CANAMEX CORRIDOR PLAN WORKING PAPER

TASK IV: EMERGING TECHNOLOGIES
Implications on Corridor Development
Telecommunications Technologies
Transportation Technologies

Prepared for

THE CANAMEX CORRIDOR COALITION

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INTRODUCTION

Recognizing the shared challenges and opportunities presented by the region's principle north/south transportation corridor, the governors of Arizona, Nevada, Utah, Idaho and Montana established the CANAMEX Corridor Coalition. The Governors signed a memorandum of understanding to prepare a Corridor Plan: a bold, forward looking document designed to guide long term economic development policies and strategic transportation and other infrastructure investment. The Plan will enable the five-state region to more fully harness the benefits of a changing national economy. This Task IV Working Paper explores how emerging technologies, with a focus on telecommunications and transportation, are likely to affect future Corridor development.

In addition to the Executive Summary, this Task IV Working Paper is divided into the following three sections:

Section I: Emerging Technologies and Corridor Development – This section reviews the transformation of the national and world economies from the industrial era to the information age. It discusses the emergence of e-commerce and its implications for freight movement and various types of land development in the CANAMEX Corridor. The section also explores the strategic implications of this economic change for the Corridor's tourism industry. Finally, it presents some ideas on the long-term drivers of economic development in the information age.

Section II: Emerging Telecommunications Technologies – Because of the importance of infrastructure development to the Corridor Plan, this section presents a more detailed analysis of emerging telecommunications technologies, especially as they relate to mobile and fixed wireless systems. This section emphasizes wireless technologies over wireline because of their much greater relevance to future mobile and rural infrastructure in the Corridor.

Section III: Emerging Transportation Technologies – This section evaluates the way emerging technologies may enhance future transportation safety and efficiency in the Corridor. The section reviews a number of different technologies and identifies their potential application. It then examines the suitability of each technology to beneficial uses within the Corridor. It finally prioritizes the most constructive clusters of usable technologies for implementation.

EXECUTIVE SUMMARY

I: EMERGING TECHNOLOGIES AND CORRIDOR DEVELOPMENT

The first section of this paper examines the fundamental shift in the United States economy away from industrial production toward the use of information technology. It then explores the implications of this shift for the five CANAMEX states in terms of demand for freight movement and various commercial and industrial land uses. The section moves on to discuss how technology changes affect tourism and its potential as an instrument for rural economic development. The section concludes with a discussion of the shifting economy's long term implications for accelerated economic progress in the CANAMEX states.

Implications for Land Use and Freight Movement

The Internet, with its vast array of websites, is becoming not only a storehouse of information but also a worldwide marketplace. An increasing share of purchases will be made online, including both business and consumer purchases. The new economy, propelled most recently by Internet facilitated commerce, will have the following implications for the CANAMEX Corridor over the next 10 to 15 years:

- E-commerce will increase freight shipment across all modes, but its greatest impact will be on trucking and air freight shipments.

- Demand for modern distribution space with sophisticated logistics capability will increase rapidly. These distribution facilities will tend to cluster in areas that are most convenient for trucking service to major population centers such as the west side of Salt Lake City, the west side of Phoenix and the north side of Las Vegas.

- Technology firms prefer office districts that appeal to workers in the 25 to 35 age bracket. These are typically urban mixed-use districts that offer multi family housing, restaurants, entertainment venues, shops and recreation opportunities. Proximity to one or more universities concerned with preparing students for the new economy has also proven to be an important advantage.

- The office districts and buildings themselves must be able to offer broadband access, ideally from a selection of service providers.

- Standard suburban shopping malls in marginal locations will struggle.

New Tourism Strategy as Instrument of Rural Economic Development

As new technologies have accelerated the pace of economic change, policy makers at the state and national levels have grown concerned that rural communities are not benefiting from this economic progress to nearly the same extent as more dynamic urban centers. This concern is certainly present in all five CANAMEX states, where rural economies have been largely dependent upon mining and agriculture.

With the expected healthy rate of population growth for the American West and improving global communications and transportation, tourism is clearly an expanding opportunity area for rural economic development in all five CANAMEX states. Considering the explosive growth of information technology, changing consumer values and narrowing income disparity between the United States and many foreign countries, no aspect of the tourism industry will remain unchanged as we move into the 21st century.

For these five states, the string of National Parks and National Recreation Areas form an obvious critical mass of well established attractions. With growing demand for tourism products driven by fewer barriers to international travel and rapid regional population increases, it is time for the CANAMEX states to cooperate in developing new tourism themes and products along the Corridor.

One theme that would have great international appeal and appears to be relatively under exploited outside of the region is the "History of the American West." The images evoked include cowboys, Indian wars, buffalo hunts, wagon trains, outlaws, banditos, early explorers, mining towns and Mormon Pioneers. All five states could cooperate in a new marketing campaign. The domestic marketing strategy could be directed at the numerous historical societies and organizations to promote travel during off-peak seasons. The foreign marketing campaign could take advantage of romantic images of the American West conveyed by landscape painters and generations of Hollywood movies. Most points of historical interest are located in smaller rural communities that would derive considerable economic benefit from increased tourism.

Importance of Knowledge and Innovation

Longer term economic progress during the 21st century will depend upon knowledge and innovation. For the CANAMEX states to catapult into the forefront of the new economy, long term state and local economic development policies need to place emphasis on attracting talented and well educated workers with a range of experiences and ideas. The communities that are best able to educate, attract and retain a highly qualified workforce capable of sustaining innovation will emerge as the leading communities of the 21st century economy.

II: EMERGING TELECOMMUNICATIONS TECHNOLOGIES

The second section of this paper addresses emerging telecommunications technologies that are viewed as key to developing the wireless Internet of tomorrow. Due to the fast-paced evolution in the telecommunications industry, some of the names of firms and technologies referenced in this section of the report may change. The emerging technologies addressed in this section include third generation cellular networks and other emerging wireless spectrum applications, the Wireless Application Protocol (WAP) associated with wireless content delivery, Bluetooth technology related to universal wireless appliance connections, telecommunications in support of Intelligent Transportation System (ITS) wireless applications and Wireless Local Loop (WLL) technology associated with fixed wireless access in rural areas. The three most relevant telecommunications applications for satisfying CANAMEX Corridor Plan objectives, along with strategies for developing their required infrastructure, are presented below.

Telecommunications Infrastructure in Support of Mobile Services

The effective deployment of Corridor applications that rely on mobile data telecommunications infrastructure support such as Traveler Information Systems, Commercial Transportation Applications and On Line Services are expected to require the deployment of third generation digital cellular networks with higher data throughput rates. Current data rates as supported by analog Advanced Mobile Phone Service (AMPS) networks are capped at 19.2 Kbps, which is not considered sufficient to address the development of mobile Internet applications. Third generation rates throughout the Corridor could be provided at a significantly improved 384 Kbps—equivalent to today's medium speed fixed wireline capacities.

In addition, the continued penetration of WAP enabled cell phones and Internet Gateways will be required if mobile users expect to deal with this information flow in a manner consistent with Internet browsing and Internet data transfers. The ubiquitous deployment of WAP Gateways would bring the Internet to the mobile user with no perceived loss in functionality.

Telecommunications Infrastructure in Support of ITS Services

The effective deployment of Corridor ITS applications is expected to require the deployment of Dedicated Short Range Communications (DSRC) systems operating in the ITS radio service.

While some ITS communications requirements may be met within the framework of existing and emerging cellular systems, it is expected that the deployment of DSRC systems will be required to ensure reliable short range wireless communications links between vehicles traveling at highway speeds and roadside systems.

Telecommunications Infrastructure Supporting Last Mile Rural Broadband Access

The future availability of rural "last mile" access to advanced telecommunications capability will likely rely in part on the deployment of WLL technology such as Multichannel Multipoint Distribution Service (MMDS) and Local Multipoint Distribution Service (LMDS).

WLL technology deployment may be facilitated through certification of WLL carriers as Eligible Telecommunications Carriers per the requirements of the 1996 Telecommunications Act. The Corridor Plan should review the status of WLL carriers in the Corridor states with a view of facilitating deployment of wireless technology in rural areas.

III: EMERGING TRANSPORTATION TECHNOLOGIES AND CORRIDOR DEPLOYMENT

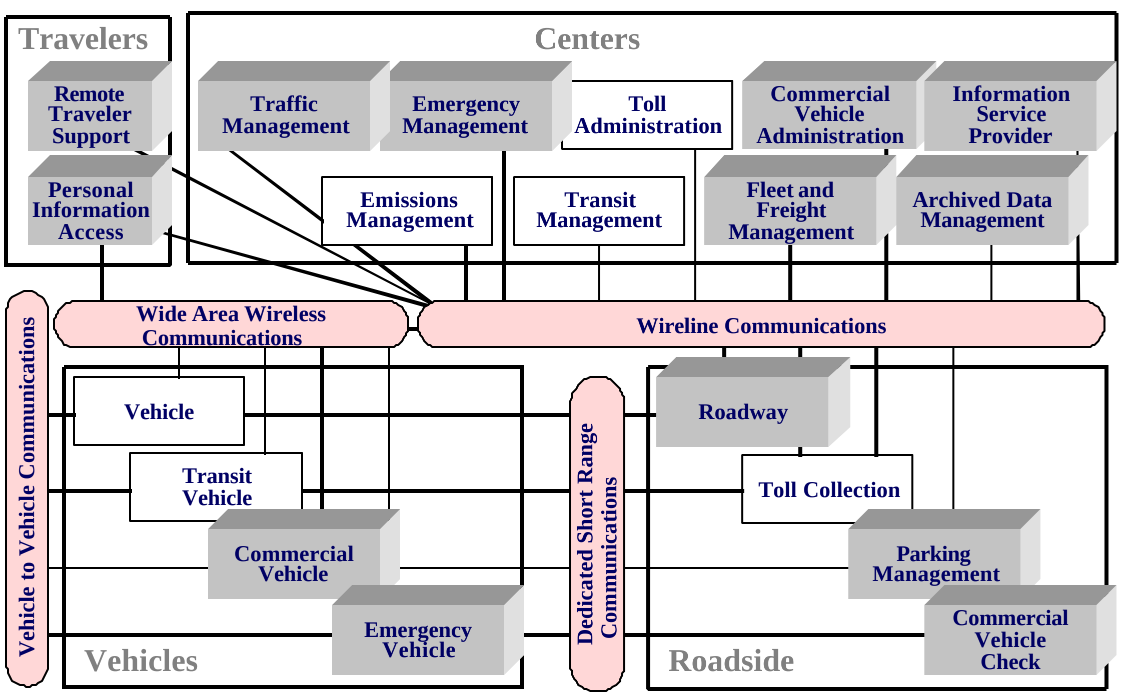
In the third section, the Corridor Plan's transportation objectives were analyzed against emerging transportation technology applications, notably ITS. From this analysis, three Corridor-wide ITS applications were selected as the most relevant to satisfying the transportation corridor objectives. These are: (1) CANAMEX Corridor Transportation Management And Information Network (MAIN), (2) CANAMEX Smart Tourist System, and (3) CANAMEX Smart Freight System.

Planning for the deployment of ITS initiatives requires consideration be given to a number of technical details to ensure the implemented systems can accommodate current and future demands. A regional ITS architecture is planning tool that serves as a technical framework for integrating ITS services. It is recommended that a CANAMEX Corridor ITS architecture be established to coordinate ITS implementations throughout the Corridor. The Corridor ITS architecture, and the standards that it encompasses, would help to ensure the following benefits are achieved:

- *Interoperability* - the ability of ITS components to be connected to, mixed with, and controlled by other components.
- *Integration* - maximizing the opportunities to combine systems and exchange data to take advantage of synergies among systems.
- *Expandability* - the ability to readily increase the scale and scope of the deployed systems.
- *Risk Reduction* - the identification of standardized interfaces to ensure the deployed systems are as open as possible and are supported by a non-proprietary, multi-vendor market.

The U.S. Department of Transportation has created the National ITS Architecture and recently issued regulations requiring the development of regional ITS architectures that are consistent with the National ITS Architecture. The figure below depicts a high level view of the National ITS Architecture and the subsystems expected to be key elements of principal Corridor applications. The three priority ITS application are described below.

High-Level View of the National ITS Architecture (CANAMEX Application Subsystems are Highlighted)



CANAMEX Corridor Transportation Management And Information Network (MAIN)

This system would include the following elements:

- Data sharing and coordination between all five CANAMEX states for transportation planning purposes.
- Maintaining a traveler information database for real-time dissemination by private sector information providers as well as over the Corridor Web Site. This includes connectivity to Advanced Traveler Information Systems (ATIS) and Advanced Traffic Management Systems (ATMS) activities in metropolitan regions as well as initiatives at National Parks and other attractions.
- Coordination of incident management and commercial vehicle operation activities across the five states as well as Canada and Mexico.
- Coordination of strategic operational strategies related to construction or rerouting activities that may involve multiple states (e.g., construction work on US 89 in northwest Arizona may have implications for travelers headed from Nevada to Arizona).

Components would include a communications network (either Internet based or a private network) tying together traffic management, emergency operations and commercial vehicle systems centers, and may include a "central" CANAMEX Management Center if deemed to be of value. As noted above, the first step in developing this and other programs will be developing a Corridor system architecture that establishes the most cost-effective, institutionally acceptable and efficient transportation solutions. Once the architecture is defined, stakeholders in the CANAMEX development process will need to identify the standards associated with sharing data between management centers. The MAIN initiative requires the free exchange of traffic and traveler information among multiple CANAMEX Corridor operational centers. Three emerging standards efforts that should be given particular considerations are: (1) Standard for Functional Level Traffic Management Data Dictionary (TMDD) Data elements, Messages, and communications protocols, (2) Message Sets For External Traffic Management Center Communication (MS/ETMCC), and (3) National Transportation Communications for ITS Protocol (NTCIP) – Application Profile for Common Object Request Broker Architecture (CORBA).

The TMDD standard provides the basic information definitions, generally described as data elements (DEs), that are used in the exchange of information between systems. The MS/ETMCC standard defines messages; i.e., groups of data elements that include information about how the data elements are grouped and are used to convey information among ITS systems. A message set provides a series or set of individual messages, established in a strict format, for exchanging information on a given topic. Thus, an agreed-upon message set with unambiguous definitions is one of the essential standards required to exchange information between, for example, traffic management centers (TMCs) or between a traffic management system (TMS) and other ITS users and/or suppliers of traffic-related information. The CORBA standard is a general-purpose protocol for object-oriented software packages that allows systems from different manufacturers to exchange data and interoperate with each other.

***CANAMEX* Smart Tourist Corridor System**

This program would create a "branded identity" for a route system throughout the CANAMEX Corridor that supports the needs of recreational travelers (tourists). Associated with this network would be traveler information services supported by coordination activities in the MAIN program. The Smart Tourist Corridor program would support public-private partnering activities in order to provide tourist-oriented real-time information services at strategically-located kiosks at rest areas and tourist centers. One means of defraying the cost of deployment will be through the integration of Traveler Services Information activities. Traveler information in general for the Smart Tourist Corridor would be provided over a CANAMEX traveler information web site.

Traveler information may include static and real-time information. Examples of static information include:

- location of rest areas
- location of national parks and other landmarks
- international border crossings
- traveler services information (hotels, gas stations, restaurants, hospitals, etc.)
- hunting, fishing license information
- border crossing
- other traveler information

Examples of real-time information include:

- weather conditions (current and forecast)
- highway blockages and anticipated delays due to construction
- highway incidents and lane closures
- congestion locations
- National Park information (parking availability, shuttle services, road closures, and status of attractions)

Also included would be specific En-Route Information elements such as Variable Message Signs and Highway Advisory Radio that would support real-time information and demand management activities. Provision of parking facilities and transit shuttle services to and from National Parks and other Attractions would be supported through the Smart Tourist Corridor program.

***CANAMEX* Smart Freight System**

The Smart Freight system would provide the mechanism to: 1) integrate and standardize state and provincial Commercial Vehicle administrative processes to the greatest extent practicable; 2) support interoperability and integration with federal trade movement data systems; and 3) make available better traveler information and facilities for conducting electronic commerce and coordination between commercial carriers and intermodal facilities. It would also provide a "branded identity" that would be expanded to physical travel routes for commercial vehicles throughout the Corridor.

The system would provide service information oriented to commercial vehicle operators and motor carriers, either over the Web, at strategically located truck stop kiosks, or through in-vehicle systems that may be implemented as a result of public-private partnerships.

Traveler information may include static and real-time information. Examples of static information include:

- location of rest stops
- location of truck stops
- international crossing requirements and operating hours
- locations and facilities for conducting electronic commerce and processing of international shipments
- agriculture inspections facilities at border crossings
- information on obtaining permits
- other Commercial Vehicle Operations service information

Examples of real-time information include:

- weather conditions (current and forecast)
- highway blockages and anticipated delays due to construction
- highway incidents and lane closures

Included would be specific En-Route Information elements such as Variable Message Signs and Highway Advisory Radio that would support real-time information associated with commercial operations and advisories along Smart Freight corridors.

Hazardous Materials (HAZMAT) activities would be serviced through use of automated roadside inspection and vehicle tracking schemes that would permit states to track HAZMAT shipments. Those shipping companies would be required to set up a network connection between their vehicle tracking systems (or to procure them if not currently in place) and implement a geographic information standard throughout the Corridor.

International Trade Processing Centers and Intermodal Centers would be incorporated into this network. In particular, the development of International Trade Processing Centers would be encouraged by the CANAMEX Corridor as a method to reduce delays associated with credentials and administrative processes. International Trade Processing Centers permit direct transportation of containers across international borders with reduced delay. Centers in strategic locations near railway terminals and intermodal interfaces should be identified for implementation.

To implement this effort, a comprehensive project plan should be developed to help guide the stakeholders in the CANAMEX Corridor in deploying the Smart Freight system. This should be done in coordination with development of the Corridor ITS Architecture. Coordination with state efforts in implementing CVISN (Commercial Vehicle Systems and Networks) should also be sought in developing the CANAMEX Smart Freight System. CVISN is a Federally sponsored effort aimed at enabling government agencies, the motor carrier industry, and other parties engaged in CVO safety assurance and regulation to exchange information and conduct business transactions electronically.

Section I
EMERGING TECHNOLOGIES AND CORRIDOR DEVELOPMENT

GLOBAL COMPETITION AND ECONOMIC TRANSFORMATION

The United States economy is undergoing a transformation from the industrial age to the information age. The industrial age was best symbolized by the assembly line production techniques initially popularized by Henry Ford. It had a hierarchical production structure with industrial workers performing routine and repetitive tasks. It led to the creation of massive industrial plants and large urban populations to sustain those plants. At the beginning of the 20th century, two-thirds of working US citizens earned their living by making "things," many of which were manufactured in these large industrial plants.

Today, due to changing technology, two-thirds of working US citizens earn their living by processing information and making decisions. The technology changes of the last half of the 20th century have intensified global competition. The globalization of commerce, pushed by relentless market competition, has caused the United States and world economies to change in several fundamental ways:

- The production of commodities that still require a substantial labor component largely have moved to lower labor cost Third World countries. Most of the apparel we wear is now produced in Asia, and even the newly designed Volkswagen Bug is assembled in Mexico.

- To offset the higher labor cost in this country, we have developed production techniques that are more knowledge and capital intensive and less labor intensive. For example, modern farming techniques now use global positioning systems, weather information and soil analysis to determine the amount of water and fertilizer needed for each square meter of farmland, substantially reducing the farmer's water and fertilizer cost. Even farm tractors can be fully automated. American farms can produce more output with less labor than two or three decades ago.

- Being at the forefront of this information revolution, US firms have a competitive advantage in knowledge intensive industries and are able to export that knowledge on a worldwide basis. For example, American architectural firms designed many of the significant new office buildings in China; and the US headquartered engineering firm of Bechtel International manages many of the largest and most complex construction projects in the world.

- Third World countries have been able to leap frog several generations of technology change experienced by the US and Western European countries. Selected areas in countries like India and China have been able to transform their early 20th century economies to 21st century economies in one or two decades. This transformation has narrowed the standard of living difference between the United States/Western Europe and much of Asia and Eastern Europe. The narrowing income gap has favorable international tourism implications for the CANAMEX states.

- The national economic boom of the past eight years has resulted in severe labor shortages in many of the Western states. The job opportunities in CANAMEX states like Arizona, Nevada and Utah have attracted many foreign in-migrants. For example, the Salt Lake Valley, which had very few Hispanics 30 years ago, now has a substantial Hispanic population living on the Westside.

- From a cynical European perspective, globalization is simply a euphemism for Americanization. This perspective is perhaps true for American English, technical terminology, music and cinema. However, part of the reason for America's success, which the Western Europeans have not been able to duplicate, is the result of America itself becoming multicultural. The increase in the numbers of bi-cultural and/or multi-lingual Americans facilitates American business penetration of foreign markets.

DISINTERMEDIATION AND REINTERMEDIATION

The transformation into the information age has been accelerated by network connections that allow more direct access to information. This direct access to the sources of information has caused a number of intermediaries to become less and less essential. This phenomenon, which economists call "disintermediation" has decreased the need for travel agents, bank tellers and even stock brokers. The middle-men, who handle more or less routine transactions, have become increasingly expendable. With this disintermediation, the national economy has become more efficient and able to sustain more growth with less inflation. The power of immediate access to more market information has allowed businesses and individuals to make more cost effective and therefore more productive decisions. Internationally, societies built upon centralized decision making implemented by layers of bureaucratic intermediaries are becoming anachronisms.

The rapid pace of technology change has caused the total amount of knowledge to grow exponentially. Individuals now are less and less able to keep pace with the growing amount of knowledge outside of one's own field. The need for experts or specialized consultants will actually increase as a result. With this transformation to the new information based economy, our need for intermediaries that provide more-or-less routine functions will diminish while our need for specialists who possess state-of-the-art knowledge will increase.

IMPLICATIONS ON LAND USE AND FREIGHT MOVEMENT

The Internet, with its vast array of websites, is becoming not only a storehouse of information but also a worldwide marketplace. An increasing share of purchases will be made online, including both business and consumer purchases.

Changing Pattern of Retail Goods Movement

During the past 30 years, the path products follow to reach consumers has undergone several iterations of change:

- In the traditional pattern of 30 years ago, manufacturers shipped their products to wholesale distributors. The wholesalers stored these products in warehouses and then shipped them to retail stores. Consumers traveled to the retail stores to examine and purchase the goods.

- With widespread acceptance of automobiles making suburban housing tracts popular, regional shopping centers emerged. Consumers traveled further to enjoy the larger concentration of stores and greater selection of goods offered by regional shopping centers. Many street retailers in older central city neighborhoods disappeared.

- During the past 20 years or so, the wholesale style retailer or "big box" retailer has diverted substantial retail dollars from regional shopping centers. These big box retailers, like Walmart, K-Mart and Costco, were able to by-pass wholesale distribution intermediaries and offer consumers a lower price. However, consumers still drove to the stores; and major big box retailers still employed back-up distribution facilities. For example, Walmart placed its distribution facilities in low cost communities like Hurricane, Utah and Porterville and Red Bluff, California.

- With the Internet, an increasing percentage of consumer retail purchases will be made online. The transactions are more like mail order purchases without the cost of printing and distributing colored catalogues. In this model, consumers do not travel to the retail outlet. Rather the e-commerce company receives the order and ships the products from its central distribution facility directly to the consumer's residence or place of work. This business model of shipping from distribution centers directly to consumers, greatly increases the need for truck transport, particularly from the smaller Class I to IV variety of trucks.

At this point in development of e-commerce, the cost advantages of shipping individual parcels directly to the consumer, as compared to having the consumer come into the retail outlet to make the purchase, are not fully proven. However, even if only 10 to 15 percent of all consumer purchases of retail goods and services move online, the transformation means that the need for additional retail space will slow and the need for distribution space will accelerate.

Business to Business E-commerce

With the business to consumer model still not proven in terms of sustainable profitability, many in the investment community believe that business to business e-commerce holds the greatest promise. With the use of the Internet, buyers are able to search for suppliers faster and over a larger geographic area. The Internet also allows groups of buyers to consolidate their orders to gain leverage on suppliers. The cost advantage of the business to business model over the business to consumer model is more consolidated shipping.

The growth of business to business e-commerce will accelerate the growth of freight movement. More products will be shipped over longer distances. All types of freight transport will benefit from this increase in demand, although we expect the primary mode beneficiaries to be air freight and trucking, because these two modes tend to handle the smaller, higher value and more time sensitive shipments.

Freight Movement and Distribution Activity Will Grow

E-commerce will substantially increase and diversify both the origin and destination of freight shipments. As a consequence, truck and air freight volumes are expected to increase at above historic rates over the next 10 to 15 years. Distribution areas that offer convenient truck access to major metropolitan population centers along with low land costs, low tax burdens and low labor costs will grow. For example, Amazon.com located a major distribution facility in Fernley, Nevada just east of Reno to take advantage of its overnight trucking accessibility to most West Coast population centers. In addition, Nevada offers lower tax rates and lower land and labor costs when compared to West Coast population centers.

Within the larger CANAMEX metropolitan centers, the following areas will flourish as regional truck based distribution centers over the next ten to fifteen years due in no small part to the increasing prominence of all types of e-commerce:

- The west side of the Salt Lake Valley, inside the loop formed by I-80 on the north, I-15 on the east and I-215 on the west and south.

- The north side of the Las Vegas metropolitan area, within the "V" formed by US-95 and I-15 and in the Apex area—a few miles south of the junction of US-93 and I-15.

- The west side of the Phoenix metropolitan area along I-10. Once the new Hoover Dam crossing is in place and US-93 is upgraded to a four lane restricted access highway, some distribution facilities will find the US-93 corridor attractive as well.

- The south side of Tucson immediately south of Tucson International Airport. This area enjoys easy access to I-19, I-10, two rail lines and the airport and benefits from the proximity to Mexico.

While much of the short and intermediate haul freight will go by truck, the importance of air freight will increase for longer haul shipments. Great Falls, Montana expects to benefit from the growing demand for air freight service, including the air freight demand generated by e-commerce. Because of its low air traffic volumes, generally favorable flying climate, and low land and labor costs, Federal Express has selected to locate its new Northwest regional distribution facility in this city.

With the Puerto Nuevo project, Tucson intends to take advantage of its growing linkage with Mexico and its ability to offer a large amount of acreage with convenient air freight service, north/south and east/west interstate highway access and two rail line access to stimulate job growth and regional economic development in Southern Arizona.

The New Economy and Office Location

In the "hot" new economy markets, like the San Francisco Bay Area and the Seattle Metropolitan Area, office demand from technology companies in Internet related services, multi media and software development has been exceedingly strong. In the South of Market Area in San Francisco, technology companies have driven office rents in renovated warehouse type buildings from $15 to $20 per square foot four years ago to the $60 to $80 per square foot level today.

Although shakeouts in the technology sector are expected over the next several years, the Bureau of Labor Statistics projects that the percentage of the United States workforce in technology-related fields will increase to 49 percent by 2006 from 44 percent today. In actual numbers of employees, information technology workers will increase from 46 million to 56 million over this period. Since a majority of these employees will be housed in office buildings, demand for office space is expected to increase at a brisk pace over the next five to ten years in metropolitan areas that have a strong technology component to their economies.

The type and location of office space preferred by these new economy companies is very different from that preferred by old economy companies such as law firms, financial institutions, insurance companies, and manufacturing firm headquarters. In the new economy, the life cycles of products and systems are extremely short, often lasting no more than 18 months. Success depends upon getting the idea or product to market first to establish position and gain the scale necessary for market dominance.

These firms employ young workers who are able to work long hours because they have few competing commitments. Given intense pressure to succeed, often fueled by stock options, this workforce has little time for commuting, cooking meals, recreation and social interaction. The preferred office environment has housing, restaurants, recreation, social and entertainment opportunities nearby so a minimum amount of time is lost traveling. In contrast to the prestigious office buildings in grand settings preferred by old economy firms, the younger new economy workforce prefers urban mixed use locations like Seattle's Belltown, San Francisco's South of Market, Santa Monica's Third Street Promenade, and downtown Tempe in Arizona.

Because access to high speed telecommunications capability is essential for these firms, the office districts where new economy firms have thrived are also areas where the investment in advanced telecommunications infrastructure have been made. For the office buildings themselves, high band width telecommunications access is a must. Ideally, the access is to multiple service providers. Landlords have found that providing this service is a viable new source of revenue.

The communities along the CANAMEX Corridor offer few urban mixed use districts similar to those mentioned above. Most Corridor communities do not have the size and therefore the numbers of younger sophisticated workers to foster this type of district. In CANAMEX's larger metropolitan areas, the Phoenix, Tempe and Scottsdale downtown areas probably would have the most appeal for the new economy workforce.

Along the Wasatch Front, downtown Salt Lake City has not spawned this type of smaller scale urban mixed use district because its large ten-acre blocks and wide streets are not particularly conducive to this development pattern. The new Gateway project, which recently started construction at the western edge of downtown, may help create this type of new economy environment. In contrast to downtown Salt Lake City, downtown Provo has the scale and urban texture to appeal to a young workforce and new economy firms; however, it location is currently too distant from the much larger and more culturally diverse Salt Lake County workforce. As the Utah County population and workforce increases and diversifies over the next 30 years, Provo could emerge as a significant new economy node in the CANAMEX Corridor. A number of high technology firms already have facilities in the Lehi, American Fork and Orem area just north of Provo because of the area's access to both the Salt Lake and Utah

County labor pools and its proximity to both Brigham Young University (BYU) in Provo and the University of Utah in Salt Lake City.

In Idaho, downtown Pocatello has one of the Corridor's most diverse and well preserved historic districts. The district covers 18 blocks and includes more than 80 buildings of brick, stone and terra cotta that reflect wide-ranging historic styles such as Gothic Revival and Art Deco. Being close to the Idaho State University and about 60 miles from the Idaho National Engineering & Environmental Laboratory, downtown Pocatello has the potential to evolve into an area attractive to new economy firms over the next two or three decades.

STATE GOVERNMENT'S ROLE IN FACILITATING E-COMMERCE

As more and larger transactions move onto the Internet, many efficiencies gained by e-commerce are often negated since our legal systems continue to require paper documents and hand written signatures. Most of our laws were written during an era when paper was the only realistic medium for the execution and documentation of transactions. Each national, state or local law or regulation that requires original paper documents and written signatures inhibits e-commerce. The five CANAMEX states have the opportunity to act in concert to remove the barriers to electronic commerce and to provide an effective alternative as technology and commercial transaction models continue to evolve.

There is already a body of information and some laws that address this issue. The State of Utah, with the passage with the Digital Signature Act in 1995, has been a leader in the field. Utah is currently discussing a Uniform Electronic Transaction Act, and the Federal Government has recently passed the Millennium Digital Commerce Act to establish a baseline for electronic transactions.

TOURISM AS AN INSTRUMENT OF RURAL ECONOMIC DEVELOPMENT

As new technologies have accelerated the pace of economic change, policy makers at the state and national levels have grown concerned that rural communities are not benefiting from this economic progress to nearly the same extent as more dynamic urban centers. This concern is certainly present in all five CANAMEX states, where rural economies have been largely dependent upon mining and agriculture. Many of the communities with historic dependence on mining are now struggling as ore fields become exhausted or as new environmental standards cause past mining techniques to become no longer viable. With increasing global competition and the application of more labor efficient farming techniques, communities historically based upon agriculture have a surplus of labor and few new employment opportunities.

With the expected healthy rate of population growth for the American West and improving global communications and transportation, tourism is clearly an expanding opportunity area for rural economic development in all five CANAMEX states. Considering the explosive growth of information technology, changing consumer values and narrowing income disparity between the United States and many foreign countries, no aspect of the tourism industry will remain unchanged as we move into the 21st century.

Based upon ERA's considerable body of work in tourism planning and development, the strategic implications of this economic change for the tourism industry in the CANAMEX states include:

Need for Additional Tourism Product Development

- Apply an integrated approach to new product development that combines individual attractions into a mutually supportive critical mass environment.
- Expand regional cooperation in product development and long haul marketing.
- Have more than one system of anchor attractions that are linked by key tourist routes.
- Include environmental enhancement and heritage conservation in tourism development programs.

Opportunities for Branding and Cooperative Marketing

- Create a branding program associated with new product development.
- Identify regional, national and international special interest organizations with which to affiliate.
- Develop special interest marketing strategies to encourage off-peak season visitation.
- Develop interpretation, entertainment and information sites around these themes and identity.
- Use special events as triggering cues for short vacations.
- Expand market awareness in new markets.
- Encourage extended stays through education and cultural programs attractive to foreign visitors.

Benefits of Information Technology

- Apply multimedia technology to improve the interpretation of tourism attractions and the presentation of handicrafts and cultural programs.
- Provide short range radio channels for local tourism information along key Corridor routes.
- Work with rental car companies and other ground transportation providers to include tourism industry information and directions in their on-board GPS systems.
- Incorporate high band width capability in new resort developments and renovations to serve the connectivity needs of a growing number of those who can live, work and vacation anywhere they choose.

New Tourism Theme – History of the American West

For these five states, the string of National Parks and National Recreation Areas form an obvious critical mass of well established attractions. With growing demand for tourism products driven by fewer barriers to international travel and rapid regional population increases, it is time for the CANAMEX states to cooperate in developing new tourism themes and products along the Corridor.

One theme that would have great international appeal and appears to be relatively under exploited outside the region is the "History of the American West." The images evoked include cowboys, Indian wars, buffalo hunts, wagon trains, outlaws, banditos, early explorers, mining towns and Mormon Pioneers. In Arizona at the southern end of the Corridor points of interest include the likes of Tombstone (Wyatt Earp, Doc Holliday and the shootout at OK Corral) and Wickenburg, which has a fine Western Museum. In Nevada along the Corridor, the history of Hoover Dam construction is a tourist destination of national and international repute. The new Hoover Dam bypass will make this attraction safer and more popular. Utah has the site of the first Church of Latter-Day-Saints (LDS) Temple in St. George and much LDS history in the Salt Lake area. Idaho has historic attractions like Massacre Rocks State Park and the Old Fort Hall Replica. In Montana at the northern end of the Corridor there is Bannack State Park (a well preserved main street of the town that had Montana's first gold strike in 1862 and the State's first territorial capital) and the Butte Historic Landmark District (old mining town with 4,000 buildings on the National Historic Registry). Most of these and numerous other similar points of historical interest are in smaller rural communities that would derive considerable economic benefit from increased tourism.

All five states, could cooperate in a new marketing campaign. The domestic marketing strategy could be directed at the numerous historical societies and organizations to promote off-peak season travel. The foreign marketing campaign could take advantage of the romantic images of the American West conveyed by landscape painters and generations of Hollywood movies.

ECONOMIC PROGRESS DEPENDS UPON KNOWLEDGE AND INNOVATION

Longer term economic progress during the 21st century will depend upon knowledge and innovation. Unlike the old industrial economy model of a vertically integrated hierarchical organization, where decisions were largely centralized and employees were valued for loyalty and stability, the new economy model requires knowledge specialization and encourages employee innovation. Based upon a detailed comparison between Silicon Valley in Santa Clara County, California and the Highway 128 Corridor outside of Boston in Massachusetts[1], the key characteristics of Silicon Valley that simulated a much higher rate of innovation included:

- A well educated and very talented workforce – although this type of workforce clearly was also present within the Highway 128 Corridor, including Harvard and the Massachusetts Institute of Technology (MIT).

[1] Annalee Saxenian, "Regional Advantage ? Culture and Competition in Silicon Valley and Route 128," Harvard University Press, 1994.

- A very culturally diverse workforce – Silicon Valley had a much greater foreign and immigrant worker presence, and their presence tended to broaden the range of ideas and markets considered.

- The presence of a large number of small and medium sized organizations, each with its own specialization – rather than vertically integrated organizations that performed a number of functions reasonably well, these smaller firms survived and prospered because they were the best at their respective specialized niches.

- Innovation often occurred when a series of systems and products produced by these smaller firms were integrated in incrementally new ways - innovation did not typically occur in large steps but rather in a rapid sequence of many small steps.

For the CANAMEX states to catapult into the forefront of the new economy, long term state and local economic development policies need to place emphasis on attracting talented and well educated workers with a range of experiences and ideas. The communities that are best able to educate, attract and retain a highly qualified workforce capable of sustaining innovation will emerge as the leading communities of the 21st century economy.

EDUCATION AND COMMUNITY QUALITY ARE LONG TERM DRIVERS OF DEVELOPMENT IN THE NEW ECONOMY

In looking ahead for the next 30 years, the key drivers of long term economic growth will be quality of education institutions and quality of community.

Importance of Education Institutions

Communities that are able to sustain innovation tend to have many linkages to top quality advanced education institutions. Much of the success of Silicon Valley has been attributable to its many linkages with Stanford University. Texas' decision some 20 years ago to invest heavily to attract top notch faculty to the University of Texas has paid dividends in the Austin area. The successful development of the Raleigh-Durham area in North Carolina was integrally related to the locations of Duke University, the University of North Carolina at Chapel Hill and North Carolina State University. The Microsoft Campus in Redmond, Washington is only a few miles from the University of Washington. Within the Corridor, the University of Utah, with the research park it sponsored, presents a prime example of this type of development. In addition, the high technology development in the Phoenix metropolitan area is clustered around the Arizona State University campus in Tempe. World class universities not only attract top quality faculty and students to the community, they also increase the propensity for the talented graduates to remain and contribute to the local economy. Advanced research laboratories, like Idaho National Engineering & Environmental Laboratory, would tend to have a similar influence.

Attributes of Successful New Economy Communities

The telecommunications advances driving the new economy have provided knowledge based firms and workers with increasing choice of location for both residence and business. The communities that are best able to attract and retain this leading edge workforce will need to offer a high quality living and working environment. In addition to having good advanced education institutions, the communities that will have easiest time attracting and retaining a workforce capable of sustained innovation will tend to have the following attributes:

- Quality primary and secondary schools – these knowledge based workers, particularly as they have families, will select their communities in a good part on the basis of the quality of the schools. For the Corridor communities that aspire to be at the forefront of the new economy, the quality of the primary and secondary schools are of paramount importance.

- Comfortable climate and attractive natural setting – government policy will not have great impact on these attributes. State governments may wish to use their most attractive areas as economic development lures; however, protecting the character of those areas will be of long term importance.

- Clean air and clean water – these are some of the more important reasons for migration to the CANAMEX states. Having higher volumes of through truck and automobile traffic which generate ever greater amounts of pollutants will challenge the long term economic interests of the CANAMEX communities.

- Attractive cultural, entertainment and recreation opportunities – this includes restaurants, entertainment venues, museums, performing arts facilities, libraries and well maintained parks.

- Areas of permanent open space – these are important to offer outdoor recreation opportunities and to define community boundaries or provide buffers.

- Quality planning and urban design – this could include protecting the integrity of residential neighborhoods, minimizing land use conflicts, the under-grounding of utilities, improving streetscape, promoting quality building design and investing in attractive public urban spaces.

- Responsive municipal services – this usually means low crime rates and short fire response times.

- A reasonable tax burden – state and local taxes are necessary to gain most of the above attributes, but an uncharacteristically high tax burden will place the community at a competitive disadvantage.

- A well planned and targeted business friendly attitude – many of the higher quality communities are ambivalent about rapid growth. Those communities need to define the types, locations and possibly the rate of growth desired so that interested businesses are able to respond to a well defined set of rules or guidelines.

- High quality telecommunications and transportation infrastructure – broadband access will be essential for participants in the new economy, and having sufficient highway, local roadway and transit capacity will keep the cost of doing business competitive.

Because of the importance of infrastructure to the CANAMEX Corridor Plan, the emerging technologies in telecommunications and transportation infrastructure are discussed in much greater detail in the following two sections.

Section II
EMERGING TELECOMMUNICATIONS TECHNOLOGIES

BACKGROUND

For many of us today, sitting at a personal computer means access to the Internet. We use the Internet for e-mail, information searches, Web roaming, file downloads, listening to music, playing on line games or just chatting with friends. It is apparent that indeed the Internet is where it is at and where it is going to be for many years to come. On that basis, this section identifies emerging telecommunications technologies in terms of their relevance to the development of Internet based applications since these are the technologies that would be reasonably expected to flourish in a future Internet rich environment.

This future Internet rich environment is expected to rely in part upon small mobile devices to access and receive information from Internet based databases and services. Devices similar to today's cell phones or personal digital assistants (handheld computers) are expected to communicate with the Internet for the transfer of e-mail and service specific information and instructions.

Today, companies have developed and marketed micro browsers for small devices such as cell phones as well as wireless Internet servers for service providers who offer e-mail and other Internet services using wireless technology. In a similar fashion, personal digital assistants are now wireless ready and can seamlessly connect to the Internet for a variety of on line and e-mail services.

It is therefore apparent that future telecommunications technologies will be emerging from the wireless arena. This bodes well for mobile applications in the Corridor including traveler information systems, commercial transportation applications and online services in general.

Another aspect of this Internet rich environment will be the importance of database technology. Database systems permit one to store and retrieve information in different ways. Databases are the de facto brains of the Internet and as such this technology should be expected to evolve with the proliferation of Internet access and services. In terms of future telecommunications technologies, one would therefore expect a closer coupling between the Internet and database applications themselves.

Today this coupling of databases with the Internet is referred to as "e-commerce". E-commerce is essentially the marriage of a company's databases with the Internet in order to make the company's operations, sales and marketing more efficient, less expensive and more flexible. Today many database companies offer suites of e-commerce software that attempt to do exactly that. This should be viewed as a positive development for the Corridor Plan, in that related Corridor initiatives are expected to rely extensively on database and e-commerce technology.

The Internet community is indeed preparing to go wireless. Companies such as America Online Inc. are developing their wireless strategies today by enabling their subscribers with e-mail using Wireless Application Protocol (WAP) capable phones and Palm Computing Co. devices. WAP technology is discussed later in this paper. Handset manufactures are also jumping on the bandwagon, by enabling their phones with WAP technology micro browsers that enable users to access the Web.

However, wireless networks are playing catch up for now. E-mail on handsets is expected to remain the biggest wireless Internet use for users until the wireless networks upgrade their speeds. Current data rates, which peak at 19.2 Kbps on analog cellular networks, are not adequate. Higher thresholds in the 300 to 400 Kbps range are expected in third generation cellular networks, a speed that most wireless networks are not expected to reach for many years. Nonetheless 56 Kbps rates may be reached in the near future to meet initial demand. On that basis, the broad adoption of the wireless Internet is not expected in the short term although WAP handsets and wirelessly enabled personal digital assistants and laptops are expected to continue to proliferate.

Finally, the introduction of the "wireless cable connection" as offered by the Bluetooth technology consortium, is another technology development that is consistent with an Internet rich telecommunications environment.

The following sections of this paper address emerging telecommunications technologies that are viewed as key to the development of the wireless Internet of tomorrow. These include third generation cellular networks and other emerging wireless spectrum applications, the WAP associated with wireless content delivery, Bluetooth technology related to a universal wireless appliance connection, telecommunications in support of Intelligent Transportation System (ITS) wireless applications and Wireless Local Loop (WLL) technology associated with fixed wireless access in rural areas. A glossary of the acronyms used throughout this section is located in an Appendix to this report.

EMERGING THIRD GENERATION CELLULAR NETWORKS

As described in the Task I Working Paper, cellular service operates in the 800 MHz frequency band. Competing cellular systems in each market share 50 MHz of spectrum (25 MHz for each system). A cellular system operates by dividing a large geographical service area into cells and assigning the same channels to multiple, nonadjacent cells. This allows channels to be reused, increasing spectrum efficiency. Because the system operates at such a low power, a frequency being used to carry a phone conversation in one cell can be used to carry another conversation in a nearby cell without interference. Cells can be as small as an individual building (say an airport or arena) or as big as 20 miles across, or any size in between.

Each cell is equipped with its own radio transmitter/receiver antenna and is allocated a set of channels with adjacent cells assigned different channels to avoid interference. In total, the 25 MHz assigned to each cellular system consists of 395 voice channels and 21 control channels.

As a subscriber travels across the service area the call is transferred (handed-off) from one cell to another. When a customer using a wireless phone approaches the boundary of one cell, the wireless network senses that the signal is becoming weak and automatically hands off the call to the antenna in the next cell into which the caller is traveling. When subscribers travel beyond their home geographical area, they can still make wireless calls. The wireless carrier in the area where they are traveling provides the service. This is called roaming.

All the cells in a cellular system are connected to a Mobile Telephone Switching Office (MTSO) by landline or microwave links. The MTSO controls the switching between the Public Switched Telephone Network (PSTN) and the cell site for all wireline-to-mobile and mobile-to-wireline calls. Wireless carriers own MTSOs.

Analog versus Digital

Analog cellular service sends a voice signal through the air using continuous radio waves. As the voice signals travel through the air they get weaker with distance. Equipment in the cellular network returns the signal to its original strength, or amplifies it. This technology is the predominant system in use today. This method of operation, the air interface, is called Advanced Mobile Phone Service (AMPS) for analog systems. AMPS transmits voice signals as Frequency Modulated (FM) radio signals

Digital cellular shares the 800 MHz frequency band with analog and is typically available in urban areas where analog service is offered. In digital transmissions, a conversation is converted into the ones and zeros of computer code. Unlike analog transmissions that are sent out as a continuously varying electrical signal in the shape of a wave, digital transmissions are a combination of on-and-off signal pulses. There are a number of digital air interfaces as discussed below.

Digital Air Interfaces

Several incompatible air interfaces are used to implement digital cellular networks, including Code Division Multiple Access (CDMA), Time Division Multiple Access (TDMA) and the Global System for Mobile Communications (GSM).

With CDMA, a phone call is assigned a code, which identifies it to the correct receiving phone. Using the identifying code and a low-power signal, a large number of calls can be carried simultaneously on the same group of channels.

TDMA is a digital air interface technology designed to increase the channel capacity by chopping the signal into pieces and assigning each one to a different time slot, each lasting a fraction of a second. Using TDMA, a single channel can be used to handle simultaneous phone calls.

GSM is a digital cellular telephony standard of European origin that supports voice telephony, emergency signaling similar to North America's wireline 911, a 9.6 Kbps circuit switched data service, and the short message service. GSM uses frequency division duplexing, with 200 KHz Radio Frequency (RF) channels (symmetric for the up and down links).

Our interest in this paper is mainly related to the data transmission capabilities of cellular systems in that data information access and transfer is expected to be our prime area of concern in support of potential Corridor initiatives.

Current Cellular Data Approaches

Cellular networks have traditionally been designed to provide circuit switched voice access to the PSTN and secondarily data services at modest (19.6 Kbps or less) rates.

Circuit Switched Cellular Data (CSCD) is the cellular telephone version of a dial-up modem connection. Using a computer (typically a laptop) with a wireless modem, the user establishes a dial-up connection with a remote modem in a manner analogous to the establishment of a voice call. Typical CSCD modems support data rates to 14.4 Kbps. Mobile access to the Internet is inherently supported since this capability is built into the circuit switched wireless cellular network protocols. CSCD is also transparent to the cellular service provider and does not require any special network infrastructure.

This approach is generally inefficient and costly since a fixed (symmetrical) bandwidth channel is established and maintained continually throughout the duration of the connection even if little or no data flow is taking place. This last fact accounts for the system's limited popularity since it is expensive to use cellular airtime in this way.

Cellular Digital Packet Data (CDPD) was an early attempt to use packet oriented techniques to transmit data over AMPS cellular networks. CDPD never significantly penetrated the marketplace and has an unlikely future since it is tied to AMPS, which is rapidly being displaced as a cellular technology, as discussed later.

CDPD supported a modest data rate increase to 19.2 Kbps but its major benefit was its more effective use of cellular bandwidth. Suitable for applications with relaxed delay requirements CDPD would occupy bandwidth at a secondary priority to voice traffic, relying on the ability to delay transmissions to facilitate the better sharing of bandwidth. Motorola is a source of both CDPD modems and network side CDPD infrastructure.

Third Generation Cellular Networks

The International Telecommunications Union has been attempting for years to formulate and approve a single "3rd Generation" cellular telephony standard that would be worldwide, allowing seamless roaming and interoperability for handset owners from all countries, and eventually replacing the first generation analog systems and second generation digital systems used in various parts of the world. It was to be called, variously, Universal Mobile Telephone System or IMT-2000.

The two leading proposals for IMT-2000 were W-CDMA, promoted by European manufacturers, and cdma2000 promoted by Qualcomm of San Diego. In the end, the International Telecommunications Union did not agree on a single standard, and on November 5, 1999 gave preliminary approval to five terrestrial radio interfaces including W-CDMA and cdma2000, which are expected to be the emerging standards in North America. IMT-2000's broadband capabilities and strong support for data transport mean that cell phones based on these standards are expected to carry significant Internet related traffic.

CDMA carriers such as Sprint PCS, GTE Wireless, AirTouch Cellular and U.S. West Wireless are expected to lead the way to the wireless Internet, with GSM carriers following. GSM's data technology exists and is in use elsewhere around the world but carriers in the U.S. are relatively new and are expected to devote their energy to building out their voice networks first. TDMA carriers such as AT&T Wireless are also expected to migrate to the higher data rates.

The path for existing CDMA carriers to reach cdma2000 is expected to be 1XRTT, which uses 1.25 megahertz of bandwidth and offers packet data and voice access speeds up to 144 Kbps. Upgrades to 1XRTT are expected to require relatively inexpensive channel cards and software enhancements. The next step for CDMA carriers is 3XRTT, which requires 5 MHz of bandwidth and enables 384 Kbps rates for mobile packet data, voice and video and 2 Mbps rates for fixed uses.

For GSM carriers, the path is expected to be through General Packet Radio Service, which has a 115 Kbps data rate as a data overlay to the voice network. Third generation for GSM carriers is W-CDMA, which provides 384 Kbps with full mobility and requires 5 MHz of bandwidth. Most GSM carriers are expected to go General Packet Radio Service, then to W-CDMA, since the latter does require a change of air interface. A third alternative is called Enhanced Data

Rates for Global Evolution, which provides the same 384 Kbps speed as W-CDMA but provides existing TDMA carriers a migration path to W-CDMA.

It is apparent that notwithstanding the development of appropriate air interfaces, be they CDMA, GSM or TDMA based, the uptake on wireless Internet services will likely be driven by applications. For example, time and location sensitive applications are expected to be the drivers of the wireless Internet world since wire line technologies do not address these issues well. Such applications are a good fit for the Corridor Plan since they include applications related to traffic conditions, directions, travel information and commercial transportation.

Although no one can today envision how the wireless Internet will be used, as was the case when the broader Internet became a reality a number of years ago, it is expected, as discussed earlier, that e-mail will take off as well as the ability to "pull" content off the Internet, such as travel information and location-sensitive data.

OTHER EMERGING WIRELESS SERVICES

Other wireless services of interest to the development of the Corridor Plan include Personal Communications Service (PCS), the Wireless Communications Service (WCS), the General Wireless Communications Service (GWCS), the 39 GHz service and the Location and Monitoring Service (LMS). These are discussed in the Task I Working Paper, with updates provided in this section as appropriate.

Personal Communications Service (PCS)

PCS encompasses a wide variety of emerging mobile and portable communications services. The PCS spectrum is divided into three broad categories, Broadband, Narrowband and Unlicensed.

Broadband PCS operates in the 2 GHz band of the electromagnetic spectrum with 120 MHz of spectrum assigned between 1850 and 1990 MHz. The spectrum is divided into six frequency blocks, half of which have a 30 MHz bandwidth and half a 10 MHz bandwidth. The system design for Broadband PCS system is similar to cellular, except that these systems operate exclusively in a digital format and are expected to use an entire family of new communications devices utilizing very small, lightweight, multi-function portable phones, portable facsimile and other imaging devices, new types of multi-function cordless phones, and advanced devices with two-way data capabilities.

A total of 3 MHz of spectrum has been allocated for Narrowband PCS. Narrowband PCS is expected to be used for advanced messaging and paging. Narrowband PCS operates in the 900 MHz band.

A total of 20 MHz of spectrum has been assigned for Unlicensed PCS. Unlicensed PCS is expected to be used for short-range communications such as local area networks in offices.

In the context of the Corridor Plan, PCS services may be expected to continue to deploy as an extension of current digital cellular service and eventually analog cellular. From 1995 to 1999, the FCC granted 1466 Broadband PCS licenses and 41 Narrowband national and regional licenses. Over 3,500 Narrowband licenses have yet to be auctioned.

Wireless Communications Service (WCS)

The WCS occupies the 2.3 GHz band of the electromagnetic spectrum. The channeling plan provides for four frequency blocks with two licenses per block in 128 markets. The service is defined to provide fixed, mobile, radio-location or satellite communication capable of providing more advanced wireless phone services. The WCS is expected to be used to provide a variety of mobile services similar to those expected to be provided by Broadband PCS. Licenses associated with the service were granted in July 1997. Similar to Broadband PCS, WCS services may be expected to deploy as an extension of current digital cellular service.

General Wireless Communications Service (GWCS)

The GWCS occupies the 4.6 GHz band of the electromagnetic spectrum. The channeling plan provides for five frequency blocks of 5 MHz each. A GWCS licensee may provide any fixed or mobile communications service except broadcast services (e.g. broadcast television and radio). Five licenses with ten year terms are expected to be awarded in each of the defined service areas following a spectrum auction whose date has yet to be announced. This service may develop in the future as another wireless alternative to wireline for access to advanced telecommunications capabilities.

39 GHz Service

The 39 GHz Service occupies the 38.6 to 40.0 GHz band of the spectrum. The channeling plan provides for fourteen frequency blocks of 50 MHz each. A 39 GHz licensee may provide fixed communications including point-to-point and point-to-multipoint communications. Twenty nine companies won 2,173 licenses in the recent FCC auction. This service may develop in the future as another wireless alternative to wireline for access to advanced telecommunications capabilities.

Location and Monitoring Service (LMS)

The LMS occupies the 904 to 928 MHz portion of the electromagnetic spectrum. The channeling plan provides for three frequency blocks ranging from 2 MHz to 6 MHz in bandwidth.

An LMS licensee may utilize the assigned spectrum, with non-voice radio techniques, to determine the location and status of mobile radio units. LMS systems are authorized to transmit status and instructional messages, either voice or non–voice, so long as they are related to the location or monitoring functions of the system.

One license for each of the frequency blocks were made available for auction in February 1999. Four small business bidders won licenses in a number of service areas. The FCC retains the remainder of the licenses. In the context of the Corridor Plan, LMS services may be used in the future to support commercial trucking operations or other location and monitoring transportation applications.

THE WIRELESS APPLICATION PROTOCOL (WAP)

Advanced wireless networks and services are considered a key emerging telecommunications technology associated with the development of the Internet in the future. These advanced networks are expected to rely on a number of emerging telecommunications standards that are now in the process of on-going development and initial deployment. One such standard is the WAP.

WAP is designed to support limited capability wireless devices such as cell phones and allow them to access the Internet for simple operations such as web browsing. It defines a service interworking approach whereby the normal Internet services are simplified for use with the wireless devices. End-user applications do not entirely reside in the wireless device (as would be the case for normal Internet end systems) but are rather distributed between the device and the wireless application gateway (WAP Gateway). Other competing standards exist, for example as offered by Pixo Inc, however WAP is viewed as the leader at this time.

The originators of WAP were Motorola, Nokia, Ericsson and the software company Phone.com (formerly Unwired Planet). Today the WAP forum members include 14 major telecommunications hardware manufacturers, 21 software manufacturers, 20 network operators, and five smartcard and data security firms.

WAP defines a special simplified version of HTML (HyperText Markup Language, the protocol used by web browsers to access the web), called WML (Wireless Markup Language), in order to minimize resource requirements imposed on the wireless device and to simplify the wireless network protocols needed.

The wireless device contains a micro-browser that makes simplified requests using WML to the WAP Gateway. The gateway then retrieves the information from an Internet server either in standard HTML format or preferably already prepared for wireless terminals using WML. The WAP Gateway translates the information as necessary into WML and forwards it to the wireless device using whatever wireless network services are most appropriate.

The importance of the WAP protocol specifications is that they permit software engineers and programmers to develop applications and services on the Internet for the wireless environment. WAP is expected to be the way people on the move will access information sources on the Internet using a mobile phone device. WAP Gateways will likely increase as more and more content and services are accessed through wireless networks.

The significance of WAP technology is that it facilitates the development of wireless Internet applications in areas of prime interest to the Corridor, notably related to traveler information services, commercial transportation applications and online services.

BLUETOOTH

Bluetooth is a proposed specification for short range (30 feet typical, 300 feet max), point-to-multipoint voice and data transfer. Currently specified for the 2.4 GHz band, Bluetooth supports up to eight devices on a piconet and is designed for networking with a bandwidth of 1 Mbps. Its promoters, which include Ericsson, Nokia, IBM, Toshiba, and Intel, believe Bluetooth could find application in phones, pagers, modems, Local Area Network (LAN) access devices, headsets, and portable computers.

Bluetooth Version 1.0 was published in 1999. Bluetooth Version 2.0 is expected to be released in 2001. The purpose of the Version 1.0 specification is to promote the development of inter-operable applications targeted at the highest priority usage models (discussed later) identified by the consortium marketing team. The specification is also expected to serve as a framework for further applications development.

The Bluetooth suite of protocols and specifications enable users to connect a wide range of computing and telecommunications devices easily and simply, without the need to buy, carry, or connect cables. It delivers opportunities for rapid ad hoc connections, and the possibility of automatic, unconscious, connections between devices. If widely adopted, it is expected to virtually eliminate the need to purchase additional or proprietary cabling to connect individual devices.

Bluetooth describes a set of high priority usage models. These include file transfer, Internet bridging, LAN Access, Synchronization and the Three In One Phone. The file transfer usage offers the ability to transfer data objects from one device (e.g., personal computer, smart-phone, or personal digital assistant) to another. Object types include, but are not limited to, .xls, .ppt, .wav, .jpg, and .doc files, entire folders or directories or streaming media formats. Also, this usage model offers a possibility to browse the contents of the folders on a remote device and simple push and exchange operations (e.g. business card exchange).

In the Internet Bridge usage model, a mobile phone or cordless modem acts as modem to the personal computer, providing dial-up networking and fax capabilities without the need for a physical connection to the personal computer.

In the LAN Access usage model, multiple data terminals use a LAN access point as a wireless connection to LAN. Once connected, the data terminals operate as if it they were connected to the LAN via dialup networking. The data terminals can access all of the services provided by the LAN.

The synchronization usage model provides a device-to-device (phone, personal digital assistant, personal computer, etc.) synchronization of personal information management, including address book, calendar, messages, and notes.

In the Three In One Phone usage model, telephone handsets built to this profile may connect to three different service providers. First, telephones may act as cordless phones connecting to the PSTN at home or the office and incurring a fixed line charge. Second, telephones can connect directly to other telephones for the purpose of acting as a "walkie-talkie" or handset extension. Referred to as the intercom scenario, the connection incurs no additional charge. Third, the telephone may act as a cellular phone connecting to the cellular infrastructure and incurring cellular charges.

In terms of the Corridor Plan, Bluetooth supports a future Internet rich environment and the proliferation of wireless communications over short distances. This would be expected to impact all of the Corridor applications discussed to date including traveler information, online services and commercial transportation.

It is notable that Motorola has recently released several new products using the Bluetooth wireless technology including a Bluetooth-enabled car kit that offers hands free wireless phone operation and a modem card that can be used for in a PC to provide a wireless link for the exchange of information.

We would also note that the Bluetooth Protocol Specification does leverage computing usage models using the WAP features discussed in the previous section. Bluetooth has been designed to reuse the upper software applications developed for the WAP Application Environment including WML and WAP browsers that can interact with applications on the personal computer.

INTELLIGENT TRANSPORTATION SYSTEM (ITS) SPECTRUM

As discussed in the Task I Working Paper, the FCC allocated 75 MHz of spectrum from 5.850 to 5.925 GHz for use by Dedicated Short Range Communications (DSRC) systems operating in the ITS radio service in late 1999. The rationale for the frequency allocation is that DSRC systems are being designed that require a short range wireless link to transfer information between vehicles and roadside systems. Communications are the backbone of most ITS systems and many saw a need for spectrum for reliable short range wireless communications links between vehicles traveling at highway speeds and roadside systems. Licensing, service and channeling plans for the service have yet to be developed, however, spectrum has been set aside for ITS applications.

ITS applications rely upon the integration of advanced communications systems and highway infrastructure systems. Communications are an essential component of the backbone of all ITS applications, which rely on the swift and accurate flow of information. While many ITS communications requirements may be met within the framework of existing and emerging wireless telecommunications systems discussed in the previous sections, it is apparent that development of DSRC systems may be a separate telecommunications element.

In the ITS spectrum assignment, short range communications of up to a mile are expected for typical application including Automated Roadside Safety Inspection and Automated Highway Systems where the roadside infrastructure would need to communicate with vehicles up to a mile away and may have to go around or through obstacles such as trees and buildings along a highway.

Current DSRC applications include Electronic Payment Services which allow cars to pay tolls automatically without stopping and Commercial Vehicle Electronic Clearance where commercial vehicle operators pass over weigh-in-motion sensors at inspection stations without stopping while the vehicle transmits relevant information such as credentials, size, weight, cargo, and safety information.

Emerging DSRC based services are expected to include:

- Traffic Control whereby traffic data is gathered from stationary traffic surveillance monitors and DSRC-equipped vehicles and uses the data to assign rights-of-way to certain vehicle types. Rights-of-way are assigned through the control of traffic signals, freeway ramps, reversible lanes, and information signs.

- Incident Management whereby roadway sensors and DSRC-equipped vehicles will allow incident management users to reduce congestion by accelerating incident detection and response time. The system can track cars as they travel to their destination and use the information to estimate traffic flow and detect incidents.

- En-Route Driver Information that provides drivers with real-time advisories about traffic conditions, accidents, construction and transit schedules.

- In-Vehicle Signing that displays information from roadside transmitters on video monitors or "heads-up" displays within the vehicle to provide the driver information pertinent to their specific circumstances based on their destination, surroundings and current activities. Information could include roadway conditions, alert drivers to railroad crossings, construction zones, fallen rocks, chemical spills, winding curves and other hazards. In-vehicle signing may also serve as the driver interface for many other DSRC-based applications.

- Driver Advisory that allows traffic managers to control the content of real-time and location-specific traffic advisory information.
- Automated Roadside Safety Inspection whereby DSRC would download information from a commercial vehicle's transponder memory about the driver, the vehicle (braking system and load distribution), the carrier and previous safety inspection, and upload inspection results to the transponder's memory. This function can increase the number of inspections while not increasing the number of inspectors or delaying commercial vehicle travel.
- Freight Mobility that allows dispatchers to locate and track commercial fleet vehicles, transit vehicles and their cargo, and re-route vehicles based on real-time traffic information. Allows fleet operators to optimize performance by enabling just-in-time pick-up and delivery, reducing driver hours sitting in congestion and waiting to deliver or receive goods, and automating cargo inventory and tracking systems.
- Automatic Equipment Monitoring whereby transponders on vehicles, trailers, rail cars, and cargo containers may be tracked, and information such as type and temperature of cargo, delivery schedule, and hazardous materials can be checked.
- Fleet Management Trip Log that downloads all DSRC events made during a trip into a log while the vehicle is stopped at a freight yard enabling fleet managers to determine the vehicle's route, time on the route and safety information.
- Highway-Rail Intersection whereby DSRC equipment can be used to trigger warning systems at railroad intersections when a train is approaching.

Standards activity in the ITS area is significant and addresses a number of issues including telecommunications. ITS standards are evolving. For example, as announced by Standards America, the Advanced Traveler Information Systems (ATIS) standards committee has begun work on developing an eXtensible Markup Language (XML) vocabulary for traveler information exchange which would build on the existing data dictionary and message sets and other related standards work. This type of work is equivalent to that done by the WAP Forum for WML as discussed in an earlier section.

One can conclude that notwithstanding the mode of wireless communications that will be used, there are many emerging applications that may benefit from related telecommunications infrastructure. Whether these applications are using digital cellular spectrum, ITS spectrum, PCS spectrum in combination with WAP, Bluetooth or other ITS technologies, the ultimate measure of success will be the extent to which applications are developed in the Corridor and the associated availability of suitable infrastructure.

THE WIRELESS LOCAL LOOP (WLL)

As outlines in the Task I Working Paper, wireless technology can be used to provide broadband access in the last mile, or local loop. The interest in the technology is that it may be more cost competitive than wireline for providing broadband access service in rural and remote areas.

Analysts with the Cellular Telecommunications Industry Association in a research report issued in late 1999, conclude that there are two critical drivers for the adoption of wireless for local loop applications. One is the cost advantage wireless offers compared with the cost of setting up a specific local wireline and the second is the recognition of a WLL provider as an Eligible Telecommunications Carrier for purposes of universal service and related subsidies.

Eligible Telecommunications Carrier Certification

In 1996, Congress added Section 214(e) to the Telecommunications Act, which promised to provide competitive opportunities to new service providers in local service markets across the United States. Congress provided that such new service providers would need to be certified as "Eligible Telecommunications Carriers" in order to offer universal service and receive subsidies. Pre 1996 providers of traditional wireline phone service were grandfathered as Eligible Telecommunications Carriers.

In its research report on WLL deployment the Cellular Telecommunications Industry Association implies that many state regulators are blocking wireless companies from providing universal service by not certifying these carriers as Eligible Telecommunications Carriers. They argue that it is a "catch 22" situation in that applications are denied because the companies do not already provide universal service throughout the state. Accordingly, Cellular Telecommunications Industry Association alleges that WLL providers are therefore denied the opportunity to compete with the Incumbent Local Exchange Carriers. If this is the case in the Corridor, CANAMEX state regulatory agencies should be approached to discuss the potential for the deployment of wireless access in rural and remote areas by certifying wireless service providers as Eligible Telecommunications Carriers.

The Task I Working Paper discussed the importance of certain nascent fixed wireless technologies such as Multichannel Multipoint Distribution Service (MMDS), Local Multipoint Distribution Service (LMDS) as well as emerging technologies such as GWCS and 39 GHz, for the development of broadband access in rural areas. Accordingly any of these alleged regulatory impediments to such fixed wireless deployments should be addressed by the state agencies.

WLL and Costs

The Cellular Telecommunications Industry Association Research Report also argues that wireless has significant advantages over wireline systems including both expenses and speed of deployment. The Research Report provides various cost comparisons between average wireless local loop costs and average wireline local loop costs. Data from 1996, as provided in the report, suggests costs of roughly $1,000 per line for rural wireless applications as compared to over $3,000 per line for rural wireline.

In terms of the Corridor Plan, these cost estimates reinforce the preliminary conclusion from the Task I Working Paper that a wireless solution for the rural last mile access environment may be more appropriate than a wireline approach.

Multichannel Multipoint Distribution Services (MMDS)

MMDS is associated with wireless spectrum blocks in the 2.1 to 2.7 GHz band. As discussed in the Task I Working Paper, a total of 33 channels, each with a 6 MHz bandwidth, are available. Often referred to as "wireless cable," the service was originally licensed to permit the delivery of video programming to subscribers through microwave transmitting and receiving antennas. The assigned channels were assigned to provide a multichannel video programming service similar to cable television.

MMDS spectrum, until recently, supported one-way transmission only. Accordingly, any offered data services required a wireline telephone return path. The FCC however ruled in favor of MMDS licensees being able to offer two-way digital services with the result that MMDS providers may now offer two-way high-speed data services.

In terms of a system's service overage, MMDS was originally intended to provide single-tower TV coverage over areas 30 to 35 miles in radius. However, it would appear logical to develop a cell based architecture for broadband access applications in order to boost a system's channel carriage capacity. This cell based approach could be achieved by reducing system transmitted power. Because the service depends upon line-of-sight microwave signals, natural and man-made terrain obstructions, such as trees and buildings, can disrupt the transmission of the signal.

The relevance of this technology to the Corridor Plan lies in the service's capacity to provide an alternative to wireline access to advanced telecommunications capabilities in rural areas. Using digital modulation and compression techniques in combination with the large per channel bandwidth, MMDS should be capable of offering maximum data rates well in excess of 1 Mbps for Internet access applications.

The MMDS market is not currently well developed in terms of data applications however is expected to provide for a viable access alternative in the future. In the Corridor states, American Telecasting offers MMDS video service in Montana and Nevada but does not currently offer Internet access in these service areas.

Sprint has also recently launched a two-way high speed data service in the Phoenix market under the brand name of Sprint Broadband Direct using MMDS technology originally marketed by SpeedChoice. The service addresses both residential and business users and offers download speeds of up to 5 Mbps and upload speeds to 512 Kbps. This appears to be Sprint's initial deployment of a broadband Internet access service since it acquired licenses from a number of other companies including Peoples Choice TV and Videotron USA.

Local Multipoint Distribution Service (LDMS)

LDMS operates in the 28 to 31 GHz band, representing 1.3 GHz of spectrum as discussed in the Task I Working Paper. LDMS is a service capable of offering subscribers one or two-way broadband services, such as video programming, wireless local loop telephony, and high speed Internet access.

A LDMS system consists of a multi cell distribution system with return path capability within the assigned spectrum. Generally each cell contains a centrally located transmitter hub, multiple transceivers and point to point links interconnecting the cell with a central processing center and other cells.

As with MMDS, the relevance of this technology to the Corridor Plan lies in the service's capacity to provide an alternative to wireline access to advanced telecommunications capabilities in rural areas. LDMS has recently developed into a viable solution for a number of carriers. The main technical advantage of LDMS over MMDS is the larger available bandwidth.

LDMS licensees include Winstar, Touch America (which is based in Montana) and HighSpeed.Com. In the Corridor, Touch America has licenses covering all of Montana and Idaho as well as partial coverage in North Central Utah outside Salt Lake City. Winstar advertises high capacity wireless broadband access in 45 markets nationwide under the Wireless Fiber brand and recently announced an agreement with Microsoft to provide Microsoft Office

2000 applications to its customers using its wireless and fiber networks. HighSpeed.Com offers high speed wireless access in Pocatello and Idaho Falls, Idaho.

Nextlink Communications is the largest holder of broadband fixed wireless spectrum, with FCC licenses in the 30 largest U.S. cities but has yet to deploy these wireless services. The company offers wireline based services in the Corridor in Phoenix, Salt Lake City, Provo and Las Vegas. One would therefore expect initial wireless deployments in those markets.

Teligent Inc. uses the 24 GHz portion of the spectrum to offers services in a number of markets including Phoenix, Tucson, Salt Lake and Las Vegas.

CONSIDERATIONS FOR THE FUTURE

Telecommunications Infrastructure in Support of Mobile Services

The effective deployment of Corridor applications that rely on mobile data telecommunications infrastructure support such as Traveler Information Systems, Commercial Transportation Applications and On Line Services are expected to require the deployment of third generation digital cellular networks with their attendant higher data throughput rates. Current data rates as supported by analog Advanced Mobile Phone Service (AMPS) networks are capped at 19.2 Kbps, which is not considered sufficient to address the development of mobile Internet applications. Third generation rates throughout the Corridor could be provided at 384 Kbps, a significant improvement in performance and a speed that is equivalent to today's medium speed fixed wireline capacities.

In addition, the continued penetration of Wireless Application Protocol (WAP) enabled cell phones and Internet Gateways will be required if the mobile users expect to deal with this information flow in a manner consistent with Internet browsing and Internet data transfers. The ubiquitous deployment of WAP Gateways would bring the Internet to the mobile user with no loss in perceived functionality.

Telecommunications Infrastructure in Support of ITS Services

The effective deployment of Corridor Intelligent Transportation System (ITS) applications are expected to require the deployment of Dedicated Short Range Communications (DSRC) systems operating in the ITS radio service.

While some ITS communications requirements may be met within the framework of existing and emerging cellular systems, it is expected that the deployment of DSRC systems will be required to ensure reliable short range wireless communications links between vehicles traveling at highway speeds and roadside systems.

Telecommunications Infrastructure in Support Last Mile Rural Broadband Access

The availability of rural "last mile" access to advanced telecommunications capability in the future is expected to rely in part on the deployment of Wireless Local Loop (WLL) technology such as Multichannel Multipoint Distribution Service (MMDS) and Local Multipoint Distribution Service (LMDS).

Such WLL technology deployment may be facilitated through certification of said WLL carriers as Eligible Telecommunications Carriers per the requirements of the 1996 Telecommunications Act. The Corridor Plan should review the status of WLL Carriers in the Corridor states with a view of facilitating the deployment of wireless technology in the rural areas.

Section III

EMERGING TRANSPORTATION TECHNOLOGIES AND CORRIDOR DEPLOYMENT

In this section, specific opportunities are defined using transportation technology applications (notably Intelligent Transportation Systems (ITS)) to improve mobility for persons, goods and information in the CANAMEX Corridor.

SUMMARY OF CURRENT ITS ACTIVITIES IN CORRIDOR

The Task I Report provided a brief overview of ITS and assessment of current activities. ITS applications are categorized as follows:

- Advanced Traffic Management Systems (ATMS)
- Advanced Traveler Information Systems (ATIS)
- Advanced Public Transportation Systems (APTS)
- Commercial Vehicle Operations (CVO)
- Advanced Vehicle Control and Safety Systems (AVCSS)
- Advanced Rural Transportation Systems (ARTS)
- Emergency Management Systems (EMS)
- Information Management Systems (IMS)

The new Federal Notices of Proposed Rulemaking (NPRM), dated May 2000, state that Federal funding for ITS programs requires the incorporation of ITS strategic planning activities into statewide and regional transportation plans. This planning process is followed by distinct system architecture development activities in order to map system functions and requirements to the National ITS Architecture framework. This is a prerequisite before further design and contract document activities occur. In several of the urban and rural areas in the Corridor (as well as for the Yellowstone National Park area in rural Wyoming/Montana/Idaho), ITS regional architectures have been developed. Currently, the level of connectivity between the different ITS architectures and activities in the Corridor has not been determined.

Several existing ITS initiatives are underway or have been completed within the CANAMEX Corridor. They can be classified as Urban Area ITS Activities or Intercity/Rural ITS Activities. Urban area activities in the Phoenix, Las Vegas, and Salt Lake City regions are in various stages of completion, with smaller scale activities occurring in the Tucson area. Specific urban area ITS activities are summarized in Table IV-1.

Intercity/rural activities in general have involved traveler information systems and commercial vehicle pre-clearance and administrative systems – generally implemented through public-private partnerships. Most activities to date have been in Arizona, though a number of proposed initiatives have been identified in other locations in the corridor. Rural and intercity ITS activities are summarized in Table IV-2.

Table IV-I

Urban Area ITS Activities in CANAMEX Corridor

Area	Traffic Management	Traveler Information	Public Transportation
Tucson, AZ	Real-time traffic monitoring (traffic sensors and video cameras, connected by fiber optics) along I-10 and I-19. Variable message signs along I-10 and I-19. ADOT freeway management system co-located at City of Tucson's Traffic Management Center with existing traffic signal system.	Metro Networks is serving as the private sector partner with the City of Tucson in developing a Regional Traveler Information Center that will coordinate dissemination of traffic information.	Public kiosks are being deployed to provide real-time and static transit information.
Phoenix, AZ	42 miles of freeways and eight major surface streets ("smart corridors") with cameras, traffic sensors, upgraded traffic signals, and electronic variable message signs, 200-mile fiber optic communication network.	Metro Networks and ETAK workstations in ADOT Traffic Operations Center, permitting traffic reporters to more quickly disseminate information to the public via radio and TV. ADOT supplies real-time information over web site. Personalized traffic reports and information services are being provided through a series of public-private partnering initiatives.	Automatic vehicle location systems using Global Positioning Systems (GPS) on over 90 transit vehicles providing real-time traffic condition updates and schedule information. Kiosks at transit centers provide bus route, schedule and traffic condition information.
Las Vegas, NV	Deployment of traffic sensors, CCTV cameras, ramp metering and variable message signs along freeway network (including I-15 and I-515), and integration with traffic signal systems along arterial routes. New regional traffic management center to be located at the regional Nevada Highway Patrol facility.	Includes implementation of data archiving functions to permit access to historical traffic data collected by the system, and a real-time traveler information dissemination capability to support media and public information needs.	

Table IV-I

Urban Area ITS Activities in CANAMEX Corridor

Area	Traffic Management	Traveler Information	Public Transportation
Salt Lake / Ogden / Provo, UT	Regional Traffic Operations Center (TOC) at UDOT's Region 2 offices, satellite operations centers for Salt Lake City and Salt Lake County traffic signals. 300 miles of fiber optic communications, variable message signs, closed circuit TV, arterial signal upgrades under the I-15 reconstruction effort. Video cameras installed both by UDOT and by local television stations to monitor operations for informational purposes.		

Table IV-2

Rural and Intercity ITS Activities in CANAMEX Corridor

State	ITS Planning and Architecture	Traveler Information	Incident Management
Arizona	A statewide ITS Early Deployment study is covering those areas not previously covered under prior Early Deployment Studies for the Phoenix and Tucson urban areas and the rural I-40 corridor.	Road Weather Information Systems (RWIS) locations that detect low visibility, icing and precipitation conditions, use of RWIS data in dissemination of statewide traveler information over the Internet. Traveler information services along I-40 include real-time weather, construction and incident information as well as traveler services information. Disseminated through the Internet as well at strategically-located kiosks.	Statewide incident management plan to establish consistent methods, procedures, responsibilities and communication channels among both the state-level agencies and local responders. Statewide Alternate Route Plan to provide route alternatives for all major rural highway segments during incidents, construction or weather-related closures.
Nevada	An I-80/US 395 Corridor ITS Strategic Master Plan is being developed from CA to UT state lines. In 1999 Nevada completed a Statewide ITS/CVO business plan.	25 Road Weather Information Systems (RWIS) locations have been deployed in the Reno/Lake Tahoe area (outside the CANAMEX Corridor area)	
Utah		Road Weather Information Systems (RWIS) locations that detect low visibility, icing and precipitation conditions, bridge de-icing systems; use of RWIS data in dissemination of statewide traveler information over the Internet.	
Idaho	Statewide ITS Strategic Plan developed. WTI developed Greater Yellowstone Rural ITS Priority Corridor plan involving Montana, Idaho and Wyoming and serving the Yellowstone and Grand Teton National Parks. Rural Regional Architecture has been developed.	Development of regional Traffic Management Center in Boise / Treasure valley area, road weather info systems, testing of emissions compliance measurement systems, limited variable message sign deployment.	

Table IV-2

Rural and Intercity ITS Activities in CANAMEX Corridor

State	ITS Planning and Architecture	Traveler Information	Incident Management
Montana	Statewide ITS Strategic Plan and ITS/CVO Business Plan developed. WTI developed Greater Yellowstone Rural ITS Priority Corridor plan involving Montana, Idaho and Wyoming and serving the Yellowstone and Grand Teton National Parks. Rural Regional Architecture has been developed.	Traveler Information Booths being developed by Montana Tourism and Recreation Initiative (MTRI), providing traveler services information on kiosks at tourist offices.	

MAPPING TECHNOLOGY APPLICATIONS TO CANAMEX CORRIDOR NEEDS

The CANAMEX Corridor plan contains a series of objectives that are common to all five Corridor states (and that have relevance to cross-border movement of people and goods as well). In addition, there are some state-specific needs that have been identified both through initial Study team reconnaissance as well as through the extensive public outreach effort completed to date.

Summary of Overall Corridor Plan Objectives

- Stimulate economic development and enhance economic opportunity in the communities traversed by the CANAMEX Corridor
- Provide safe and efficient movement of people, goods and services for the next 30 years
- Establish the Corridor as a leader in the innovative use of emerging technologies to accelerate economic development and sustain quality growth
- Enhance global competitiveness of the CANAMEX Corridor states
- Provide opportunities for the five CANAMEX states to present a "united front" for the purposes of project funding and support

Specialized Interests of Different States

- Increase access to technology and communications superhighway for all citizens and businesses (all states)
- Enhance air transportation and multi-modal linkages (all states)
- Create a goods movement route through the Corridor and a tourism route through the Corridor. (Arizona, Utah)
- Create truck friendly roadways and dedicated truck lanes in congested urban areas (Utah)
- Support "smart growth" strategies adopted at local and regional levels (Utah)
- Provide improved communications/information connectivity between eastern Idaho and Wasatch Front region of Utah (Utah and Idaho)
- Enhance preclearance and ITS activities along the Corridor and at border crossings (all states)

User Service Requirements

To define appropriate ITS activities, the first step in the process is to consider the appropriate User Services as defined in Exhibit 1. As defined by the National ITS Program Plan (FHWA - 1995, updated 1999), User Services represent the high-level functional requirements for ITS activities – identifying what the systems are to do.

The User Services are compared with the CANAMEX Goals and Objectives in Exhibit 2 as to their level of relevance (H = highly relevant, R = relevant, blank = low relevance). They were then clustered according to relevance with respect to the objectives listed above:

- KEY SERVICES: Relevant/highly relevant to 3 or more objectives
- SUPPORTING SERVICES: Relevant/highly relevant to fewer than 3 objectives

Some additional services not part of the National ITS Program Plan have been identified as key rural activities by FHWA as well as regional user services by various agencies. These include Road-Weather Information Service (RWIS) under category 1 (Travel and Transportation Management), Intermodal Center Coordination and Automated Border Crossing under category 5 (Commercial Vehicle Operations). Exhibit 3 illustrates the relevance of these services. RWIS was specifically identified under the Salt Lake Valley ITS Early Deployment Planning Study.

EXHIBIT 1. NATIONAL ITS USER SERVICES

1. Travel and Transportation Management

1-1. En-Route Driver Information
1-2. Route Guidance
1-3. Traveler Services Information
1-4. Traffic Control
1-5. Incident Management
1-6. Emissions Testing and Mitigation
1-7. Archived Data

3. Travel Demand Management

2-1. Demand Management and Operations
2-2. Pre-Trip Travel Information
2-4. Ride Matching and Reservation

3. Public Transportation Operations

3-1. Public Transportation Management
3-2. En-Route Transit Information
3-3. Personalized Public Transit
3-4. Public Travel Security

4. Electronic Payment

4-2. Electronic Payment Services

5. Commercial Vehicle Operations

5-1. Commercial Vehicle Electronic Clearance
5-2. Automated Roadside Safety Inspection
5-3. On-board Safety Monitoring
5-4. Commercial Vehicle Administrative Processes
5-5. Hazardous Materials Incident Response
5-6. Freight Mobility

6. Emergency Management

6-1. Emergency Notification and Personal Security
6-2. Emergency Vehicle Management

7. Advanced Vehicle Control and Safety Systems

7-1. Longitudinal Collision Avoidance
7-2. Lateral Collision Avoidance
7-3. Intersection Collision Avoidance
7-4. Vision Enhancement for Crash Avoidance
7-5. Safety Readiness
7-6. Pre-Crash Restraint Deployment
7-7. Automated Highway System

EXHIBIT 2. NATIONAL ITS USER SERVICES vs. CANAMEX OBJECTIVES

CANAMEX ITS OBJECTIVE / NATIONAL ITS USER SERVICE	1) Support access to employment and educational opportunities for citizens in the Corridor	2) Support economic viability and competitiveness in the Corridor	3) Provide safe and efficient movement of people, goods and services for the next 30 years	4) Promote coordination of information and operational activities between the Corridor states	5) Support more environmentally-friendly transportation activities	6) Create distinct CANAMEX tourism route	7) Create distinct CANAMEX commercial vehicle route
1. Travel and Transportation Management							
1-1. En-Route Driver Information			R	H		H	H
1-2. Route Guidance			R	R		H	H
1-3. Traveler Services Information		R				H	
1-4. Traffic Control			H				
1-5. Incident Management			H	H		R	R
1-6. Emissions Testing and Mitigation					H		
1-7. Archived Data			R	H		R	R
2. Travel Demand Management							
2-1. Demand Management and Operations			H	R	H	R	R
2-2. Pre-Trip Travel Information	R		H	H	R	H	H
2-3. Ride Matching and Reservation	H	R	R	R	R		
3. Public Transportation Operations							
3-1. Public Transportation Management	H	H	H	H	H		
3-2. En-Route Transit Information			R	R			
3-3. Personalizd Public Transit	H	R	R	R	H		
3-4. Public Travel Security	R	R	H				
4. Electronic Payment							
4-1. Electronic Payment Services		R					
5. Commercial Vehicle Operations							
5-1. Commercial Vehicle Electronic Clearance		H	H	H	R		H
5-2. Automated Roadside Safety Inspection		H	H	H	R		H
5-3. On-board Safety Monitoring		H	H	H			R
5-4. Commercial Vehicle Administrative Processes		H	H	H			R
5-5. Hazardous Materials Incident Response		H	H	H	H		R
5-6. Freight Mobility		H	H	H			H
6. Emergency Management							
6-1. Emergency Notification and Personal Security	R		H	R			
6-2. Emergency Vehicle Management			H	R			
7. Advanced Vehicle Control and Safety Systems							
7-1. Longitudinal Collision Avoidance			H				
7-2. Lateral Collision Avoidance			H				
7-3. Intersection Collision Avoidance			H				
7-4. Vision Enhancement for Crash Avoidance			H				
7-5. Safety Readiness			H				
7-6. Pre-Crash Restraint Deployment			H				
7-7. Automated Highway System	R	H	H	R			R

EXHIBIT 3. CORRIDOR-SPECIFIC ITS USER SERVICES vs. CANAMEX

CANAMEX ITS OBJECTIVE / CORRIDOR-SPECIFIC ITS USER SERVICE	1) Support access to employment and educational opportunities for citizens in the Corridor	2) Support economic viability and competitiveness in the Corridor	3) Provide safe and efficient movement of people, goods and services for the next 30 years	4) Promote coordination of information and operational activities between the Corridor states	5) Support more environmentally-friendly transportation activities	6) Create distinct CANAMEX tourism route	7) Create distinct CANAMEX commercial vehicle route
1. Travel and Transportation Management							
1-8 Road Weather Information System			H	H	R		
5. Commercial Vehicle Operations							
5-7. Intermodal Center Coordination		H	H	H	R		H
5-8. Automated Border Crossing		H	H	H	R		H

MATCHING OF TECHNOLOGY SERVICES WITH CORRIDOR OBJECTIVES

Key Services

The following summarizes key transportation technology services and their requirements relative to CANAMEX Corridor objectives. These requirements include the activities to be supported on a urban, rural, or Corridor-wide basis. Existing applications in the Corridor are described briefly. Finally, a suggested approach for deployment is identified. At this stage, specific services have not been identified for specific states or localities within the Corridor.

It is noted that these do not represent the programs for deployment – various elements of the User Services will be combined and incorporated into the eventual deployment programs, defined later in this Section.

1-1. En-Route Driver Information

RURAL: Provide incident, delay, construction, weather and road closure information along key highways in advance of decision points. Also provide parking and park access information in vicinity of national parks. Typical applications include Variable Message Signs (VMS) and Highway Advisory Radio (HAR).

URBAN: Provide incident, delay, construction, weather and road closure information along key highways and streets in advance of decision points. Provide special event information and rerouting to alternate streets. Typical applications include VMS and HAR.

CURRENT APPLICATIONS IN CORRIDOR: VMS implemented on urban area Interstate highways in Tucson, Phoenix and Salt Lake areas. Under construction in Las Vegas. Forms key function of ATMS activities. Arizona is installing 50 VMS in rural portions of the state and 30 kiosks have been deployed in Phoenix and rural portions of I-40.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: State DOT's or local operations entities should deploy VMS (and HAR where feasible or desirable) on CANAMEX Corridor highways ahead of key decision points (alternate routes, access to travel generators). Integrate information across state boundaries through connection of systems into Corridor Management function (physical or virtual). Such a facility may be integrated within existing urban TMC's (virtual Corridor Management Center approach) or accomplished through a dedicated multi-state center networked with the existing urban TMC's. A Corridor-wide ITS system architecture should be developed as a first step toward this deployment, leveraging from current Yellowstone and statewide ITS architecture studies in Utah, Montana and Arizona, as well as regional architectures in Salt Lake, Las Vegas, Phoenix and Tucson.

NATURE OF COMMUNICATION: Generally involves dedicated network infrastructure, including fiber optics (owned or leased), or long-range wireless communications.

1-2. Route Guidance

RURAL: Provide preferred route information for tourism access to national parks and attractions, based on geographical information, historical flow information, and real-time information such as incidents, congestion or weather conditions. Provide preferred route information for commercial vehicle routings based on geographical information, historical flow information, and real-time information such as incidents, congestion or weather conditions. Information may be disseminated through VMS (limited information) or via in-vehicle systems.

URBAN: Provide preferred route information based on access to specific points within urban area. Routing may be tailored for commuters, tourists or commercial traffic, based on geographical information, historical flow information, and real-time information such as incidents, congestion or weather conditions. Information may be disseminated through VMS (limited information) or via in-vehicle systems.

CURRENT APPLICATIONS IN CORRIDOR: Developed by private sector to date as autonomous (stand-alone) in-vehicle navigation tools. Limited experience in Los Angeles, Orlando, and Oakland County, Michigan with real-time dissemination of data to in-vehicle systems. More experience with this concept in Britain, Sweden, Germany and Japan.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Support development of industry standards for disseminating real-time data to in-vehicle devices. Main effort by public sector should be to provide consistent means throughout Corridor of delivering real-time information and advisories to private service providers, either through common interfaces from statewide and regional ATMS/ATIS centers or through coordination with one center for the Corridor. Main industry tools involve some form of wireless Internet access – some standards are in place but none are dominant at this time.

NATURE OF COMMUNICATIONS: Connectivity from information sources to service providers typically requires some dedicated channel, either via the Internet or direct connection (leased or owned). Connectivity to vehicles or personal systems requires the use of emerging wireless communication standards. These may include Wireless Application Protocol (WAP) or the emerging Wireless Mark-Up Language (WML) standards over wireless cellular networks as well as through some combination of trunk communications and wireless short-range links such as Bluetooth and Dedicated Short-Range Communications (DSRC) over the 5.8-5.9 GHz frequency.

1-5. Incident Management

RURAL: Provide improved access to emergency center or rescue services through full wireless telephone coverage in remote areas or through use of emergency roadside phones at reasonable intervals. Provide common cellular wireless numbers to report accidents or stalls along Corridor roads (e.g., 911 for reporting accidents/emergencies and 511 for traveler information), with state police call centers available to respond. Provide quick response teams for incidents, using service patrols on fixed beats near national parks, and located at convenient “stand-by” or “on-call” locations along other rural routes. Provide quick response to truck accidents using major clearance and clean-up vehicles. This service should ultimately be available 24 hours.

URBAN: Provide improved access to emergency center or rescue services through wireless telephone or through use of emergency roadside phones at reasonable intervals. Provide common cellular wireless numbers to report accidents or stalls along Corridor roads (e.g., 911 for reporting accidents/emergencies and 511 for traveler information), with state police call centers available to respond. Provide quick response teams for incidents, using service patrols on fixed beats. Provide quick response to truck accidents using major clearance and clean-up vehicles. This service should ultimately be available 24 hours.

CURRENT APPLICATIONS IN CORRIDOR: Salt Lake City and Phoenix areas already provide state police coordination with traffic management centers for incident response and clearance. This is being developed in Las Vegas as well.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Expand urban incident management schemes to rural and national park areas, either through: 1) expansion of urban system functions to include regional or statewide incident management functions, or 2) development of statewide or subregional travel/incident management centers. These also may be coordinated through a central Corridor clearinghouse, but may not be as efficient due to current state police infrastructure.

NATURE OF COMMUNICATIONS: Involves combination of wireless cellular voice communications (traveler to call center) as well as a dedicated network (Internet or Intranet) for connectivity between different public service and DOT partners. Tracking of individual service patrol vehicles is accomplished using wide-area wireless communications (data radio networks or wireless cellular) in combination with Global Positioning Systems (GPS).

1-8. Road Weather Information Service

RURAL and URBAN: Provide weather and pavement condition information to public and to state maintenance staffs through sharing of data with traveler information and traffic management systems. Data may be displayed as part of En-Route Information (Service 1-1) or Pre-Trip Information (Service 2-2) services and may support other activities as well.

CURRENT APPLICATIONS IN CORRIDOR: Existing weather station and pavement sensor installations located throughout each state, connected into central computers.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Increase number of devices depending on frequency of inclement conditions along specific Corridor route segments. Provide improved connectivity of information between states and integrate RWIS data into ATMS and ATIS activities.

NATURE OF COMMUNICATIONS: RWIS devices may be connected via point-to-point connections (leased line) to operations centers or connected across fiber trunk network depending on accessibility. Many “autonomous” sensor systems developed in Europe provide connectivity (via hard-wire phone cable) directly to a nearby VMS, which provides one of several pre-selected messages depending upon the measured condition (e.g., road icing).

2-1. Demand Management and Operations

RURAL: Provide access management to national parks and other attractions based on crowding or congestion conditions within the facility. This may include supporting remote parking facilities and the use of transit services to access park facilities or attractions. The ITS tools may involve messages on VMS in advance of decision points as well as parking management and traffic flow monitoring within the park itself in order to determine when demand management strategies are required to be instigated.

URBAN: Provide access management to key locales such as downtown areas or event centers based on congestion, incidents, or pollution levels. This access management may include traffic control and parking management services that permit high-occupancy vehicles to access specific zones while requiring other drivers to use parking facilities outside the demand management zone, and utilize public transit services to access the zone. May also be utilized to reroute commercial vehicles around congested zones during peak periods.

CURRENT APPLICATIONS IN CORRIDOR: High-Occupancy Vehicle (HOV) lanes being deployed in various locations in Salt Lake City and Phoenix areas. Some demand management will likely be required in Salt Lake City in conjunction with 2002 Winter Olympics

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Demand Management is typically a policy function, and needs to address the “full picture”. In other words, access to a specific area must be provided through some alternative means to private vehicles, such as public transit in combination with adequate outlying parking facilities. Likewise, if commercial vehicle access is restricted during certain times during the day, but the truck driver needs to make a delivery or a pick-up a shipment within the district, either adequate commercial vehicle parking or layover facilities are required (and correct advance traveler information provided). Otherwise, access privileges through automated commercial vehicle dispatch information (e.g., knowledge of destination within the restricted-access zone) must be provided. Demand management strategies are typically integrated with ATMS and ATIS applications for operational planning purposes.

NATURE OF COMMUNICATIONS: VMS, traffic and parking management sensors may be connected through point-to-point connections or incorporated within fiber optic communications network. Demand management is tied into traffic management and traveler information infrastructure as discussed in other User Services.

2-2. Pre-Trip Travel Information

RURAL: Provide information (text, map-based, video image) on national park parking, congestion, and various attractions in the Corridor. Provide information on current roadway construction, incidents and weather conditions along routes in the Corridor. May be provided as Internet web site, output to personal communications devices, or as a dial-up telephone service connected to real-time systems. May be in the form of an interactive kiosk at strategic locations in the Corridor, including rest areas, truck stops, national park entry and commercial facilities. Kiosks may be tailored to specific travel audience. Other pre-trip services for local residents may include transit information in rural areas.

URBAN: Provide information (text, map-based, video image) on traffic congestion, incidents, events, construction, public transit along routes in urban area. May be provided as Internet web site, output to personal communications devices, or as a dial-up telephone service connected to real-time systems. May be in the form of an interactive kiosk at strategic locations, including shopping malls, employment centers, multi-modal transit centers.

CURRENT APPLICATIONS IN CORRIDOR: Internet Web Sites provide video and congestion information in Phoenix and Salt Lake City through connections to ATMS information. ATIS is proposed for deployment in Salt Lake City for 2002 Winter Olympics, and is being expanded through a public-private partnership in Phoenix. I-40 corridor in Arizona is utilizing kiosks and a web site to provide real-time traffic and construction information along I-40. The Metro Phoenix area has many sources of travel information that range from kiosks and internet enabled phone services that provide traveler information. An effort to implement a 3-digit statewide traveler phone number 511 is underway in Arizona.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Integrate information across state boundaries through connection of systems into Corridor Management function (physical or virtual). Such a facility may be integrated within existing urban TMC's (virtual Corridor Management Center approach) or accomplished through a dedicated multi-state center networked with the existing urban TMC's. A Corridor-wide ITS system architecture should be developed as a first step toward this deployment, leveraging from current Yellowstone and statewide ITS architecture studies in Utah, Montana and Arizona, as well as regional architectures in Salt Lake, Las Vegas, Phoenix and Tucson. Support development of industry standards for disseminating real-time data to in-vehicle devices. Similar to en-route information and route guidance services, the key effort by public sector should be to provide a consistent means throughout the Corridor of delivering real-time information and advisories to private service providers. This would be either through common interfaces from statewide and regional ATMS/ATIS centers or through coordination with one center for the Corridor.

NATURE OF COMMUNICATIONS: Connectivity from information sources to service providers typically requires some dedicated channel, either via the Internet or direct connection (leased or owned). Connectivity to vehicles or personal systems requires the use of emerging wireless communication standards. These may include Wireless Application Protocol (WAP) or the emerging Wireless Mark-Up Language (WML) standards over wireless cellular networks as well as through some combination of trunk communications and wireless short-range links such as Bluetooth and Dedicated Short-Range Communications (DSRC) over the 5.8-5.9 GHz frequency.

2-3. Ride Matching and Reservation

RURAL: Facilitates arranging carpools for access to specific destinations; may be useful for providing access from isolated or poor communities to employment centers.

URBAN: Facilitates arranging carpools for access to specific destinations, supports Demand Management activities as well as improvements to traffic flow through increased use and efficiency of HOV lanes in lieu of mixed flow lanes.

CURRENT APPLICATIONS IN CORRIDOR: Various ridesharing cooperatives have been developed in major metropolitan areas, but have decreased in popularity as single-occupancy vehicle use has increased. Not especially suited to scattered-site employment activities, especially in regions such as Phoenix which are highly decentralized.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Is generally best-suited to rural areas or locales where the travelers have similar destinations. Generally involves development of a ride-sharing database accessible via the Internet or via a “rideshare hotline”.

NATURE OF COMMUNICATIONS: System typically takes advantage of existing communications infrastructure, including the Internet and public switched telephone networks.

3-1. Public Transportation Management

RURAL: Automated monitoring and dispatch of transit services in response to demand as well as scheduling needs. Facilitates “protection” of connections between different transit lines and services where there are transfers, may include bus loading and running time information.

CURRENT APPLICATIONS IN CORRIDOR: Automatic Vehicle Location (AVL) systems are being deployed in Salt Lake City and Phoenix to support information services for passengers. The Phoenix area’s Valley Transit system (which also includes AVL) is integrated within the regional AzTech ITS deployment program, permitting shared information between transportation agencies in the region.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Should be limited in locales with transit systems that require frequent transfers or where operations are schedule-dependent and information for passengers is needed at transfer points.

NATURE OF COMMUNICATIONS: Tracking of individual transit vehicles is accomplished using wide-area wireless communications (data radio networks or wireless cellular) in combination with Global Positioning Systems (GPS). Sharing of data and dissemination to other systems should use a wide-area agency-to-agency network, including the use of a fiber optic network. Dissemination to traveler information providers should use this network or a standard interface to an information provider, who can then provide the updated information to the public.

3-3. Personalized Public Transit

RURAL: Provide flexible transit routings to serve rural residents, focusing on access to jobs and shopping opportunities from remote communities in Corridor.

URBAN: Provide flexible transit routings to serve low-density suburban areas as well as paratransit customers for access to jobs and shopping activities.

CURRENT APPLICATIONS IN CORRIDOR: Paratransit activities in major urban areas.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Key focus would be on development of rural transit access opportunities focused on access to jobs and commercial. To monitor operations and provide real-time dispatch capability, these services should utilize similar technologies to Service 3-1, Public Transportation Management.

NATURE OF COMMUNICATIONS: Ride requests typically take advantage of existing communications infrastructure, including the Internet and public switched telephone networks.

Tracking of individual transit vehicles is accomplished using wide-area wireless communications (data radio networks or wireless cellular) in combination with Global Positioning Systems (GPS). Sharing of data and dissemination to other systems should use a wide-area agency-to-agency network, including the use of a fiber optic network. Dissemination to traveler information providers should use this network or a standard interface to an information provider, who can then provide the updated information to the public.

3-4. Public Travel Security

RURAL and URBAN: Provide security at transit and bus stations and parking facilities through cameras monitored by police as well as emergency phone systems (panic button activation)

CURRENT APPLICATIONS IN CORRIDOR: Often provided at universities to provide security for pedestrians walking around at night.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Should be deployed in coordination with Demand Management and expanded transit services associated with parking facilities external to national parks and attractions, as well as urban park-and-ride facilities.

NATURE OF COMMUNICATIONS: Cameras typically utilize wide bandwidth data channels – tie into fiber optics network or utilize digitized real-time video; phone services may be via direct fiber optic connection to call center or may use public-switched telephone network.

5-1. Commercial Vehicle Electronic Clearance

RURAL and URBAN: Enables transponder-equipped trucks and buses to have their safety status, credentials and weight checked at normal mainline travel speeds. Vehicles that are safe, legal, properly registered, meet legal weight requirements and have no outstanding citations may pass inspection facilities, weigh stations and ports of entry without stopping.

CURRENT APPLICATIONS IN CORRIDOR: Prepass and Norpass standards are utilized in Corridor. Montana, Arizona and Nevada utilize the Prepass system. In contrast, the Norpass standard is used in Utah, Idaho and Washington state as well as the Canadian province of British Columbia and soon, Alberta.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: CANAMEX Corridor stakeholders should strongly encourage and support national initiatives to create full interoperability between the Prepass and Norpass standards in order to permit delay-free freight operations throughout the Corridor, encouraging development and operation of intermodal freight and shipping facilities throughout Corridor that support commerce to and from Mexico and Canada. Deployment should also promote use of the same system in Mexico in order to reduce delays to and from Mexico, as well as stopping illegal or substandard commercial vehicles from entering the U.S. In addition, it is desirable to unify weight and clearance standards from each of the five states in order to assure that a vehicle legal in one state is legal in another and vice versa.

NATURE OF COMMUNICATIONS: Electronic clearance systems, while they may utilize different communication protocols and administrative schemes, utilize similar communications technology. Automatic Vehicle Identification (AVI) systems utilize vehicle transponders that communicate short-range data to and from roadside reader locations using Dedicated Short-range Communications (DSRC), relying upon a communications link of 5.8 to 5.9 gigahertz (GHz), which has also been set aside by the FCC as a dedicated ITS bandwidth. The details of this technology are presented in Section II. The AVI readers are connected to administrative facilities through the use of either point-to-point communications (leased) or using wide-area fiber optics networks, where installed for other applications.

5-2. Automated Roadside Safety Inspection

RURAL and URBAN: Permits real-time roadside access to safety performance records of carriers, vehicles and drivers, assisting in the stoppage of vehicles or drivers with safety records. It also permits automation of manual inspection processes via brake performance inspection and truck operational systems using in-vehicle sensors (see Service 5-3, On-Board Safety Monitoring).

CURRENT APPLICATIONS IN CORRIDOR: The national CVISN program (see Appendix) is developing a consistent system across state boundaries, utilizing the Safety and Fitness Electronic Records System (SAFER). INEEL has also been involved in automated safety testing research involving a demonstration at the East Boise port of entry in Idaho.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: There is a great deal of sensitivity by private carriers to this level of inspection activity, although the national CVISN program is encouraging compliance by trucking companies. The CANAMEX Corridor should coordinate with other states and the Federal government as well as private commercial carriers in any deployment of this system. Hazardous Materials (HAZMAT) carriers would be good initial candidates to utilize this system.

NATURE OF COMMUNICATIONS: Utilization of DSRC similar to Service 5-1 (Commercial Vehicle Electronic Clearance, along with on-vehicle diagnostic sensors using SAE-standard data bus architecture for communication of information. The diagnostic information required here is obtained and consolidated into messaging over DSRC, although this has not yet been implemented for the Norpass or Prepass systems.

5-3. On-board Safety Monitoring

ON-VEHICLE SYSTEM: Involves on-board systems to monitor operating systems of the truck, cargo and driver; including lights, engine, tires, brakes, cargo shifting, monitoring of driver operating time and alertness.

CURRENT APPLICATIONS IN CORRIDOR: Systems have been tested and are used for in-vehicle system monitoring.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Systems have been deployed by private sector, but would be required in order to support CVISN programs. As per the above, there is a great detail of trucking industry sensitivity to communicating truck sensor data to government-managed systems. HAZMAT carriers would be natural candidates for initial deployment of this system.

NATURE OF COMMUNICATIONS: Utilization of on-vehicle diagnostic sensors using SAE-standard data bus architecture for communication of information.

5-4. Commercial Vehicle Administrative Processes

RURAL and URBAN: Permits electronic purchasing of credentials, permits automated mileage and fuel reporting and auditing functions.

CURRENT APPLICATIONS IN CORRIDOR: Applications limited to electronic credential purchasing activities to date.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Develop, promote uniformity in state procedures for purchasing credentials, similar to promotion of consistency in tracking weight, safety and credentialing using AVI and DSRC technologies. Automated mileage and fuel reporting and auditing functions for preparing fuel tax and registration reports may be useful to carriers, but as with other commercial vehicle functions, there is some industry sensitivity to transferring trip-specific data electronically to the government. HAZMAT carriers would be good candidates for initial deployment.

NATURE OF COMMUNICATIONS: Would require connectivity of fueling facilities and odometers to administrative systems maintained by government agencies, using either DSRC technologies (readers would be connected via point-to-point communications with the monitoring center) or through networking of records at fuel stations with the monitoring center. Involves dedicated network (Internet or Intranet) for connectivity between different public service and DOT partners.

5-5. Hazardous Materials Incident Response

RURAL or URBAN: Would provide immediate description of hazardous materials following an incident and coordination of appropriate incident response strategies.

CURRENT APPLICATIONS IN CORRIDOR: Planned programs and current procedures in each state to handle HAZMAT activities.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Hazardous Materials carriers would be good candidates to deploy Services 5-2 through 5-4, which monitor operation and safety of specific vehicles and drivers. Through implementing those components, tracking of HAZMAT shipments could be done in a nearly continuous fashion, such that an incident would permit tracking of current location as well as actions taken that may have either caused the unsafe condition or vehicle conditions that may have been overlooked. This service should be coordinated heavily with Incident Management (Service 1-5).

NATURE OF COMMUNICATIONS: Utilization of DSRC similar to Service 5-1 (Commercial Vehicle Electronic Clearance), along with on-vehicle diagnostic sensors using SAE-standard data bus architecture for communication of information. The diagnostic information required here is obtained and consolidated into messaging over DSRC, although this has not yet been implemented for the Norpass or Prepass systems. Involves dedicated network (Internet or Intranet) for connectivity between different public service and DOT partners.

5-6. Freight Mobility

RURAL and URBAN: Permits communication between drivers, dispatchers and intermodal transportation providers. Provides private networks for sharing of information related to container pick up requirements – through integration with En-Route Driver Information Service (Service 1-1), permits real-time information to be provided to all interested parties in order to ascertain potential delays.

CURRENT APPLICATIONS IN CORRIDOR: Frequently deployed by private sector for management of trucking operations, typically using AVL/GPS technologies.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Encourage integration of private vehicle tracking systems with intermodal facility monitoring systems in order to coordinate pick-up or delivery of freight containers.

NATURE OF COMMUNICATIONS: Tracking of individual commercial vehicles is accomplished using wide-area wireless communications (data radio networks or wireless cellular) in combination with Global Positioning Systems (GPS). Sharing of data and dissemination between trucking companies and intermodal centers may utilize the internet or point-to-point connections (phone), or could be accomplished over a private intranet involving one or more shippers and intermodal facilities.

5-7 Intermodal Center Coordination

RURAL or URBAN: Permits the networking of intermodal facilities with utilizing the support activities associated with Services 5-1 and 5-4. For hazardous materials carriers, support activities associated with Services 5-2 and 5-3 are also utilized. This networking would permit credentialing and paperwork to be accomplished as a container is offloaded from one mode (e.g., rail) to another (e.g., truck).

CURRENT APPLICATIONS IN CORRIDOR: Intermodal centers are coordinating extent with individual shippers; currently, single-point services available through an intermodal center have not been deployed as there are two different standards for preclearance in the Corridor.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: A prototype International Trade Center facility should be identified at an intermodal trade location where rail and truck services meet. Eventually, most or all intermodal centers in the Corridor should be equipped to handle credentialing and administrative activities which will minimize delays for carriers, assure the proper fees are being collected, and, for hazardous materials, assure that their whereabouts and identification can be continuously tracked.

5-8 Automated Border Crossing

Combines Services 5-1 and 5-4 into applications for Border Crossings within CANAMEX Corridor.

6-1. Emergency Notification and Personal Security

RURAL or URBAN: Permits immediate notification of incidents and requests for assistance to emergency services.

CURRENT APPLICATIONS IN CORRIDOR: Private sector entities such as GM's OnStar and the Visteon system provide a clearinghouse of driver information and emergency "Mayday" activation when incidents occur (e.g., vehicle airbags deploy). The service providers, using the GPS data from the vehicles using the service, notify the appropriate emergency call center (police, other entity) regarding vehicle location.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Support private sector services through coordination between all states in Corridor and the various service providers. The private service providers need to have access to the same information for all states related to emergency response activities. It may be useful for a central Corridor function to exist that provides updates to the service providers related to any coordination activities and contact information.

NATURE OF COMMUNICATIONS: Systems use GPS coordinates for location and satellite communications for voice and data between vehicles and service providers

7-7. Automated Highway System

RURAL and URBAN: Provide fully-automated, hands-off environment for high-speed intercity travel

CURRENT APPLICATIONS IN CORRIDOR: None – demo in 1997 in San Diego successfully showed how an infrastructure-based solution could work.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: Automated Highway System (AHS) technologies have migrated into the Federal Intelligent Vehicle Initiative (IVI), which focuses on in-vehicle systems (see "Supporting Services" discussion below). At the same time, the potential opportunity for maximizing personal and freight transport efficiency through dedicated automated vehicle operations for trucks and intercity buses may have merit – particularly using dedicated lanes or rights-of-way in conjunction with the IVI technologies represented by User Services 7-1 through 7-6 as described below.

Supporting Services

As with key services, the requirements pertinent to CANAMEX objectives are defined as well in terms of urban or rural applications. Current activities within the Corridor are described as well. The lower relevance of these supporting services does not diminish their importance with respect to overall deployment of ITS in the Corridor. However, the applications demonstrated here typically are more limited in deployment (e.g., focused on urban areas), may already be in place based on local needs or issues, or may be implemented through means other than public sector initiatives. In the case of the 7-series services, these relate to AVCSS technologies that are typically developed as autonomous in-vehicle services provided by auto manufacturers or private system developers.

1-3. Traveler Services Information

Provides a business directory related to specific tourist or travel needs, e.g. hotels, restaurants, and hospitals. May be deployed as part of Pre-Trip Traveler Information Service through private sector partnering, and could reduce costs of providing all traveler information services in regions. Specific information could be localized depending on location in Corridor, or could be made available at all times over the Internet or upon request. Recommended for Private Sector deployment.

1-4. Traffic Control

Improvements in traffic operation on freeways and arterials (including real-time signal system coordination and traffic flow monitoring/ramp metering on freeways) should be carried out based on regional operational needs. This is occurring in the four largest metropolitan areas in the Corridor and should be implemented in smaller communities or corridors where congestion and traffic flow warrants this level of improvement. Should be deployed on a locally/regionally specific basis.

1-6. Emissions Testing and Mitigation

Provide information for monitoring air quality and developing air quality improvement strategies. This information will be increasingly necessary as Federal air quality standards tighten. It also serves as an input to the Demand Management and Operations process. This service, focused generally on urban areas, will involve expansion of local/regional systems.

3-2. En-Route Transit Information

This information is provided on board the transit vehicle and provides real-time information on connections, schedule and next stop. It is useful based on local/regional transit operational needs and is dependent upon deployment of Public Transportation Management systems such as AVL.

4-1. Electronic Payment Services

This service is relevant for electronic toll collection activities, electronic transit fare payment (using Smart Cards), and electronic parking system payment. Currently, no toll roads exist in the CANAMEX Corridor. Numerous different standards and technologies exist for electronic fare payment, including both swipe-action Smart Cards and contact-free proximity cards. These services are most appropriate for regions with extensive transit services such as Salt Lake City and Phoenix, but are useful for regular transit use in other regions as well. The need for these services should be determined at a local or regional level.

1-7. Archived Data

RURAL: Collection of traffic flow and classification data at strategic locations along Corridor routes may be archived for periods defined by the state DOT's for the purposes of planning roadway improvements, as well as to evaluate traffic and incident management actions, including route diversion and guidance. Collection of preclearance and weight data may also be used for planning and evaluation purposes. Location of data collection stations is based on the need to obtain information for specific roadway segments, and thus may not be located at regular intervals (e.g., ¼ mile to 1 mile) unless congestion is a frequent issue.

URBAN: Collection of traffic flow and classification data by the urban ATMS systems (typically at ¼ mile to 1 mile intervals) may be archived for periods defined by the state DOT's for the purposes of planning roadway improvements, as well as to evaluate traffic and incident management actions, developing modified response plans and traffic-responsive automated strategies, including advisory messages, route diversion and guidance. Collection of preclearance and weight data may also be used for planning and evaluation purposes.

CURRENT APPLICATIONS IN CORRIDOR: Generally involves use of count stations in rural areas that obtain accumulated data over user-defined periods, and are not "real-time" in nature, as well as collection of traffic flow data by urban ATMS activities. Phoenix is currently archiving data of 150 miles of arterials and 42 miles of freeway. An enhanced archive is currently being implemented.

SUGGESTED CORRIDOR DEPLOYMENT APPROACH: This approach can build on current data collection locations for rural and urban areas. For rural locations, development of full-time communication links and continuous data collection activities can permit automated data collection activities. Urban ATMS's typically have data collection and storage function. By developing a means of archiving, the data serves as a planning tool. The archiving of data may occur at the state DOT level, but may also be shared for the purposes of Corridor planning activities, especially for commercial vehicle operations.

NATURE OF COMMUNICATIONS: In rural areas, either connect data collection stations to a trunk fiber network used for other activities or through leased-line connections. Data sharing between agencies uses a dedicated network (Internet or Intranet) for connectivity between different DOT partners.

6-2. Emergency Vehicle Management

This service focuses on reducing the time for an emergency vehicle to arrive at an incident location, and typically involves coordination with traffic management systems (signal priority or pre-emption along emergency routes) as well as route guidance systems in the vehicle. The need for these services should be determined at a local or regional level.

7-1. Longitudinal Collision Avoidance

7-2. Lateral Collision Avoidance

7-3. Intersection Collision Avoidance

7-4. Vision Enhancement for Crash Avoidance

7-5. Safety Readiness

7-6. Pre-Crash Restraint Deployment

The above systems are being implemented through both private sector research and through USDOT-sponsored research as part of the IVI program as discussed above. Increased deployment of these systems will enhance safety in the Corridor and should be supported by the Coalition.

CANDIDATE TRANSPORTATION TECHNOLOGY PROGRAMS

As several of the User Services above have natural overlaps and interdependencies, it is most appropriate to consider consolidating the functions as needed to address specific areas of interest. Common themes that are apparent in review of the User Services above include:

- The need for some level of coordination for traveler information throughout the full Corridor, as well as data collection and analysis

- The need to unify interface and communications standards for commercial vehicle functions along with sharing of information for intermodal activities

- The need to provide expanded traffic and incident management and information functions for rural corridors and national park areas

- The need for improved data sharing to support intercity tourists and commercial vehicle operators. The I-95 Corridor Coalition in the northeastern U.S. has developed an initial data sharing system (the Information Exchange Network) involving the various state DOT's. That system is in the process of becoming a real-time system. Similarly, the Southern California Priority Corridor and the Gary-Chicago-Milwaukee Corridor have developed the Showcase and Gateway systems, respectively, to provide a similar multi-regional traveler information function. The CANAMEX Corridor provides a similar opportunity, with a greater emphasis on rural and National Park area travel information to be disseminated along with urban conditions in the region. *One of the first steps toward developing the programs defined below will be establishing a system architecture framework that incorporates the other system architecture programs and systems that have been implemented or are being developed.* Federal regulations require that "a regional ITS architecture shall be developed to guide the development of ITS projects and programs…for all ITS projects that are funded in whole or in part with the Highway Trust Fund". Thus a Corridor ITS architecture must be developed to comply with Federal requirements and to realize the benefits of integration, interoperability, and expandability, and risk reduction that were noted previously. Federal regulation are flexible with respect to which agency or agencies should lead the architecture development and be responsible for its maintenance.

CRITERIA FOR DEPLOYMENT

The criteria for deployment of various technology programs are dependent upon various needs as well as the commitment of the public sector to support the deployment of such programs, whether by the public or private sector. For example, rural management programs should be initially oriented to those corridors that do not have convenient private sector services, e.g., telephone access, repair services available. Likewise, the feasibility any public transportation programs oriented to bringing financially-challenged citizens closer to jobs will depend on the demographics as well as the ability of communities to attract these employers.

Finally, there are varying desires between the different states with regard to setting aside specific routes or corridors for truck operations. In urban areas such as Phoenix, there are major environmental and quality-of-life concerns involving construction of through limited-access routes that may have a truck focus. Conversely, Utah stakeholders have indicated an interest in dedicated truck routes through the Corridor.

Thus, development of dedicated corridors, while recommended below, may in fact involve a variety of tools, including dedicated truck lanes, truck roadways, preclearance technologies, automated ports of entry, or special signing indicating preferred truck routes. A "branded identity" for such a corridor is one tool to tie together the various approaches that may be taken throughout the corridor by the different states. At the same time, implementation of common standards for automated preclearance and administrative functions is highly recommended, using the CVISN framework as documented in the Appendix to this document.

CANAMEX Corridor Transportation Management And Information Network (MAIN)

This system would include the following elements:

- Data sharing and coordination between all five CANAMEX states for transportation planning purposes
- Traveler information database for real-time dissemination by private sector information providers as well as over Corridor Web Site. This includes connectivity to ATIS and ATMS activities in metropolitan regions as well as initiatives at National Parks and other attractions.
- Coordination of incident management activities across the five states as well as with Canada and Mexico.
- Coordination of commercial vehicle operations activities across the five states as well as with Canada and Mexico.
- Coordination of strategic operational strategies related to construction or rerouting activities that may involve multiple states (e.g., construction work on US 89 in northwest Arizona may have implications for travelers headed from Nevada to Arizona).

Components would include a communications network (either Internet based or a private network) tying together traffic management, emergency operations and commercial vehicle systems centers, and may include a "central" CANAMEX Management Center if deemed to be of value. The first step in developing this and other programs will be developing a Corridor system architecture that establishes the most cost-effective, institutionally acceptable and efficient transportation solutions.

CANAMEX Smart Tourist System

This system would create a "branded identity" for a route system throughout the CANAMEX Corridor that supports the needs of recreational travelers (tourists). Associated with this network would be traveler information services supported by the coordination activities in the MAIN program. The Smart Tourist program would support public-private partnering activities in order to provide tourist-oriented real-time information services at strategically-located kiosks at rest areas and tourist centers. ***It would also support emerging wireless Internet applications including in-vehicle and handheld devices.*** One means of defraying the cost of deployment will be through the integration of Traveler Services Information activities. Traveler information in general for the Smart Tourist would be provided over a CANAMEX traveler information web site.

Traveler information may include static and real-time information:

Examples of static information

- location of rest areas
- location of national parks and other landmarks
- international border crossings
- traveler services information (hotels, gas stations, restaurants, hospitals, etc.)
- hunting, fishing license information
- other traveler information

Examples of real-time information

- weather conditions (current and forecast)
- highway blockages and anticipated delays due to construction
- highway incidents and lane closures
- congestion locations
- National Park information (parking availability, shuttle services, road closures, and status of attractions)

Also included would be specific En-Route Information elements such as Variable Message Signs (VMS) and Highway Advisory Radio (HAR) that would support real-time information and demand management activities. Provision of parking facilities and transit shuttle services to and from National Parks and other Attractions would be supported through the Smart Tourist program. Interface with wireless Internet services would occur through support of industry standards

***CANAMEX* Smart Freight System**

The Smart Freight system would provide the mechanism to: 1) integrate and standardize state and provincial Commercial Vehicle administrative processes to the extent practicable, 2) support interoperability and integration with federal trade movement data systems, and 3) the availability of better traveler information and facilities for conducting electronic commerce and coordination between commercial carriers and intermodal facilities. It would also provide a "branded identity" that would also be expanded to physical travel routes for commercial vehicles throughout the Corridor.

The system is to provide service information oriented for commercial vehicle operators and motor carriers, either over the Web, at strategically located truck stop kiosks, or through in-vehicle systems that maybe implemented as a result of public-private partnerships.

Traveler information may include static and real-time information:

Examples of static information

- location of rest stops

- location of truck stops
- international crossing requirements and operating hours
- locations and facilities for conducting electronic commerce and processing of international shipments
- agriculture inspections facilities at border crossings
- information on obtaining permits
- other CVO service information.

Examples of real-time information

- weather conditions (current and forecast)
- highway blockages and anticipated delays due to construction
- highway incidents and lane closures

Included would be specific En-Route Information elements such as Variable Message Signs (VMS) and Highway Advisory Radio (HAR) that would support real-time information associated with commercial operations and advisories along Smart Freight corridors.

Hazardous Materials (HAZMAT) activities would be services through use of automated roadside inspection and vehicle tracking schemes that would permit states to track HAZMAT shipments. Those shipping companies would be required to set up a network connection between their vehicle tracking systems (or to procure them if not currently in place) and a standard geographic information standard throughout the Corridor.

International Trade Processing (ITP) Centers and Intermodal Centers would be incorporated into this network. In particular, the development of ITP Centers is to be encouraged by the CANAMEX Corridor as a method to reduce delays with respect to credentials and administrative processes, and will permit direct transportation of containers across international borders with reduced delay. Centers in strategic locations near railway terminals and intermodal interfaces should be identified for implementation.

To implement this effort, a comprehensive project plan should be developed that will help guide the stakeholders in the CANAMEX Corridor in deploying Smart Freight. This should be done in coordination with development of the Corridor ITS Architecture.

Rural Traveler Aid Network (RTAN)

For rural intercity corridors and major routes outside normal coverage areas for wireless phone service and vehicle repair activities, the following is to be accomplished:

- An initiative to encourage universal wireless coverage along these corridors
- Implementation of a single Corridor number for stalls, accidents or emergencies (*911, *511, or other easy-to-remember number that can also be displayed periodically on signs along the road). These would be connected to the pertinent statewide call center for police and emergency services and major incident and closure information would be provided to the MAIN system as described above for dissemination purposes.

- Emergency motorist aid phones at one-mile intervals where current pay phones or wireless service cannot be provided. These would be connected to statewide call centers for police and emergency services.
- A network of service patrols (either patrolling beats in the vicinity of national parks and attractions or strategically stationed along key rural routes) should be provided to assist with incident clearance and minor vehicle repairs.

Rural Region Smart Shuttle (RRSS)

This program will support access to jobs, commercial/retail activities, and facilities such as airports by residents of rural or isolated areas within the Corridor. The program will include demand-responsive transit services that are based on a "core travel route" but will travel off the core route to service ride requests. Ride requests will be supported through Internet and phone access. New buses/vans will be procured to support these services, which will be provided in areas that currently have limited or no public transportation activities. The vehicles will be tracked using AVL systems and GPS location technologies.

APPENDIX – GLOSSARY OF ACRONYMS USED IN SECTION II: EMERGING TELECOMMUNICATIONS TECHNOLOGIES

AMPS	Advanced Mobile Phone Services
ATIS	Advanced Traveler Information Systems
CDMA	Code Division Multiple Access
cdma2000	Proposed standard for the IMT-2000
CDPD	Cellular Digital Packed Data
CSCD	Circuit Switched Cellular Data
DSRC	Dedicated Short Range Communications
FM	Frequency Modulated
GSM	Global System for Mobile Communications
GWCS	General Wireless Communications Service
HTML	HyperText Markup Language
IMT-2000	Also called the Universal Mobile Telephone System
ITS	Intelligent Transportation Systems
LAN	Local Area Network
LMDS	Local Multipoint Distribution Service
LMS	Location and Monitoring Service
MMDS	Multichannel Multipoint Distribution Service
MTSO	Mobile Telephone Switching Office
PCS	Personal Communications Service
PSTN	Public Switched Telephone Network
RF	Radio Frequency
TDMA	Time Division Multiple Access
WAP	Wireless Application Protocol
W-CDMA	Proposed standard for the IMT-2000
WCS	Wireless Communication Service
WLL	Wireless Local Loop
WML	Wireless Markup Language
XML	eXtensible Markup Language