VIRGINIA CENTRAL REGION ITS ARCHITECTURE IMPLEMENTATION PLAN

Version 1.0

Prepared for:

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ITERIS® Innovation for better mobility

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1 Introduction

The Virginia Central Region (CR) ITS Architecture is a blueprint for the deployment of ITS in the region. Just as blueprints are critical for constructing a building, an ITS architecture is invaluable for ITS deployment. To assist ITS deployment, this Architecture Implementation Plan includes information on how to use the Virginia CR ITS Architecture for planning and deploying ITS projects. It also includes a sequence of ITS projects that can be used to implement the vision captured in the architecture agreements that are needed for deployment of the projects.

2 Use of Architecture

A critical part of developing an ITS architecture is establishing an approach to using it. An architecture provides guidance for planning ITS projects within a region. It also provides information that can be used in the initial stages of project deployment.

This section presents an approach for integrating the Virginia CR ITS Architecture into the transportation planning processes used in the region thereby leveraging the architecture for project definition. The approach provides a mechanism for the projects identified in the architecture to be planned and deployed in an orderly and integrated fashion thereby facilitating comprehensive planning of ITS in the region.

The overall objective of an ITS architecture is to support the effective and efficient deployment of ITS that addresses the transportation needs of the region. The architecture focuses on the integration of systems to gain the maximum benefit of each system's information and capabilities across the transportation network. Use of the architecture connects the ITS projects that are deployed within the region with the stakeholders' vision. The architecture defines "what" needs to be put in place to address the needs and requirements of the region. Using the architecture in the transportation planning process will leverage the architecture as a roadmap to project sequencing to achieve an integrated transportation system that addresses the strategic objectives of the region.

The architecture supports planning of ITS projects in both the long range and short term and the initial stages of project deployment. The approach to using the Virginia CR ITS Architecture for these three activities is given in the following sections. The section concludes with examples of how to use an architecture.

2.1 Architecture Use for Planning

One of the most important outcomes of the Virginia CR ITS Architecture is that it will be used to plan ITS across the region. To do this, the architecture must be integrated into the region's transportation planning processes. The primary goal of a transportation planning process is to make quality, informed decisions on the investment of funds for regional transportation systems and services, so integrating use of the architecture into the process will link the objectives and needs of the region identified in the architecture with ITS project deployments.

Figure 1 is a basic diagram of planning of transportation projects in Virginia. The elements of the process that the Virginia CR ITS Architecture will support are highlighted.

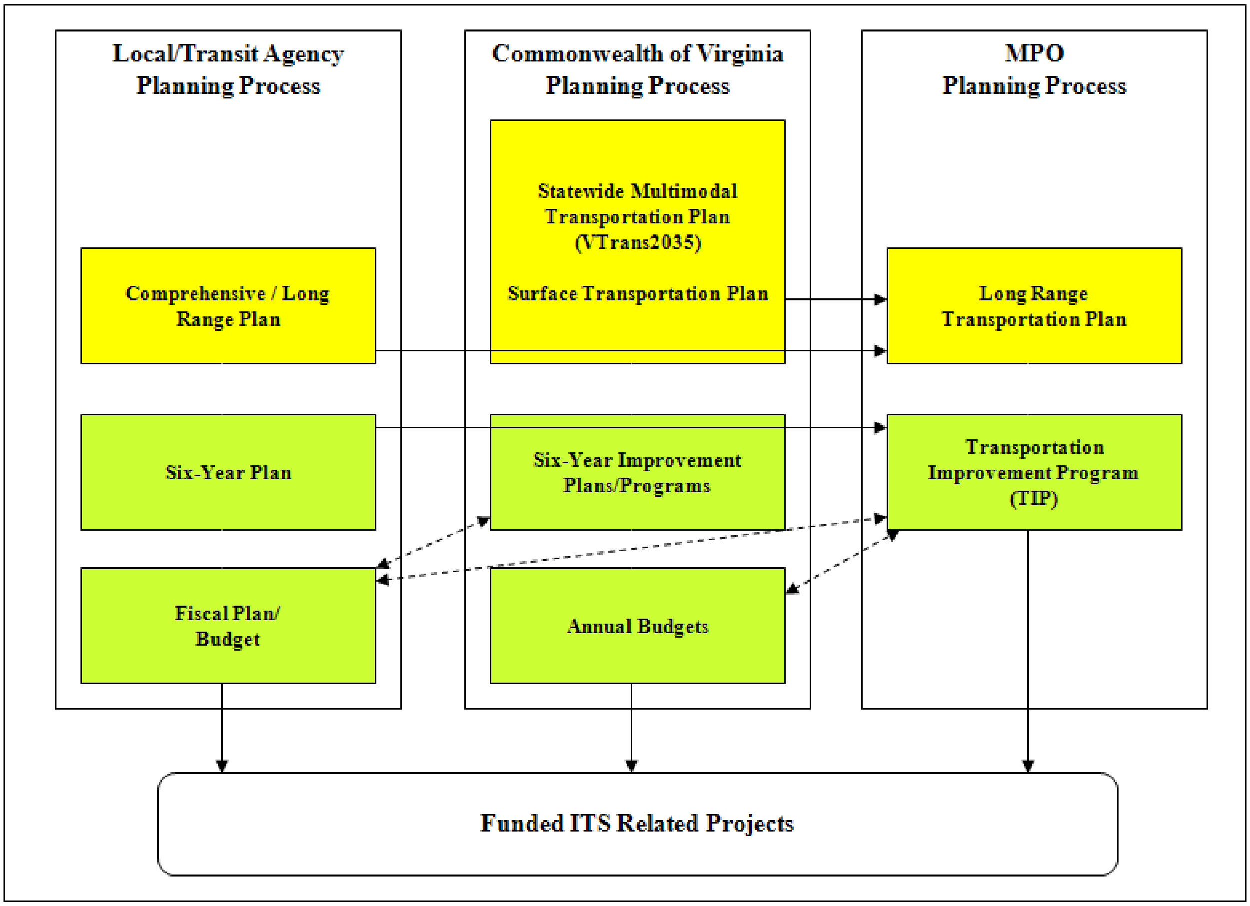

Figure 1: Use of Virginia CR ITS Architecture for Planning

In the Central Region of Virginia, transportation planning is performed by many agencies including the Virginia Department of Transportation (VDOT), the Virginia Department of Rail and Public Transportation (DRPT), the Central Region Metropolitan Planning Organizations (MPOs) and local (i.e. county and municipal) transportation and transit agencies.

Figure 1 shows how ITS related projects are identified and funded. Since various agencies are responsible for transportation assets and projects are funded from varying sources including federal, state and local funds and transit revenue, there are multiple planning processes occurring simultaneously in the region.

The planning processes in the region can be categorized as three types:

- Local/Transit Agency Planning Process (the left hand box) - the typical process used to allot local or transit agency funds including matching funds for federally funded projects. There are no specific requirements for local agency planning.
- Commonwealth of Virginia Planning Process (the middle box) - Transportation planning for the Commonwealth of Virginia is lead by the Commonwealth Transportation Board (CTB). The CTB provides funding for airports, seaports and public transportation and allocates state transportation funds and federal funds administered by the state to specific highway projects for state maintained roads including interstates and primary and secondary state highways. Two outputs of the process are:

VTrans2035 - The statewide long-range multimodal transportation plan is the “blueprint for shaping the transportation future” in the state. The plan “establishes a commonly held vision, goals, and objectives to guide and direct decision-making across transportation modes.” VDOT and DRPT assist the CTB in preparing the Surface Transportation Plan which is part of the multimodal plan. *VTrans* plan has a time horizon of at least 20 years and is updated at least every 5 years.

Six-Year Improvement Plans/Programs – The Six-Year Plans/Programs allocate funding for projects proposed for construction, deployment, development or study in the next six years. The plans are developed by VDOT for the interstate and primary roadway system, local agencies for the secondary roadway system, transit agencies, etc. The plans are updated yearly.

- MPO Planning Process (the rightmost box) – In Central Region, MPOs, in cooperation with the state, locals and transit operators, are responsible for planning of federally funded projects. In the Central Region the MPOs are the Fredericksburg Area, Richmond Area, and CRATER. The federally-mandated documents of the process are:

  Long Range Transportation Plan - Must cover a period of at least 20 years and be updated every 4 or 5 years, respectively, if the region is an air-quality attainment or not.

  Transportation Improvement Program - Lists projects for the next one or two years. The Program must be updated yearly.

All three types of processes can be used to fund ITS projects in Central Virginia. Most ITS projects are funded from more than one funding source, as for most federally funded projects, the state and/or locals must contribute matching funds.

Although there are multiple organizations involved, each with their own process, the planning processes in the region are similar at the highest level. Each organization plans for the long range and plans and/or budgets for the near term. Long range plans are highlighted in yellow in Figure 1 while short term plans, programs and budgets are in green. Long range plans including VDOT’s VTrans2035, Local or Transit Agencies’ Comprehensive Plan and the MPO’s Long Range Transportation Plan establish the vision, goals and objectives to guide funding decisions. Based on current needs, plans for the shorter term, such as MPO’s Transportation Improvement Program, VDOT’s Six-Year Improvement Program and Local/Transit Agencies’ Capital Improvement Program or Strategic Plan, identify the specific projects that will be funded based on expected funding levels. To officially allocate funds annually or biannually, agencies have a budget or capital plan.

How the Virginia CR ITS Architecture can be used to support long range planning and programming and budgeting is presented in the following sections.

2.1.1 Architecture Use for Long Range Planning

Long range planning sets the policy direction for the agency or in the case of the MPO, the region. A long range plan defines a vision of the transportation system to guide project deployment decisions. Since the Virginia CR ITS Architecture contains the stakeholders’ vision of ITS for the region in the next 10+ years, it can serve as direct input to a long range plan.

For the Virginia Statewide Multimodal Transportation Plan (currently VTrans2035) and region’s Long Range Plans, the Virginia CR ITS Architecture could be incorporated either directly as a section or appendix or by reference. For comprehensive plans of local and transit agencies, it may be appropriate to include portions of the architecture (such as the relevant services, stakeholders and their elements, and/or interfaces). In long range plans, an ITS architecture is typically included or referenced in a section on systems management and operations which is required in state and metropolitan area plans by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

In addition to being a direct input to the plan document, the Virginia CR ITS Architecture can be used in the process to develop a long range plan. While there isn't a set process for transportation long-range planning, steps that are typical to a process are listed in Table 1. The architecture can be used to support the initial steps of the process as described in Table 1. For an example of how an architecture can be used to support development of a long range plan, see Section 2.3.1.

Table 1: How the Architecture Supports Long Range Transportation Planning

Typical Long Range Planning Step	How to Use the Architecture
Development of goals and objectives for the region	As the architecture provides the vision of ITS for the future as seen by regional stakeholders it can be used to define ITS-related goals and/or objectives. Specifically the list of ITS services provides insight into how stakeholders plan to meet their transportation needs so they can be used to define goals and/or objectives.
Identification of existing transportation needs	In addition to roadway capacity and safety data analysis, the list of ITS services included in the architecture should be reviewed as they were selected to address needs of the stakeholders. Additionally, the list of ITS elements should be reviewed to identify any that require on-going operation and/or maintenance.
Forecasting of future travel conditions and needs	The ITS services included in the architecture were selected to address both existing and future needs so they should be reviewed to identify future needs as well.
Development of candidate strategies and/or projects to meet needs and goals and objectives of the region	The types/categories of ITS services included in the architecture can be defined as candidate operational strategies for the region. Additionally, projects are defined in the project sequencing for near, medium and long term. The longer term projects are typically not specific projects but operational strategies that will be deployed. Finally, more traditional candidate strategies identified for the region should be evaluated to see if ITS (primarily the elements and services from the architecture) can and should be included in them. For example, ITS may be able to better manage traffic during and/or following a construction project.
Estimating the cost of the candidate strategies and/or projects	In the project sequencing in the architecture, ITS projects can be defined for the near, medium and long term. A cost estimate of each project may be derived from the project definition/scope.

Table 1: How the Architecture Supports Long Range Transportation Planning

Typical Long Range Planning Step	How to Use the Architecture
Estimating the expected effectiveness of each candidate strategy and/or project	In the project sequencing, the expected benefits of ITS projects defined for the near, medium and long term may be available.
Calculating the expected amount of funding from existing sources	N/A
Selecting preferred strategies and/or projects from list of candidates	N/A
Calculating expected air-quality impacts of projects	N/A
Finalizing list of projects	N/A

There are synergistic benefits of combined ITS deployments including improved efficiency and reduced risk. Due to jurisdictional and service lines, it is difficult for agencies to take a broad view, a regional view, when deploying ITS. Since the architecture is a regional plan, using it architecture for long range planning addresses this challenge.

2.1.2 Architecture Use for Programming and Budgeting

Before transportation projects can be deployed, funding must be identified and the projects defined in more detail. In the project programming and budgeting process, the Virginia CR ITS Architecture is useful to project sponsors who will deploy the project and are responsible for securing funding for the project, and to planners who assist decision-makers in making funding decisions. As detailed in the following sections, the architecture can be used by ITS project sponsors to identify projects and define the scope of them and by planners to assist in prioritizing projects. For an example of how an architecture can be used to support programming and budgeting, see Section 2.3.2.

Use by Project Sponsors

The Virginia CR ITS Architecture can be used by ITS project sponsors to identify and define a project in more detail to assist in obtaining funding for it. It is important to use the architecture to identify potential integration opportunities for the project early so adequate funding can be acquired. Using the architecture benefits a project sponsor as they are able to more accurately estimate the project budget and schedule based on a full understanding of the elements and interfaces included in the project. The components of the architecture most useful to project sponsors are:

- Services – Services offer service-oriented slices of the architecture that facilitate project definition with an understanding of integration opportunities. The services provide sponsors with insight into the elements included and impacted by a project so the project can be as comprehensive as possible. Looking at the services involved in a project, project sponsors can identify potential partners who can share development costs, material and/or labor, facilities, etc.

- Interfaces / Information Flows – Much like the services, the interfaces or information flows within the architectures provide information about the relationships between systems in the region. A project sponsor can review the interfaces between systems in a project to determine what other systems and stakeholders are affected by a project.

- Project Sequencing – The project sequencing identifies ITS projects for the region in the near, medium and long term. This list can guide project sponsors in identifying projects. The project sequencing in the architectures gives insight into the dependencies of the projects and map provide estimates of the cost and benefits of each project.

Use by Transportation Planners

The Virginia CR ITS Architecture can be used by transportation planners to assist in prioritizing projects for funding. Since ITS projects are weighed against other transportation projects or may be part of more traditional projects, it can be difficult to compare them for prioritization. An additional challenge is achieving integration across ITS projects in a region as projects can depend on each other. The architecture focuses on interfaces between systems, giving an understanding of how the systems interrelate and, therefore, how the projects are related. The architecture can be used to identify integration opportunities to assist in making project funding decisions. The components of the architecture most useful in programming and budgeting ITS projects are:

- Operational Concept - The operational concept of the architecture defines the roles and responsibilities of the stakeholders of the region. It helps in understanding the relationships and dependencies that exist between stakeholders and their systems. When a project is defined with a scope, the operational concept provides more insight into the validity and comprehensiveness of the project definition. Deficiencies in the project definition can be identified and addressed in a more direct manner with specific information of the issues involved. In the end, this ensures thorough project definitions to support funding decisions.

- Services – Services offer service-oriented slices of the architecture that facilitate project definition with an understanding of integration opportunities. The services provide insight into the elements and stakeholders that can be included in a project, making the project as comprehensive as possible. To guide funding decisions, the services involved in a project can be reviewed to ensure that the project is as comprehensive as it needs to be to maximize benefits.

- Interfaces / Information Flows – Much like the operational concept and services, the interfaces or information flows within the architectures provide information about the relationships between systems in the region. The interface definitions in the architecture are more specific than in the operational concept in that information exchanges are defined rather than more general descriptions. The interfaces between systems in a project can be reviewed to determine if other systems affected by a project are included in it.

- Project Sequencing – The project sequencing provided in the architectures gives insight into the timelines and dependencies of one project to the next. Near term projects should be addressed first, before the medium or long term ones. The project sequencing also contains information for each project which may be useful in the evaluation or prioritization of projects including cost estimate, anticipated benefits (when available) and which ITS services are covered.

Since federally funded ITS projects are subject to project deployment requirements (of the FHWA Rule /FTA Policy on ITS Architecture and Standards Conformity), in a transportation program or budget, projects that contain ITS elements should be designated in some fashion so that project sponsors are aware of the associated requirements. See Section 2.2 for a discussion of the requirements.

2.1.3 Strategy to Promote Architecture Use for Planning

Using the Virginia CR ITS Architectures for transportation planning will coordinate ITS projects deployed based on the needs of the stakeholders. If the planning processes are using the same reference point, the architecture, then project coordination will occur regardless of stakeholder and funding source.

VDOT is responsible for planning of state funding and federal funding for state highways and interstates. VDOT will designate an individual or create a group who will be responsible for the application and monitoring of the Virginia CR ITS Architecture in the transportation planning process. The roles and responsibilities will be:

- Include checkpoints and review opportunities for architecture use in the planning process,
- Provide guidance on taking advantage of the information contained in the architecture for the planning of ITS projects,
- Lead the evaluation of ITS projects for their compliance with the architecture,
- Serve as the point of contact for architecture questions regarding its application in the planning process,
- Outreach to stakeholders about how to use the architecture in the planning process,
- Provide feedback to the maintainer of the architecture on any architecture changes resulting from the planning of projects,
- Serve as a liaison between the MPOs and other planning organizations to share information about the projects in the various planning processes and coordinate integration opportunities.

In addition to the VDOT process, the MPOs and agencies of the region may need to make process modifications. It is recommended that these organizations designate an individual or group to be responsible for the application and monitoring of the ITS architecture in their respective planning processes and coordinate with the state and neighboring regions.

2.2 Architecture Use for Project Deployment

Using the Virginia CR ITS Architecture can benefit ITS project development and deployment. The architecture identifies more integration opportunities than can be implemented in a single project. Using it to identify potential opportunities in a project allows for future integration requirements to be included in the project and for phased implementation, if necessary, to be planned. Figure 2 shows the project development process for deploying ITS projects and highlights the steps that the architecture can support.

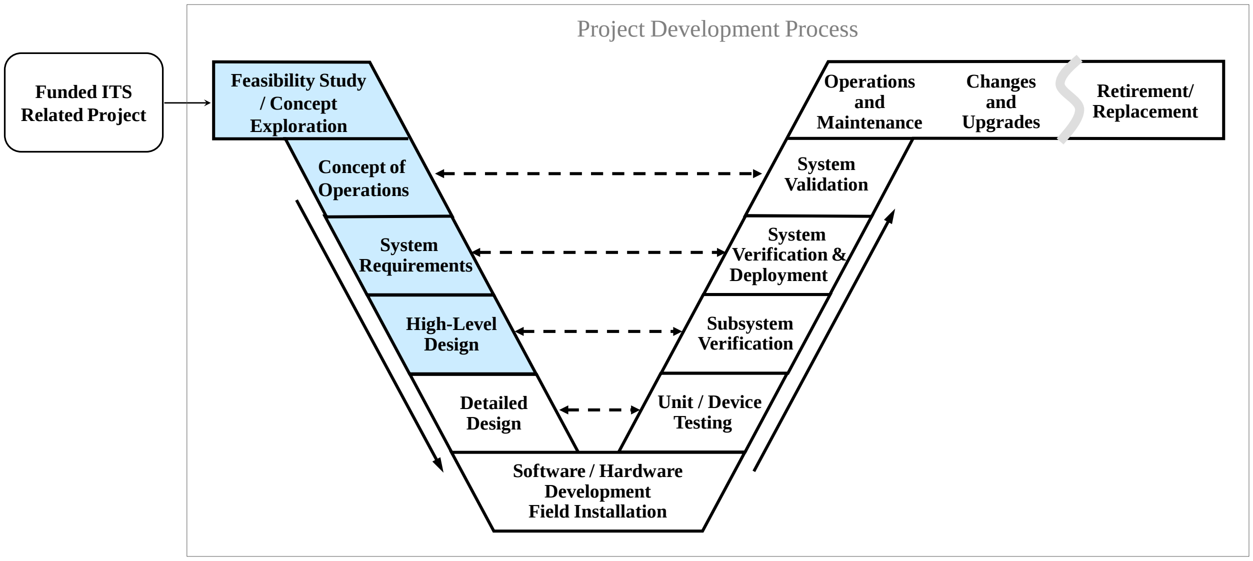

Figure 2: Use of Virginia CR ITS Architecture in the Project Development Process

The project development process shown in Figure 2 is the systems engineering process. It is a process that can be used to systematically deploy ITS to reduce risk. The systems engineering process is more than just steps in systems design and implementation; it is a life-cycle process. The process recognizes that many projects are deployed incrementally and expand over time. It can be tailored based upon the complexity and risk of a project. The FHWA Rule/FTA Policy on ITS Architecture and Standards Conformity requires that the systems engineering process be used to deploy ITS projects that are funded with federal funds.

While use of the systems engineering process may be new, the process is similar to the current process used to deploy state highway projects. Table 2 shows the relationship between the VDOT project development process and the FHWA system engineering process as well as the application of the ITS Architecture elements. The steps in which the architecture can be used are italicized.

Table 2: Relationship of VDOT Project Development Process to System Engineering Process and ITS Architecture

Project Development Process		System Engineering Process		Architecture Inputs
Pre Scoping Activities	→	*Concept Exploration*	←	• *Operational Concept/Roles* • *Services/Market Packages*
		Concept of Operations	←	• *Operational Concept/Roles* • *Services/Market Packages*
Scoping Activities	→	*High Level Requirements*	←	• *Functional Requirements*
		Detailed Requirements		
Initial Design	→	*High Level Design*	←	• *Interfaces/Information Flows* • *ITS Standards*
Preliminary Design	→	*High Level Design*	←	• *Interfaces/Information Flows* • *ITS Standards*
Detailed Design	→	Detailed Design		
Final Design	→	Detailed Design		
Construction	→	Implementation		

Table 2: Relationship of VDOT Project Development Process to System Engineering Process and ITS Architecture

Project Development Process		System Engineering Process		Architecture Inputs
		Integration & Test		
		Subsystem Verification		
		System Verification		
Operation and Maintenance	→	Operations & Maintenance		

2.2.1 Architecture Use for Deployment

The Virginia CR ITS Architecture can be used in the following initial steps of the systems engineering process:

Concept Exploration	The objectives of this initial step are to identify alternative concepts, evaluate them and select the superior, cost-effective concept. If the project has not been defined in too much detail by this point, the architecture may be useful in identifying various options. For all projects, the architecture, primarily the services and interfaces, can be reviewed to identify elements impacted by a project so the impacts can be evaluated appropriately during the concept exploration.
Concept of Operations	In deployment of an ITS-related project, the operational concept of the architecture should be used as the starting point for developing a project concept of operations. The operational concept in the architecture defines the roles and responsibilities of the stakeholders in the region. The project concept of operations would include relevant information from the operational concept and have added details specific to the project or system's operation.
High Level Requirements	The service diagrams tailored by the stakeholders can assist in definition of requirements for ITS systems involved in a specific project. The architecture contains high level functional requirements for all ITS systems in the region. These requirements can be the beginning point for developing more detailed requirements.
High Level System Design	From the architecture, system designers can identify the ITS standards that are applicable for the interfaces being implemented in the project. The standards are used in developing specifications for the design.

For an example of how an architecture can be used to support project deployment, see Section 2.3.3. For more information on systems engineering and applying it to ITS projects, see the US DOT's Systems Engineering for Intelligent Transportation Systems: An Introduction for Transportation Professionals at: http://ops.fhwa.dot.gov/publications/seitsguide/index.htm.

2.2.2 Strategy to Promote Architecture Use for Deployment

One of the challenges of using the ITS Architecture in the deployment of a project is educating stakeholders about the process and its benefits. The systems engineering process is not a new process to many organizations. They may not be following a formal systems engineering process but their existing processes are related as can be seen in Table 2 for the VDOT process. Making these types of linkages between processes makes it easier to incorporate the architecture as a tool in the process.

Another challenge is engaging a broader stakeholder base on a project when the architecture indicates that possibility. This activity of identifying, investigating and including integration opportunities is more institutional than technical. There will be instances where getting more stakeholders involved in a project will increase its complexity or cross jurisdictional boundaries that may not have been considered in the initial scope. It is important to explore these integration opportunities so that, at the very least, they are accounted for and supported in the project design even though they may not be implemented with that specific project. The ultimate goal is to make ITS deployment as economical as possible in the long run.

It is important that the agencies in Virginia modify their project development/implementation processes to incorporate the use of the architecture as is beneficial and actually required if federal funds are used. The process modifications should be distributed to stakeholders so they are aware of the steps to follow and understand that this process is a necessary part of any project receiving federal funding.

2.3 Use of Virginia CR ITS Architecture Examples

As presented in the previous section, the Virginia CR ITS Architecture can be used in various ways to support planning, programming and budgeting and deploying ITS projects. Specific steps for using the architecture are presented below. These steps are representative and are definitely not complete. They are provided as guidance for stakeholders but should not limit how they use their architecture. Below each step, an example is provided in italics to illustrate how a stakeholder can use the Virginia CR ITS Architecture.

2.3.1 Architecture Use for Long Range Planning Example

Use of the Virginia CR ITS Architecture in long range planning promotes deploying projects that are beneficial to the region. How it can assist in the development of a long range plan is presented below.

Examples of using the Virginia CR ITS Architecture to develop a long range transportation plan:

1. In the development of goals and objectives for the region, review the list of ITS services included in the architecture to identify ITS service(s) that will address transportation needs.

   A goal in the long range plan might be to "preserve the existing transportation system and promote efficient system management." The Virginia CR ITS Architecture has three maintenance and construction management services in which VDOT CRO elements are involved: MC03 Road Weather Data Collection, MC04 Weather Information Processing and Distribution and MC10 Maintenance and Construction Activity Coordination. Reviewing the definition of these services, VDOT long range planners can define potential objectives for the existing goal such as:

   - *Monitor environmental condition of roadways to more effectively deploy road maintenance resources and issue general traveler advisories.*
   - *Coordinate maintenance and construction activities with other agencies to minimize impact to travelers.*

2. While identifying existing and future transportation needs, review the list of ITS services included in the architecture to see if the needs that they address are identified. Also review the list of ITS elements to identify existing elements that require operations and/or maintenance.

Note: When reviewing the architecture, be sure to consider that the Virginia CR ITS Architecture is a regional architecture and focuses on regional services and any services offered on a statewide basis that are not included or not defined in detail may be covered in the Virginia Statewide ITS Architecture.

In addition to developing the Highway Needs Assessment, a planner at VDOT reviews the services in the Virginia CR ITS Architecture and identifies the Road Weather Data Collection service (MC03). The Road Weather Data Collection service that includes monitoring of icing on bridges addresses the need to provide safe travel across bridges. This need was then added to the list for the region.

The VDOT planner reviews the inventory of ITS elements in the architecture and confirms that operations and maintenance of the VDOT CR Environmental Sensor Stations (ESS) is included as a need for the region.

3. To develop candidate strategies and/or projects to meet needs and goals and objectives of the region, review the list of projects and services included in the architecture to identify candidate projects and/or operational strategies that will address the transportation needs. Also review traditional strategies to see if ITS can and should be included in them.

The Plan may contain recommendations for existing and new roadways for the interstate and primary roadway system. The Virginia CR ITS Architecture contains a service for Roadway Automated Treatment (MC05). The roadway recommendations should be reviewed to see if any should include automated treatment systems.

2.3.2 Architecture Use for Programming and Budgeting Example

The architecture is also useful to organizations and agencies in deciding which projects to fund through their programming and/or budgeting process. As discussed in Section 2.2.2, the Virginia CR ITS Architecture is useful to both project sponsors and planners in their project programming or budgeting process to assist decision-makers in making funding decisions. Through the use of the examples outlined below, the CR ITS Architecture can be incorporated into the transportation planning process.

Examples for using the Virginia CR ITS Architecture for project sponsors to identify and define ITS projects:

1. Review the projects sequenced in the architecture to identify the project(s) ready to be deployed. Using the information in the project sequencing, estimate the potential benefits and costs of the project(s).

   The project sponsor reviews the information contained in the Architecture Implementation Plan and decides which project(s) would help address their current transportation needs. If the listed projects include cost and benefits information, that information is noted. The listed projects may not contain information on the typical costs or benefits but that information can be derived from architecture services associated with the identified project.

2. Review the ITS service(s) in the architecture to identify the ITS stakeholders and systems that are impacted by the project and should be involved. Consider if any of the stakeholders are potential partners who can share development costs, material and/or labor.

"*In the architecture, there are several stakeholders and systems involved in a service. The project sponsor reviews the list and decides which stakeholders and systems are relevant to the VDOT project and invites them to the initial project meeting.*

3. Review the interface diagrams (i.e. interconnect and architecture flow diagrams) for the service. Look for opportunities to include additional related interfaces in the project. Be cognizant of potential partners who can share development cost, material and/or labor, facilities, etc.

4. Define and scope the project using the information gathered from the architecture. The information can be used to support the need and purpose of a project, to provide necessary justification to acquire funding for the project, or in a request for proposals (RFP) to acquire consultant services.

   Using the information from the architecture, the sponsor clearly defines the project. On the funding requests, he defines the scope of the project including a diagram showing the stakeholders, systems, and interfaces involved in the project. Project sponsor submits the well defined project for funding showing how the project addresses a transportation need of the state and fits into the stakeholder's vision as captured in the Virginia CR ITS Architecture.

Examples for planners to use the Virginia CR ITS Architecture to assist decision makers in programming and funding ITS projects:

1. Review the projects sequenced in the architecture to identify the timeline for deployment of project(s) based on factors including the dependencies between projects. Review information for each project including cost estimate, anticipated benefits and which ITS services are covered. A table can be used to show the relationship between a project and a service in the architecture and the timeline for deployment. *Based on this information, it can be determined when a project should be funded in relation to other projects.*

2. Review the operational concept to identify the roles and responsibilities of the stakeholders involved in the project. Make sure that all stakeholders that should be involved are and that their roles and responsibilities are clearly defined including for on-going operations and maintenance.

3. Review the ITS service(s) involved in the project to identify integration opportunities including the stakeholders and systems that could be involved in the project to maximize the benefits of the project.

4. Review the interface diagrams (i.e. interconnect and architecture flow diagrams) for the service to identify additional integration opportunities.

5. Use the information from the architecture to assist in prioritizing projects. *Based on the information reviewed in the architecture, the projects can be prioritized with the well defined projects that agree with the architecture promoted.*

2.3.3 Architecture Use for Project Deployment Example

Once an ITS project is planned and funded, the Virginia CR ITS Architecture can be of further use in the deployment of the project. Using the architecture to deploy projects helps bridge the gap between the planning of the project and the operation of the implemented project.

Steps for using the Virginia CR ITS Architecture for deploying ITS projects:

1. Use the architecture to identify various options for deploying an ITS related project. Review the architecture, primarily the services and interfaces, to identify elements impacted by the project so the impacts can be evaluated appropriately during the concept exploration.

2. Use the operational concept as the starting point for developing a project concept of operations. Identify the components of the operational concept that show at a high level how the systems involved in the project operate in conjunction with the other systems of the region. Beginning with the high level, define details in a concept of operations for the project.

   A VDOT engineer uses the high level stakeholder roles and responsibilities (r&rs) from the operational concept as the starting point in clearly defining the roles and responsibilities in the project concept of operations. He coordinates with those stakeholders with a role or responsibility in the project to ensure a coordinated and efficient deployment.

3. Use the functional requirements as a starting point in defining the requirements of the system(s) to be deployed in the project. While the functional requirements in the regional architecture are at a high level, the use of these requirements provides a better alternative than starting from scratch and will also ensure that the identified functions are not overlooked.

   The VDOT engineer reviews the Virginia CR ITS Architecture and identifies the functional area(s) and associated requirements that are related to the project. The engineer uses the requirements as the highest level requirements and develops more detailed requirements for each.

4. Use the list of standards in the architecture to support high level system design. The architecture identifies the ITS standards that are applicable for the interfaces between the systems in the architecture. For the interfaces being deployed in the project, identify the standards applicable in a project. The architecture identifies all applicable standards so decisions must be made in the design of each specific project. Use of the architecture easily directs designers to the applicable standards.

   The VDOT engineer uses the architecture to identify the interfaces involved in the project and their applicable standards to ensure compatibility with the other components of the CR ITS network.

The Virginia CR ITS Architecture is a guide for agencies and organizations in efficiently planning, programming, and deploying ITS. The architecture is ready to be used to guide integrated ITS deployment throughout the region.

3 Project Sequencing

The Virginia CR ITS Architecture represents the vision of the stakeholders for the transportation system in the region for the next 10+ years. The deployment of all the capabilities described in the architecture will not be accomplished at one time or in one project. The deployment will be made in many projects that contribute a piece of the architecture to achieve the vision of the stakeholders.

As a framework, the architecture can be used as a guide in identifying projects that meet the transportation needs of the region and in determining the order in which to best deploy the projects. Since the Virginia CR ITS Architecture is based on the needs for the region, the architecture identifies which systems operated by agencies in the region should be interfaced to maximize integration opportunities throughout the region. ITS projects to support the ITS services and the information exchanges represented in the Virginia CR ITS Architecture were identified. Once deployed, the ITS projects make up the integrated regional transportation system depicted in the Virginia CR ITS Architecture.

Each ITS project provides one or more ITS service(s) that meet the needs of the stakeholders in the region. In the architecture, these services are represented by market packages. Market packages identify the systems and information exchanges between those systems that facilitate the delivery of a service. The stakeholders of the region selected the market packages that best meet their needs in the regions. Based on the selected market packages, ITS projects can be identified. The related market package(s) provide scope for each ITS project as well as insight into the hierarchy and dependencies between the identified ITS projects.

The project sequencing list should include ITS projects currently planned for deployment in the region. Those projects should be linked to architecture services or market packages that best match their scope and functionality. Based on this information, projects are allocated for implementation in two timeframes: planned (i.e. funding has been identified) or future. Obtaining stakeholder feedback on the prioritization of projects is necessary to:

- Ensure each ITS project was consistent with stakeholder needs.
- Confirm estimated timeline or priority for project deployment.
- Understand the relationship and traceability between ITS projects and the Virginia CR ITS Architecture.

The project sequencing for the Central Region of Virginia is provided in Appendix A. The projects are categorized by the following functional areas:

- Electronic Payment
- Emergency and Incident Management
- Maintenance and Construction Operations
- Planning and Archive
- Regional Coordination
- Traffic Operations
- Transit and Rail Operations
- Traveler Information

For each functional area, the information provided for the project sequencing includes:

- **Project Name -** Name of the proposed ITS project.
- **Market Package -** Maps the proposed ITS project to an ITS service identified in the National ITS Architecture and reflects traceability to it.
- **Market Package Diagram Number -** Provides a reference for locating diagrams in the Virginia Central ITS Architecture that displays the interfaces among systems included in proposed project.

- **Timeframe (Planned or Future) -** Indicates whether the project is in a current plan or is expected in the future.

4 Agreements

The Virginia Central ITS Architecture defines ITS systems and their interfaces and the projects to deploy them. Deployment and operation of interagency interfaces may require agreements between the stakeholders defining the roles and responsibilities of the parties. It is important to consider agreements early in the project deployment process to avoid barriers to institutional integration.

There are many different types of agreements. The ones commonly used for ITS projects include:

Handshake Agreement:
- Early agreement between one or more partners - Not recommended for long term operations.

Memorandum of Understanding (MOU):
- Initial agreement used to provide minimal detail and usually demonstrating a general consensus.
- Used as a first step before expanding to a more detailed agreement. It may be broad in scope but contains all of the standard contract clauses required by a specific agency.
- May serve as a means to modify a much broader Master Funding Agreement, allowing the master agreement to cover various ITS projects throughout the region and the MOUs to specify the scope and differences between the projects.

Interagency Agreement
- Between public agencies (e.g. transit authorities, cities, counties, etc.) for operations, services or funding
- Documents responsibility, functions and liability, at a minimum.

Intergovernmental Agreement
- Between governmental agencies (e.g., Agreements between universities and State DOT, MPOs and State DOT, etc.)

Operational Agreement
- Between any agency involved in funding, operating, maintaining or using the right-of-way of another public or private agency. The Operational Agreement identifies respective responsibilities for all activities associated with “shared” systems being operated and/or maintained.

Funding Agreement
- Documents the funding arrangements for ITS projects (and other projects), usually includes at minimum, standard funding clauses, detailed scope-of-services to be preformed for the specific funding, detailed project budgets, etc.

Master Agreements
- Standard contract and/or legal verbiage for a specific agency and serving as a master agreement by which all business is done. These agreements can be found in the legal department of many public agencies.
- Allows states, cities, transit agencies, and other public agencies that do business with the same agencies over and over (e.g., cities, counties) to have one Master Agreement that uses smaller

agreements (e.g., MOUs, Scope-of-Work and Budget Modifications, Funding Agreements, Project Agreements, etc.) to modify or expand the boundaries of the larger agreement, to include more specifics.

Deployment of an ITS project may begin with something as simple as a handshake agreement. But, once interfaces and integration of systems begin, agencies probably need to have something more substantial in place. Formal agreements are necessary to define financial arrangements and for participation in large regionally significant projects. A documented agreement will aid agencies in planning their operational costs, understanding their respective roles and responsibilities, and building trust for future projects.

The list of agreements that may be necessary for deployment of the ITS projects identified in the Virginia CR ITS Architecture is given in Appendix B. Each agreement should be associated with a project and thereby a service (i.e. market package) of the architecture.

5 ITS Standards

5.1 Introduction

Standardizing the flow of information between the systems in Virginia's Central region is essential to integrating ITS throughout the region. ITS standards are fundamental to the establishment of an open ITS environment that achieves the goal of interoperability desirable for ITS. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances and new approaches evolve.

Establishing standards for exchanging information among ITS systems is important not only from an interoperability point of view; it also provides interchangeability and expandability thereby reducing risk and cost. Since an agency using standardized interfaces can select among multiple vendors for products and applications, competition is maintained and prices are lower in the long term.

Standards Development Organizations (SDO) are developing ITS standards that support interoperability and interchangeability. Several of the communication standards overlap in applicability. This provides flexibility in the design of ITS systems allowing agencies to choose the most applicable standard for their needs. Before systems are designed, all stakeholders involved in the applicable ITS service(s) should decide upon the standards and their specifics that will be used. Once a decision is made, all future systems should use the agreed upon standards.

Currently there are over a hundred ITS standards, but not all of these standards will be used in the Virginia statewide and central regions. The Central Region's ITS Architecture references only those standards that are applicable to the interfaces between the ITS systems of the region. The set of standards for the central region is based on the architecture flows on the system interfaces which were included in the Architecture. Appendix C presents the standards applicable to the ITS deployments in the central region.

In addition to the interface standards that have been discussed and are being defined for ITS, a range of other standards may be considered that would facilitate interoperability and implementation of the ITS architecture. For example, standard base maps, naming conventions and measurement and location standards can help facilitate efficient and meaningful exchange of information between systems in the region.

5.2 Standards Development Organizations (SDOs)

The ITS community recognized the advantages of standards and encouraged Standards Development Organizations (SDOs) or equivalents to create ITS standards between the most critical ITS interfaces. The following is a list of SDOs or equivalents that are developing ITS standards. This list provides acronyms that show up repeatedly throughout the list of standards applicable to the central region:

American National Standards Institute (ANSI)
American Public Transportation Association (APTA)
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)
National Transportation Communications for ITS Protocol (NTCIP)

NTCIP is really a joint product of the National Electronic Manufacturers Association (NEMA), the American Association of State Highway and Transportation Officials (AASHTO), and ITE. NTCIP is a family of standards for traffic and transit systems.

5.3 Stages of Standards Development

There are numerous levels of maturity or stages of development for standards. The process varies between SDOs but some of the common stages include:

Draft Under Development. During this phase, there are significant changes likely to occur.

Draft for Ballot or in Balloting. Standards being voted upon by a committee or working group or are undergoing other SDO procedures.

Approved. Standards that have passed all necessary ballots and have been approved by an SDO, but have not yet been published.

Published. Standards available for purchase and use. Note: currently some of the SDOs, most notably the NTCIP group are providing particular ITS standards for free for a limited time.

Tested/Deployed Standard. Only minor changes are likely to occur in this phase of a standard development.

It’s important to understand at what stage, in the typical development cycle, a standard is in, especially if you are considering the inclusion of a specific standard in procurement specifications. Early in the cycle before approval or publishing, there are many changes to a standard. Many standards have yet to undergo testing or initial deployment.

The US DOT standards website http://www.standards.its.dot.gov/default.asp contains the latest status of each ITS standard as well as supporting information about the standards. Other information that can be obtained from this website are pointers to general information, including status charts for each ITS standard, web links, standards deployments and training courses.

5.4 Strategy for Using the ITS Standards

In the central region, quite a bit of ITS has been deployed in the past so it is important to consider the national standards. The use of ITS standards in procurement specifications often depends on how much risk can be afforded. There are often lots of changes to an early standard and even some risk of change in a balloted standard. Also, early deployers will likely have suggested improvements to the standard that will require an update via an amendment to the standard (amendments do typically pass through the process more quickly).

In addition to understanding the relative maturity of the standards, making proper choices for standards depends on multiple factors, including throughput (how much data must be transmitted or received on the interface), network topology (how the ITS systems are connected together), and infrastructure (fiber optic lines, leased land lines, etc.), among others.

New systems should be deployed using ITS standards. To guide stakeholders in the choice of standards, the Appendix C contains the initial list of ITS Standards derived directly from the information flows contained in the Central Region's ITS Architecture. The ITS Standards can be grouped into two broad categories: Center-to-Field and Center-to-Center. The Center-to-Field (C2F) standards are primarily overseen by the NTCIP Joint Committee that is comprised, as was mentioned before, of representatives from AASHTO, NEMA and ITE. NTCIP is also responsible for the transport protocols for center-to-center (C2C) standards. Other Standards Development Organizations are responsible for defining the message set content. IEEE is responsible for Incident Management, SAE for traveler information, ITE/AASHTO for traffic management and ITE/APTA for transit. In addition there is a combined effort to define the Dedicated Short Range Communications standards in the 5.9GHz range, now called WAVE or Wireless Access in a Vehicular Environment for vehicle-to-field and vehicle-to-vehicle communications.

It is common to have a family of standards for a particular transportation domain and those families have been placed in groups below with a footnote explaining each group. It is important to note that some groups contain standards that are redundant with each other (i.e., accomplish the same purpose) so it requires choosing the best standard that satisfies the region's requirements. For example, there are currently two center-to-center transport protocol standards: DATEX-ASN and XML. The CORBA transport protocol is no longer being supported by the SDOs. Most regions would not deploy every transport protocol standard; they would most likely choose one or maybe two. For the central region, it is recommended that the NTCIP 2306 Application Profile for XML Communications standard be strongly considered for regional center-to-center communications. The XML standard, although not as bandwidth efficient as

DATEX-ASN, is a nice compromise and there are volumes of XML literature to rely on.

Most ITS standards also have mandatory and optional parts to them. It is incumbent on the project RFP to not only specify the standard and its version but also what optional functionality is required. The US DOT standards website http://www.standards.its.dot.gov/default.asp contains the latest status of each ITS standard as well as supporting information about the standards.

As each ITS project explores the ITS standards, it is strongly encouraged that reports by those project elements be run using the Turbo Architecture tool. The Standards Activity report can provide standards down to the architecture flow level for each project.

Appendix A: ITS Project Sequencing

Electronic Payment Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1				

Emergency and Incident Management Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1				

Maintenance and Construction Operations Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1				

Planning and Archive Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1				

Regional Coordination Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1	Integration of Statewide Weather ESS Data to Richmond TOC	Road Weather Data Collection	MC03	Planned

Traffic Operations Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1	Integrate Richmond TOC with Salem TOC	Regional Traffic Management	ATMS07	Planned

Transit and Rail Operations Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1				

Traveler Information Projects

#	Project Name	Market Package(s)	Market Package(s) Diagram #	Timeframe (Planned/Future)
1				

Appendix B: Agreements

Agreement	Stakeholders Involved	Type of Agreement	Associated Project/Service	Agreement Status
	•			
	•			
	•			

Appendix C: ITS Standards

Standards for Virginia Central Region ITS Architecture

NOTE: The ITS standards presented in this report may represent a superset of options, and in some cases, provide redundant capabilities. In addition, these ITS standards are at different maturity levels. Care should be taken to select the standards that best meet the needs of the region or project.

Lead SDO	Standard Name	Version	Document ID
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)		ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group		(See Footnote)
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group		(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions		NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Actuated Traffic Signal Controller (ASC) Units		NTCIP 1202
AASHTO/ITE/NEMA	Object Definitions for Dynamic Message Signs (DMS)		NTCIP 1203
AASHTO/ITE/NEMA	Object Definitions for Environmental Sensor Stations (ESS)		NTCIP 1204
AASHTO/ITE/NEMA	Object Definitions for Closed Circuit Television (CCTV) Camera Control		NTCIP 1205
AASHTO/ITE/NEMA	Object Definitions for Ramp Meter Control (RMC) Units		NTCIP 1207
AASHTO/ITE/NEMA	Object Definitions for Closed Circuit Television (CCTV) Switching		NTCIP 1208
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)		NTCIP 1209
AASHTO/ITE/NEMA	Field Management Stations (FMS) - Part 1: Object Definitions for Signal System Masters		NTCIP 1210
AASHTO/ITE/NEMA	Object Definitions for Signal Control and Prioritization (SCP)		NTCIP 1211
APTA	Standard for Transit Communications Interface Profiles		APTA TCIP-S-001 3.0.0
ASTM	Dedicated Short Range Communication at 915 MHz Standards Group		(See Footnote)

Standards for Virginia Central Region ITS Architecture

Lead SDO	Standard Name	Version	Document ID
ASTM	**Standard Practice for Metadata to Support Archived Data Management Systems**		**ASTM E2468-05**
ASTM	**Standard Specifications for Archiving ITS-Generated Traffic Monitoring Data**		**ASTM WK7604**
ASTM/IEEE/SAE	**Dedicated Short Range Communication at 5.9 GHz Standards Group**		**(See Footnote)**
IEEE	**Incident Management Standards Group**		**(See Footnote)**
IEEE	**Standard for Message Sets for Vehicle/Roadside Communications**		**IEEE 1455-1999**
SAE	**Advanced Traveler Information Systems (ATIS) General Use Standards Group**		**(See Footnote)**

Lead SDO	Standard Name	Version	Document ID

Footnotes:

Advanced Traveler Information Systems (ATIS) General Use Standards Group

SDO	Standard Name	Document ID
SAE	Location Referencing Message Specification (LRMS)	SAE J2266
SAE	Message Set for Advanced Traveler Information System (ATIS)	SAE J2354
SAE	Messages for Handling Strings and Look-Up Tables in ATIS Standards	SAE J2540
SAE	RDS (Radio Data System) Phrase Lists	SAE J2540/1
SAE	ITIS (International Traveler Information Systems) Phrase Lists	SAE J2540/2
SAE	National Names Phrase List	SAE J2540/3

Dedicated Short Range Communication at 5.9 GHz Standards Group

SDO	Standard Name	Document ID
ASTM	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems - 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications	ASTM E2213-03
IEEE	Standard for Wireless Access in Vehicular Environments (WAVE) - Resource Manager	IEEE 1609.1-2006
IEEE	Standard for Wireless Access in Vehicular Environments (WAVE) - Security Services for Applications and Management Messages	IEEE 1609.2-2006
IEEE	Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services	IEEE 1609.3
IEEE	Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-Channel Operation	IEEE 1609.4-2006
IEEE	Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part II: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification	IEEE 802.11p
IEEE	Standard for Wireless Access in Vehicular Environments (WAVE) - Architecture	IEEE P1609.0

Incident Management Standards Group

SDO	Standard Name	Document ID
IEEE	Standard for Common Incident Management Message Sets for use by Emergency Management Centers	IEEE 1512 -2006
IEEE	Standard for Traffic Incident Management Message Sets for Use by Emergency Management Centers	IEEE 1512.1-2006
IEEE	Standard for Public Safety Traffic Incident Management Message Sets for Use by Emergency Management Centers	IEEE 1512.2-2004
IEEE	Standard for Hazardous Material Incident Management Message Sets for Use by Emergency Management Centers	IEEE 1512.3-2006

Standards for Virginia Central Region ITS Architecture

Lead SDO	Standard Name	Version	Document ID

Incident Management Standards Group

SDO	Standard Name	Document ID
IEEE	Standard for Common Traffic Incident Management Message Sets for Use in Entities External to Centers	IEEE P1512.4

NTCIP Center-to-Center Standards Group

SDO	Standard Name	Document ID
AASHTO/ITE/NEMA	Octet Encoding Rules (OER) Base Protocol	NTCIP 1102
AASHTO/ITE/NEMA	Center-to-Center Naming Convention Specification	NTCIP 1104
AASHTO/ITE/NEMA	Ethernet Subnetwork Profile	NTCIP 2104
AASHTO/ITE/NEMA	Internet (TCP/IP and UDP/IP) Transport Profile	NTCIP 2202
AASHTO/ITE/NEMA	File Transfer Protocol (FTP) Application Profile	NTCIP 2303
AASHTO/ITE/NEMA	Application Profile for DATEX-ASN (AP-DATEX)	NTCIP 2304
AASHTO/ITE/NEMA	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML)	NTCIP 2306

NTCIP Center-to-Field Standards Group

SDO	Standard Name	Document ID
AASHTO/ITE/NEMA	Octet Encoding Rules (OER) Base Protocol	NTCIP 1102
AASHTO/ITE/NEMA	Transportation Management Protocols (TMP)	NTCIP 1103
AASHTO/ITE/NEMA	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile	NTCIP 2101
AASHTO/ITE/NEMA	Point to Multi-Point Protocol Using FSK Modem Subnetwork Profile	NTCIP 2102
AASHTO/ITE/NEMA	Point-to-Point Protocol Over RS-232 Subnetwork Profile	NTCIP 2103
AASHTO/ITE/NEMA	Ethernet Subnetwork Profile	NTCIP 2104
AASHTO/ITE/NEMA	Transportation Transport Profile	NTCIP 2201
AASHTO/ITE/NEMA	Internet (TCP/IP and UDP/IP) Transport Profile	NTCIP 2202
AASHTO/ITE/NEMA	Simple Transportation Management Framework (STMF) Application Profile	NTCIP 2301
AASHTO/ITE/NEMA	Trivial File Transfer Protocol (TFTP) Application Profile	NTCIP 2302
AASHTO/ITE/NEMA	File Transfer Protocol (FTP) Application Profile	NTCIP 2303

Standards for Virginia Central Region ITS Architecture

Lead SDO	Standard Name	Version	Document ID

Filters

Entity Class

Show	Class
Yes	Center
Yes	Field
Yes	Traveler
Yes	Vehicle

Entity Type

Show	Type
Yes	System
Yes	Human
Yes	Environment

Interconnects

Show	Interconnect
Yes	Center to Center
Yes	Center to Field
Yes	Center to Traveler
Yes	Center to Vehicle
Yes	Field to Field
Yes	Field to Vehicle
Yes	Traveler to Field
Yes	Traveler to Traveler
Yes	Traveler to Vehicle
Yes	Vehicle to Vehicle

Flow Type

Show	Type
Yes	Request
Yes	Information

Flow Status

Show	Status
Yes	Existing
Yes	Planned
Yes	Existing voice comm.
Yes	Future

Flow Futuristic

Show	Futuristic
Yes	Futuristic

Market Package

Show	Market Package
Yes	All