has close functional and economic ties to the nearby village of Ludlow, which is a hub of visitor services including lodging, restaurants, ski rentals, supplies, and other necessities catering to visitors and residents.

A network of secondary highways connects the Okemo region to the Interstate Highway System that leads to major urban centers where a majority of long-distance traffic is generated. The case study can be loosely defined as the geographic area bounded by Interstate 91 to the east, Interstate 89 to the North, Vermont Route 100 to the west, and Route 103 to the south (Figure 9-1). This incorporates the Okemo resort and the village of Ludlow, as well as other gateway communities including Rutland, Chester, Springfield, and Cavendish. To a lesser extent, the case study included consideration of the major highway corridors leading into the case study region, i.e., Interstates 89 and 91; U.S. Route 7; and U.S. Route 4 (which connects to the NY State Thruway system).

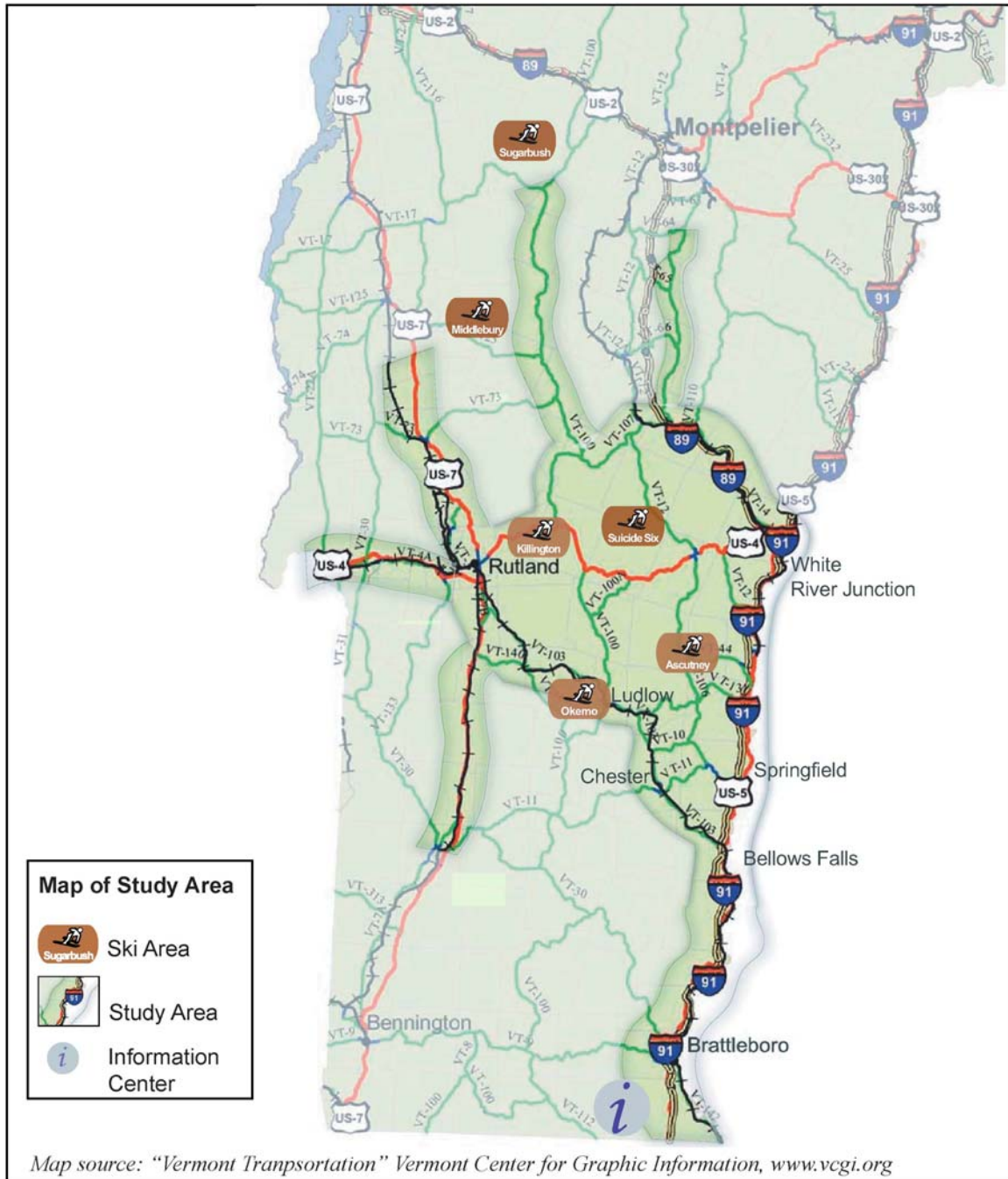


Exhibit 8-1: Ludlow/Okemo Study Region

8.3 Transportation Characteristics and Needs

Several regional planning commissions in south-central Vermont have commissioned a transportation study¹ to help diagnose and improve transportation conditions in this part of the state. Key findings of the study include:

- Heavy peaking of demand due to ski resort traffic on weekend/holiday mornings and afternoons. Typically 50 percent of skiers leave the resort property in a single hour (4:00-5:00 pm), with a broader peak for morning arrivals (50% between 8:00 and 10:30 am);
- Localized intersection congestion, particularly at the intersections of U.S. 4 and VT 100; U.S. 7 in Rutland center; the Buttermilk Falls Road, Second Access Road, and Depot Road intersections with VT 103 in Ludlow, and the VT 103/VT 11 intersection in Chester;
- Quality-of-life concerns for residents and visitors alike due to traffic congestion; and
- Isolated High Accident Locations (HALs) throughout the corridor.

Similarly, participants in the September stakeholder workshop cited peak hour congestion as by far the most important transportation consideration in the region. At non-peak periods, the transportation system operates smoothly with the exception of severe weather incidents. From the perspective of the Okemo resort, transportation improvements that directly reduce peak hour congestion, and thereby mitigate Act 250 concerns, are most beneficial.

The principle cause of this peak-hour traffic congestion is not necessarily the Okemo resort alone. The Okemo region is adversely impacted by ski resort traffic generated by resorts to the north, most notably the Killington area. Vermont Route 100 funnels traffic from the U.S. Route 4 corridor south to an intersection with Vermont Route 103 northeast of Ludlow Center, and this traffic continues on Route 103 through the villages of Ludlow and Chester until it reaches Interstate 91 southbound in the Town of Rockingham. During peak weekend periods, particularly Saturday and Sunday afternoons, the combined flows of Killington and Okemo resort traffic leads to significant traffic congestion in village centers and critical intersections in the corridor.

Workshop participants noted that the fall foliage season produces similar, if not more severe, strains on the local transportation network as the peak ski travel periods. Therefore any proposed solutions should consider year-round transportation events that cause a similar influx of traffic into this otherwise quiet transportation network.

A review of accident data in the region shows a combination of vehicle collisions clustered around major intersections and town centers, as well single vehicle off-the-road and head-on collisions on two lane secondary highways. (Exhibit 8-2).

¹ *Ski Corridor Traffic Management Study (Draft Final Report)*, prepared for the South Windsor Regional Planning Commission the Rutland Regional Planning Commission; and the Two Rivers-Ottawaquechee Planning Commission; Wilbur Smith Associates, April 26, 2001.

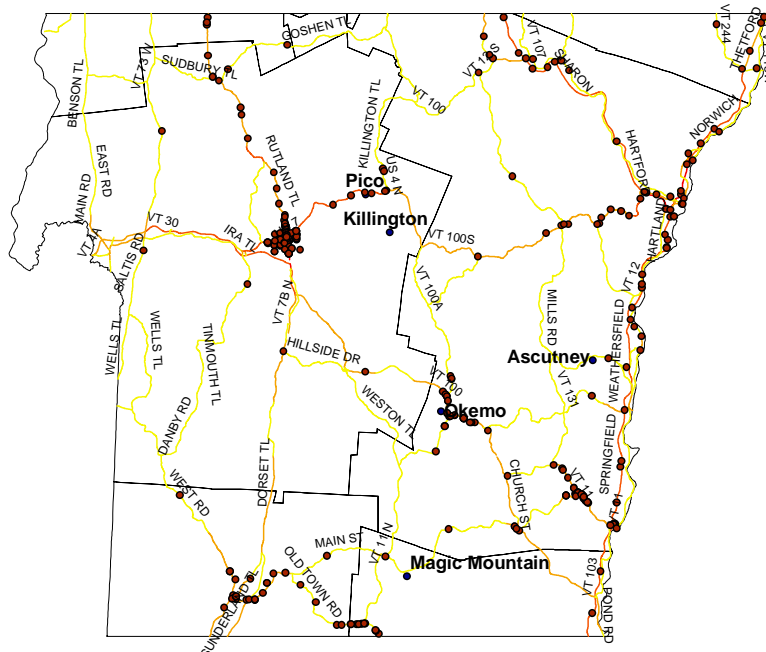


Exhibit 8-2: Accident Locations in South-Central Vermont (2002)

8.4 Existing Transportation Management Measures

A Ski Country Traffic Management Plan (SCTMP) and two Memoranda of Agreement² form the basis for traffic management in the region. One purpose of the SCTMP is to identify traffic management techniques that can be implemented when traffic congestion is predicted to exceed a set of thresholds that are considered acceptable.

Existing mitigation measures in place in the region include:

- Use of traffic control officers at key intersections along the corridor at peak travel hours;
- A free Okemo Village Shuttle Bus service;
- A free employee shuttle provided by The Town and Village Bus; and
- A free resort trolley.

The available transit services are popular with resort visitors and employees, and are perceived to have a positive impact on traffic congestion. Expansion of the services in terms of geographic coverage, frequency, and hours of operation has been proposed.

² One MOA is between Okemo resort and So. Windsor County RPC, and the second agreement is between Killington resort and So. Windsor County RPC, Two Rivers-Ottawaquechee RC, and Rutland RPC.

A traffic management plan is put into place when the number of parked vehicles at the Okemo resort exceeds a threshold of 1100. At this time, Okemo notifies the communities of Ludlow and Chester as well as the Windsor County Sheriff, and traffic details are placed at key intersections to override traffic signals. At the present time, there is no real-time traffic coordination with state agencies (Agency of Transportation or State Police), nor with the Killington resort or communities to the north where a significant portion of the peak hour traffic originates.

Okemo has a rather unique program to alleviate traffic congestion in the Sunday afternoon peak. The resort offers a “Sunday Solution” lift ticket good for a morning half-day of skiing, to encourage weekend patrons to leave the resort before the peak travel period.

8.5 Potential for ITS in the Okemo Region

The *Ski Corridor Traffic Management Study* identifies Intelligent Transportation Systems as one of three “promising mitigation techniques” for the region. (The other mitigation techniques are Roadway Mitigation and Travel Demand Management.)

In general, ITS shows promise in the region because it faces the transportation management/mitigation concerns that ITS is best suited to address. These include:

- An overburdened transportation network with few opportunities or resources for large-scale expansion;
- The need to disseminate information on real-time travel conditions (including weather, traffic and transit) as well as traveler services to support trip planning and mode/route decisions;
- The need to provide alternative transportation that operates in a reliable, efficient, and user friendly manner;
- The need to ensure efficient operation of traffic signals in response to fluctuations in traffic flow; and
- The need for inter-resort, inter-agency and inter-jurisdictional communication and cooperation.

8.6 Existing and Planned ITS Initiatives in the Region

There are a number of existing ITS planning programs and deployment initiatives in Vermont and neighboring states that the Okemo region can leverage to support relatively efficient ITS deployment. In many cases, ski region needs may be addressed by simply expanding how existing ITS infrastructure is utilized, rather than deploying entirely new systems.

A few of the more significant ITS initiatives in the state and region are discussed below:

- **Statewide ITS Deployment Plan and Architecture:** The State of Vermont has a Statewide ITS Strategic Deployment Plan that was

developed in 2002 as a framework for ITS deployment. The Vermont Agency of Transportation is currently embarking on an effort to develop a fully-compliant statewide ITS architecture.

- **Traveler Information Online (TRIO) Project:** This project is a joint effort between the states of Vermont, New Hampshire, and Maine to develop an integrated event reporting and weather forecasting system. This information is available in real time to public agencies and the general public through various sources, including the VAOT website. The TRIP system can be used to report construction, incident, event, and weather information for travel planning and traffic management purposes.
- **Vermont 511 System:** Vermont is deploying its first generation of voice-activated "511" traveler information, in conjunction with the USDOT's national 511 program. The system will allow users in any part of the state to access real-time traveler information for specific regions or corridors using voice commands over a land-based or cellular telephone service.
- **ConnectVermont:** ConnectVermont is an initiative that grew out of the efforts of the Vermont Travel Information Council (TIC), and the Vermont Agencies of Commerce, Community Development and Transportation. This project will provide travel planning, route guidance, and advisory functions for drivers of all types. Both pre-trip and en-route trip planning and assistance will be provided via personal computers, kiosks, telephones (with voice recognition), and other access technologies as they emerge.
- **Rutland ITS Project:** The Vermont Agency of Transportation has received a federal ITS earmark to develop and deploy a multi-faceted ITS project in the greater Rutland region along the U.S Route 4 and 7 corridors. Rutland serves as a gateway from the west to the central Vermont ski region, particularly Killington. The system will incorporate dynamic message signs, road weather information systems (RWIS), and weigh-on-motion systems, along with improved incident and traffic management procedures using the new ITS technologies.

8.7 Case Study Region ITS Analysis

The six ITS travel zones developed earlier in this report were applied to the Okemo case study region. The following table and figure illustrate the case study region equivalents of each of the ITS travel zones.

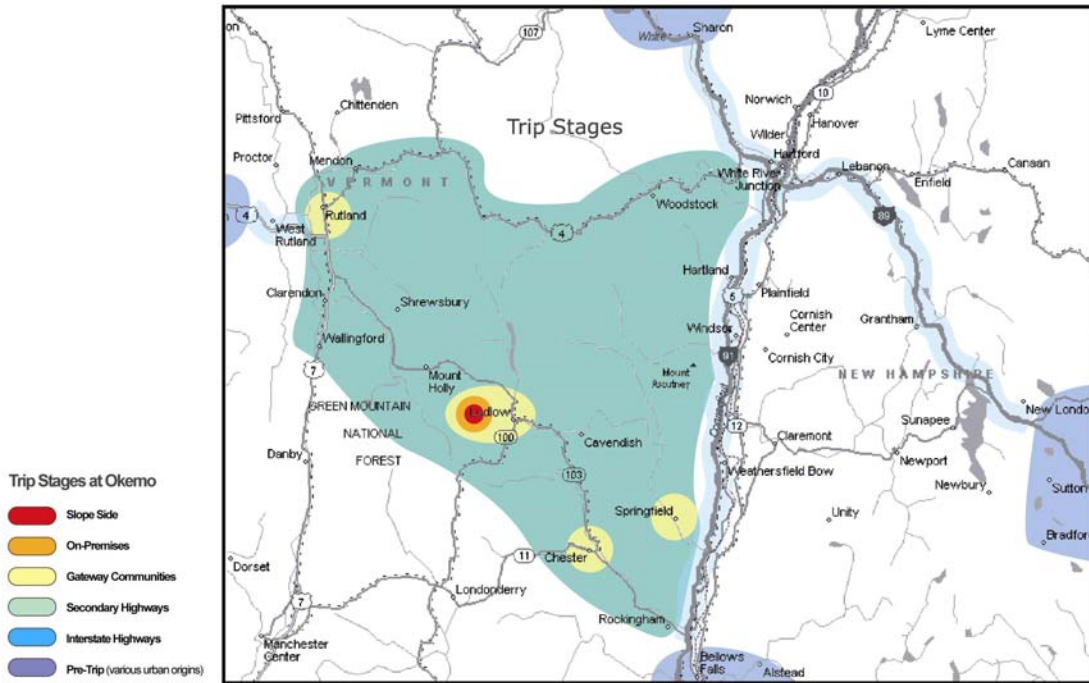


Exhibit 8-3: Application of Ski Travel Zones to Okemo Region.

ITS Travel Zone	Case Study Region Equivalent
1. Pre-Trip	Urban centers in southern New England & New York as well as local trip origins (e.g. condominiums)
2. Principle Highway	Interstates 91, 89, and 87
3. Secondary Highway	VT 103, 100, 131, 106, 143, 11; U.S. 4
4. Gateway Community	Ludlow Center; Chester; Springfield; Rutland; others
5. On-Resort	Okemo Mountain Resort-Roadways, Parking Lots, Shuttle Stops, etc.
6. Slopeside	Okemo Mountain Resort-Base Lodges

Exhibit 8-4: Application of Ski Travel Zones to Study Region.

The epicenter of the study region is the Okemo resort itself, which serves as the “slopeside” and “on-resort zones. Three gateway communities were identified: Ludlow, which experiences the most intensive traffic congestion and serves as the services hub for the area; Chester, which is subject to negative traffic impacts from upstream ski resort traffic; and Springfield, a community on an alternative access route which has an interest in promoting additional through traffic for economic development purposes.

The secondary highway zone includes the state and local routes within the shaded region shown, and the major north-south and east-west access corridors formed by interstates 91 and 89, as well as US Route 4 to the New York Thruway, are labeled

as principle highways. The pre-trip phase technically incorporates all regions from which ski resorts originate, but primarily refers to major urban centers located off of the map.

The following table provides a summary of ITS needs in the corridor and maps the relevant travel zones where these needs are met. The same need may be addressed differently in different zones based on the traveler's trip stage and applicable information dissemination and traffic control options.

	Zone 1 Okemo Resort Slopeside	Zone 2 Okemo Resort Roadways and Lots	Zone 3 Ludlow Village, Chester, Springfield...	Zone 4 Secondary Highways plus air, rail, and bus terminals	Zone 5 Interstates 91, 89, 87 and adjacent states	Zone 6 Pre-trip (home)
Need/Issue						
Traveler Information						
Real-time traffic information for ski travelers						
Real-time Traffic Information for local residents/others						
Real-time Roadway Condition Information						
Advanced information on weather/approaching storms						
Advice on route selection based on travel conditions						
Transit and Shuttle Information-Real Time						
Transit and Shuttle information-Trip Planning						
Real-Time Parking Availability and Location						
Parking reservation						
Available Traveler and Tourism Services						
Alternative Long-Distance Travel Modes (Air, Rail, Motorcoach)						
Traffic Management						
Management of Okemo peak traffic						
Management of through traffic from Killington and points north						
Congestion in village centers/major intersections						
Conditional use of alternative route off mountain (Doug Rd/High St)						
Incident Management						
Coordination of state, local, and resort resources (traffic/police/maint/EMS)						
Employee transportation						
Roadway Safety/Enforcement						
Vehicles traveling too fast for weather conditions						
Speed enforcement in villages/highways						
Pedestrian safety on major roadways						
Discouraging use of shortcuts in residential areas						
Parking Management						
Directing parking traffic and managing capacity						
Coordination of parking arrivals and transit/shuttle services						
Managing restricted/premium parking areas						
Encouraging use of remote park-and-ride facilities (convenience)						
Transit Management						
Dispatching and coordination of services						
Maintaining constant headways						
Passenger Load Management						
Encouraging use of transit/shuttles for local circulation						
Other Issues						
Capturing economic benefits from ski/tourism through-traffic						

Exhibit 8-5: ITS Needs Mapped to the Applicable Ski Zones

8.7.1 APPLICABLE TOOLKIT CONCEPTS

The Toolkit presented earlier in this report contains a number of ideas that are applicable to the Okemo/Ludlow case study region because they address the needs and concerns of the stakeholders. The following table presents the ITS Toolkit applications that are particularly relevant to requirements of the case study region.

ITS Toolkit Application	Need(s) Addressed
Pre-Trip Traveler Information	<ul style="list-style-type: none"> • Pre-trip information needs (traffic, weather, services, modes, etc.)
En-Route Traveler Information	<ul style="list-style-type: none"> • Real-time information and updates on traffic conditions, weather conditions, accidents, best travel routes to and from the area
Traffic and Incident Management Systems	<ul style="list-style-type: none"> • Detection of upstream traffic demand from Killington area; management of traffic throughout 100/103 corridors and interstate approaches • Management of peak-hour demand surges • Management and clearing of traffic incidents
Advanced Traffic Signal Systems	<ul style="list-style-type: none"> • Improved throughput in signalized segments of 103 through Ludlow village • Management of peak-hour demand surges
Road Weather Information Systems	<ul style="list-style-type: none"> • Improved detection of deteriorating weather conditions for roadway maintenance coordination and traveler information advisories
Transit CAD/AVL	<ul style="list-style-type: none"> • Improved tracking and reliability of transit and shuttle services • Headway management • Vehicle load management • Coordination with parking activity
Dynamic Transit Passenger Information	<ul style="list-style-type: none"> • Provision of real-time passenger information to increase system utilization
Dynamic Parking Guidance System	<ul style="list-style-type: none"> • Direct visitors to available parking, including remote park-and-ride locations • Reducing unnecessary traffic circulation
Parking Reservation System	<ul style="list-style-type: none"> • Allow users to reserve premium parking at the resort for a fee

Exhibit 8-6: Toolkit ITS Applications for the Case Study Region

8.7.2 HIGH-LEVEL ITS SYSTEMS ARCHITECTURE

The following Figure 9-5 is a high-level representation of an ITS system architecture for the Okemo region. The architecture is designed to leverage existing ITS investments in order to provide new ITS functionalities in the study corridor.

The architecture proposes the involvement of several key stakeholders in ITS operations as data/information providers and/or operators of certain aspects of the ITS system. These include:

- **Vermont Agency of Transportation:** A local VAOT District Office (possibly through the proposed traffic management infrastructure in Rutland) will serve as a gateway for data interchange with statewide ITS initiatives and coordination of roadway maintenance activities. It is expected that VAOT will also retain final

authority to issue travel alerts and operate traffic control devices on state highways.

- **Okemo Mountain Resort:** The ski resort itself is a critical participant it is the primary source of information on anticipated travel demand. Okemo also directly operates shuttle and parking services, and its premises could serve as host to a variety of traveler information and traffic surveillance equipment. It is proposed that the resort have access to the VAOT traffic control apparatus as well as direct access to the TRIO project's CARS event reporting system database for event and incident reporting.
- **Transit Operations:** Local contract transit providers will require communication with the CARS event reporting system as well as passenger information system located on the resort and in the Village of Ludlow. These components will support real-time transit information for passengers based upon transit vehicle tracking and central transit dispatch software. Joint deployment and/or operations with resort-owned shuttle operations should be considered for a "seamless" transit ITS operation.
- **State, County, and Municipal Police:** Police agencies, who currently participate in traffic management and incident response activities, can utilize the ITS infrastructure to improve coordination and effectiveness. Coordination with VAOT will be required for implementation of traffic management plans that require alternative signal timing plans, traffic messages, and/or sharing of traffic surveillance data.
- **Other Resorts:** The participation in other resorts from outside of the region (particularly Killington in this case) will allow stakeholders in the Okemo region to become aware of future events and emerging traffic management issues based on upstream demand. Information from the resort may be supplemented by field devices that provide traffic counts or by observations at upstream locations on Routes 4, 100, and 103.
- **Visitor Information Centers:** Through the ConnectVermont project and other initiatives, the statewide traveler information infrastructure can be utilized to provide travel and visitor service information to ski resort patrons through information kiosks, telephone 511, or web-based services.
- **Adjacent State DOTs:** The architecture includes a placeholder for future interstate coordination through TRIO or other interstate information sharing initiatives (e.g, I-95 Corridor Coalition) to communicate pre-trip and en-route traveler information and traffic management alerts to travelers and authorities in adjacent states during major traffic or weather events.

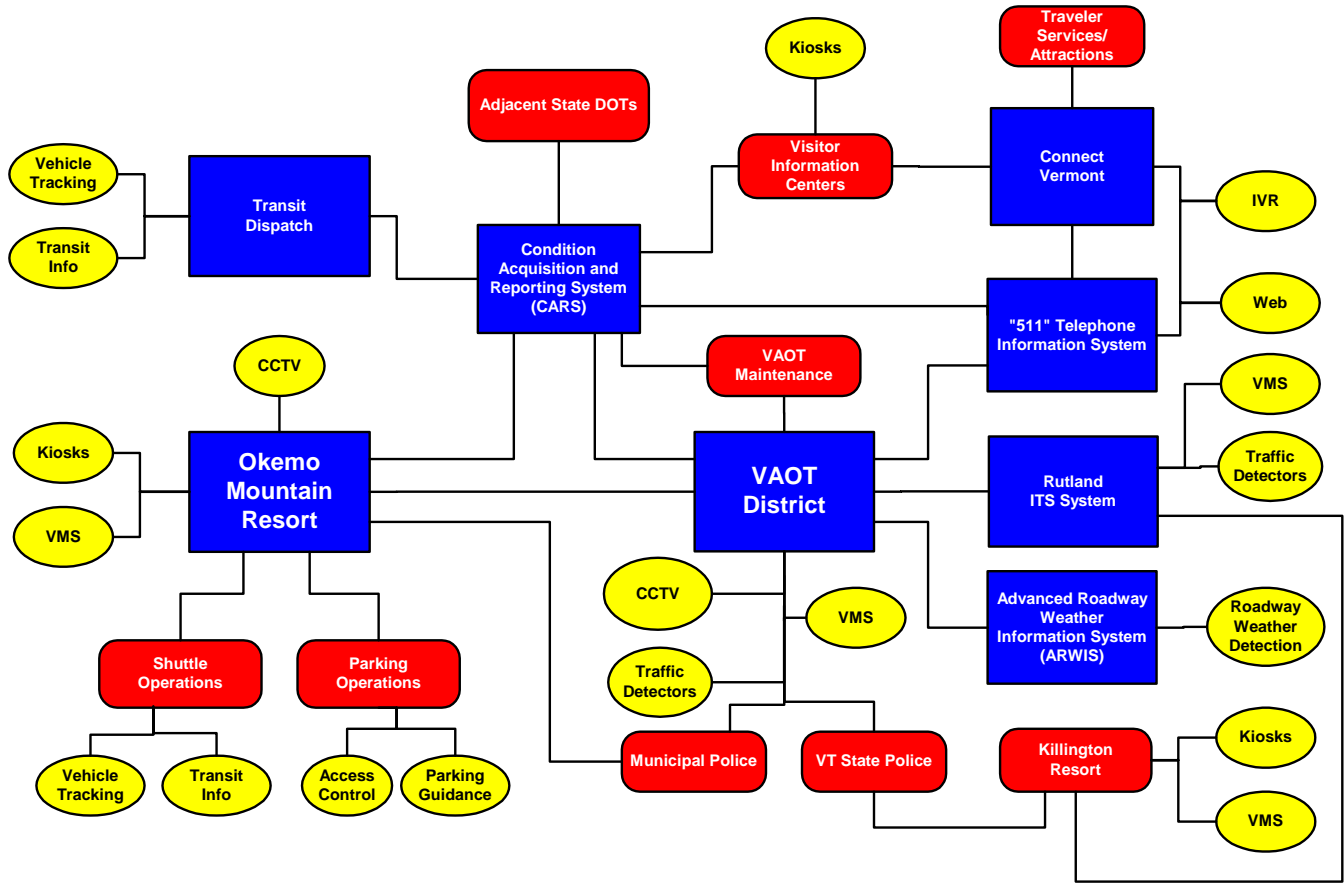


Exhibit 8-7: Build-out ITS Vision: High-Level System Block Diagram

8.7.3. TURBO ARCHITECTURE™ ANALYSIS

The USDOT has sponsored the development of a software analysis tool known as Turbo Architecture™ to facilitate the development of regional and project ITS architectures. This tool was used to develop a model architecture for the Okemo region using the stakeholders and systems outlined previously. The following pages present several views of the ITS project architecture resulting from the use of this tool.

8.7.2.1 ITS “Sausage Diagram”

The ITS “sausage diagram” represents the high-level interfaces between systems and sub-systems represented in the *National ITS Architecture*. Boxes highlighted in the sausage diagram presented here are proposed as part of the Okemo ITS architecture. The literature of the *National ITS Architecture* provides additional details about each element represented in the diagram.

Note that the proposed system utilizes a variety of communications paradigms for interfacing the various elements (wire line, wireless, etc.). In the case study area, as with most rural ITS deployment regions, a careful analysis of the availability and

limitations of communications technologies in the Okemo area will be required as part of the systems design.

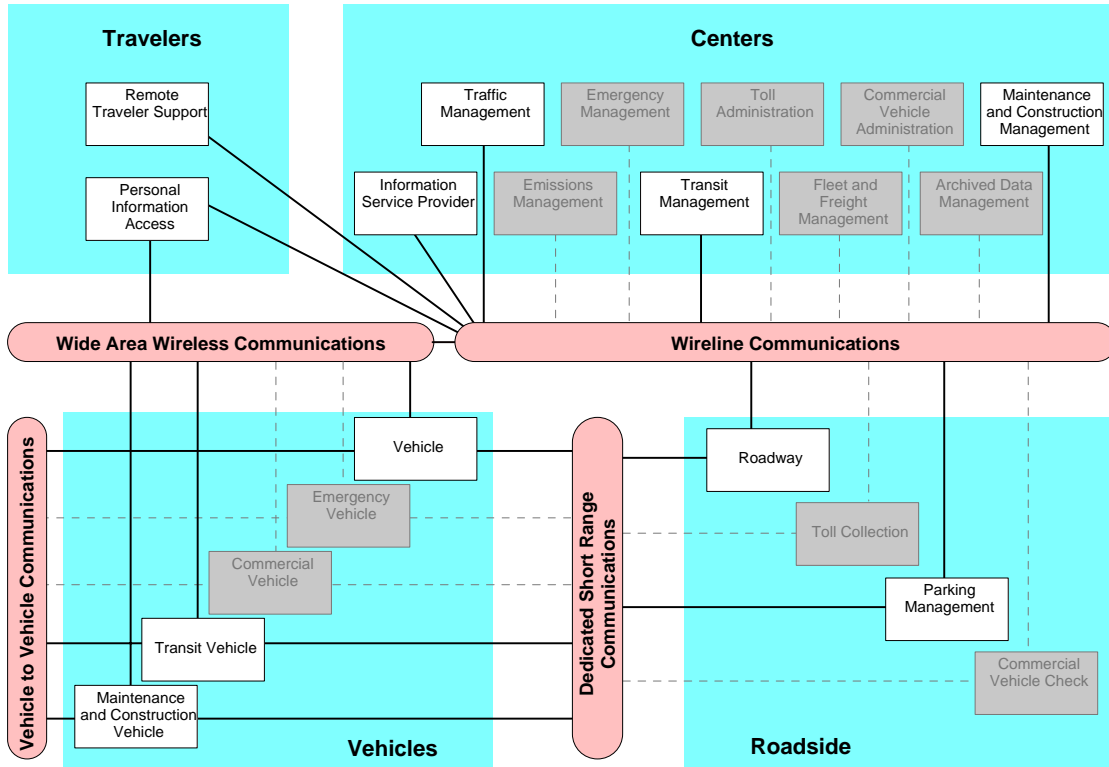
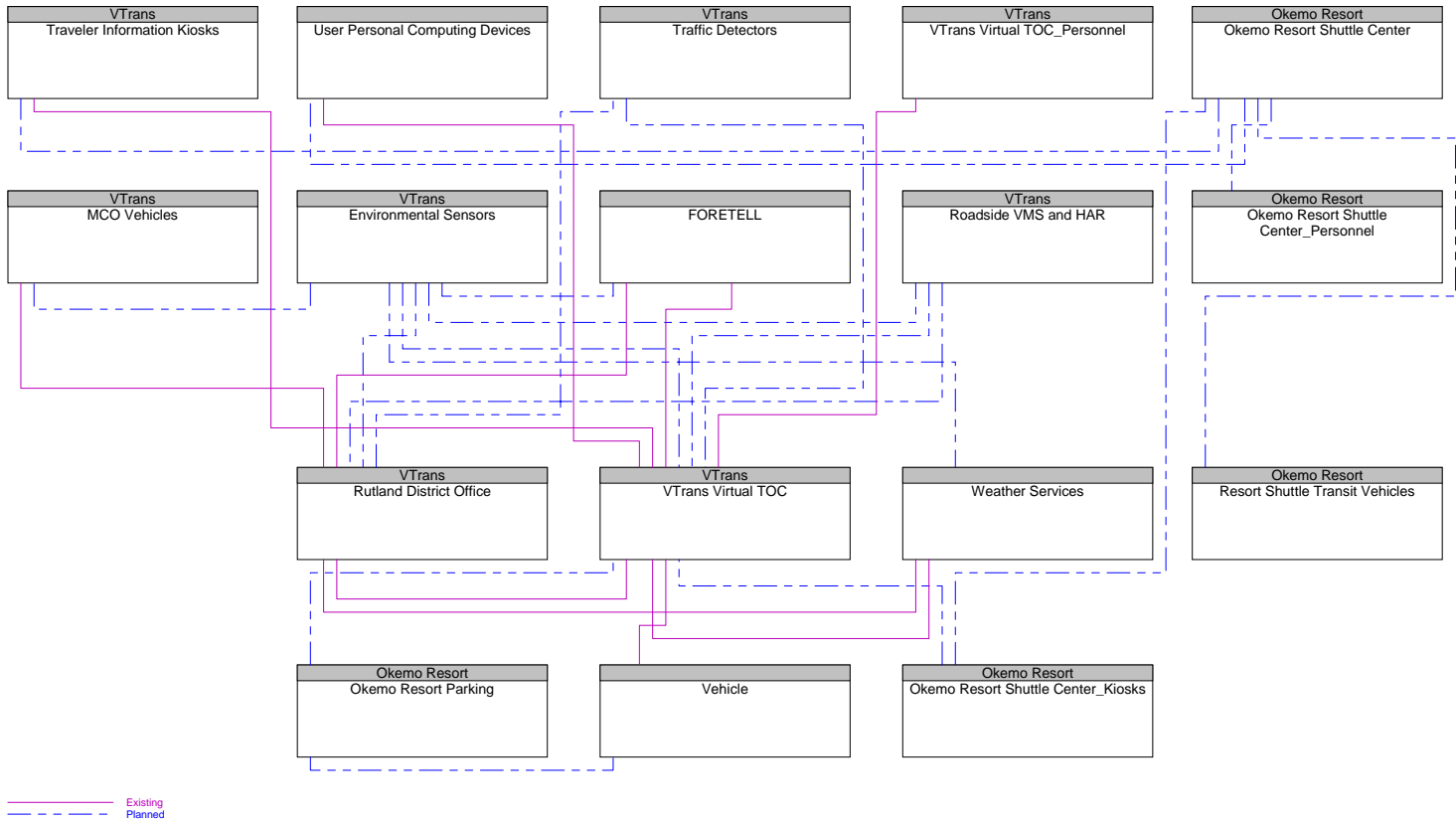


Exhibit 8-8: Okemo Region ITS Architecture “ Sausage Diagram”

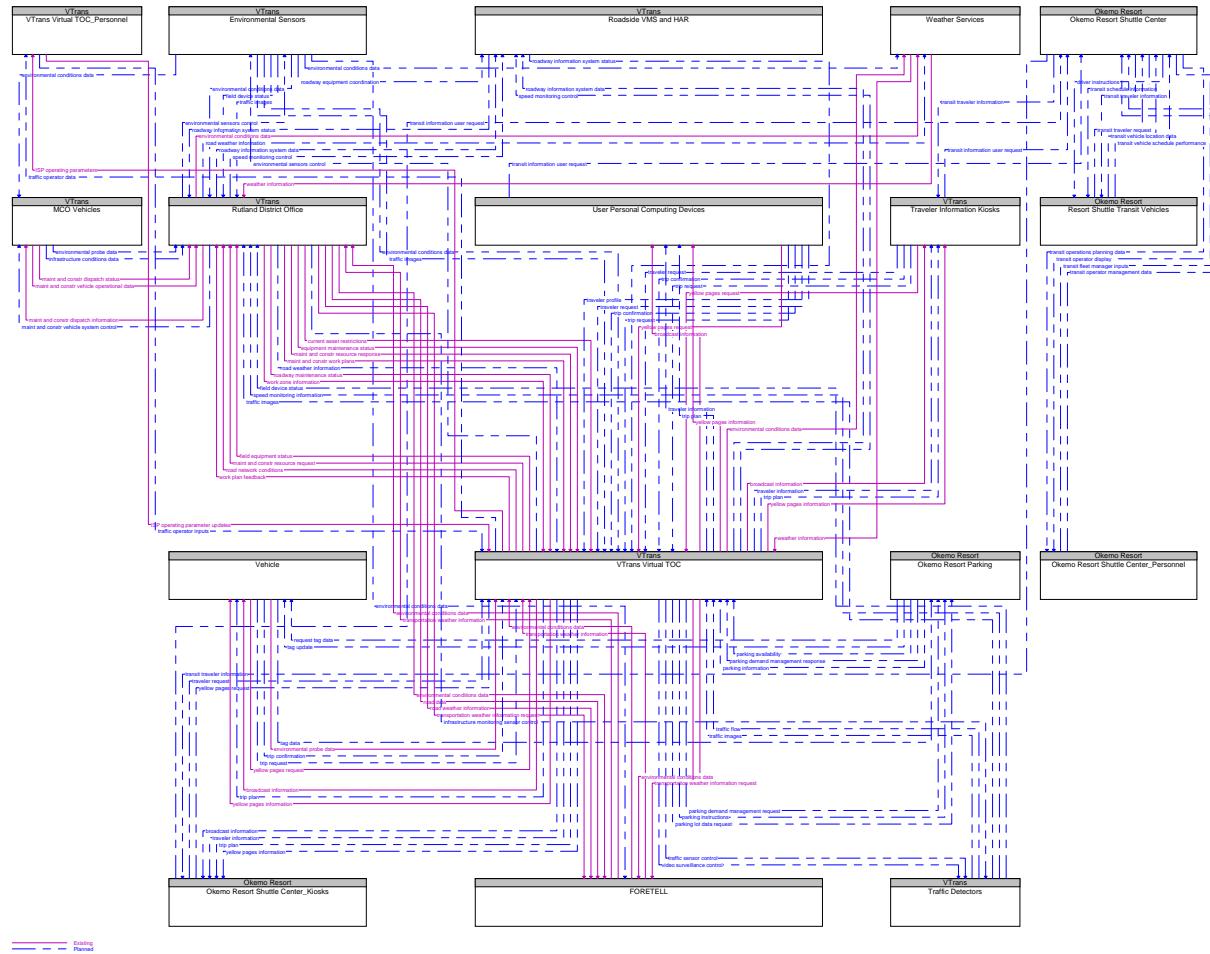
8.7.2.2 Interconnect Diagram

The Interconnect Diagram presented here is a non-directional representation of links among entities in the architecture. The diagram is generated by Turbo Architecture based upon a description of the role of these entities in the proposed ITS market packages.



8.7.2.3 Flow Diagram

The flow diagram presented here illustrates directional data flows that are part of the architecture. It indicates the origin, destination, and description of all data transfers within the architecture. During a system design phase, the logical and technical requirements for these information flows would be described in greater detail.



8.7.2.4 ITS Architecture Sub-Components

The Appendix includes examples of sub-system information flows generated by Turbo Architecture for the following elements of the Okemo ITS system:

- Rutland District Office: Field Device Integration;
- Okemo Transit and Parking Management Systems;
- VAOT 'Virtual' Traffic Operations Center; and
- Weather Applications

8.8 ITS Deployment Considerations

In the Okemo region, the “early success” ITS deployment opportunities involve leveraging other regional and statewide ITS deployments to suit the particular needs of the corridor. The presence of statewide event reporting/weather forecasting infrastructure (TRIO), along with the emerging statewide 511 initiative, provide a springboard for deployment of a system that addresses the specific needs of the Okemo corridor. Perhaps the most important aspect of customizing existing systems is to develop an operating plan that involves Okemo region stakeholders in ITS operations. Within the context of this plan, appropriate software modifications, additional field hardware installation, and operating rules can be developed to obtain the desired functionality.

Regarding ITS systems design, a general rule is that the initial early success systems deployed in this region should be robust and scalable enough to support future functional or geographic additions as future generations of systems are implemented.

Okemo Mountain Resort and other resorts in the area are active participants in cooperative public/private traffic management programs in their regions. Intelligent Transportation Systems applications provide yet another set of options to the traffic management toolkit available to the resorts and their public counterparts. Thus the region should strongly consider the potential role of private ski resorts in funding ITS deployment to address mutual transportation concerns.

8.9 ITS Operations Considerations

ITS systems require ongoing operations and maintenance intervention due to the ‘real-time’ nature of these systems. Several stakeholders, including the ski resorts themselves, have a potential role to play in the operations phase of ITS systems deployed.

An important operations consideration for this region related to the peaking of travel demand (centered around certain weekend travel periods and major events). The ITS infrastructure does not have to be staffed and operated on a “24/7” basis, which greatly increases the feasibility and cost-effectiveness of ITS deployment in a rural region such as the case study area. The operating plan developed to support any ITS investments can discuss the circumstances under which the system is completely activated. Existing thresholds used in the region to implement traffic management measures can serve as guidelines.

It is important to emphasize the ITS often introduces new inter-agency and intra-agency working relationships that are necessary to reap the full benefits of the technology deployed. These include information sharing relationships, real-time collaboration, inter-jurisdictional cooperation, and development of coordinated, consistent incident responses and traveler information alerts. The Okemo case study region is no exception, and this case study identified potential operational roles for each of the key stakeholders involved (Exhibit 8-9).

Stakeholder	Potential ITS Operations Involvement
Vermont Agency of Transportation	<ul style="list-style-type: none"> • Coordination with other ITS deployments/traffic control systems (e.g., Rutland) • Coordination of winter roadway maintenance activities with local traffic control systems • Posting of information to TRIO (statewide event reporting system) • Posting of relevant traveler/tourism information to statewide 511 system • Coordination with <i>ConnectVermont</i> tourism information database
Okemo Mountain Resort	<ul style="list-style-type: none"> • Provision of daily travel demand data to other stakeholders • Real-time coordination with traffic control officers in peak periods • Operation and maintenance of on-resort ITS systems
Transit Operators	<ul style="list-style-type: none"> • Operation and maintenance of transit ITS systems • Real-time coordination with traffic control officers in peak periods
State, County, and Municipal Police	<ul style="list-style-type: none"> • Incident detection and management through roadway surveillance devices • Posting of incident/travel alerts to passenger information systems • Real-time coordination with traffic control officers in peak periods • Operation of traffic enforcement devices • Implementation of special traffic signal plans
Other Ski Resorts	<ul style="list-style-type: none"> • Provision of upstream travel demand/traffic data that will impact the Okemo region • Real-time coordination with traffic control officers in peak periods
Economic Development/Tourism Agencies	<ul style="list-style-type: none"> • Provision of traveler/tourism services information to ITS traveler information services
Adjacent State DOTs	<ul style="list-style-type: none"> • Major event response (e.g., blizzard) coordination • Provision of downstream/upstream traffic data and traveler information

Exhibit 8-9: Potential ITS Operational Responsibilities of Key Stakeholders

The importance of developing a thorough operating plan for the proposed ITS systems cannot be overstated. Travelers and traffic management personnel alike must trust in the availability of

accurate, up-to-date, and complete information to effectively plan travel and manage the network. Failure of any of the key stakeholders to uphold obligations in this regard will undermine the credibility of the system.

8.10 Conclusion

This case study demonstrates that Intelligent Transportation Systems can serve a valuable role in ski regions under realistic conditions. The Okemo region, like others in the Northeast and across the country, is already grappling with transportation system and demand management issues for which ITS is ideally suited. ITS can complement existing strategies to shift travel demand, to improve the attractiveness of alternative modes of transportation, increase the efficiency of signalized corridors, improve interagency coordination, enhance detection and response to weather and incident situations, along with many other benefits.

The precedent for transportation cooperation between the resort, local, regional, and state agencies can form the basis for a successful ITS deployment that requires planning, implementation, and operations support from a variety of local stakeholders. This may include coordination with other traffic generators (in this case, the Killington resort) that impact traffic operations in the region.

Rather than deployment of brand new ITS infrastructure, some of the greatest short-term gains in the region may be realized by tailoring existing and planned ITS systems being deployed at the statewide level to address the transportation needs of the region. This includes providing local entities with valuable transportation data or transportation management responsibilities (such as local police and the resorts themselves), access to regional resources such as event reporting systems, and 511 to better disseminate information about ski travel conditions.

Any ITS deployment requiring the participation of the resort must, of course, address the resorts own needs and obligations regarding traffic management. In this case, reduction of peak hour travel demand was far and above the most important concern for Okemo management because of the relationship between peak hour mitigation and resort expansion.

9. CONCLUSIONS AND RECOMMENDATIONS

Intelligent Transportation Systems should be considered side by side with other, more conventional transportation management strategies being deployed in ski regions across the country. As ski resort travel demand continues to grow, and resort communities grapple with often conflicting goals of environmental stewardship and economic efficiency, the market for ITS and alternative transportation solutions will continue to grow.

Contrary to initial perceptions, major ski resorts located in natural mountain areas are complex and highly regulated environments that in some ways resemble major urban trip generators. ITS can play a role in preserving the economic vitality, environmental quality, and enjoyment of these special regions for visitors and native residents alike.

9.1 Rationale for ITS Deployment in Ski Regions

Improvements in ski region transportation yield a variety of efficiency, convenience, safety, economic, and quality of life benefits for visitors, resort employees, and residents of ski regions. The application of Intelligent Transportation Systems to solve ski-related transportation needs shows promise for several reasons:

- Many ski resort regions experience complex transportation demand and system management issues (e.g., alleviating peak-hour transportation demand, encouraging use of alternative modes) for which ITS applications are well suited. ITS can complement existing ski resort transportation management strategies such as:
 - Encouraging the use of alternative travel modes;
 - Shifting peak hour demand; and
 - Encouraging the use of remote park-and-ride lots.
- The transportation network in rural ski regions is subject to intense peaking of demand during certain travel periods, but conventional expansion of the transportation infrastructure is often cost-prohibitive;
- For many travelers, journeys to ski resorts involve long journeys on unfamiliar roads, sometimes in severe winter weather conditions. If real-time information is available, travelers could avoid congestion by re-routing or postponing trips. Thus there are benefits to providing information on weather, traffic conditions, and alternative travel modes for both pre-trip planning and en-route decision-making.
- Ski regions have an economic incentive to provide traveler information services that assist visitors in locating services or attractions that promote additional spending in resort areas;
- The efficiency and reliability of alternative modes of travel, such as transit shuttle services, can be increased using ITS. This in turn will increase the attractiveness of these alternative modes to resort visitors, contributing to reductions in congestion.
- Because of development permitting requirements in effect in some areas, ski resorts have a vested interest in supporting transportation improvements which mitigate congestion and/or increase roadway capacity, such as ITS; and

- The involvement of some ski resorts in funding of transportation improvements to mitigate traffic impacts provides a potential source of revenue for ITS deployment.

9.2 Ski ITS Deployment Considerations

Many of the challenges of ski region ITS deployment are similar to rural ITS deployment in general. These include:

- Limitations in available infrastructure to support ITS (particularly for power and communications);
- Limited technical staff for system operations and maintenance;
- Lower overall ITS resources per network mile or area of coverage.

There is a substantial and growing literature related to the challenges of rural ITS deployment in general. Some of these challenges are being overcome through technological advances (e.g., solar-powered field devices, increased cellular coverage, automated systems) and precedence (i.e., lessons learned successful ITS projects).

One advantage of ski region ITS over rural ITS in general is the focused nature of the transportation issues which must be addressed. Some of the most successful and noteworthy rural ITS project involve deployments in National Park regions and other tourism destination sites. This is attributable to the ability to precisely define project needs and focus to address critical transportation issues with specific solutions. Ski regions possess similar characteristics and thus are a special case of rural ITS with the following deployment advantages:

- Ski regions typically have only one or a handful of primary focal points (the ski resort(s), gateway communities, critical bottlenecks) which have the greatest transportation needs;
- Transportation issues of greatest concern typically occur over limited time periods on specific seasonal dates, such as weekends or holidays), meaning that ITS systems do not necessarily have to be operated or staffed “24/7”;
- In some resort areas, the groundwork for interagency and public-private cooperation required for ITS deployment and operation is already in place through existing traffic mitigation agreements using more conventional techniques; and
- Key private-sector interests (the ski resorts and other ski-related businesses) have a strong vested interest in the resolution of certain congestion issues. Nationally, ski resorts have a demonstrated willingness to contribute financially or in-kind to traffic mitigation measures that address mutual public and private concerns.

The ultimate reaction of ski travelers to ITS systems is a subject for future empirical evaluation based on detailed evaluation of pilot systems. How a traveler responds to ITS infrastructure when he or she has nonrefundable lodging reservations, and is fighting through a severe snowstorm to reach fresh powder skiing conditions, remains to be seen. The objectives of ski region ITS infrastructure might be summarized as shown in Exhibit 9-1.

Ski Travel Scenario	Potential Objectives of ITS Systems
Travelers considering travel to ski resorts (Pre-trip Planning)	<ul style="list-style-type: none"> • Identify transportation alternatives to driving for trips to, from, and around the ski resort; • Identify traveler services and tourism attractions while en route; • Identify real-time travel conditions to better plan departure time, to avoid congestion, construction, and adverse weather conditions.
Travelers going to/from ski resorts (En-route Travel)	<ul style="list-style-type: none"> • Receive real-time updates about changing traffic or weather conditions for dynamic route planning; • Identify traveler services and attractions en route that provide convenience to the traveler and economic benefit to local businesses; • Provide safety information related to severe weather or poor roadway conditions to prevent accidents and related traffic delays; • Facilitate prompt winter maintenance and accident clearing to keep travel conditions as satisfactory as possible.
Travelers on or near resorts and gateway communities (Local Circulation)	<ul style="list-style-type: none"> • Ensure smooth traffic flow on local streets and second arterials providing access to resorts and gateway communities; • Maintain reliable and convenient transit services that provide attractive travel alternatives for visitors and employees; • Provide real-time guidance to available parking, including remote park-and-ride facilities that alleviate traffic congestion on resort access roads; • Provide electronic payment alternatives that streamline transit, parking, and other payments in a format that is easy for visitors to understand and apply.
Travelers departing ski resorts (Departure Phase)	<ul style="list-style-type: none"> • Provide up-to-date information on roadway and traffic conditions to allow travelers to time their departure according to conditions. • Inform transit passengers of the arrival time of transit shuttles.

Exhibit 9-1: Potential ITS System Objectives by Traveler Type

Incorporation of Ski Region Concerns in ITS Planning: For ITS to fulfill its potential for meeting ski resort transportation needs, the concerns of ski resort travelers, resort managers, resort communities, and other affected parties must be taken into consideration throughout the ITS deployment pipeline. This process must begin by including representatives of ski regions who are

involved in traffic management (similar to the participants in this study's Ludlow/Okemo workshop) within the ITS architecture development and strategic planning process. Particularly in the northern New England states and upstate New York, ski resorts represent a large fraction of winter transportation and economic activity, and are key stakeholders in the ITS planning process.

Leveraging Statewide and Regional ITS Investments: The most cost-effective short-term ITS benefits for ski resorts will result from better utilization of existing ITS infrastructure to meet the requirements outlined earlier in this document. For example, large-scale information dissemination needs are best addressed through state, interstate, or regional initiatives that leverage broader investments in ITS technology (e.g., 511 programs, incident reporting and management systems). These systems can be tailored to address ski region concerns relatively simply by addressing the concerns of additional stakeholders (such as resorts and local police involved in resort traffic management) in system planning and operation. In some cases, focused deployment of new infrastructure, such as information kiosks, weather stations, and/or dynamic message signs will allow ski regions to effectively tap into these statewide resources to address their own needs.

The following table illustrates how some statewide initiatives being planned and deployed across the Northeastern states could be tailored to address ski region transportation needs.

Statewide/Regional ITS System	Application to Ski Regions
Event Reporting Systems	Encourage participation of resorts, local authorities, and local districts to report traffic, weather, and event information that can be used to inform traffic management procedures as well as visitors traveling to or from resorts.
511 Telephone Information	Ensure content is relevant and easily accessible to skiers; Consider using quick-access features to connect skiers with up-to-date forecasts of road conditions and transportation options.
Traveler and Tourism Information Websites/Kiosks	Utilize these devices for pre-trip planning information on available transportation options at the resorts, as well as current or forecast weather and traffic information. Information on visitor services can also be provided. Content should be accessible through the web as well as kiosks at strategic locations (rest stops, visitor centers, ski lodges).
Weather Information (ARWIS)	Position weather sensing stations along key ski travel corridors. Ensure that information from these systems is made available to travelers at key destinations
Advanced Traffic Management Systems (ATMS)	Utilize statewide/interstate infrastructure to provide notification of accidents/congestion in ski corridors to facilitate rerouting or trip postponement decisions.

Exhibit 9-2: Statewide/Regional ITS Systems Applicable to Ski Resorts

It is always advisable to select early deployment initiatives according to an “early success” philosophy—that is, projects should produce a high-level of short term, visible benefits to build support for ITS deployment, while at the same time forming a basis for future functional and geographic expansion.

Localized ITS Deployment Initiatives: Within the inner rings of the ski travel zones diagram (secondary highways, gateway communities, on-resort, and slopeside), it may be necessary to undertake smaller-scale ITS deployments to address localized transportation needs. When possible, these initiatives (Exhibit 9-3) should be consistent with the statewide ITS architecture to avoid incompatibility and to make the set use of available ITS resources.

Promising applications for ski region ITS on a local scale include corridor traffic signal management, localized safety improvements with the goal of preventing accidents (e.g., dynamic speed warning systems, automatic de-icing equipment), and advanced public transportation systems.

Localized ITS System	Application to Ski Regions
Advanced Transit Tracking/Dispatch	Global positioning Systems (GPS) devices onboard vehicles allow dispatchers to track vehicle location and make schedule adjustments if necessary, resulting in more reliable transit service and supporting real-time transit information infrastructure.
Real-Time Transit Information	Provides vehicle arrival and service status information to passengers based on actual vehicle location and schedule adherence. Can be linked to display signs or cable televisions in lodges and lodging to indicate the position and estimated arrival of the next vehicle to a given location.
Electronic Payment	Smart cards can be used for access to transit systems and shuttles in lieu of cash payment to reduce vehicle dwell time at stops. Pre-payment or smart card systems can be used to provide access to reserved or VIP parking lots on the resort.
Signal Coordination	Adjusts signal timing dynamically based upon traffic flow, allowing the system to respond to time-of-day and day-of-week demand surges. Coordination with nearby upstream and downstream signals ensures maximum throughput efficiency in bottleneck locations.
Parking Guidance/Management	Provide for more efficient parking with less circulation in congested areas. Dynamic parking guidance directs patrons to resort/municipal parking based upon real-time lot availability, including guidance to remote park-and-ride facilities.
Rural Travel Safety Devices	Address "spot" hazards in high-accident locations using dynamic, automated warning and roadway maintenance devices. These may include: dynamic speed warning devices (particularly on curves and descents); automated bridge de-icing systems; road icing/fog warning systems.

Exhibit 9-3: Locally-Led Ski Region ITS Deployments

9.3 Public-Private Partnerships

As stressed throughout this report, privately operated ski resorts play an important role in ITS deployment and operations. Public agencies responsible for ITS deployment should work closely with ski resort managers, ski resort associations, chambers of commerce, and other private and quasi-private organizations involved in ski industry.

Building upon the precedent set by existing transportation management partnerships across the country, key opportunities for private-sector involvement in ski region ITS deployment include the following:

9.3.1 ITS PLANNING:

- Participation in ITS architecture and strategic plan development at the state and regional levels; and
- Consideration of ITS as potential solutions for voluntary or mandated traffic mitigation programs.

9.3.2 ITS IMPLEMENTATION:

- Placement of infrastructure on ski resort property (dynamic message signs, kiosks, dedicated telephones, cable TV channels) that provides access to traffic, weather, and traveler services information available through event reporting, traveler information, and/or traffic management systems;
- Implementation of transit management and transit information systems on transit of shuttle fleets serving resorts and gateway communities;
- Integration of resort services, parking, and/or transit payments using smart cards or other electronic fare media; and
- Funding of ITS improvements on public rights of way as part of a traffic mitigation program, such as upgraded signal controls, dynamic parking guidance signs, weather sensing stations, or highway advisory radio systems.

9.3.3 ITS OPERATIONS:

- Provision of resort traffic and event information to event reporting systems, traffic operations centers, and local authorities involved in management of ITS systems;
- Operation of on-resort ITS components including dynamic parking guidance and advanced transit/shuttle management systems; and
- Provision of information from regional ITS systems on traveler information devices (dynamic message signs, kiosks, resort cable TV, websites, etc.) located on the resort property.

It is helpful to keep in mind the legitimate concerns of the ski industry vis-à-vis ITS deployment. Some of these concerns were expressed in the survey phase of this study as well as the case study. First, the level of private interest in ITS initiatives, particularly where cost sharing is concerned, is related to the overall objectives and impacts of the ITS system.

From a resort perspective, the most important traffic concern relates to reduction in peak hour traffic volumes, as this is often the criterion against which expansion permits and traffic mitigation programs are measured. ITS projects that directly address these issues are likely to receive the greatest level of support. Other business groups may provide a natural base of support for traveler information projects that encourage additional off-resort spending in the regional economy.

Another key point relates to provision of traveler information. Some resort managers interviewed for this study expressed a concern that traveler information, particularly weather information, could discourage customers from traveling during adverse weather conditions. One manager expressed

frustration at television weather reports that portray northern New England temperatures to be colder than they actually are in some resort area microclimates. He feared that if similar reports of road conditions were provided through pre-trip traveler information systems (e.g., websites), customers would be discouraged from traveling to the ski resorts. A compromise solution might be to provide travel safety warnings en route (warning drivers to slow down to a suitable speed during adverse conditions) to accomplish the public safety objective while considering the sensitivities of the private ski resorts.

9.4 Recommendations for Future Work

This document provides a framework for implementation and adaptations of ITS systems to meet the needs of ski-related travel, traffic mitigation, and economic development. A pilot ski-ITS deployment in the Northeastern states will allow for empirical evaluation of the cost, benefits, and operations/deployment issues associated with the use of these technologies. Lessons learned from the pilot deployment can be used to inform future ITS deployments in ski regions and other rural areas that experience seasonal, tourism-driven travel involving large traffic generators.

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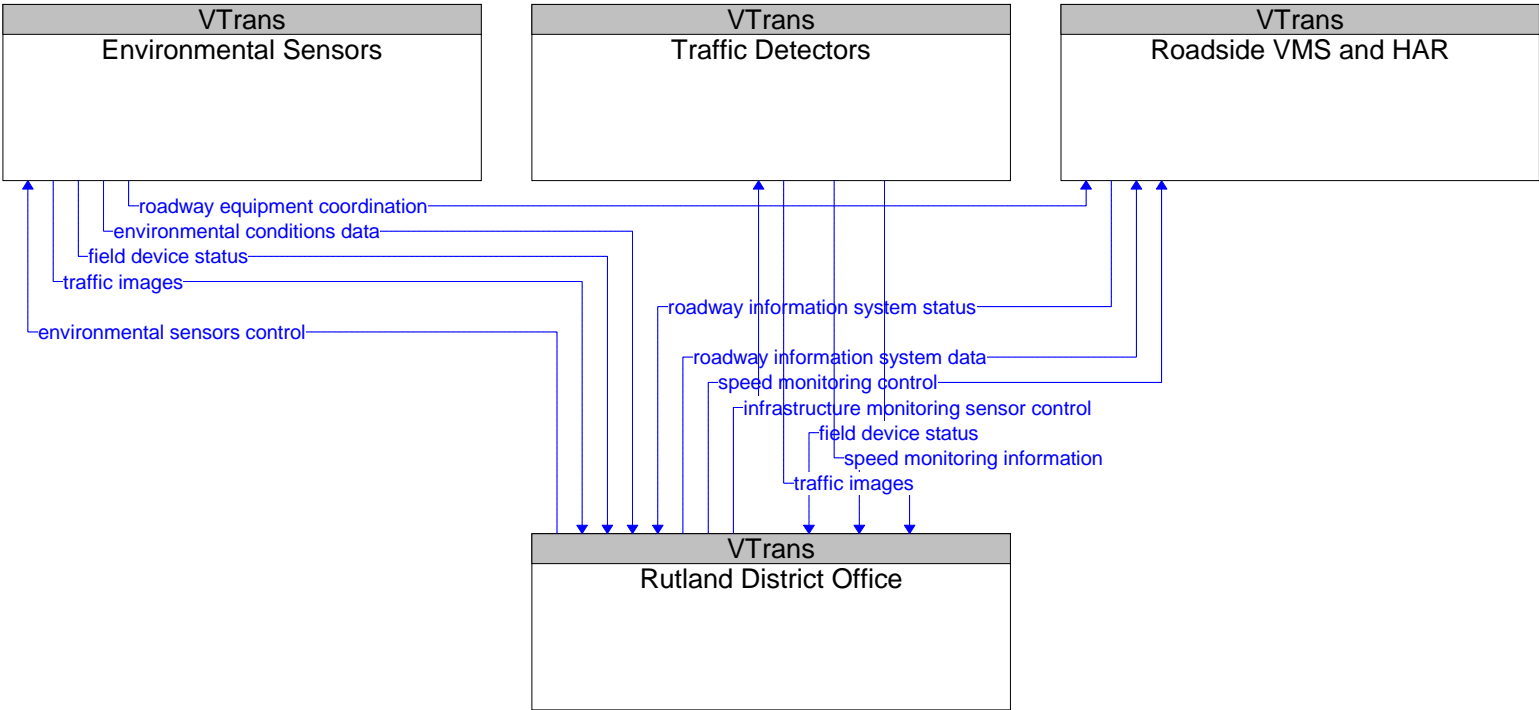
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APPENDIX



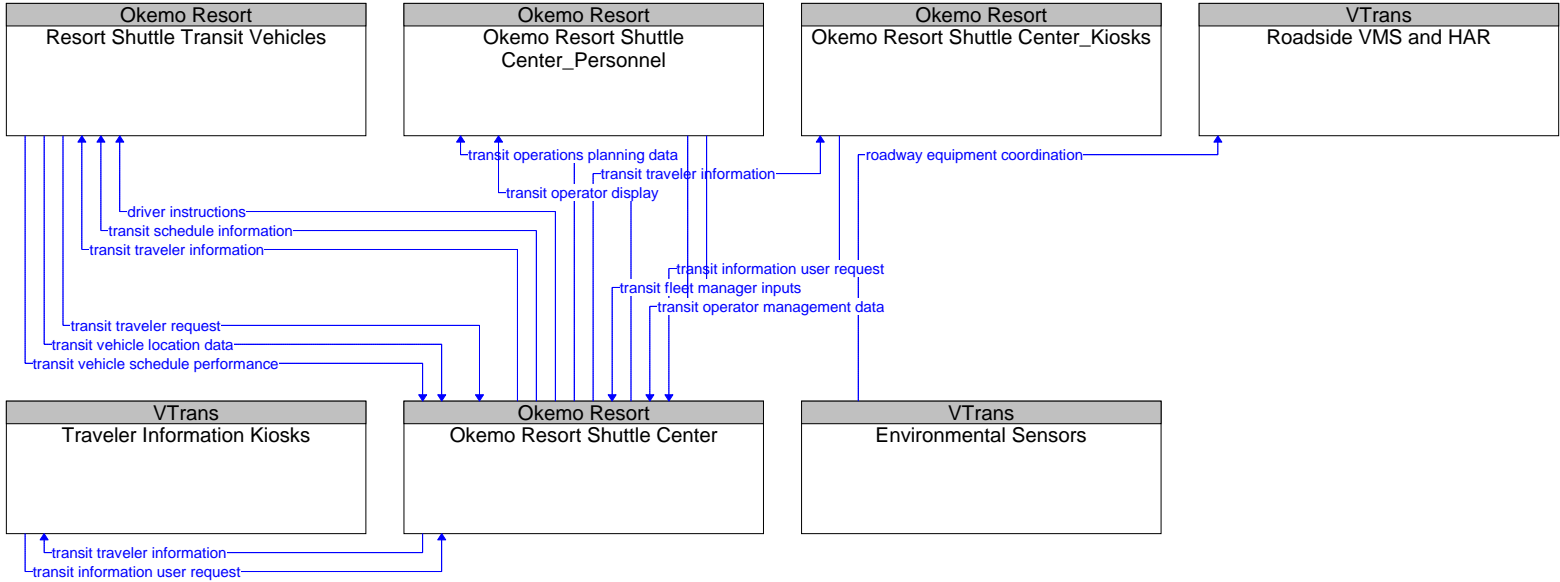
Okemo Case Study Sub-System information Flow Diagrams

Example 1: Rutland District Office



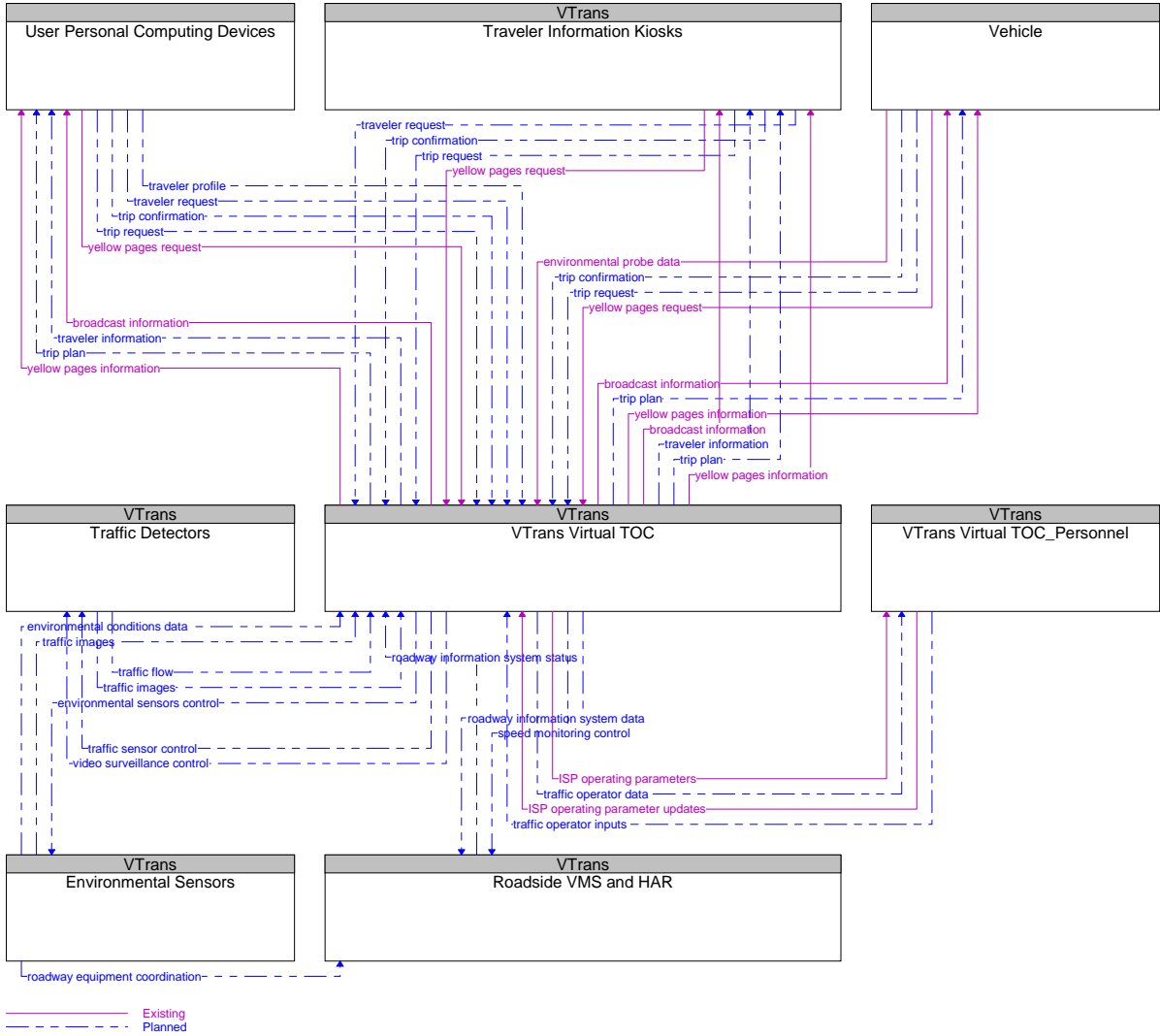
Existing
Planned

Example 2: Okemo Transit and Parking



Existing
Planned

Example 3: Virtual Traffic Operations Center (TOC)



Example 4: Weather Applications

