



Nebraska Statewide and District Operations Centers

Nebraska Department of Roads Statewide ITS Architecture

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LIST OF ACRONYMS

24/7	24 hours a day, 7 days a week
ADMS	Archived Data Management System
ANSI	American National Standards Institute
ARNG	Army National Guard
ASTM	American Society for Testing and Materials
ATIS	Advanced Traveler Information System
ATMS	Arterial Transportation Management System
CCTV	Closed-Circuit Television
CVO	Commercial Vehicle Operations
DMS	Dynamic Message Sign
DOC	District Operations Center
EIA	Electronic Industries Alliance
EMC	Emergency Management Center
EOC	Emergency Operations Center
FHWA	Federal Highway Administration
HAR	Highway Advisory Radio
HAZMAT	Hazardous Material
HLSD	High Level System Design
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Standards Organization
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
MCOC	Maintenance and Construction Operations Center
NDOR	Nebraska Department of Roads
NEMA	Nebraska Emergency Management Agency
NSP	Nebraska State Patrol
NTCIP	National Transportation Communications for ITS Protocol
O&M	Operations and Maintenance
SAE	Society of Automotive Engineers
SDO	Standards Development Organizations
STMF	Simple Transportation Management Framework
STMP	Simple Transportation Management Protocol
TEA-21	Transportation Equity Act for the 21 st Century
TCIP	Transit Communication Interface Profiles
TM	Traffic Management
TMC	Traffic Management Center
TMS	Transportation Management System
US	User Services
USDOT	United States Department of Transportation

1. INTRODUCTION

1.1 Report Summary

The National ITS Architecture provides a common framework for the planning, design, and integration of Intelligent Transportation Systems. The Architecture defines the functions that must be performed by components or subsystems (freeway surveillance system), where these functions reside (e.g., roadside, traffic management center, or in-vehicle), the interfaces and information flows between subsystems (e.g., video images, traffic volume data) and the communications requirements for the information flows in order to address the underlying user service requirements.

The National ITS Architecture, and specifically, the Nebraska Department of Roads Statewide ITS Architecture Document, is intended to serve as a “road map” to aid in the design and implementation of ITS deployed by the Nebraska Department of Roads, including all ITS field elements (e.g. cameras, dynamic message signs, traffic signals, road weather information systems) planned for deployment, and the eight District Operations Centers to be located throughout Nebraska. This Architecture helps the involved agencies determine how they fit into the “big picture” and how they can capitalize on existing and planned infrastructure. This document is intended to provide a solid foundation to guide the deployment of ITS throughout the state of Nebraska.

1.2 Report Contents

This report describes the process and results of developing the Nebraska Department of Roads Statewide ITS Architecture. This report contains a brief introduction to the National ITS Architecture, an overview of the Federal Highway Administration (FHWA) architecture requirements, and definitions for common terminology used in the report. More importantly, this report addresses the elements required in paragraph (d) of Section 940.9 of Part IV, Department of Transportation, Federal Highway Administration, 23 CFR Parts 655 and 940 Intelligent Transportation System Architecture and Standards; Final Rule. These include:

- Description of the region;
- Identification of participating agencies and other stakeholders;
- Operational Concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the Statewide ITS Architecture;
- Agreements required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operations of projects identified in the Statewide ITS architecture;
- System functional requirements;
- Interface requirements and information exchanges with planned and existing systems and subsystems (e.g., architecture interconnects and architecture flows);
- Identification of applicable ITS standards; and
- The sequence of projects required for implementation.

1.3 Methodology

On October 12, 2001, the U.S. Department of Transportation (USDOT) issued guidance on development of a regional ITS architecture through the document “Regional ITS Architecture Guidance: Developing, Using, and Maintaining an ITS Architecture for Your Region.” **Figure 1-1** summarizes the guidance provided by the USDOT.

The process used to develop the Nebraska Department of Roads Statewide ITS Architecture follows Steps 1 through 4 of the guidance. Steps 5 and 6 are designed to provide guidance upon the completion of the development of the Regional ITS Architecture.

Step 1, Get Started, of the guidance was completed in large part by NDOR TTG staff. NDOR TTG staff identified a preliminary list of relevant stakeholders, and organized a Task Force consisting of champions from ARNG, NEMA, NSP, and NDOR. The Task Force worked to identify a larger group of Stakeholders which were subsequently invited to a series of Stakeholder Workshops held in each of the NDOR Districts.

Step 2, Gather Data, was completed through the Stakeholder Workshops held in each of the NDOR Districts. The purpose of the workshops was two-fold; a) to review each agency’s ITS programs and equipment (both existing and planned) within the district area and b) to identify unmet needs that had not been defined previously. Eight district workshops and one statewide workshop were held. Over 500 stakeholders from state and local agencies were invited to attend, and approximately 170 stakeholders actively participated in the nine workshops.

The Stakeholder Workshops facilitated the completion of the ITS inventory for all of the NDOR Districts, the identification of ITS needs in the Region, the development of an operational concept and definition of functional requirements.

A summary of existing ITS inventory and ITS needs, as identified during the Stakeholder Workshops, is presented in the *Stakeholder Workshop Summary Document*, and is included in **Appendix G**. The Stakeholder Workshops encouraged a broad range of needs to be identified for Intelligent Transportation Systems throughout Nebraska. The leading needs identified included:

- Travel and Transportation Management;
- Maintenance and Construction Operations;
- Traveler Information; and
- Emergency Management.

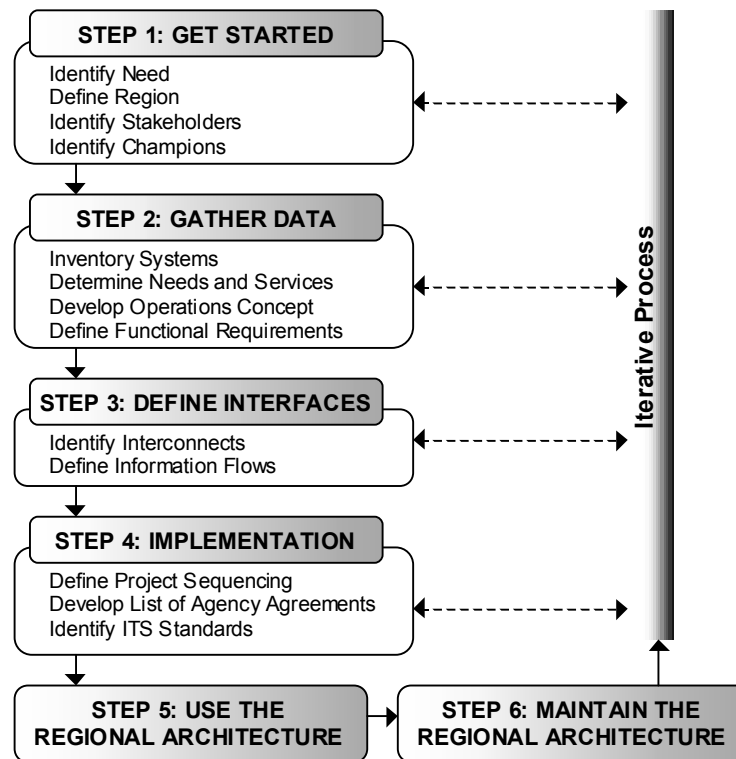
The above needs, as identified in the Stakeholder Workshops, were mapped to User Services of the National ITS Architecture, and are presented in the *Stakeholder User Requirements Document*. This document is included in **Appendix H**.

Following development of the *Stakeholder User Requirements Document*, the *Functional Requirements Document* was developed. The *Functional Requirements Document* contains a high-level description of the required functionality of each statewide ITS component, particularly as it relates to the District Operations Center system.

The *Stakeholder User Requirements Document* and the *Functional Requirements Document* served as inputs to the *NDOR Statewide Architecture Document*, providing for the identification of specific ITS elements that would satisfy the functional and user requirements, along with their appropriate counterpart in the National ITS Architecture.

Step 3, Define Interfaces, was completed by the Architecture Development team, under the direction of NDOR Transportation Technology Group staff. Market Packages for the Region were customized, which included identifying interconnects among elements in the architecture and reviewing and selecting data flows between elements.

Step 4, Implementation, was completed in cooperation with NDOR staff and the ITS Deployment Team. This final step of the architecture development included a logical grouping and phasing of projects to support deployment of the architecture. Applicable ITS standards to match the identified data flows also were identified



(Source: Regional ITS Architecture Guidance: Developing, Using, and Maintaining an ITS Architecture for Your Region, USDOT)

Figure 1-1 – USDOT Guidance on Regional ITS Architecture Development

A graphical representation of the NDOR Statewide ITS Architecture development is shown in **Figure 1-2**.

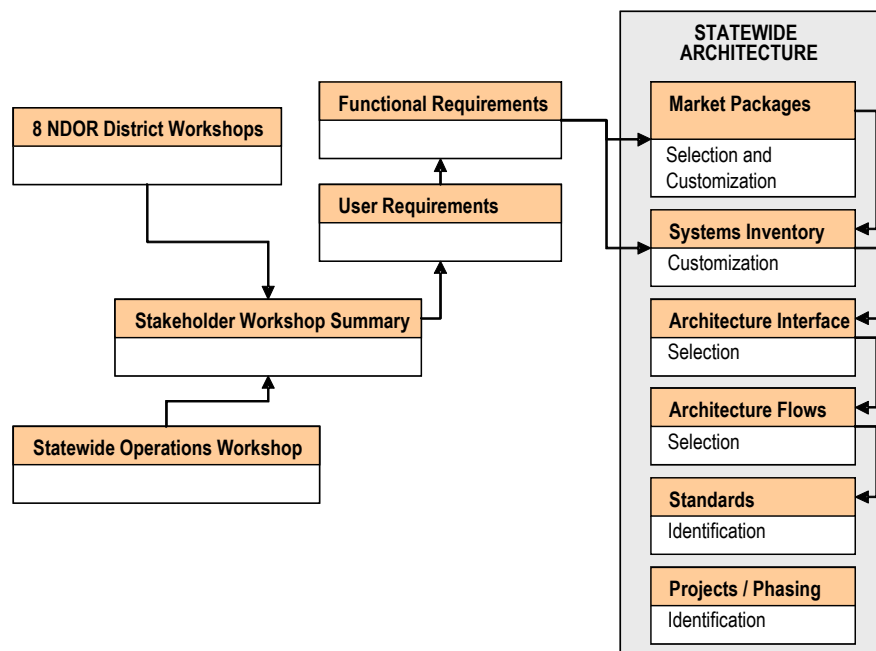


Figure 1-2 – NDOR ITS Architecture Development Process

1.4 History of the National ITS Architecture

In January 1996, FHWA Joint Programs Office completed the development of the National ITS Architecture. In January 2001, in an effort to foster regionally integrated transportation systems, FHWA published a Rule, and the Federal Transit Administration published a companion policy requiring that all ITS projects funded from the Highway Trust Fund be in conformance with the National ITS Architecture and appropriate standards. This Rule and Policy is hereafter referred to as the Rule/Policy.

The National ITS Architecture provides a common structure for the design of ITS systems, defining the functions that could be performed to satisfy user requirements and explaining how various elements of the system might connect to share information. The Architecture describes in detail what types of common interconnections should exist between ITS components and how they will exchange information and work together to deliver the given user service requirements. The National ITS Architecture identifies interconnections where standards may apply, leading to system interoperability.

In summary, the National ITS Architecture is intended to serve as a “road map” to aid in the design and implementation of ITS projects. The Architecture helps the involved agencies determine how they fit into the “big picture”, and how they can capitalize on existing and planned infrastructure. The Architecture will also help concerned agencies to avoid duplication of efforts and projects.

1.5 National ITS Architecture Conformance Requirements

The Rule/Policy implements section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21), which requires the development of a regional ITS architecture to guide the development of ITS projects and programs. The National ITS Architecture should be used as a

resource in the development of the regional ITS Architecture. **Table 1-1** presents the requirements of a regional ITS architecture as outlined in the Rule/Policy, and the section of this report that fulfills the requirement.

Table 1-1 – Rule/Policy Requirement and Relevant Section of Report

Rule/ Policy Section Number	Rule/Policy Requirement	Relevant Section of Report that satisfies Rule/Policy requirement
§940.9 d(1)	A description of the region	Section 2.1 – Description of Region
§940.9 d(2)	Identification of participating agencies and other stakeholders	Section 3 – Identification of Stakeholders and ITS Inventory
§940.9 d(3)	An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture	Section 5 – Operational Concept
§940.9 d(4)	Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture	Section 8.3 – Required Inter-Agency Agreements
§940.9 d(5)	System functional requirements	Section 6 – Functional Requirements
§940.9 d(6)	Interface requirements and information exchanges with planned and existing systems and subsystems	Section 7.3 – Customized Market Packages Section 7.4 – Architecture Interconnects Section 7.5 –Architecture Flows
§940.9 d(7)	Identification of ITS standards supporting regional and national interoperability	Section 9 – Standards
§940.9 d(8)	The sequence of projects required for implementation	Section 8.2 – Project Sequencing
§940.9 f	The agencies and other stakeholders participating in the development of the regional ITS architecture shall develop and implement procedures and responsibilities for maintaining it, as needs evolve within the region	Section 10 – Statewide Architecture Maintenance

1.6 Common Architecture Definitions

The National ITS Architecture provides a common framework for planning, defining, and integrating Intelligent Transportation Systems. Specifically, the Architecture describes how the various components fit together and interact with each other to make a system work. It defines the functions that will be performed by the system, the subsystems where those functions reside, the information flows between them, and the communications requirements for the information flows.

The Architecture is not a project design. Several different designs or implementations can fit within the same architecture. The Architecture defines the framework and functionality, while a design defines the specific plans for implementation. The Architecture provides the ability to accommodate inevitable technology changes, evolution, and growth of the system. Rather than installing technologies and implementing systems in a piecemeal fashion, it is important to have a plan and a framework in which the various systems will be designed and integrated.

The National ITS Architecture consists of a *logical component* and a *physical component*.

1.6.1 Logical Architecture

The **logical architecture** focuses on the functions to be performed by the system. The *Functional Requirements* document provides in-depth detail of the functions and processes to be performed by systems in the NDOR ITS Architecture.

1.6.2 Physical Architecture

The **physical architecture** focuses on the physical entities of the system, defining the functions that each entity performs to satisfy the user requirements outlined in the logical architecture. The physical architecture provides agencies with a physical representation (though not a detailed design) of the important ITS interconnections and major system components.

The principal elements in the physical architecture are the subsystems (processing centers, roadside equipment, vehicle equipment, and other equipment used by the traveler to access ITS services), and the associated information, or architecture flows, that connect these subsystems. The physical architecture takes the processes identified in the logical architecture and assigns them to subsystems.

1.6.3 Subsystems

Subsystems are individual elements of ITS. They correspond to physical world entities such as traffic operations centers, automobiles, and roadside signal controllers. Subsystems of the physical architecture are divided into four categories, which can be further broken down and deployed individually or incrementally depending on technology choices and project phasing strategies.

- **Center Subsystems** – These are public or private agencies responsible for administering, managing, or planning transportation-related functions (i.e., traffic management centers, police and emergency dispatch, transit management centers, private information service providers, etc.).
- **Roadside Subsystems** – These subsystems include sensors, signals, programmable signs, and other infrastructure located within or along the roadside. Subsystems communicate with or gather information from vehicles (i.e., dynamic message signs [DMS], traffic control devices, closed-circuit television [CCTV] cameras, toll collection facilities, etc.).
- **Vehicle Subsystems** – These subsystems are installed in the vehicles ranging from buses to personal, commercial, or emergency vehicles. The vehicle subsystems receive information and send data back to transportation management/dispatch centers. In-vehicle route guidance and other signage are included as part of these subsystems.
- **Traveler Subsystems** – These are the platforms from which travelers access information. These subsystems include kiosks, personal computers, cellular phones, etc.

Figure 1-3 shows the National ITS Architecture subsystems. This figure, also known as the “Sausage Diagram” is a standard interconnect diagram, showing the relationships of the various subsystems within the Architecture. Communication functions between the subsystems are represented in the ovals. It should be noted that “wireline” communication refers to fixed-point to fixed-point communications, which include not only twisted pair and fiber optic technologies but also wireless technologies such as microwave and spread spectrum.

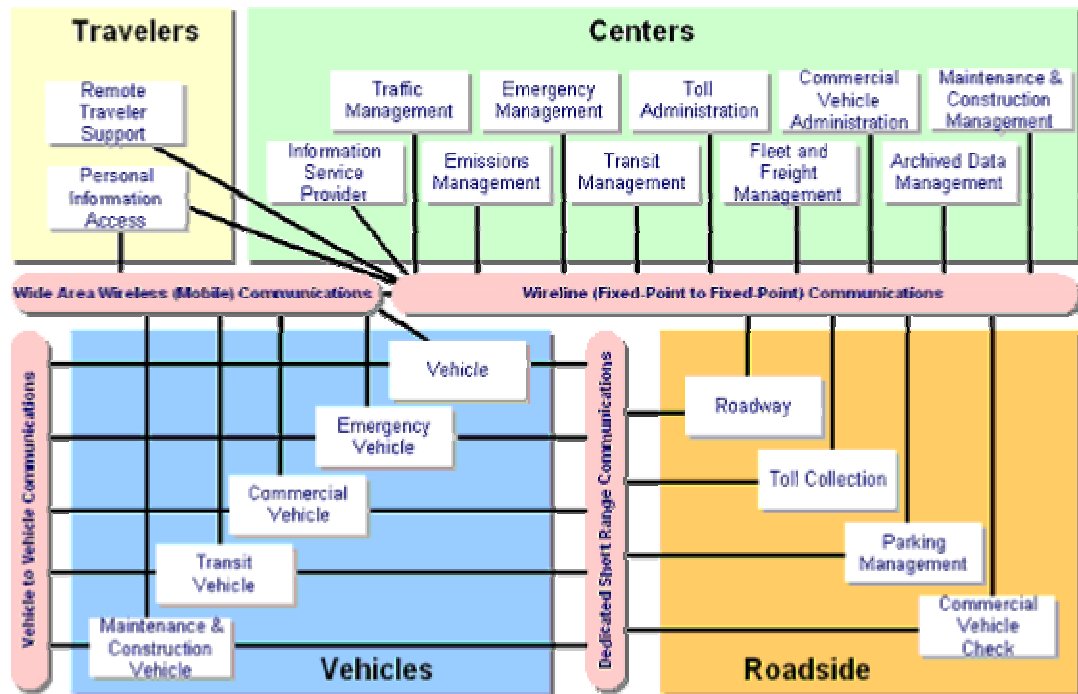


Figure 1-3 – National ITS Architecture Interconnect Diagram, or “Sausage Diagram”
Source: <http://itsarch.iteris.com/itsarch/html/entity/paents.htm>

1.6.4 Terminators

Terminators are the people, systems, other facilities, and environmental conditions outside of ITS that need to communicate or interconnect with ITS subsystems. Terminators define the boundary, or limits of the architecture. The National ITS Architecture terminators represent the people, systems, and general environment that interconnect to ITS. The interconnections between terminators and the subsystems within the National ITS Architecture are defined, but no functional requirements are allocated to terminators.

1.6.5 Architecture Interconnects

Architecture interconnects are the communications paths that carry information between subsystems and terminators in the physical architecture view of the National ITS Architecture. Several different types of interconnects are defined in the National ITS Architecture to reflect the range of interface requirements in ITS. The majority of the interconnects are various types of communication links that are defined in the

communications layer. Four different types of communications links are defined: wireline communications, wide area wireless communications, dedicated short-range communications, and vehicle-to-vehicle communications. In addition to these types, several specialized interconnects also are defined to reflect other interface requirements. These include human interfaces (e.g., what the system user sees and hears) and physical/environmental interfaces (e.g., what the ITS sensors sense).

1.6.6 User Services

User services document what ITS should do from the user's perspective. A broad range of users are considered, including the traveling public as well as many different types of system operators. User services, including the corresponding user service requirements, form the basis for the National ITS Architecture development effort. The initial user services were jointly defined by the United States Department of Transportation (USDOT) and ITS America with significant stakeholder input and documented in the National Program Plan. The concept of user services allows system or project definition to begin by establishing the high-level services that will be provided to address identified problems and needs. New or updated user services have been and will continue to be incorporated in the National ITS Architecture over time. There are currently 32 different user services.

1.6.7 Market Packages

Market Packages identify the elements of the physical architecture that are required to implement a particular transportation service. They provide a service-oriented perspective to real world transportation problems and needs. Market Packages combine one or more systems or equipment packages that must work together to deliver a given transportation service. Market Packages define the information flows that connect the systems with each other and with other important external systems. There are currently 70 Market Packages. Market Packages can be mapped to User Services, as explained in Section 4.3.

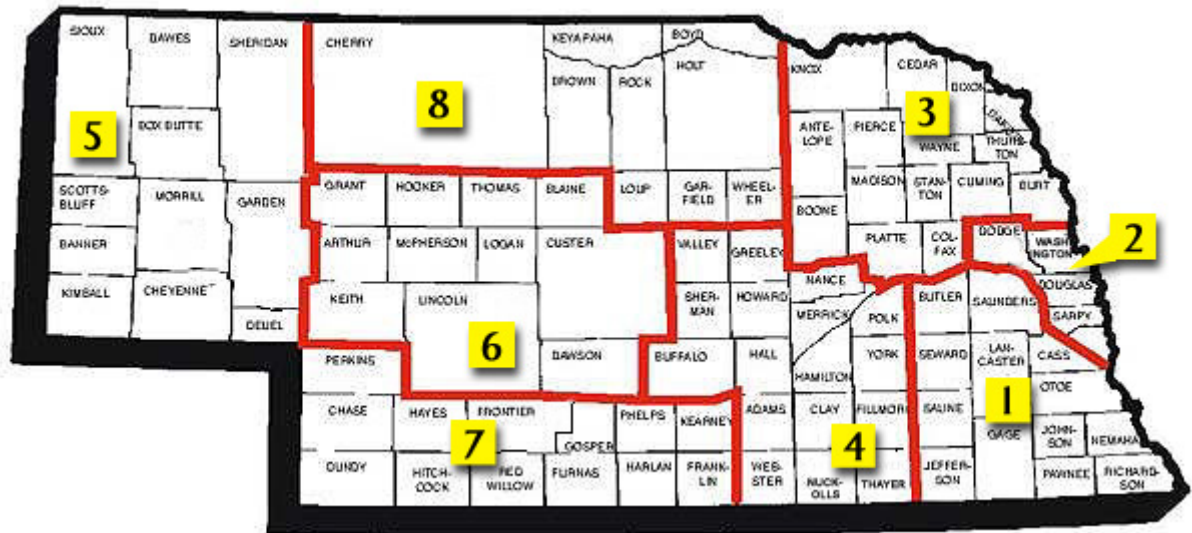
2. SCOPE OF ARCHITECTURE

This section includes a definition of the geographic region, the range of services provided, and the timeframe that the architecture covers.

2.1 Description of Region

The state of Nebraska is located in the upper Great Plains region of the United States. Nebraska is bordered to the east by Missouri and Iowa, to the south by Kansas and Colorado, to the west by Wyoming, and to the north by South Dakota.

The region, as defined by this Regional Architecture, encompasses the entire state of Nebraska. Specifically, the region includes each of the eight NDOR Districts. A map of the state of Nebraska with each of the NDOR districts identified is shown in **Figure 2-1**.



Source: Nebraska Department of Roads. <http://www.nebraskatransportation.org/admin/engineers.htm>

Figure 2-1 – State of Nebraska and NDOR Districts

The state of Nebraska is predominantly rural in nature, with the Cities of Omaha and Lincoln serving as the major population centers in the state. Interstate 80 is a key link for inter- and intra-state movement of people and goods. In Nebraska, I-80 extends from the Iowa/Nebraska border, through the City of Omaha and the City of Lincoln and west nearly 400 miles to the Wyoming/Nebraska state line. This corridor is not only a primary east-west route through Nebraska, but is also a key connector for several other major routes in the area. Incidents, hazardous weather conditions, or major delays along I-80 will impact several other routes, and potentially I-80 motorists in neighboring states. There are also long stretches of this corridor through the Region that are not convenient to any alternate routes. Nebraska also has a significant amount of railroad traffic as Omaha, Nebraska is the corporate headquarters of the Union Pacific Railroad.

In 1998, the State of Nebraska completed a statewide intelligent transportation system (ITS) strategic plan identifying projects for the purpose of improving the safety, mobility, security, and the economic well being of the people of Nebraska. The plan presented a long-term vision for ITS projects and identified the need for a near-term implementation of a statewide operations center, and It was envisioned that this operations center would provide the foundation for an integrated deployment of ITS throughout Nebraska and serve as the central hub in the data collection, processing, aggregation, monitoring, storage and dissemination of data and information necessary to achieve effective and coordinated statewide management of transportation facilities.

In the fall of 2001, the Nebraska Department of Roads (NDOR) embarked on the implementation of the statewide operations center. The statewide operations center concept would implement a facility 24/7 facility located in Omaha, with significant cooperation with NSP. Other stakeholders, including the Nebraska Army National Guard and the Nebraska Emergency Management Agency would utilize ITS systems implemented at the statewide operations center.

With this initial planning and design of the Statewide Operations Center in place, there is a foundation for continued ITS deployment and integration throughout the state.

2.2 Range of Services Provided

The process of developing a regional ITS architecture begins with defining the region for which the ITS architecture pertains. The geographic scope of the region should be established so that it encompasses [the] systems that should be integrated together (1).

Many different types of “regions” can be defined for a regional ITS architecture. Nationally, architectures have been developed for the following types of geographic areas (1):

- One or more counties or equivalent state political subdivisions;
- One or more municipalities (e.g. cities, townships);
- State DOT Districts;
- Metropolitan Planning Areas;
- A corridor (Thruway or Turnpike);
- One or more states; and
- A specific “service region”.

The last category, a “service region”, is defined by a particular service or group of services. The service region may have a specific scope of ITS services; for example, a larger regional ITS architecture that focuses on traveler information (1). This is the approach that has been followed in the development of the NDOR Statewide ITS Architecture, with the services being those ITS services that are provided by the Nebraska Department of Roads. These include:

- Traffic Management;
- Travel Information;
- Incident Management; and
- Maintenance and Construction Management.

2.3 NDOR Statewide ITS Architecture Time Horizon

The NDOR Statewide Architecture is anticipated to meet the needs of NDOR over the next 15 plus years with routine updates to reflect recent project-related implementation.

2.4 Scope of Architecture

The NDOR Statewide ITS Architecture focuses on traffic management, traveler information, incident management, and maintenance and construction management services expected to be provided by NDOR and its primary partners. As such, a comprehensive ITS Architecture for transit services and commercial vehicle operations is not included in this architecture. This section contains an explanation of the scope of the NDOR Statewide ITS Architecture with respect to transit services and commercial vehicle operations. Explanation is also given of the role of the metropolitan planning organizations with the NDOR Statewide ITS Architecture.

2.4.1 Transit Agencies

The City of Omaha and the City of Lincoln each operate transit agencies within their respective jurisdictions. While some of the interfaces with these transit agencies are depicted in the architecture, the interfaces are limited to the information transfer between the transit agency and the Nebraska Department of Roads. It is anticipated that the Omaha and Lincoln Regional Architectures that will be developed will include the full set of transit functions within their respective areas.

2.4.2 Commercial Vehicle Operations

The NDOR Statewide ITS Architecture contains limited interfaces with Commercial Vehicle Operations (CVO). The depiction of commercial vehicle operations in the Architecture is limited to those interfaces with the Nebraska Department of Roads. A separate architecture was developed by a partnership of NDOR, Nebraska State Patrol Carrier Enforcement Division, Nebraska Department of Motor Vehicles, and the Nebraska Motor Carriers Association. A full depiction of commercial vehicle operations can be found in the *Nebraska ITS/CVO Business Plan*, developed in August 1998.

2.4.3 Metropolitan Planning Organizations

The Metropolitan Planning Organizations (MPO) in Nebraska are the Metropolitan Area Planning Agency (for Omaha) and the City Lincoln (designated MPO for City of Lincoln and Lancaster County). These agencies participated in the stakeholder workshops held in the spring of 2002.

Each of these agencies is in the early stages of developing a regional ITS architecture. It is anticipated that upon completion of the architectures for these two agencies, they will be included in the NDOR Statewide ITS Architecture. NDOR will take responsibility for the integrating of statewide elements of the Omaha and Lincoln regional architectures with the NDOR Statewide ITS Architecture.

3. IDENTIFICATION OF STAKEHOLDERS AND ITS INVENTORY

Stakeholders represent the key players with ITS systems in the region. It is important that a range of stakeholders that represent the range of transportation activities within the region participate in the Architecture development. This section provides a summary of the stakeholders that own or operate statewide ITS systems, or that have an interest in statewide ITS operations.

3.1 Stakeholder Identification and Involvement

An integral aspect in the development of the Nebraska Statewide ITS Architecture includes involvement and input from individuals from participating organizations and entities throughout Nebraska.

To engage a variety of stakeholders, a statewide task force was created with participants from NDOR, NSP, ARNG, NEMA, DAS-DOC, and FHWA. In an effort to obtain a statewide multi-agency perspective of Nebraska's ITS needs, a more expansive Stakeholder Committee was created with individuals from organizations and entities from throughout the state. Over 500 potential stakeholders were identified to participate in the initial planning and needs assessment process. Coordination with the identified stakeholders was necessary to build broad consensus, obtain feedback on important issues, and identify specific operational needs. Following are the organizations/entities that are represented within the Stakeholder Committee:

- Adams County;
- Aeronautics;
- Buffalo County;
- City of Grand Island;
- City of Hastings;
- City of Lincoln;
- City of Norfolk;
- City of North Platte;
- City of Omaha;
- City of York;
- Civil Defense;
- Dawes County;
- Dawson County;
- Federal Highway Administration;
- Furnas County Emergency Manager;
- Grand Island Police Department;
- Health and Human Services (HHS);
- Lincoln County;
- Metropolitan Area Planning Agency (MAPA);
- Morrell County;
- Nebraska Army National Guard;
- Nebraska Department of Roads;
- Nebraska Emergency Management Agency;
- Nebraska Game and Parks;
- Nebraska State Patrol;
- Niobrara River Council;
- North Central Development Center;
- National Weather Service;
- Omaha Fire Department;
- Omaha Police Department;
- Phelps County Emergency Manager;
- Region 21 Emergency Management;
- Sarpy County; and
- Scottsbluff County.

3.2 Stakeholder Workshops

To facilitate the needs identification process, eight district workshops and one statewide workshop were held with members of the Task Force and Stakeholder Committee, and approximately 170 stakeholders attended the workshops. The workshop dates are outlined below.

- District 1 (Lincoln) Workshop: June 5, 2002;
- District 2 (Omaha) Workshop: June 4, 2002;
- District 3 (Norfolk) Workshop: June 3, 2002;
- District 4 (Grand Island) Workshop: April 25, 2002;
- District 5 (Bridgeport) Workshop: May 22, 2002;
- District 6 (North Platte) Workshop: May 15, 2002;
- District 7 (McCook) Workshop: May 14, 2002;
- District 8 (Ainsworth) Workshop: April 24, 2002; and
- Statewide: July 2, 2002.

The purpose of the workshops was two-fold; a) to review each agency's ITS programs and equipment (both existing and planned) within the district area and b) to identify unmet needs that had not been defined previously. The results of the Stakeholder workshops are shown in **Appendix G, Stakeholders Workshop Summary Document**.

3.3 Comprehensive Inventory of Systems

The Stakeholder Workshops were facilitated the compilation of a statewide ITS inventory. From the Stakeholder Workshops, and from subsequent discussions with agency representatives, Nebraska ITS stakeholders provided the team with a list of existing and planned ITS systems that would play a role in the State's ITS architecture.

The ITS inventory is a valuable task for several reasons. First, it provides a baseline of existing and planned ITS projects and systems throughout the state. Second, it outlines which agencies are currently deploying and operating ITS, as well as those that are planning to implement ITS programs. Third, it provides a foundation for identifying needed elements or agency participation for the statewide ITS, which will be important for subsequent tasks including the identification of market packages and system interface and integration requirements.

The *Stakeholder Workshop Summary Document (Appendix G)* contains a comprehensive district by district inventory of transportation systems throughout the state. The inventory consists of a list of relevant ITS elements in the region, the agency who owns and operates the ITS element, and an indication of whether the element is existing or planned.

3.4 Primary and Secondary Stakeholders

Following the comprehensive Stakeholder workshops, the key stakeholders that would play a significant role in statewide transportation operations were identified. The stakeholders were categorized as primary or secondary stakeholders.

Primary stakeholders include those agencies that may have direct command and control of NDOR ITS elements. Primary stakeholders include the Nebraska Department of Roads and the Nebraska State Patrol.

The secondary stakeholders are those agencies that will provide and/or use information gathered by NDOR to support operations of various field components. Stakeholder elements have been separated into Maintenance and Construction Operations Systems, Traffic Management Systems, Traveler Information Systems, and Emergency Management Systems. The primary stakeholder agencies (NDOR and NSP) and associated statewide ITS roles are shown in **Table 3-1**. Contact information has been provided for the primary stakeholders, and where available, for secondary stakeholders. Secondary stakeholders are listed in **Table 3-2**.

Table 3-1 – NDOR ITS Architecture Primary Stakeholders

Primary Stakeholder and Role
<p>Nebraska Department of Roads</p> <p>Primary Contact: Paul Cammack, NDOR Transportation Technology Division 302 Superior Street, Lincoln, NE 68521 Telephone: 402-479-1808 Email: pcammack@dor.state.ne.us</p> <p>General Statewide Role</p> <ul style="list-style-type: none"> Provide statewide coordinated transportation and incident response Provide a statewide center for the collection, fusion and dissemination of traveler information, weather information and incident/emergency situation notifications Provide PioneerNet planned event information to NDOR staff responsible for issuing over-dimensional permits Provide traffic management (for back-up control), archived data management, traveler information management and maintenance/construction operations subsystems <p>Local District Role</p> <ul style="list-style-type: none"> Provide regional coordinated transportation and incident response Provide Freeway Management System capabilities in urban areas (i.e., Omaha and Lincoln) Provide primary control of ITS field devices (e.g., DMS, HAR, Ramp Meters, etc.) at a district level Provide traffic management and maintenance/construction operations subsystems
<p>Nebraska State Patrol</p> <p>Primary Contact: Major Brian Tuma, 1600 Highway 2, Lincoln, Nebraska 68502 Telephone: 402-479-4950 Email: btuma@nsp.ne.state.us</p> <p>Statewide ITS Role</p> <ul style="list-style-type: none"> Provide statewide coordinated transportation and incident response Share Port of Entry Carrier Enforcement HAZMAT-related information with PioneerNet (Secured Area) and Troop HQ Communications Center <p>Local District Role</p> <ul style="list-style-type: none"> Provide regional coordinated transportation and incident response Co-locate Troops A-E with NDOR DOCs where appropriate Includes Emergency Management Subsystem Provide and receive relevant incident information to and from Volunteer Based Motorist Assist Programs (NEMAP, MAMAP)

Table 3-2 – NDOR ITS Architecture Secondary Stakeholder and Role

Secondary Stakeholder and Role
<p>Adjacent States</p> <ul style="list-style-type: none"> Primary role is to provide relevant travel condition information to statewide traveler information
<p>Nebraska Army National Guard (ARNG)</p> <p>Primary Contact: Col. David Petersen Telephone: 402-309-7450 Email: david.petersen@ne.ngb.army.mil</p> <ul style="list-style-type: none"> ARNG will be provided access to real-time transportation system information to support and coordinate military movement control needs
<p>City of Lincoln</p> <p>Primary Contact: Randy Hoskins, City Traffic Engineer 531 Westgate, Lincoln, NE 68521 Telephone: 402-441-7570, Email: rhoskins@ci.lincoln.ne.us</p> <ul style="list-style-type: none"> Provide and receive relevant traffic and transit (StarTran) information from PioneerNet traveler information system Coordinated control between NDOR and City traffic control devices
<p>City of Omaha</p> <p>Primary Contact: Charlie Krajicek, City Traffic Engineer 1819 Farnam, Omaha, NE 68183 Telephone: 402-444-5924 Email: dkrajicek@ci.omaha.ne.us</p> <ul style="list-style-type: none"> Provide and receive relevant traffic and transit information to PioneerNet traveler information system Coordinated control between NDOR and City traffic control devices
<p>Information Service Providers</p> <ul style="list-style-type: none"> Provide value-added traveler information to traveling public through media such as internet and 511 telephone systems.
<p>Local Cities, Counties, and Agencies</p> <ul style="list-style-type: none"> Provide and receive relevant incident information between DOCs and local agencies to support coordinated response and regional traveler information
<p>Local Cities, Counties, and Agencies</p> <ul style="list-style-type: none"> Provide and receive relevant incident information between DOCs and local agencies to support coordinated response and regional traveler information
<p>Local Media Outlets</p> <ul style="list-style-type: none"> Provide traffic reports, travel conditions, and other transportation-related news services to the traveling public through radio, TV, and other media
<p>NDEQ</p> <ul style="list-style-type: none"> Provider/receive information to facilitate coordinated response to incidents involving hazardous materials
<p>NEMA</p> <p>Primary Contact: Al Berndt, Assistant Director, 1300 Military Road, Lincoln, Nebraska 68508 Telephone: 402-471-7410 Email: al.berndt@ne.ngb.army.mil</p> <ul style="list-style-type: none"> The NEMA facility, located in the STARC Building in Lincoln, will have facilities to support a statewide EOC and support communications to all county levels

Table 3-2 – NDOR ITS Architecture Secondary Stakeholder and Role (continued)

Secondary Stakeholder and Role
<p>NOAA</p> <ul style="list-style-type: none"> Provide weather information for traveler information services, and maintenance and construction operations centers
<p>Private Rail Companies</p> <p>Primary Contact: Jack Dobrinska, Union Pacific Railroad, Manager, Industry & Public Projects 1416 Dodge Street , Rm 940 Omaha, Nebraska 68179</p> <ul style="list-style-type: none"> Provide and receive relevant information to/from PioneerNet concerning blockages and maintenance at or near highway-rail crossings.

3.5 Strategy for Engaging Additional Stakeholders

As the needs of the State change, additional stakeholders may need to be included in the Architecture development, assessment, and update cycle. In order to facilitate the inclusion of additional stakeholders, it is recommended that ITS issues be placed on the agenda of the annual District Update/Information Meetings. These meetings, which are held annually within each NDOR District, present the opportunity for additional stakeholders to be identified.

NDOR formally responds to each issue identified during the District Information/Update Meetings. Through the District Engineers participation in the District Information/Update Meetings, they will be in a position to identify new stakeholders for inclusion in the NDOR Statewide ITS Architecture. At the annual architecture assessment meeting (as explained in Section 10), the District Engineers will report whether they have identified new stakeholders that should be included in the Architecture.

4. ITS NEEDS AND SERVICES

A description of the regional needs and services and the transportation services required to address those needs is included in this section. The needs are also mapped to the National ITS Architecture.

4.1 User Services

ITS services are referred to in the National ITS Architecture as activities that can be performed to improve the efficiency, safety, and convenience of the transportation system. ITS services are defined to meet the needs of a project or region and are referenced in the National ITS Architecture as User Services.

Section 4 of the *Stakeholder Workshop Summary Document (Appendix G)* provides a detailed analysis of the transportation needs and issues identified during the eight NDOR District workshops. The format used to identify the needs and services generally follows the eight User Service bundle categories contained within the National ITS Architecture. The major needs identified during the NDOR District Workshops included:

- Travel and Transportation Management
- Maintenance and Construction Operations,
- Traveler Information, and
- Emergency Management.

With the stakeholder needs identified during the NDOR District Workshops, the next step in the Architecture development process was to match the needs with User Service Requirements as defined in the National ITS Architecture.

The *Functional Requirements Document (Appendix I)* identified the User Services (US), User Service Requirements (USR), and process specifications applicable to NDOR statewide operations. The User Service Requirements, as identified in Section 3 of the *Functional Requirements Document* include:

- Pre-Trip Travel Information (US 1.1);
- En-route Driver Information (US 1.2);
- Traveler Services Information (US 1.5);
- Traffic Control (US 1.6);
- Incident Management (US 1.7);
- Highway-Rail Intersection (US 1.10);
- Emergency Vehicle Management (US 5.2);
- Archived Data Function (US 7.1); and
- Maintenance and Construction Operations (US 8.1).

4.2 Market Packages

The next step in the Architecture development process was to identify the Market Packages that are applicable to NDOR statewide operations.

Market Packages provide a service-oriented view of the National ITS Architecture and identify the elements of the architecture that are required to implement a particular service.

Market Packages present the “real-world” view of the systems contained within the National ITS Architecture. Because Market Packages present a combination of systems from a service perspective, stakeholders can utilize the market packages to identify interfaces between systems develop system functional requirements, and validate the concept of operations

Figure 4-1 depicts the Traffic Information Dissemination Market Package. The market package graphic can be used to identify specific information flows that should occur between stakeholders and systems. For example, the Traffic Management subsystem is shown to interface with Maintenance and Construction Management, Transit Management, Emergency Management, Roadway and Information Service Provider Subsystems. Stakeholders can verify if the information flows shown in the market package graphic between subsystems is desired, whether it satisfies the needs of the agency, or whether additional information flows are required.

Similarly, the market package can assist agencies in developing functional requirements specific to their system. In the example shown, a sample functional requirement for Emergency Management systems may be that the system should be capable of receiving road network conditions (e.g., congestion levels, road closures) from the traffic management system.

Finally, the Market Package graphic can be used to validate a concept of operations. The pictorial view of the Market Package can be used to define specific agency roles and responsibilities. For example, maintenance and construction operations personnel should enter current asset restrictions into the statewide system so that traffic management personnel can let post warning messages to travelers. The traffic management personnel will also support incident management by providing information to the emergency management subsystem.

ATMS06 Traffic Information Dissemination

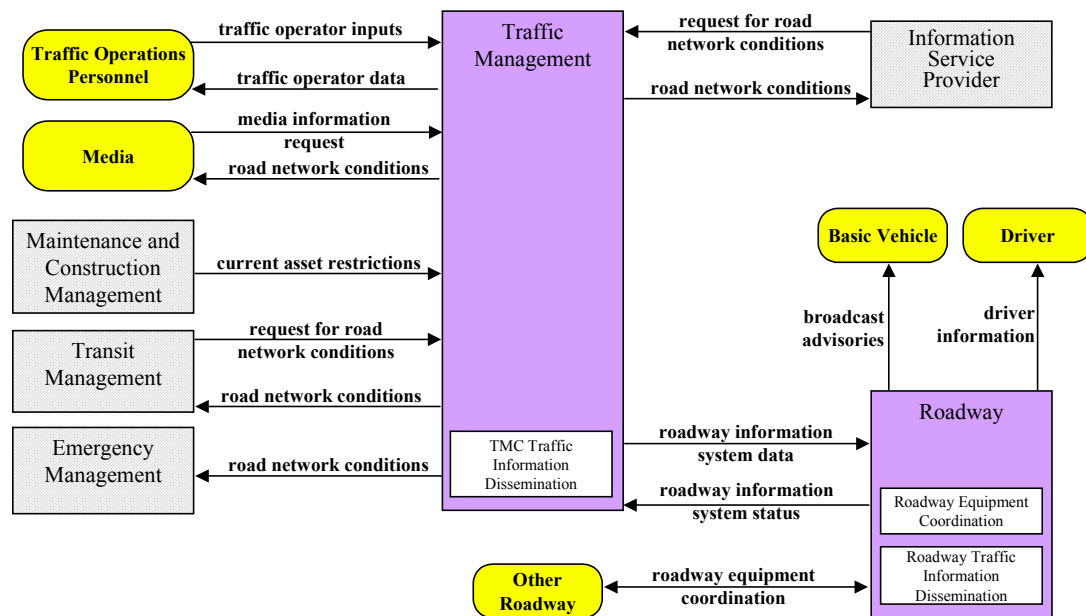


Figure 4-1 – Sample Market Package

4.3 Correlation of User Services to Market Packages

The relationship between the User Services (US) and the Market Packages is well correlated. This relationship allows translation between User Services and the Market Packages that should be included in the NDOR Statewide ITS Architecture.

The User Services are traceable to the Market Packages using **Table 4-1** (Market Packages, Prepared for FHWA, June 2002). The open squares (□) in **Table 4-1** designate a potential match of a User Service with a Market Package. A single User Service often requires a range of capabilities separated into different Market Packages so they may be considered separately from a deployment-oriented perspective. As a result, there is often a many-to-many relationship between the Market Packages and the user services.

The National ITS Architecture market packages were reviewed and selected based on the correlation with the User Services, and based upon the relevance of the service that the market package could provide to the state. The solid squares (■) designate an actual match, in terms of the needs of NDOR ITS stakeholders, of a needed User Service with the appropriate Market Package.

In **Table 4-1**, the shaded columns represent those User Services of NDOR ITS stakeholders and the solid squares (■) designate the Market Packages that provide the needed services. Market Packages were selected based upon their fulfillment of the User Services and whether they meet the needs of statewide system stakeholders. The selected Market Packages are illustrated in **Appendix B, Figures B1-B21**. The market packages that are considered applicable to the NDOR Statewide ITS Architecture are:

- Network Surveillance;
- Surface Street Control;
- Freeway Control;
- Traffic Information Dissemination;
- Regional Traffic Control;
- Incident Management System;
- Standard Railroad Grade Crossing;
- Railroad Operations Coordination;
- Broadcast Traveler Information;
- Emergency Response;
- Roadway Service Patrols;
- ITS Data Warehouse;
- Maintenance and Construction Vehicle Tracking;
- Road Weather Data Collection;
- Weather Information Processing and Distribution;
- Roadway Automated Treatment;
- Winter Maintenance;
- Roadway Maintenance and Construction;
- Work Zone Management; and
- Maintenance and Construction Activity Coordination.

Table 4-1 – User Services and Associated Market Packages

		User Services																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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		Network Surveillance	Probe Surveillance	Surface Street Control	Freeway Control	HOV Lane Management	Traffic Information Dissemination	Regional Traffic Control	Incident Management System	Traffic Forecast and Demand	Electronic Toll Collection	Emissions Monitoring and Virtual TMC and Smart Probes	Standard Railroad Grade Crossing	Advanced Railroad Grade Crossing	Railroad Operations Coordination	Parking Facility Management	Regional Parking Management	Reversible Lane Management	Speed Monitoring	Drawbridge Management	Transit Vehicle Tracking	Transit Fixed-Route Operations	Demand Response Transit Operations	Transit Passenger and Fare	Transit Security	Transit Maintenance	Multi-modal Coordination	Transit Traveler Information	Broadcast Traveler Information	Interactive Traveler Information	Autonomous Route Guidance	Dynamic Route Guidance	ISP Based Route Guidance	Integrated Transp. Management/Route	Yellow Pages and Reservation	Dynamic Ridesharing	In Vehicle Signing	Vehicle Safety Monitoring	Driver Safety Monitoring	Longitudinal Safety Warning	Lateral Safety Warning	Intersection Safety Warning	Pre-Crash Restraint Deployment	Driver Visibility Improvement	Advanced Vehicle Longitudinal Control	Advanced Vehicle Lateral Control	Intersection Collision Avoidance	Automated Highway System																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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Table 4-1 – User Services and Associated Market Packages (continued)

		User Services																										
	Market Packages	CVO										EM			AD		MCO											
		Fleet Administration	Freight Administration	Electronic Clearance	CV Administrative Processes	International Border Electronic	Weigh-In-Motion	Roadside CVO Safety	On-board CVO Safety	CVO Fleet Maintenance	HAZMAT Management	Emergency Response	Emergency Routing	Mayday Support	Roadway Service Patrols	ITS Data Mart	ITS Data Warehouse	ITS Virtual Data Warehouse	Maintenance and Construction Vehicle Tracking	Maintenance and Construction Vehicle Maintenance	Road Weather Data Collection	Weather Information Processing and Distribution	Roadway Automated Treatment	Winter Maintenance	Roadway Maintenance and Construction	Work Zone Management	Work Zone Safety Monitoring	Maintenance and Construction Activity Coordination
	1.1- Pre-Trip Travel Information																											
	1.2 -En-Route Driver Information																											
	1.3 -Route Guidance		<input type="checkbox"/>																									
	1.4 -Ride Matching and Reservation																											
	1.5 -Traveler Service Information																											
	1.6 -Traffic Control											<input type="checkbox"/>																
	1.7 -Incident Management										<input type="checkbox"/>																	
	1.8 -Travel Demand Management																											
	1.9 -Emissions Testing and Mitigation																											
	1.10 – Highway -Rail Intersection																											
	2.1 – Public Transportation Management																											
	2.2 – En-Route Transit Information																											
	2.3 – Personalized Public Transit																											
	2.4 – Public Travel Security																											
	3.1 – Electronic Payment Service																											
	4.1 – Commercial Vehicle Electronic Clearance				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																					
	4.2 – Automated Roadside Safety Inspection					<input type="checkbox"/>		<input type="checkbox"/>																				
	4.3 – On-Board Safety Monitoring						<input type="checkbox"/>																					
	4.4 – Commercial Vehicle Administrative Process							<input type="checkbox"/>	<input type="checkbox"/>																			
	4.5 – Hazardous Material Incident Response									<input type="checkbox"/>																		
	4.6 – Commercial Fleet Management									<input type="checkbox"/>																		
	5.1 – Emergency Notification And Personal Security										<input type="checkbox"/>																	
	5.2 – Emergency Vehicle Management										<input checked="" type="checkbox"/>																	
	6.1 – Longitudinal Collision Avoidance																											
	6.2 – Lateral Collision Avoidance																											
	6.3 – Intersection Collision Avoidance																											
	6.4 – Vision Enhancement For Crash Avoidance																											
	6.5 – Safety Readiness																											
	6.6 – Pre-Crash Restraint Deployment																											
	6.7 – Automated Vehicle Operation														<input type="checkbox"/>													
	7.1 – Archived Data Function															<input type="checkbox"/>												
	8.1 – Maintenance and Construction Operations																<input type="checkbox"/>											

5. OPERATIONAL CONCEPT

One of the initial steps in developing the NDOR Statewide ITS Architecture is to define each stakeholder's current and future roles and responsibilities in the implementation and operation of the statewide systems.

The operational concept provides an "executive summary" view of the way the systems contained within the NDOR ITS Statewide Architecture will work together, and it documents the roles and responsibilities for each of the services that ITS will provide.

The operational concept is not a comprehensive summary of the role of all agencies throughout the state, but is limited to those agencies that provide the ITS services that are contained within the NDOR Statewide ITS Architecture. Specifically, the operational concept illustrates traffic management, traveler information, incident management, and maintenance and construction management services. The approach to describing the operational concept is to present specific operational scenarios that describe and define the stakeholders' general roles in providing the services.

In addition to the operational scenarios that illustrate the roles and responsibilities of each agency, a high-level graphical depiction of the agencies and systems that are responsible for operations in the four ITS areas is presented. In addition, specific roles and coordination requirements for operations are illustrated through the customized market package diagrams presented in **Appendix B**.

With the integration, information sharing, and in some cases joint operations of systems, there will likely be a requirement for agency agreements. Descriptions of potential agreements that may be needed are included in Section 8.2.

5.1 Operational Scenarios

Scenario 1

The first operational scenario describes how ITS technologies may be used during a multi-vehicle crash on I-80 within the City of Omaha city limits. Motorists call 911 from cellular telephones and the Nebraska State Patrol Troop B Communications Center is quickly informed of the crash. An alert is automatically sent from the Nebraska State Patrol Troop B Communications Center to City of Omaha TMC and the NDOR District 2 Operations Center. NDOR activates DMS and monitors the situation with a CCTV camera that is near the crash. The City of Omaha Fire Department uses the video feed from NDOR to determine the severity of the accident and the number and type of fire and rescue vehicles to dispatch.

Eastbound I-80 is completely closed and the Nebraska State Patrol begins setting up a closure and detour. The City of Omaha uses their closed-loop signal system to implement a modified timing plan from their TMC on alternate routes along the arterials to accommodate the large increases in traffic volume. The NDOR District 2 Operations Center also contacts the District 1 Operations Center in Lincoln so that motorist on I-80 in the Lincoln area can be forewarned of the impending delay along eastbound I-80.

NDOR enters the closure on the PioneerNet system, which also feeds the statewide 511 traveler information number. DMS and HAR continue to warn motorist that eastbound I-80 is closed. The CCTV camera feed, which has been turned away from the crash to focus on the traffic

condition on the interstate, is shared with the media which broadcasts the live shots of I-80 on the evening news to warn motorists that I-80 remains closed.

Scenario 2

Road construction along the Nebraska Highway within the City of Lincoln is expected to result in the long-term closure of two lanes of traffic. The NDOR District 1 Operations Center reports the closure to the City of Lincoln TMC. The City of Lincoln TMC implements detour timing plans on its closed-loop signal system and resets signal detectors to account for changes in approaches to the signalized intersections. The City of Lincoln posts messages on the city's DMS along the city arterials alerting motorists of the construction and potential detour routes.

The City of Lincoln TMC also sends a message to the Nebraska State Patrol Troop HQ Communications Center and Traffic Services Division so that when emergency vehicles are dispatched the drivers are cognizant of the closures and can take the appropriate detours. Additionally, the City of Lincoln Transit Management Center, which has a PioneerNet workstation in their TMC, is aware of the closure and evaluates the impact of the closure on the fixed-route transit system.

Once the construction is complete, the NDOR District 1 Operations Center sends out a message to the City of Lincoln TMC and to the Nebraska State Patrol Troop HQ Communications Center that all lanes are once again open.

Scenario 3

The third operational scenario describes how the integrated elements of the state's ITS program will function together in the event of a major incident caused by icy roadways on I-80. In this operational scenario, I-80 which traverses the entire state of Nebraska from the Iowa state line to the Wyoming state line is instrumented with road weather information system stations (RWIS), some of which have CCTV cameras transmitting images from selected locations. DMS also exist at decision points along the route. Along the corridor, vehicle detector stations, dynamic message signs, CCTV cameras, and RWIS stations have been installed and provide information to each District Operations Center along the I-80 corridor. All the systems are continuously monitored using an integrated network of detection and monitoring systems providing real-time information to each District Operations Center along I-80. At the Statewide/District 2 Operations Center, the information is assimilated and "packaged" so it can be effectively disseminated to the public.

A major snow and ice storm has hit large portions of Nebraska causing dangerous conditions along I-80. The NDOR maintenance crews have been plowing the snow that has fallen and anti-icing systems are automatically spreading chemicals on bridges and other areas that are prone to freezing. Near Grand Island, the snow plow operators come upon a jack-knifed tractor-trailer rig on the opposite side of the roadway and immediately radio to NDOR District 4 Operations Center dispatchers the nature of the crash. In parallel with this activity, a motorist with a cell phone called 911 and reached the NSP Troop C Communications Center and they recognized that these two notifications of an incident are in fact related to the same location. A District 4 Operations Center operator notifies Nebraska State Patrol Troop C Communications Center of the incident and the location, and an officer is dispatched immediately. The NDOR District 4 Operations Center operator zooms in on the incident and surrounding area to monitor conditions so that the other agencies in the incident command can be kept apprised.

5.2 High-Level Stakeholder Relationship

The operational scenarios described in the previous section illustrate the interagency cooperation and coordination that is required in the three hypothetical situations that might occur. During any operational scenario, a number of agencies will be required to coordinate closely to perform their operational responsibilities. A high-level depiction of the relationships between stakeholder agencies that have a lead role or responsibility during operations is illustrated in **Figure 5-1**. It is recognized that a number of other agencies will also need to be involved during a scenario in addition to the ones shown in the figure, although it is not expected that these agencies will play as critical a role in operations of the statewide transportation system.

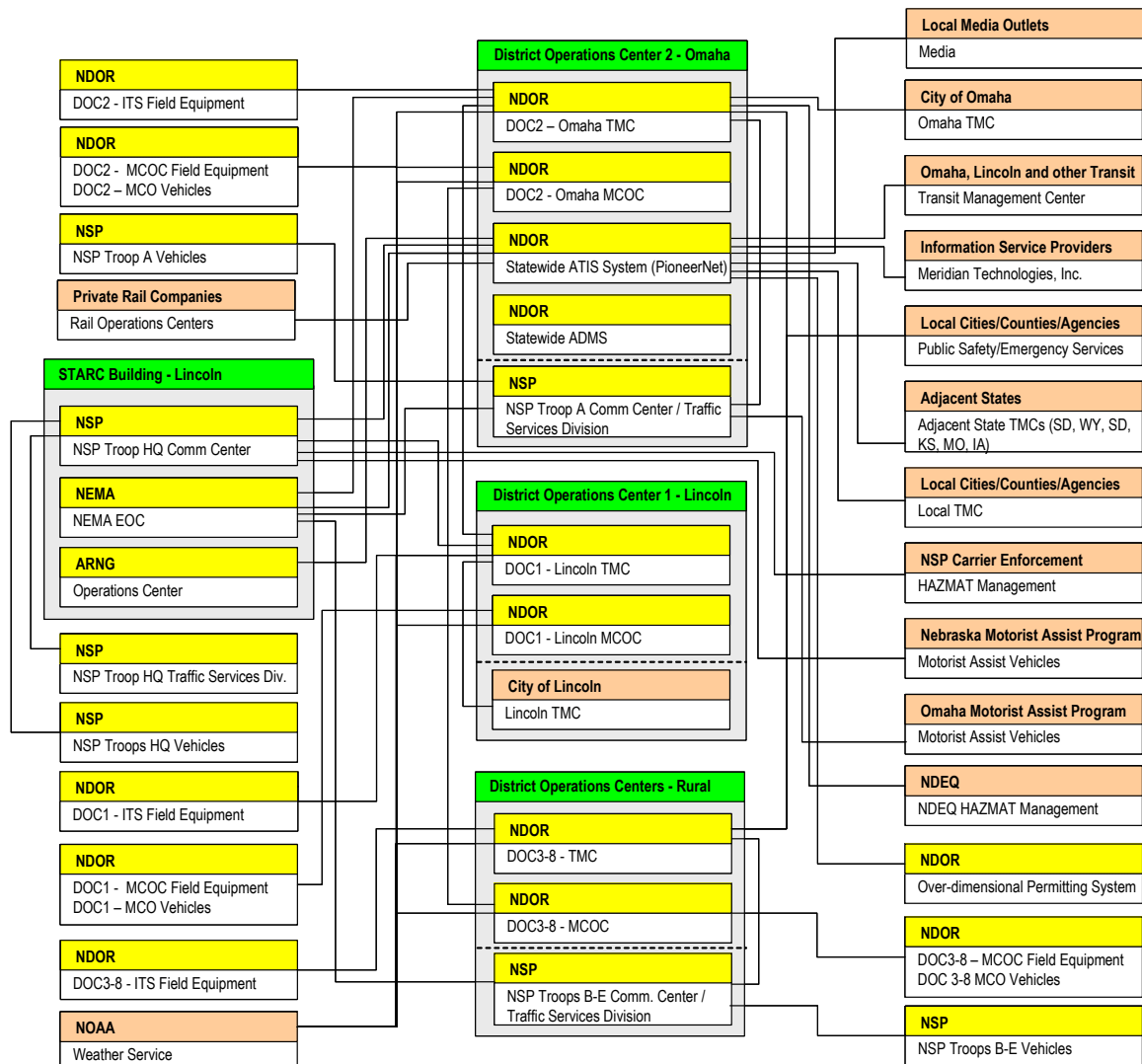


Figure 5-1 – High-Level Stakeholder Relationship

6. FUNCTIONAL REQUIREMENTS

For each primary NDOR statewide ITS system or service, a set of high-level functional requirements has been developed. The primary systems and service areas are travel information, traffic management, incident management, and maintenance and construction operations. In addition, functional requirements for communications and data archiving systems have been defined.

The functional requirements are separated into statewide system functional requirements and local NDOR district functional requirements.

A full set of functional requirements for the proposed District Operations Center System has been developed in the *Functional Requirements Document*, and is can be found in **Appendix I**.

6.1 Statewide ITS Systems Functionality

Function 1: Statewide Traveler Information

- Provide a centralized location for the collection and fusion of statewide traveler information. Real-time traveler information will be disseminated through the statewide ATIS, PioneerNet (internet based), and 511 (telephone based) and HAR.
- System will provide an ability to collect, process, disseminate, and exchange traffic and system status information with other ITS systems, transportation service providers, including access to other traveler information providers, including adjacent states.
- Support the capability for remote condition/status input to the traveler information system.
- Provide real-time and planned condition/status information to other transportation service providers and permitting agencies.
- Provide the point of contact for information dissemination to local media, establish data exchange interfaces with media and partner ISPs.
- Provide the point of contact for public outreach and education activities.

Function 2: Statewide Data Archival

- Data archiving will support information collected through system monitoring, electronically input files, manual entry into operational records/data bases and contain current and historical, real-time and static data.
- System will support the following features: a process to promote data integrity, ability to import and verify data, ability to store data, ability to access and distribute data, and a user interface allowing for data retrieval.
- System design to support data collection from statewide transportation system operations, asset management and maintenance systems and other monitoring and application systems.
- Accept real-time and static data in an electronic format either from an existing database, electronic media or web based input.

Function 3: Statewide Communications

- Establish center-to-center communications links with NDOR HQ, each DOC, NSP Troop Area A communications center (Omaha metro area), STARC Center (NEMA/ARNG and

NSP Headquarters Troop Area communications center), and other partner agencies in support of transportation system management.

- Support shared use communication network(s) partnerships with other state and local agencies, emergency response and law enforcement agencies and private partners for purposes of data exchange, collection, and system monitoring. (Possible example could be support for Lifelink programs through deployed ITS technologies and wireless communications systems capable of receiving and transmitting voice/data/video).

Function 4: Statewide Incident Coordination

- Provide incident management capability, including detection, verification, and response capability utilizing ITS field devices and systems.
- Provide intra- and inter- district and statewide incident notification capability, interaction and agency coordination including with other state and local agencies, NEMA, ARNG, NSP), local emergency response and law enforcement agencies.
- Provide assistance and coordination to the Nebraska Motorists Assist Program.
- Provide facilities and capability to function as the regional EOC, as required.
- Provide a regional/statewide “Hotline” call center for incident notification or notification point for transporting of hazardous materials, etc.
- Maintain a statewide local emergency response agency contact list and a list of public agency and a private industry contractors “call out list” of equipment resources.
- Support development, implementation and periodic review of public outreach and education programs focusing on emergency and incident situations, assist with development of statewide standards/policies for incident coordination, response and data exchange.
- Collect information in support of incident and emergency response regarding transport of hazardous materials and route of vehicles traveling through state.

Function 5: Statewide Traffic Management

- Support integration and development of standard procurement specifications for deployed ITS field devices and systems providing intra- and inter-district and sub-regional traffic management.
- Manage traffic control response to district, regional and statewide incident and special events. Provide interaction/coordination with local jurisdiction, emergency response, and law enforcement agencies.
- Support shared use of ITS field devices and systems with partner agencies. Provide secondary field device access and control, provide capability to log user agency operations.
- Support collocation of DOCs, NSP Troop Area communications centers and other traffic management functions within the same facility.
- Implement capability to operate 24/7/365.
- Provide NSP, NEMA, and ARNG real-time statewide roadway system monitoring and system status information.
- Coordinate development, implement, and periodically review appropriate statewide operational standards/policies for ITS systems and programs. Develop operational and technical training needs.

Function 6: Statewide Maintenance and Construction

- Provide vehicle fleet management and tracking capability using GPS/AVL or other advance technologies.
- Support in-vehicle safety systems, driver notification, smart snow plow and other ITS technologies.
- Support roadway infrastructure that monitors, operates, and maintains the physical condition of the transportation system.
- Support Work Zone systems assisting with management and operation of maintenance/construction activities/traffic management.
- Support coordination of traffic operation and work zone plans with other agencies.
- Support road weather data collection, pavement forecasting and management systems.

Function 7: Urban Freeway Traffic Management

- Provide network surveillance and traffic monitoring using real-time system detection.
- Provide capability to communicate with arterial traffic signal system, including the capability to monitor the system and make adjustments in real-time (e.g., ramp metering rates).
- Establish dedicated communications and real-time control of field devices and provide secondary access and control to partner agencies.
- Capable of disseminating and exchanging traffic control/management information with other ITS systems, transportation service providers (including State of Iowa/Council Bluffs), NSP Lincoln and Omaha Troop Area communications centers, NDOR District 2 Headquarters, Omaha Transit, local law enforcement and emergency response agencies, local jurisdictions, parking management systems and special event operators.

Function 8: Urban Incident Management

- System shall have the ability to identify and verify an incident, and support site management and report preparation.
- Incident detection will be through an automated system capable of determining incident location.
- System will have the ability to formulate a response including emergency services notification. Response formulation will include a traffic control plan including control of ITS field devices, messages placed on DMS, and broadcast messages on HAR.
- Support scheduled/planned incidents and event management including response formulation and ITS field device control.
- Provide incident management coordination and assist with inter-agency communications needs.
- Support Lifelink programs through deployed ITS technologies and communications systems.
- Provide system support/program coordination for motorist assist programs.

Function 9: Urban Traveler Information

- Support data collection from ITS field devices and process and disseminate information to the statewide ATIS (PioneerNet, Statewide 511), including real-time video images, message displayed on DMS, vehicle monitoring information, speeds and occupancy, etc.
- Provide system status information to FMS operators for dissemination through en-route traveler information ITS field devices.
- The FMS shall provide the ATIS information on incidents, scheduled events, road construction, and maintenance closures and/or restrictions.

Function 10: NSP Communications Center

- Serve as communications center for the NSP Troop-Area command.
- Provide back-up state agency intra/inter-regional and statewide communications needs.
- Provide roadway incident and status information including notification and updates to the DOC and/or District 2/Statewide Operations Center.
- Provide coordination and assistance to the Nebraska Motorists Assist Program.
- Operate 24/7/365.

6.2 NDOR District ITS System Functionality

The following functions are to be performed by the rural District Operations Center.

Function 1: Manage District Traffic Operations (Traffic Management)

- Primary operational control of smart work zone system deployments.
- Primary operational control of Traffic Management System, ITS field device deployments.
- Collocation of NDOR/NSP and traffic management functions within the same center, where appropriate.

Function 2: Provide operation coordination and voice/data links between Agencies

- Intra-district, sub-regional and adjacent state weather data exchange, traffic response/management and emergency/incident coordination.
- Responsibility for interaction/coordination with local emergency response and law enforcement agencies.
- Maintaining a local emergency response contact list of staff and equipment resources.
- Support intra-district multi-agency communications network.
- Primary responsibility for center-to-center communications with local transportation management systems, emergency response, and law enforcement agencies.

Function 3: Manage and/or participate in district and regional incident response (Incident Management)

- Point of contact for local media outreach/education activities.

7. PHYSICAL ARCHITECTURE

The physical architecture is the part of the National ITS Architecture that provides agencies with a physical representation (though not a detailed design) of the important ITS interfaces and major system components. The principal elements in the physical architecture are the subsystems and architecture flows that connect these subsystems and terminators into an overall structure (2).

The physical architecture takes the concepts and processes that were outlined by the operational concept (Section 5) and by the functional requirements (Section 6) and assigns them to subsystems. The Market Packages, as selected in Section 4, form the foundation for determining the information flows (interconnects) between systems. These systems and their interconnections comprise the physical architecture.

7.1 Mapping of NDOR ITS Inventory to National ITS Architecture Subsystems and Terminators

The first task in the development of the physical architecture is to associate system in the NDOR ITS Architecture with a subsystem from the National ITS Architecture.

7.1.1 NDOR ITS Elements by Stakeholder

The NDOR Statewide ITS Architecture inventory is made up of the transportation and communications centers, the field equipment, the vehicles, and other systems essential to NDOR statewide transportation system operations. These components have been mapped to the associated subsystem or terminator as defined by the National ITS Architecture. **Table A1, Appendix A**, presents the NDOR Statewide ITS inventory sorted by stakeholder.

Appendix A, Table A1 presents each of the NDOR ITS principal subsystems, as well as other elements that will either provide information to or receive information from the principal NDOR Statewide subsystems. Included in the table is a brief description of the inventory element, element status (existing or planned), and the associated National ITS Architecture subsystem or terminator.

7.1.2 Architecture Subsystem Extensions

In order to satisfy all of the functional requirements of the Statewide ITS systems, it was necessary to extend the architecture. The extended subsystems, as shown in **Table A1, Appendix A**, include:

- Commercial Vehicle Permitting Subsystem: This subsystem represents the NDOR Over-dimensional permitting system, and was created to enhance statewide incident management capabilities involving hazardous materials.
- Commercial Vehicle Enforcement Subsystem: This subsystem represents the NSP Carrier Enforcement division and was created to enhance statewide incident management capabilities involving hazardous materials.

7.2 Mapping of Statewide ITS System Inventory to Market Packages

The National ITS Architecture Market Packages present groups of subsystems and terminators that together provide a particular transportation service. **Table A-2, Appendix A** presents each Market Package selected in Section 4, the National ITS Architecture elements that comprise the Market Package, and the associated NDOR Statewide ITS Architecture element.

7.3 Customized Market Packages

In the National ITS Architecture, services are referred to as market packages. Market packages can include several stakeholders and elements that work together to provide a particular service throughout the state. Examples of market packages from the National ITS Architecture include Network Surveillance, Traffic Information Dissemination, and Emergency Management. There are currently a total of 75 market packages identified in the National ITS Architecture.

The National ITS Architecture market packages were reviewed and selected based on the User Service Requirements, and based on the relevance of the service that the market package could provide to statewide transportation operations, as shown in Section 4. The market packages that were selected for statewide implementation are identified in **Table 4-1, Table A-2, Appendix A**, identifies the elements (or systems) in the state that serves key roles in each market package service.

Appendix B, Figures B1 through **B21** illustrates each Market Package selected for statewide implementation. Each market package was reviewed and the elements that could be included to customize it for the state were included. Each graphic contains the Market Package name, the NDOR ITS Architecture element, and the relevant information flows between entities. A short description of the Market Packages follows each figure.

Equipment packages, where applicable, are also shown for each market package. An equipment package is a functional capability that may be deployed at a specific time. While the Market Packages represent a service that will be deployed as an integrated capability, the equipment packages make up those Market Packages and are the most basic functions that will be developed or procured by implementers.

Figure 7-1 is an example of the customized ATMS01 Network Surveillance Market Package. This Market Package shows the two architecture subsystems (Traffic Management and Roadway) and the associated DOC elements (DOC1 TMC, DOC2 TMC, DOC 3-8 TMC, ITS Field Equipment) and the equipment packages. The equipment packages are the rectangles inside of the subsystems and represent the functions that deliver a particular service to support the Market Package. The equipment packages are the deployable-sized packages that can implement a particular function.

In addition to the standard Market Packages developed in the National ITS Architecture, an additional market package was created to satisfy the need to track hazardous materials throughout the State of Nebraska. This Market Package is shown in **Appendix B, Figure B21**. This Market Package was created to facilitate support of statewide incident response by enabling the collection of information regarding the transport of hazardous materials and the route of vehicles transporting hazardous materials traveling through the state.

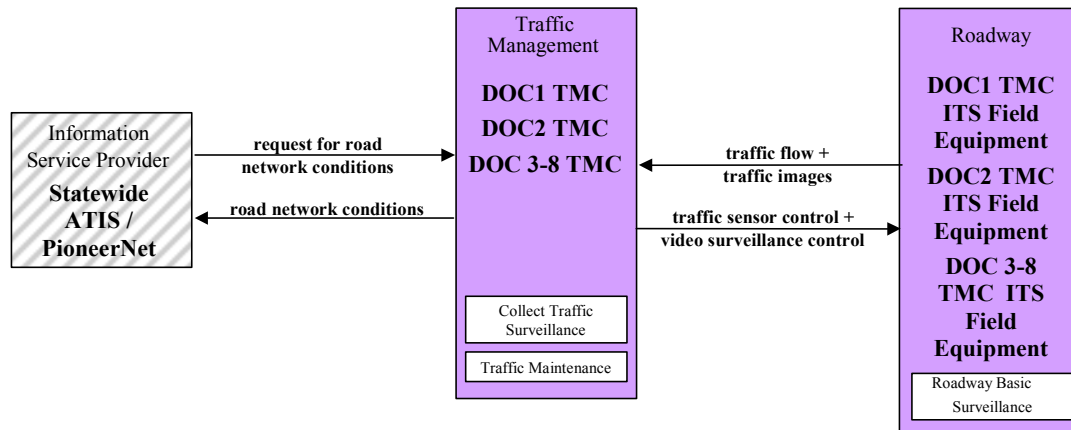


Figure 7-1 – Example Customized Market Package for Network Surveillance

7.4 Architecture Interconnects

While it is important to identify the various systems and stakeholders that comprise the statewide transportation system, a primary purpose of the architecture is to identify the *connectivity* between transportation systems.

The market package diagrams show the information flows between the subsystems and terminators that are most important to the operation of the market packages. How these systems interface with each other is an integral part of the overall ITS architecture.

There are 42 different elements identified as part of the NDOR Statewide ITS Architecture. These elements include local and state traffic operations centers, dispatch systems, emergency management agencies, media outlets, and others – essentially, all of the existing and planned physical components that contribute to the statewide intelligent transportation system. Interfaces have been identified for each element in the NDOR Statewide ITS Architecture, and each element has been mapped to those other elements with which it must interface. For example, the District 1 Traffic Management Center has existing or planned interfaces with 8 other elements, ranging from field equipment and dispatch centers to local media and NDOR systems.

An example of one of the system interfaces is included as **Figure 7-2** on the following page. This graphic shows the NDOR DOC1 Traffic Management Center and the interfaces with other elements throughout the state. These interfaces are shown as existing or planned.

Appendix C contains the complete set of architecture interconnects for each subsystem of the NDOR Statewide ITS Architecture.

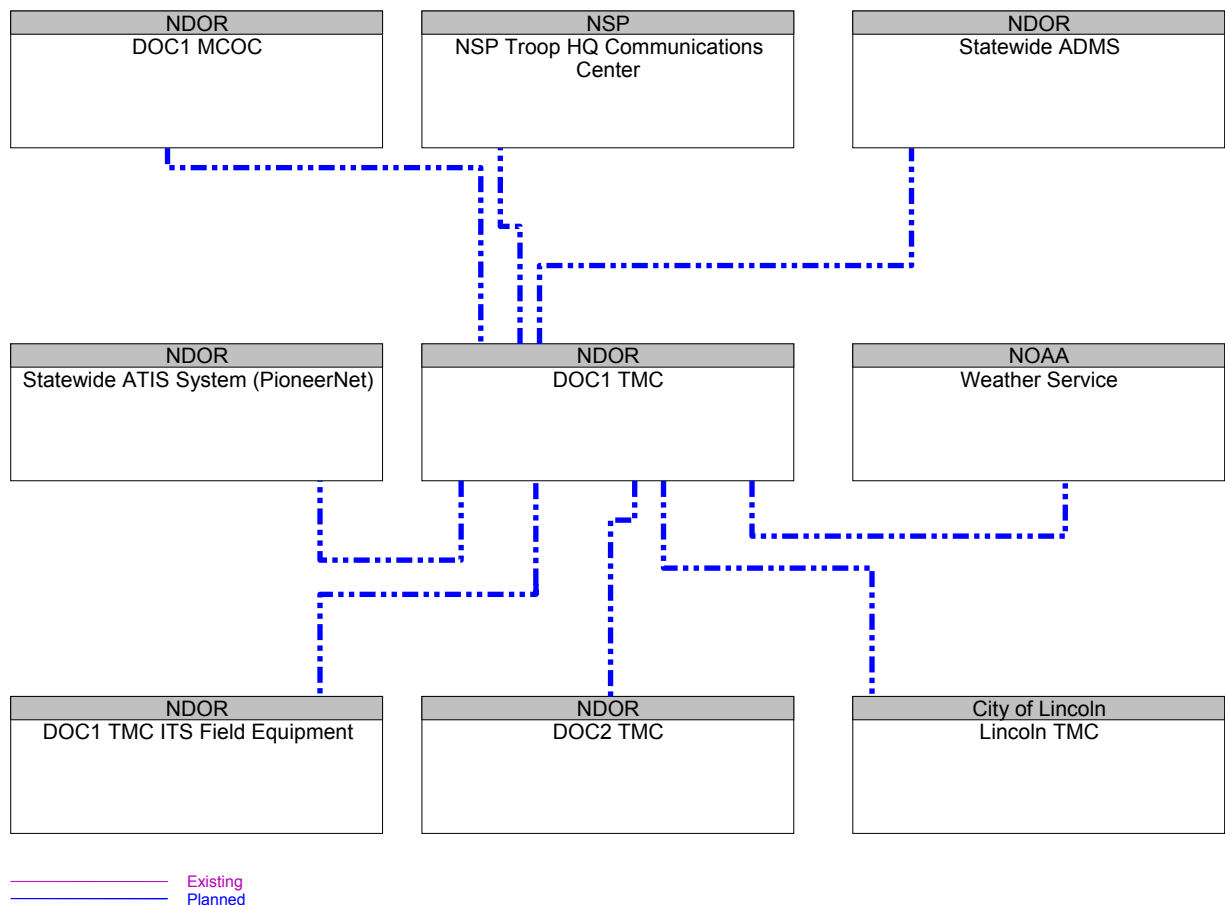


Figure 7-2 – Example Interconnect Diagram for District Operations Center 1

7.5 Architecture Flows

Architecture flows between the subsystems and terminators define the specific information (data) that is exchanged between subsystems and terminators. Each architecture flow has one or more data flows that specify what information is exchanged and the direction of the exchange. These data flows could be requests for information, alerts and messages, status requests, broadcast advisories, event messages, confirmations, electronic credentials, and other key information requirements. These architecture flows define the interface requirements between the various elements in the NDOR Statewide ITS Architecture.

An example of the architecture flows between two elements is shown in **Figure 7-3**. In this interface, the flows between the NSP Troop HQ Communications Center and the DOC 1 TMC show information that must go from the DOC1 TMC to the NSP Troop HQ Communications Center, as well as information that the DOC1 TMC needs from NSP. Similar to the interfaces, architecture flows also are defined as existing or planned.

A complete set of the architecture flows between individual elements are shown in **Appendix D**. A narrative description of each Architecture Flows is contained in **Table E1** in **Appendix E**.

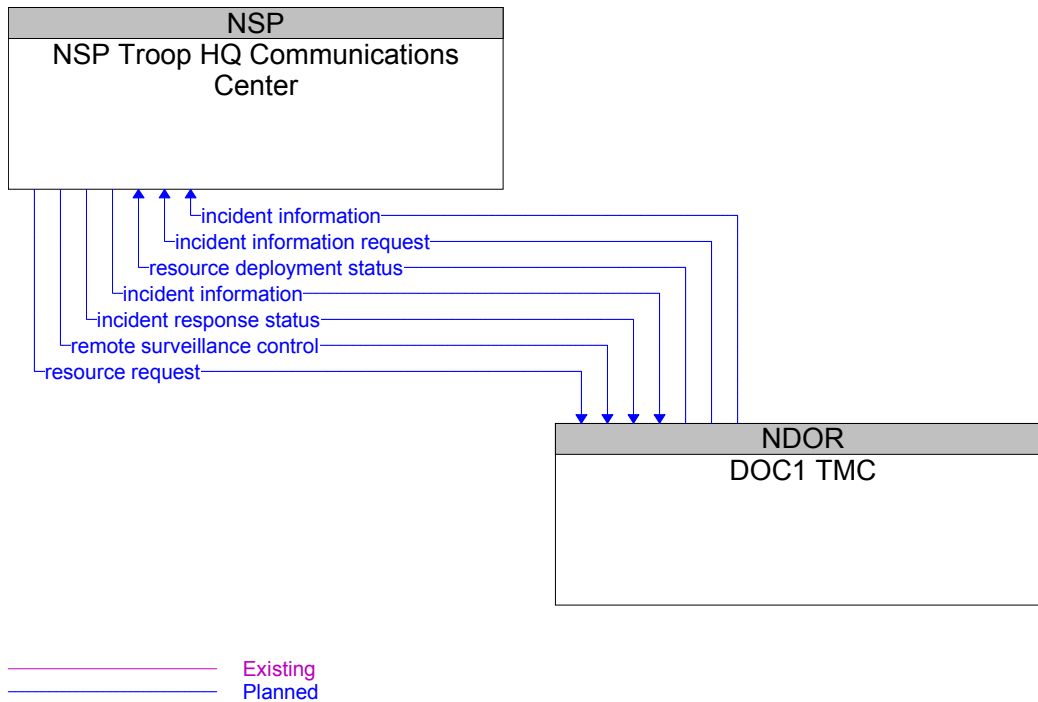


Figure 7-3 – Example Architecture Flows

7.6 Architecture Flow Extensions

In order to provide the required data exchange between subsystems, the following architecture flow extensions were created:

1. *Current asset restrictions (extended)*: This flow was created to enable data transfer to the Commercial Vehicle Permitting Subsystem (extended) from the Maintenance and Construction Management Subsystem. This flow represents restrictions levied on transportation asset usage based on infrastructure design, surveys, tests, or analyses. This includes standard facility design height, width, and weight restrictions, special restrictions such as spring weight restrictions, and temporary facility restrictions that are imposed during maintenance and construction.
2. *Hazmat information (extended)*: This architecture flow was created to enable data transfer between the Commercial Vehicle Enforcement Subsystem (extended) and the Traffic Management Subsystem. This flow represents information about a particular hazmat load including nature of the load and unloading instructions; it may also include hazmat vehicle route and route update information.
3. *Hazmat spill notification (extended)*: This data flow is used by the Commercial Vehicle Enforcement Agency to contact other emergency response organizations when incidents occur that result in a release of hazardous material. The Traffic Management Subsystem, upon notification by the Carrier Enforcement, can act as a central repository for hazmat information, and notify other pertinent agencies. Ideally, this information will include the vehicle location as well as identifying the carrier. The information may be provided as a response to a real-time query or proactively by the source.
4. *Remote surveillance control (extended)*: This extension was created to enable information exchange between the Traffic Management Subsystem and the Other Emergency

Management Terminator. This flow contains the control commands used to remotely operate another center's sensors or surveillance equipment so that roadside surveillance assets can be shared by more than one agency. Specifically, this flow enables the remote control and monitoring of surveillance cameras by the Nebraska Army National Guard Operations Center.

5. *Secure area surveillance data (extended)*: This flow enables data transfer between the Traffic Management Subsystem and the Other Emergency Management Terminator. This flow contains data collected from surveillance systems to monitor secure areas, and includes video, audio, and other security sensor outputs. Specifically, this flow enables the monitoring of Nebraska Army National Guard surveillance cameras by the District 2/Statewide District Operations Center.
6. *Work zone information (extended)*: This flow was created to enable data transfer between the Maintenance and Construction Management Subsystem and the Commercial Vehicle Permitting Subsystem (extended). This flow contains current and planned work zone and special event status including current location (and future locations for moving work zones and special events), impact to the roadway, required lane shifts, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits.

8. IMPLEMENTATION PLAN

Once the NDOR Statewide ITS Architecture has been developed, it is important that the architecture be used in the transportation planning process. The NDOR Statewide ITS Architecture should be considered for support in ITS project implementation, as it can assist with the development of a concept of operations and draft project specifications. A plan for the use of the NDOR Statewide ITS Architecture in the planning process and ITS project implementation is defined in this section. Additionally, an efficient implementation sequence of ITS project based on statewide needs is presented that considers costs and benefits, technical feasibility, institutional issues, and funding availability. A list of required agency agreements is also included in this section.

8.1 Use of the ITS Architecture in the Statewide Transportation Planning Process

The success of the Nebraska Department of Roads Statewide ITS Architecture development effort is dependent upon effective use of the architecture once it is developed. The Architecture should become an important tool for future planning and implementation of ITS projects throughout Nebraska, and can help to identify opportunities for making ITS investments in a cost-effective fashion. The Architecture can be used by stakeholders in planning their ITS projects to support statewide goals.

The goal of the transportation planning process is on making quality, informed decisions pertaining to the investment of public funds for regional transportation systems and services. Using the NDOR Statewide ITS Architecture to support these activities is an important step in the mainstreaming of ITS into the traditional decision-making of planners and transportation professionals (1). Once the architecture is complete, it should be used to feed information into the transportation planning process.

Specifically, the Architecture will be used as an input to the Nebraska Statewide Long Range Transportation Plan and the Nebraska Surface Transportation Program, which is updated annually. The NDOR Statewide ITS Architecture can also be utilized in the development of corridor and sub-area studies, major investment studies, and in congestion management plans, among others.

The Nebraska Statewide Long-Range Transportation Plan documents the policy direction for the state, and describes how projects and programs will be implemented over a 20-year period. The NDOR Statewide ITS Architecture can serve as a direct input to the plan. ITS goals identified in the current plan (Executive Summary, dated August 1995) include developing incident management programs and improving commercial vehicle flow. The Statewide ITS Architecture will be used to update the ITS goals stated in the plan.

The Nebraska Surface Transportation Program outlines the projects that will be funded during the next one and five year periods. The NDOR Statewide ITS Architecture will be used to identify specific projects that can be deployed to further ITS integration throughout the state. ITS projects should be included in this program in order to receive federal funding. The Statewide ITS Architecture can be used to help define projects for inclusion in the Nebraska Surface Transportation Program.

8.2 Project Sequencing

The next step in developing the NDOR Statewide ITS Architecture includes developing a logical schedule for deployment. **Table 8-1** defines specific projects that will be programmed and implemented on a statewide basis. The projects are separated by district, and consider availability of existing funds, commitment to pursue future funds, lessons learned from previous deployments, and technology evolution.

The following assumptions have been used to develop the projects and sequencing plan:

- There is commitment to provide approximately \$8 million per year to support deployment over the next 15 years;
- The Statewide/District 2 Operations Center will be located at or near the District 2 facilities in Omaha;
- The District Operations Center in Lincoln will likely be a remodel/addition on at the existing District 1 facility;
- Other District Operations Center facilities will use existing space and include minor remodeling;
- A fully functional Freeway Management System will be deployed in the Omaha area; and
- A smaller version of the Omaha Freeway Management System will be deployed in the Lincoln area.

Individual projects have been grouped together in the phasing schedule by District and Statewide ITS Projects. Please note that several of the field devices for District Operations Centers 3-8 will be installed under the auspices of the Statewide ITS Project (e.g., DMS, Rural ITS Field Equipment, etc.).

Table 8-1 – Project Descriptions

Project Name	Project Description
<i>District 2 and Statewide Systems</i>	
Omaha FMS Planning and Preliminary Engineering	Includes further refinement of FMS functions, technology alternatives assessment, phasing refinement, and preliminary engineering of a fully function FMS in the Omaha Metropolitan Area.
Omaha FMS Design (for each Phase)	Includes translating recommendations of FMS preliminary engineering and developing contract documents including plans, technical specifications, and estimate (PS&E) for multiple phases.
DOC Design (Ops. Area for FMS/Statewide Coordination)	District 2 / Statewide Operations Center will likely be located in a new stand-alone building or as an addition to an existing NDOR or NSP building in the Omaha Area. It is likely that the NSP Troop A Communications Center and Traffic Services Division will be co-located in the building.
DOC Hardware/Video Design	Design of Hardware and Video Control System for the Interim District 2 / Statewide Operations Center and the District Operations Centers.
DOC Construction	Construction of the Interim DOC. Interim DOC will most likely be trailer-based, located on District 2 property.
DOC Hardware/Video Construction	Construction of Hardware and Video Control System for the Interim District 2 / Statewide Operations Center.
DOC Hardware/Video Expansion Design	Design of Hardware and Video Control System for the District 2 / Statewide Operations Center. Design consideration will include technology assessment, alternatives, analysis, and life-cycle costs analysis.
DOC Hardware/Video Expansion Construction	Construction of Hardware and Video Control System for the Interim District 2 / Statewide Operations Center.
FMS Software Functional Design	The FMS Software Functional Design will be developed to clearly identify how the yet to be developed software is expected to operate including general requirements for a graphical user interfaces.
FMS Software System Manager	The Software System Manager will serve in many ways like a traditional program manager by providing technical expertise and overall program management functions. There will likely be several software initiatives (e.g., FMS, statewide software, archived data, etc.) under development in parallel and the System Manager will be responsible for ensuring consistency between software modules as well as overseeing overall system acceptance and configuration management.
FMS Software Development/Implementation	A software developer/integrator will be selected to develop software to operate the FMS based on the software functional design.
Stand Alone DMS Construction	As an early deployment component, several DMS will be installed in the Omaha Area. Until the FMS software is functional, the DMS will be operated through vendor supplied software applications.
Stand Alone CCTV Design	As an early deployment component, several CCTV will be installed in the Omaha Area. Until the FMS software is functional, the CCTV will be operated through vendor supplied software applications.
Stand Alone CCTV Construction	

Table 8-1 – Project Descriptions (continued)

Project Name	Project Description
<i>District 2 and Statewide Systems (continued)</i>	
ITS Field Equipment Construction Phases A-M	Several phases of construction have been proposed in an effort to balance funding needs. Each Phase will likely take 12-18 month to construct. Therefore, it will likely be 15 years before the majority of the Omaha area FMS is fully constructed.
Statewide Software Functional Design	The Statewide Software Functional Design will be developed to clearly identify the requirements for how the software is expected to operate including general requirements for a graphical user interface and a command and control structure to facilitate operation of field devices during off hours.
ITS Field Equipment Technology Upgrade Construction	As technology advancements are developed, existing field devices already implemented will require updating/upgrading within 10-15 years.
Statewide Software System Manager	The Software System Manager will serve in many ways like a traditional program manager by providing technical expertise and overall program management functions. There will likely be several software initiatives (e.g., FMS, statewide software, archived data, etc.) under development in parallel and the System Manager will be responsible for ensuring consistency between software modules as well as overseeing overall system acceptance and configuration management.
Statewide Software Development/Implementation	A software developer/integrator will be selected to develop software to operate Statewide Operations based on the software functional design.
Statewide Hardware and Communications	Procurement of servers and other communications equipment to support the build-out of the statewide software.
Statewide Communications Hardware Upgrade	Due to the rapid advance of technology, and estimated hardware design-life, hardware upgrades have been scheduled.
Statewide Software Integration Phase A	Phase A of Statewide Software Integration will include implementing the command and control structure to allow hand-off of control to the District 2 / Statewide Operations Center from other districts during off-hours. The functionality will be extended to include Traffic Management and MCO components.
Statewide Software Integration Phase B (Intrastate Partners)	Phase B of the Statewide Software Integration will include connection to NSP, NEMA, ARNG, and other partners that will be actively engaged in coordinating traffic management and incident management (i.e., City of Lincoln, City of Omaha).
Statewide Software Integration Phase C	Phase C of the Statewide Software Integration will include extending connection to adjacent states to allow sharing of data to enhance Transportation Operations throughout the Great Plains States.
PioneerNet Design/Implementation	PioneerNet includes the design and implementation of a Traveler Information System that will allow authorized users throughout the state to enter planned and unplanned incident information. As the system is built additional, real-time congestion information and video snapshots (possibly streamed) will be made available. Future developments of PioneerNet will provide standard interfaces to allow partner agencies the ability to enhance sharing of data.

Table 8-1 – Project Descriptions (continued)

Project Name	Project Description
PioneerNet Client Hardware/Software/Communications	Includes the hardware, communications, and software integration of PioneerNet at District 2 Operations Center.
Statewide Archived Data Management System	A software developer/integrator will be selected to develop software to operate the archived data management system based on the software functional design.
<i>District 1</i>	
PioneerNet Client Hardware/Software/Comm.	An effort will be required to configure a workstation(s) at District 1 to allow entering of data into PioneerNet. Work will include installing the client application and installing proper communications (if new resources are required).
DOC Build-out Design	The DOC in Lincoln will likely be built by reconfiguring existing space, or by a small addition onto the existing District 1 facility. The design will consider possible collocation with the City of Lincoln Traffic Engineering Section in an effort to enhance traffic management and sharing of data.
DOC Build-out Construction	Remodeling or addition at existing District 1 facility.
DOC Hardware and Communications	Procurement of servers and other communications equipment to support the build-out of DOC in the Lincoln area.
DOC Hardware and Communications Upgrade	Due to the rapid advance of technology, and estimated hardware design-life, hardware upgrades have been scheduled.
DOC Software Implementation	Implementation of a scaled back software package that was developed for the Omaha FMS as well as application to support handing over control to District 2 / Statewide Operations Center during off-hours.
ITS Field Equipment Design	Design of a smaller version of the Omaha FMS that will be installed in the Lincoln area.
ITS Field Equipment Construction	Construction of a smaller version of the Omaha FMS that will be installed in the Lincoln area.
<i>District 3-8 Projects</i>	
PioneerNet Client Hardware/Software/Comm.	An effort will be required to configure a workstation(s) at each District Operations Centers to allow entering of data into PioneerNet. Work will include travel to each district, installing the client application, and installing proper communications (if new resources are required).
DOC Build-out Design	The build-out of DOCs at Districts 3-8 will be accommodated by reconfiguring existing space. However, if opportunities arise, significant benefits could be realized through collocation with NSP Communication Centers / Traffic Service Divisions.
DOC Build-out Construction	Remodeling of existing space at Districts 3-8.
DOC Hardware and Communications	Procurement of servers and other communications equipment to support the build-out of DOC in each of the District Operations Centers.

Table 8-1 – Project Descriptions (continued)

Project Name	Project Description
<i>District 3-8 Projects (continued)</i>	
DOC Hardware and Communications Upgrade	Due to the rapid advance of technology, and estimated hardware design-life, hardware upgrades have been scheduled.
DOC Software Implementation	Implementation of Statewide software that will allow operations of local field devices and support handing over control during off-hours.
District 5 AVL Software	Development of software that will allow tracking of NDOR maintenance vehicle including various maintenance related sensors. Feature will include two-way messaging, mapping and reporting.
District 5 AVL Hardware and Comm. (on vehicles) Phase A	First phase of equipping NDOR vehicles with AVL hardware and communications.
District 5 AVL Hardware and Comm. (on vehicles) Phase B	Second phase of equipping NDOR vehicles with AVL hardware and communications.
<i>Statewide ITS Projects</i>	
Statewide DMS Design	Design of Dynamic Message Signs (DMS) for deployment statewide (Districts 3-8). Design includes development of contract documents for foundations, structure, sign, and communications interfaces.
Alternate Route Planning and Dynamic Message Sign Set Development	Development of a alternate route planning strategy to enhance DMS utilization and operations.
Statewide DMS Construction Phase III/IV	Construction of Dynamic Message Signs (DMS) for deployment statewide (Districts 3-8).
Statewide DMS Construction Phase V/VI/VII/VIII	
Statewide CCTV/Digital Camera Design	Design of stand alone CCTV / Digital Cameras. Design includes development of contract documents for camera, poles, foundations, and communications interfaces.
Statewide CCTV/Digital Camera Construction	Construction of stand alone CCTV / Digital Cameras.
Statewide Rural ITS Field Equipment Design	Includes design of several Maintenance and Construction Operations related components including enhanced RWIS, anti-icing at hazardous areas, work zone monitoring equipment, etc.
Statewide Rural ITS Field Equipment Construction	Includes construction of several MCO related components including enhanced RWIS, anti-icing at hazardous areas, work zone monitoring equipment, etc.
Communications Backbone – Design and Integration (Phases I, II, and III)	Design and Construction of Communications Backbone in Omaha Metropolitan area and backbone between Omaha and Lincoln along I-80 Corridor. Phase I – District 2 Operation Center to Ruff Road Phase II – Lincoln to Greenwood Phase III – Greenwood to Ruff Road and connect DOC's
DOC Hardware and Communications Upgrade Design	Due to the rapid advance of technology, and estimated hardware design-life, hardware upgrades have been scheduled.
Integration with Leased Line Communications	Integration of Backbone Communications with Leased Line Communications



The anticipated phasing of the projects outlined in **Table 8-1** is shown in **Table 8-2**.

Table 8-2 – Project Sequencing

	Interim				Near Term							Long Term						
	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19		
DISTRICT OPERATIONS CTR 2 - OMAHA																		
OMAHA FMS PLANNING/PRELIMINARY ENGINEERING	■	■																
OMAHA FMS DESIGN (for each Phase)																		
DOC DESIGN (Ops. Area for FMS / Statewide Coord.)			■	■														
DOC HARDWARE / VIDEO DESIGN		■	■															
DOC CONSTRUCTION				■	■	■												
DOC HARDWARE / VIDEO CONSTRUCTION			■	■														
DOC HARDWARE / VIDEO EXPANSION DESIGN						■	■											
DOC HARDWARE / VIDEO EXPANSION CONSTRUCTION							■	■	■									
FMS SOFTWARE FUNCTIONAL DESIGN		■	■	■														
FMS SOFTWARE SYSTEM MANAGER																		
FMS SOFTWARE DEVELOPMENT / IMPLEMENTATION		■	■	■	■	■												
STAND ALONE DMS CONSTRUCTION	■	■																
STAND ALONE CCTV DESIGN	■	■																
STAND ALONE CCTV CONSTRUCTION	■	■																
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE A			■	■	■													
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE B					■	■	■											
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE C						■	■	■										
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE D							■	■	■									
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE E								■	■	■								

Table 8-2 – Project Sequencing (continued)

	Interim				Near Term							Long Term						
	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19		
DISTRICT OPERATIONS CTR 2 – OMAHA (continued)																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE F																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE G																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE H																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE I																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE J																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE K																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE L																		
ITS FIELD EQUIPMENT CONSTRUCTION - PHASE M																		
ITS FIELD EQUIP. TECHNOLOGY UPGRADE CONST.																		
STATEWIDE SOFTWARE FUNCTIONAL DESIGN																		
STATEWIDE SOFTWARE SYSTEM MANAGER																		
STATEWIDE SOFTWARE DVLMP/IMPLEMENTATION																		
STATEWIDE HARDWARE AND COMMUNICATIONS																		
STATEWIDE COMMUNICATIONS HARDWARE UPGRADE																		
STATEWIDE SOFTWARE INTEGRATION PHASE A																		
STATEWIDE SOFTWARE INT. PHASE B																		
STATEWIDE SOFTWARE INTEGRATION PHASE C																		
PIONEERNET DESIGN / IMPLEMENTATION																		
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																		
STATEWIDE ARCHIVED DATA MANAGEMENT SYSTEM																		
DOC 1 - Lincoln																		
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																		
DOC BUILD-OUT DESIGN																		
DOC BUILD-OUT CONSTRUCTION																		

Table 8-2 – Project Sequencing (continued)

	Interim				Near Term							Long Term					
	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	
DOC 1 – Lincoln (continued)																	
DOC HARDWARE AND COMMUNICATIONS																	
DOC HARDWARE AND COMMUNICATIONS UPGRADE																	
DOC SOFTWARE IMPLEMENTATION																	
ITS FIELD EQUIPMENT DESIGN																	
ITS FIELD EQUIPMENT CONSTRUCTION																	
DOC 3 - Norfolk																	
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																	
DOC BUILD-OUT DESIGN																	
DOC BUILD-OUT CONSTRUCTION																	
DOC HARDWARE AND COMMUNICATIONS																	
DOC HARDWARE AND COMMUNICATIONS UPGRADE																	
DOC SOFTWARE IMPLEMENTATION																	
DOC 4 - Grand Island																	
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																	
DOC BUILD-OUT DESIGN																	
DOC BUILD-OUT CONSTRUCTION																	
DOC HARDWARE AND COMMUNICATIONS																	
DOC HARDWARE AND COMMUNICATIONS UPGRADE																	
DOC SOFTWARE IMPLEMENTATION																	
DOC 5 - Bridgeport																	
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																	
DOC BUILD-OUT DESIGN																	
DOC BUILD-OUT CONSTRUCTION																	
DOC HARDWARE AND COMMUNICATIONS																	

Table 8-2 – Project Sequencing (continued)

	Interim				Near Term							Long Term						
	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19		
DOC HARDWARE AND COMMUNICATIONS UPGRADE																		
DOC 5 – Bridgeport (continued)																		
DOC SOFTWARE IMPLEMENTATION																		
AVL SOFTWARE																		
AVL HARDWARE AND COMM. (on vehicles) PHASE A																		
AVL HARDWARE AND COMM. (on vehicles) PHASE B																		
DOC 6 - North Platte																		
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																		
DOC BUILD-OUT DESIGN																		
DOC BUILD-OUT CONSTRUCTION																		
DOC HARDWARE AND COMMUNICATIONS																		
DOC HARDWARE AND COMMUNICATIONS UPGRADE																		
DOC SOFTWARE IMPLEMENTATION																		
DOC 7 - McCook																		
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																		
DOC BUILD-OUT DESIGN																		
DOC BUILD-OUT CONSTRUCTION																		
DOC HARDWARE AND COMMUNICATIONS																		
DOC HARDWARE AND COMMUNICATIONS UPGRADE																		
DOC SOFTWARE IMPLEMENTATION																		
DOC 8 - Ainsworth																		
PIONEERNET CLIENT HARDWARE / SOFTWARE / COMM.																		
DOC BUILD-OUT DESIGN																		
DOC BUILD-OUT CONSTRUCTION																		
DOC HARDWARE AND COMMUNICATIONS																		

Table 8-2 – Project Sequencing (continued)

	Interim				Near Term						Long Term					
	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
DOC 8 - Ainsworth																
DOC HARDWARE AND COMMUNICATIONS UPGRADE																
DOC SOFTWARE IMPLEMENTATION																
STATEWIDE ITS PROJECTS																
STATEWIDE DMS DESIGN																
ALT. ROUTE PLANNING & DMS MESSAGE SET DEV.																
STATEWIDE DMS CONSTRUCTION - PHASE III / IV																
STATEWIDE DMS CONSTRUCTION - PHASE V-VIII																
STATEWIDE CCTV / DIGITAL CAMERA DESIGN																
STATEWIDE CCTV / DIGITAL CAMERA CONSTRUCTION																
STATEWIDE RURAL ITS FIELD EQUIPMENT DESIGN																
STATEWIDE RURAL ITS FIELD EQUIPMENT CONST.																
COMM. BACKBONE - DESIGN & INTEGRATION																
COMMUNICATIONS BACKBONE - PHASE I (D-2-Ruff)																
COMMUNICATIONS BACKBONE - PHASE II (Lnk-Green)																
COMMUNICATIONS BACKBONE - PHASE III (Connect)																
DOC HARDWARE AND COMM. UPGRADE DESIGN																
INT. W/ LEASED LINE COMM. (Capital Costs Only)																

8.3 Required Inter-Agency Agreements

The NDOR Statewide ITS Architecture has identified several agency interfaces and information exchanges that would be needed to provide the ITS services and systems identified by the stakeholders in the state. Interfaces and data flows among public and private entities in Nebraska will require agreements among agencies that establish parameters for sharing agency information to support traffic management, incident management, provide traveler information, and other functions identified in the NDOR Statewide ITS Architecture.

Currently, there are no formal operational agreements in place in Nebraska with regards to ITS. However, as a symbol of the spirit of cooperation in Nebraska, several stakeholders (NDOR, NSP, NEMA, ARNG, City of Omaha, City of Lincoln, MAPA, Metro Area Transit, University of Nebraska) did sign a cooperate agreement to support the implementation of the Joint Operations Center concept.

Stakeholders indicated that while there is a high degree of cooperation among agencies, there hasn't been a need for formal agreements to facilitate multi-jurisdictional resource sharing and cooperation. With the implementation of ITS technologies, integrating systems from one or more agencies, the anticipated level of information exchange identified in the architecture, it is likely that more formal agreements will be needed. These agreements, while perhaps not requiring a financial commitment from agencies in the state, should outline specific roles, responsibilities, data exchanges, levels of authority, and other facets of regional operations. Some agreements also will outline specific funding responsibilities, where appropriate and applicable.

Table 8-3 provides a list of potential agreements based on the interfaces identified in the NDOR Statewide ITS Architecture. It is important to note that as ITS services and systems are implemented in the state, part of the planning and review process for those projects should include a review of potential agreements that would be needed for implementation or operations.

Table 8-3 – Potential Agreements for Statewide ITS Operations

Agreement and Agencies	Agreement Description	Considerations
Data Sharing and Usage (Public) NDOR, NSP, City of Omaha, City of Lincoln, and other public agencies throughout the state	This agreement would define the parameters, guidelines and policies for inter- and intra-agency ITS data sharing. This data sharing would support statewide activities related to traffic management, incident management, and traveler information, and other functions. Data also would include video images from CCTV cameras. The terms of this agreement should generally address such items as: <ul style="list-style-type: none"> ▪ Types of data to be shared ▪ Repository for information (i.e., District Operations Centers as central hub) ▪ How the information will be used (traffic incident management, displayed on web site for travel information, distributed to media, etc.) ▪ Parameters for data format, quality, security 	These agreements are typically zero-dollar agreements, in that there is no charge among agencies for the actual data, although there might be some cost incurred for infrastructure, systems or fiber to enable communications between agencies.

Table 8-3 – Potential Agreements for Statewide ITS Operations (continued)

Agreement and Agencies	Agreement Description	Considerations
Data Sharing and Usage (Public-Private) NDOR and Private Media/Information Service Providers	This agreement would define the parameters, guidelines and policies for private media use of statewide ITS-related information from NDOR. This type of agreement is recommended between NDOR (data provider) and the media (data user) to define terms of use for broadcasting public-agency information regarding traffic conditions, closures, restrictions, as well as video images. Agreements can also include requirements for the media to 'source' the information (i.e., using the NDOR logo on all video images broadcast).	These agreements can be zero-dollar agreements, although some agencies have stipulated identifying the information, public service announcements by the media, or other requirements as a term of use. The private media entity is typically responsible for paying any necessary costs for access (i.e., communications infrastructure to link to the NDOR database or video switch). These agreements also typically include a sunset clause to allow the agency to periodically review the agreement and make any modifications prior to renewal.
Shared Video Monitoring (Public) NDOR, City of Omaha, City of Lincoln, NEMA, ARNG, NSP	This agreement would enable shared video monitoring of CCTV cameras by public safety and emergency services agencies in incident management purposes. This agreement would define the parameters and policies for public safety agencies to access video images via the NDOR video switch. It is recommended that the agreement include any NDOR policies relating to video images (including archiving, privacy, disclaimers, use of video and redistribution) as well as processes for agency requests for specific views. Shared video monitoring does not address shared use or shared control of video equipment functions.	These agreements are typically zero-dollar agreements, in that there is no charge among agencies for the actual data, although there might be some cost incurred for infrastructure, systems or fiber to enable communications between agencies, particularly with the high bandwidth required for transmitting live video images.
Mutual Aid Agreements (Public) NSP, NDOR, Local Public Safety and Emergency Services	Formal mutual aid agreements will become more important as agencies integrate systems and capabilities, particularly automated dispatch and notification.	These agreements are typically zero-dollar agreements, although there might be some funding required to support statewide incident management activities. The agreement also would outline resource commitments that would be part of any mutual aid arrangement (personnel, equipment, facilities, etc.).
Joint/Shared Control and Operations Agreements (Public) NDOR, City of Omaha, City of Lincoln, NEMA, ARNG, NSP	These agreements are formal arrangements to allow joint control of certain systems and equipment. The agreement should define the terms of this arrangement, such as hours of operation and time of day/time of week where shared control would take effect, circumstances or incidents where shared control would take effect, notification procedures between the agencies agreeing to shared control.	Joint operations/shared control agreements could consider some form of mutual funding for certain system elements, primarily communication links.

Table 8-3 – Potential Agreements for Statewide ITS Operations (continued)

Agreement and Agencies	Agreement Description	Considerations
Software Use/Ownership NDOR, NSP, NEMA, ARNG	Agreements are required for software use and ownership issues. The software use/ownership agreements should address, at a minimum, who owns the joint software, who upgrades the software, who maintains the software. In addition, all software contracts should clearly state that NDOR, or other appropriate agency, has ownership of the software and is able to use the software at will without incurring additional costs to the vendor/software developer.	Software ownership by the public agency may initially cost more, but over the life-cycle of the software will prove to be more economical. Software agreements are critical to avoid some of the challenges that other state agencies have run into when attempting to deploy statewide systems without early agreements in place.

9. STANDARDS

ITS standards are fundamental to the establishment of an open ITS environment that achieves the goals originally envisioned by the USDOT. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances and new approaches evolve.

Standards help create competition, better products, and lower prices. The examples that best exhibits this are the telecommunications and computer industries. The openness of the ITS architecture standards allow considerable latitude in the selection of technologies for use in systems and also urge manufacturers to continually improve their products and develop new ones. ITS standards:

- Facilitate interoperability of basic functionality;
- Promote system integration; and
- May be linked to federal funding in the future.

Standards can be applied to the different elements of Intelligent Transportation Systems:

- Communication standards;
- Data standards;
- Message set standards;
- Equipment standards; and
- Software standards.

9.1 Standards Development Organizations

The USDOT's ITS Joint Program Office is supporting Standards Development Organizations (SDOs) with an extensive, multi-year program of accelerated standards development to facilitate successful ITS deployment. The program is supporting and accelerating the ITS consensus-based volunteer standards processes that are underway in the United States.

The following is a list of the current standard development organizations working on developing ITS standards:

- American National Standards Institute (ANSI);
- American Society for Testing and Materials (ASTM);
- Electronic Industries Alliance (EIA);
- Institute of Electrical and Electronics Engineers (IEEE);
- Institute of Transportation Engineers (ITE);
- Society of Automotive Engineers (SAE); and
- National Transportation Communications for ITS Protocol (NTCIP).

NTCIP is a joint product of the National Electronics Manufacturers Association (NEMA), the American Association of State Highway and Transportation Officials (AASHTO), and ITE.

9.2 NTCIP Standards

NTCIP is a family of standards that provides both the rules for communicating (called protocols) and the vocabulary (called objects) necessary to allow electronic traffic control equipment from different manufacturers to operate with each other as a system. NTCIP is the first set of standards for the transportation industry that allows traffic control systems to be built using a “mix and match” approach with equipment from different manufacturers. NTCIP standards reduce the need for reliance on specific equipment vendors and customized one-of-a-kind software.

9.3 Applicable ITS Standards for Statewide ITS Systems

Looking at the ITS standards as a foundation for building the systems identified in the architecture, **Table 9-1** lists all ITS related standards at various stages of development (published, approved, in-balloting or under development) and highlights the applicable standards for the Statewide and District Operations Centers Project. NTCIP Center-to-Field (C_{2F}) and Center-to-Center (C_{2C}) Groups of Standards have also been identified.

The NTCIP Center-to-Field (NTCIP C_{2F}) Group of Standards addresses the communications protocols between a center and the ITS field devices it manages. The family includes communications profiles that cover interconnects between a traffic management center and DMS, ramp meters, traffic signals, environmental sensors, CCTVs, or other field devices under its control.

The NTCIP Center-to-Center (NTCIP C_{2C}) Group of Standards addresses the communications protocols between two centers (e.g., two traffic management centers exchanging information to facilitate regional coordination of traffic signals). Some of the communication protocols covered by this family are CORBA, DATEX-ASN and FTP.

Status is defined in **Table 9-1** as the following:

- ***Published – (P)***: Standards that are available for purchase;
- ***Approved – (A)***: Standards that have passed all necessary ballots and have been approved by a standards development organization but not yet published;
- ***In Balloting – (IB)***: Standards that are being voted upon by a committee or working group, or are undergoing other SDO procedures; and
- ***Under Development – (UD)***: Standards that are being written but are not yet ready for a formal ballot.

Turbo Architecture provides an ITS Standards Report based on all of the architecture flows selected in the Statewide and District Operations Centers System Architecture. This report is provided in **Appendix F**. **Appendix F** lists the standards associated with each of the alphabetically listed architecture flows.

Table 9-1 – Applicable Standards for Statewide and District Operations Centers System

SDO	Standard Number	Standard Title	Applicable to Statewide and DOC System	Status
AASHTO	1101	NTCIP – Simple Transportation Management Framework (STMF)	YES _{C2F}	P
AASHTO	1102	NTCIP – Octet Encoding Rules	YES _{C2F/C2C}	A
AASHTO	1103	NTCIP – Simple Transportation Management Protocol (STMP)	YES _{C2F}	UD
AASHTO	1104	NTCIP – CORBA Naming Convention Specification	YES _{C2C}	UD
AASHTO	1105	NTCIP – CORBA Security Service Specification	YES _{C2C}	UD
AASHTO	1106	NTCIP – CORBA Near Real-Time Data Service Specification	YES _{C2C}	UD
AASHTO	1201	NTCIP – Global Object Definitions	YES	P
AASHTO	1202	NTCIP – Object Definitions for Actuated Traffic Signal Controller Units	YES	P
AASHTO	1203	NTCIP – Object Definitions for Dynamic Message Signs	YES	P
AASHTO	1204	NTCIP – Object Definitions for Environmental Sensor Stations	YES	P
AASHTO	1205	NTCIP – Object Definitions for Closed Circuit Television Camera Control	YES	P
AASHTO	1206	NTCIP – Object Definition for Data Collection and Monitoring Devices	NA	UD
AASHTO	1207	NTCIP – Object Definitions for Ramp Meter Control	YES	P
AASHTO	1208	NTCIP – Object Definitions for Video Switches	YES	UD
AASHTO	1209	NTCIP – Object Definitions for Transportation Sensor Systems	YES	UD
AASHTO	1210	NTCIP – Objects Definitions for Signal System Masters	YES	UD
AASHTO	1211	NTCIP – Objects Definitions for Signal Control Priority	YES	UD
AASHTO	1301	NTCIP – Weather Report Message Set for ESS	YES	UD
AASHTO	1601	NTCIP – CORBA Base Object Model for TMS	NA	UD
AASHTO	2001	NTCIP – Class B Profile	YES _{C2F}	P
AASHTO	2101	NTCIP – Point-to-Multi-point Protocol/RS232 Subnetwork Profile	YES _{C2F}	P
AASHTO	2102	NTCIP – Subnetwork Profile for Point to Multi-point Protocol Using FSK Modems	YES _{C2F}	IB
AASHTO	2103	NTCIP – Subnetwork Profile for Point to Point using RS 232	YES _{C2F}	IB
AASHTO	2104	NTCIP – Subnetwork Profile for Ethernet	YES _{C2F/C2C}	IB
AASHTO	2201	NTCIP – Transportation Transport Profile	YES _{C2F}	IB
AASHTO	2202	NTCIP – Internet (TCP/IP and UDP/IP) Transport Profiles	YES _{C2F/C2C}	P
AASHTO	2301	NTCIP – STMF Application Profile	YES _{C2F}	P
AASHTO	2302	NTCIP – Trivial File Transfer Protocol – Application Profile	YES _{C2F}	P
AASHTO	2303	NTCIP – File Transfer Protocol – Application Profile	YES _{C2F/C2C}	P
AASHTO	2304	NTCIP – Application Profile – Data Exchange (DATEX)	YES _{C2C}	A
AASHTO	2305	NTCIP – Application Profile – CORBA	YES _{C2C}	UD
AASHTO	2501	NTCIP – Information Profile for DATEX	YES _{C2C}	UD
AASHTO	2502	NTCIP – Information Profile for CORBA	YES _{C2C}	UD
AASHTO	8003	NTCIP – Profiles – Framework and Classification of Profiles	NA	P
ITE	1400	TCIP – Framework	NA	P
ITE	1401	TCIP – Common Public Transportation (CPT) Objects	NA	P



SDO	Standard Number	Standard Title	Applicable to Statewide and DOC System	Status
ITE	1402	TCIP – Incident Management (IM) Objects	NA	P
ITE	1403	TCIP – Passenger Information (PI) Objects	NA	P
ITE	1404	TCIP – Scheduling/Runcutting (SCH) Objects	NA	P
ITE	1405	TCIP – Spatial Representation (SP) Objects	NA	P
ITE	1406	TCIP – Onboard (OB) Objects	NA	P
ITE	1407	TCIP – Control Center (CC) Objects	NA	P
ITE	1408	TCIP – Fare Collection (FC) Objects	NA	P
ITE	9603-1	ATC Application Program Interface (API)	YES	UD
ITE	9603-2	ATC Cabinet	NA	UD
ITE	9603-3	Advanced Transportation Controller (ATC)	YES	UD
ITE	TM 1.03	Standard for Functional Level Traffic Management Data Dictionary (TMDD)	YES	A
ITE	TM 2.01	Message Set for External TMC Communication (MS/ETMCC)	YES	A
ITE	TS3.TM	TCIP – Traffic Management (TM) Objects	NA	UD
ANSI	TS284	Commercial Vehicle Safety Reports	NA	P
ANSI	TS285	Commercial Vehicle Safety and Credentials Information Exchange	NA	P
ANSI	TS286	Commercial Vehicle Credential	NA	P
ASTM	E2158	Standard Specification for DSRC – Physical Layer 902-928 MHz	NA	P
ASTM	E2213	Standard Specification for Telecommunications and Information Exchange between Roadside and Vehicle Systems: 5.9 GHz DSRC	NA	P
ASTM	PS105	Standard Specification for DSRC – Data Link Layer	NA	P
ASTM	DD17.54.00.2	ADMS Data Dictionary Specifications	Unable to locate status information	
EIA/CEA	EIA-794	Data Radio Channel (DARC) System	NA	P
EIA/CEA	EIA-795	Subcarrier Traffic Information (STIC) System	NA	P
IEEE	P1404	Guide for Microwave Communications System Development	NA	P
IEEE	P1455	Message Sets for DSRC ETTM and CVO	NA	P
IEEE	P1488	Standard for Message Set Template for ITS	NA	P
IEEE	P1489	Standard for Data Dictionaries for Intelligent Transportation Systems	NA	P
IEEE	P1512.a	Standard for Emergency Management Data Dictionary	Unable to locate status information	
IEEE	P1512-2000	Standard for Common Incident Management Message Sets (IMMS) for use by EMCs	YES	P
IEEE	P1512.1	Standard for Traffic Incident Management Message Sets for Use by EMCs	YES	A
IEEE	P1512.2	Standard for Public Safety Incident Management Message Sets for Use by EMCs	YES	UD
IEEE	P1512.3	Standard for Hazardous Material Incident Management Message Sets for Use by EMCs	YES	P

SDO	Standard Number	Standard Title	Applicable to Statewide and DOC System	Status
IEEE	P1556	Standard for Security and Privacy of Vehicle/Roadside Communication Including Smart Card Communication	N/A	UD
IEEE	P1570	Standard for Interface Between Rail Subsystem and Highway Subsystem at Highway Rail Intersection	YES	P
IEEE	SH94633-94638	Survey of Communications Technologies	NA	P
SAE	J1746	ISP-Vehicle Location Referencing Standard	NA	P
SAE	J1663	Truth-in-Labeling Standard for Navigation Map Databases	NA	P
SAE	J1708	Serial Data Comm. Between Microcomputer and Heavy Duty Vehicle Applications	NA	P
SAE	J1760	ITS Data Bus Data Security Services Recommended Practice	NA	P
SAE	J1761	Information Report on ITS Terms and Definitions	NA	P
SAE	J1763	A Conceptual ITS Architecture: An ATIS Perspective – Information Report	NA	P
SAE	J2313	On-Board Land Vehicle Mayday Reporting Interface	NA	P
SAE	J2352	Mayday Industry Survey Information Report	NA	P
SAE	J2353	Advanced Traveler Information System (ATIS) Data Dictionary	YES	P
SAE	J2354	Message Set for Advanced Traveler Information Systems (ATIS)	YES	P
SAE	J2355	ITS Data Bus Reference Architecture Information Report	NA	P
SAE	J2366-4	ITS Data Bus Protocol – Thin Transport Layer Recommended Practice	NA	P
SAE	J2366-7	ITS Data Bus Protocol – Application Layer Recommended Practice	NA	A
SAE	J2366-1	ITS Data Bus Protocol – Physical Layer Recommended Practice	NA	P
SAE	J2366-2	ITS Data Bus Protocol – Link Layer Recommended Practice	NA	P
SAE	J2369	Standards for ATIS Message Sets Delivered Over Bandwidth Restricted Media	NA	P
SAE	J2372	Field Test Analysis Information Report	NA	P
SAE	J2373	Stakeholders Workshop Information Report	NA	P
SAE	J2374	National Location Referencing Information Report	NA	P
SAE	J2395	ITS In-Vehicle Message Priority	NA	P
SAE	J2396	Measurement of Driver Visual Behavior Using Video Based	NA	P
SAE	J2399	Adaptive Cruise Control: Operating Characteristics and User Interface	NA	A
SAE	J2400	Forward Collision Warning: Operating Characteristics and User Interface	NA	IB
SAE	J2529	Rules for Street Names and Route IDs	YES	A
SAE	J2539	Comparison of GATS Messages to SAE ATIS Standards Information Report	NA	P
SAE	J2540	Messages for Handling Strings and Look-Up Tables in ATIS Standards	YES	P

9.4 Application of Standards

NDOR is fully committed to both the concept and practice of using standards whenever and wherever feasible and/or practical. However, the required functionality of a system must not, at

any point in time, be **unduly** constrained by the **availability** or lack of availability of applicable standards. In fact, whether or not to use an available standard must ultimately be based on whether or not (or to what extent) it supports the required system function and its overall associated implementation costs. The use of this approach to the application of standards is consistent with FHWA's recommended ITS systems engineering approach and will help facilitate the overall successful implementation of the associated systems.

In view of this, NDOR will utilize all applicable NTCIP standards (per **Table 9-1**) that have been Published and/or Approved at the time the final design scopes are being prepared for the NDOR Statewide system final designs. It is anticipated that, at a minimum, center-to-field standards, applicable to certain field devices (e.g. dynamic message signs and traffic signal controllers), and a standard protocol, applicable to center-to-center communication, will be utilized in these systems. However, due to the potential impact of such decisions on system costs, schedule and project risk, the final determination in regard to the application of these standards must be made during the final system design. At that time, the design team will determine what modifications, if any, have to be made to the applicable standard to make sure all functional requirements are supported and at the same time assess the associated project risk and costs. The associated project cost and risk will be presented to the project steering committee by which the final decision will be made as to whether or not the standard in question should be utilized.

NDOR recognizes that standards development is an ongoing process; therefore, in an effort to incorporate as many standards as possible, throughout the final design process, the design team will monitor the status of those standards in **Table 9-1** considered to be applicable. If an applicable standard whose status is currently "**In Balloting**" or "**Under Development**" achieves "**Approved**" status between now and the end of the final design, it will be evaluated (with regard to its impact on project functionality, budget and schedule) for use on this project.

9.5 Standards Testing

Testing is an important step toward interoperable ITS systems because it provides information to potential users on the reliability, interoperability, functionality, and performance of systems based upon the standards. The ITS standards testing efforts currently underway by the USDOT will prove the standards in actual transportation settings and give current and future users of the standards the information they need. For example, the standards testing program will provide needed information that will enable:

- Standards developers to improve the standards (if necessary);
- Systems developers and integrators to make business decisions about designing and building standardized ITS equipment; and
- Future deployers to know whether and how to specify standardized systems that will meet their needs.

Because integration with other transportation and public safety systems to the DOCs will likely be incremental and staged over a period of several years, it is critical that the standard interfaces be tested to ensure that future integration challenges will be minimized. Since the scope of the DOC project will include a sophisticated command and control structure, it will be beneficial to leverage the expertise and resources of the USDOT's Testing Program to ensure long-term compatibility as initial software-based interfaces are developed.

10. MAINTENANCE PLAN FOR THE NDOR STATEWIDE ITS ARCHITECTURE

As the region's needs change and as ITS systems are planned, the NDOR Statewide ITS architecture should be evaluated and updated. A plan for maintaining the architecture, including baseline definition, configuration management, and responsibility for this activity is documented in this section.

10.1 Statewide Architecture Maintenance

The NDOR Statewide Architecture is a living document. The recommendations contained in the document reflect the needs of the NDOR and associated stakeholders at the time when the document was developed. It is expected that the needs of the State will change as ITS deployments are put into place, population, and travel patterns change, and as new technology is developed. In order for the Architecture to remain a useful document, it must be evaluated and updated.

10.1.1 *Responsible Agency*

NDOR Transportation Technology Group, located in Lincoln, Nebraska, will serve as the lead agency and main custodian of the Architecture; however, close coordination will be required as the Metropolitan Planning Organizations in the Omaha and Lincoln areas develop regional ITS architectures. The primary contact for the Architecture is Paul Cammack, NDOR Transportation Technology Group. His telephone number is (402) 471-1808.

10.1.2 *Architecture Assessment and Gathering of Information*

The NDOR ITS Deployment Team and primary stakeholders will review the NDOR Statewide ITS Architecture document on an annual basis. Amendments resulting from changes during project implementation will be incorporated. In addition, amendments related to the future years work program will also be incorporated, thus allowing the element status (existing or planned), to be updated for many of the system components. Addition of new elements or subsystems may also occur during this time.

Throughout the year, stakeholders may also submit requests for changes to the Architecture to the NDOR Transportation Technology Group. Requests, which may be submitted informally via email, will be evaluated by NDOR to determine the impact of the change on the Architecture. NDOR TTG may either approve the change, and make the change in the Turbo Architecture database, or decide that the change should be presented to the ITS Deployment Team for discussion and approval at the next available opportunity.

The primary input to the annual ITS Architecture assessment, by the ITS Deployment Team, will be the changes required for the one and six year plans. Additional sources of input will be any emerging regional and project level ITS architecture documents; specifically, those requesting connections or changes to the NDOR Statewide ITS Architecture.

The Architecture assessment will ensure that projects included in the one and six year plan are included in the NDOR Statewide ITS Architecture as they advance to final design.

Following the annual review and assessment, the Turbo Architecture database files will be updated to reflect the evolution of the architecture flows from “planned” to “existing”, or other changes identified. The Turbo database will also be updated with new projects as they advance, subject to approval by NDOR TTG and the NDOR ITS Deployment Team.

10.1.3 Architecture Update Cycle

It is anticipated that major updates to the Architecture Report will occur approximately every five years, according to the needs identified during the annual review and assessment by the ITS Deployment Team.

10.2 Lincoln and Omaha Regional Architectures

As previously mentioned, the Lincoln and Omaha metropolitan areas are planning to develop regional architectures for their respective regions. These will be developed by the City of Lincoln, and the Metropolitan Area Planning Agency. During development of the Lincoln and Omaha regional ITS architectures, care should be taken to integrate the NDOR ITS elements into the Regional Architectures. In order to effectively use Turbo Architecture to manage the statewide and regional architectures, names for ITS elements common to each of the architectures must be identical. As the regional architectures are developed, NDOR staff will work with the MPO's to ensure consistency in naming conventions.

The next update of the NDOR Statewide Architecture will incorporate regional elements from the Lincoln and Omaha metropolitan areas that will connect to statewide systems. It is expected that this update will occur in approximately three to five years.

11. SUMMARY

The National ITS Architecture provides a common framework for the planning, design, and integration of ITS. The Architecture defines the functions that must be performed by components or subsystems, where these functions reside (e.g., roadside, traffic management center, or in-vehicle), the interfaces and information flows between subsystems, and the communications requirements for the information flows in order to address the underlying user service requirements.

This report presented the development NDOR Statewide ITS Architecture. This report included:

- Description of the region;
- Identification of participating agencies and other stakeholders;
- Operational Concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the Statewide ITS Architecture;
- Agreements required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operations of projects identified in the Statewide ITS architecture;
- System functional requirements;
- Interface requirements and information exchanges with planned and existing systems and subsystems (e.g., architecture interconnects and architecture flows);
- Identification of applicable ITS standards; and
- The sequence of projects required for implementation.

In summary, the National ITS Architecture is intended to serve as a “road map” to aid in the design and implementation of ITS projects. The NDOR Statewide ITS Architecture helps agencies in Nebraska determine how they fit into the “big picture” and how they can capitalize on existing and planned infrastructure.

12. NATIONAL ARCHITECTURE INFORMATION SOURCES

The following documents and web sites can be accessed for more detailed information about the National ITS Architecture and other related standards:

- Download the National Architecture documents from the ITS America web site (www.itsa.org/architecture.html)
- For more information on current standards and development efforts:
 - ITS America Standards Home Page (www.itsa.org)
 - USDOT Standards Home Page (www.its-standards.net)
 - Standards Acceleration Program Information (www.its.dot.gov)
 - National Transportation Communications for ITS Protocol (NTCIP) (www.ntcip.org)
 - Transit Communication Interface Protocol (TCIP) standards (www.tcip.org)
 - American National Standards Institute (ANSI) (www.ansi.org)
 - Institute of Transportation Engineers (ITE) (www.ite.org)
 - International Standards Organization (ISO) (www.iso.ch)
 - Society of Automotive Engineers (SAE) (www.sae.org)

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