Virginia Department of Transportation
On-Call ITS / Safety / Operations Contract
151-BLW

Task 02: Northern Virginia Task Support
Subtask C.2 Architecture Definition Maintenance Beyond Rule Conformity

NOVA ITS Architecture Version 2.1
FINAL REPORT

Prepared for:

Northern Virginia District

Prepared by:

Battelle
The Business of Innovation

Task Managed by:

STREET SMARTS
Planning • Transportation Engineering • Surveying

Under Subcontract to:

Wilbur Smith Associates
ENGINEERS PLANNERS ECONOMISTS

December 28th, 2005

Table of Contents

1 Introduction

An update of the Virginia Department of Transportations' (VDOT) Northern Virginia (NOVA) Intelligent Transportation Systems (ITS) Architecture was performed as part of the overall NOVA Task Support for the VDOT On-Call ITS/Safety/Operations Contract.

This report documents the work performed on Task C.2 – Architecture Definition Maintenance Beyond Rule Conformity and covers the changes made from May 2005 to December 2005. The report is organized as follows:

- Project Scope and Deliverables - describes the work performed and deliverables
- 2005 Changes – describes the changes that were made to the NOVA ITS Architecture for Task C-2
- Ongoing and Future Activities – describes the architecture maintenance and training activities

The purpose of the Task C.2 was to

- Update the NOVA ITS Architecture to incorporate activities conducted under Subtask Areas A (Operational Platform/Architecture) and B (Strategic Assessments), and ensure the architecture accurately reflects the results of this work while also supporting Area A and Area B technical teams to ensure their documentation and designs are consistent with the NOVA ITS Architecture.

- Update the NOVA ITS Architecture to ensure consistency with the DC Regional Architecture. Ensure all initiatives documented in version 1.2 and the new initiatives started after May 2004 are included in the NOVA ITS Architecture.

The update of the NOVA ITS Architecture was conducted under VDOT's On-Call ITS/Safety/Operations Contract. Battelle Memorial Institute prepared the update under as part of the Go-Forward Plan development team which was lead by Street Smarts, Inc and supported by Kimley-Horn and Associates, Inc., and Trevilon under contract to Wilbur Smith Associates.

2 Scope and Deliverables

The NOVA ITS Architecture identifies interfaces among VDOT Systems and non-VDOT systems in the District. The architecture was updated using Turbo Architecture (Version 3.1) and is based on the National ITS Architecture definition. The purpose of the NOVA ITS Architecture is to guide the planning and deployment of ITS systems within VDOT NOVA and those systems that interface with VDOT to facilitate integration across the region's transportation system.

VDOT is committed to leveraging this architecture to deploy ITS more efficiently. The NOVA ITS Architecture has been updated and documented and is available on the web at **www.vdot-itsarch.com**. The website includes the latest **hyperlinked version (Version 2.1)** of the architecture enabling a user to explore the various interfaces and subsystems defined in the architecture. In addition, the documentation and Turbo Architecture database are available for download.

2.1 Definition Update to Incorporate Activities Conducted Under Subtask A, B and D

The following are the updates performed to the architecture Task 02 subtasks. Only sub-tasks with architecture impacts are discussed. All subtasks were reviewed for impacts to the regional architecture. Subtasks that were reviewed and used as input to the architecture update included:

- Subtask A - Operational Platform/Architecture
- Subtask B - Strategic Assessment
- Subtask D – Program Plan (Concept of Operations task)

2.1.1 Subtask A Updates

In Task A.1, "ATMS Platform Migration Plan – Possible Upgrade Options" report was reviewed and recommendations were submitted to VDOT on March 18, 2005 and in a technical memorandum titled "Recommended Immediate Action Items Memorandum". Three regional architecture related findings were discussed:

- *Utilize the Incident Management Subsystem currently being developed by the University of Maryland CATT Lab that can be run by the operators on the XP workstations. If possible, show Safety Service Patrol (SSP) locations from the Automatic Vehicle Locating (AVL) system on the map.*
- *If the Incident Management Subsystem encounters problems of showing SSP positions on its map, install AVL Comet-Tracker software. This software has been tested in the Smart Traffic Center (STC) environment (on Virginia Information Technology Aadministration network) on new workstations. Reconfigure as necessary to operate in the Windows XP workstation environment.*

- *Upgrade Virginia State Police (VSP) Computer Aided Design (CAD) Data Viewer - Taken from Quick Fix Recommendation, Solution 6a[1]. Since the VSP CAD Data Viewer has been installed and tested on VDOT workstations in the STC control room, VDOT should consider using internal staff to install the Viewer and seek costs and schedule from PB for testing.*

Based on the architecture findings, the architecture was updated by ensuring that SSP has a connection with STC with CAD data and vehicle location information includes as a dataflow.

In Task A.2, as part of the ITS strategic assessment, the Virginia Department of Transportation (VDOT) Northern Virginia District (NOVA) had requested a survey of the status of ITS standards. As VDOT NOVA plans for a major upgrade of its freeway traffic management system, it needs to know which standards to adopt and which to keep on a watch list for future consideration.

Since the architecture includes ITS Standards, all priority National ITS standards identified in the report are now included in the regional architecture Turbo database.

In Task A.4 - The Statewide STC Platform Assessment Memorandum and the Statewide STC Template Recommendation Memorandum discuss the STC platforms used in Virginia. Currently, VDOT operates STC facilities in five districts; Northern Virginia, Richmond, Hampton Roads, Salem, and Staunton. Each STC is unique in design and operations. In terms of design, the STC facilities are unique because they were procured at different times using different procurement techniques using different equipment vendors from an ever-changing ITS industry. In addition, VDOT as an organization has had an evolving approach to the ITS and STC programs throughout this time period. VDOT has been seriously considering a regional STC Model – The use of other STCs to control field devices is also discussed in the memorandum.

Currently, NOVA STC controls only NOVA field devices but this might change in the near future with more regional operations, with all STCs being able to control field equipment across the state. In light of this, the architecture was changed to show Center-to-Field connections from other VDOT STCs to VDOT NOVA STC field equipment from

[1] McElwain, Amy, "STC Software/Operation Assessment Quick-Fix Recommendation", VDOT Northern Virginia District, October 2004

2.1.2 Subtask B Updates

The System Baseline Data Collection Memorandum submitted under Subtask B.3 outlines the field device subsystems that make up the STC system operations. These existing subsystems include:

- Closed Circuit Television (CCTV) Cameras: Video cameras used for visual observation of traffic, confirmation of incidents
- Variable Message Signs (VMS): Electronically changeable signs used to disseminate travel information to motorists
- Gate Control System (GCS): Series of gates used to provide/block access to HOV lanes on Interstates 95 and 395
- Lane Control System (LCS): Green arrow/red X signals used to notify motorists of temporary lane availability during peak hour on Interstate 66
- Condition Monitoring System (CMS) and Incident Detection System (IDS): Subsystem used to monitor traffic conditions through various forms of vehicle detectors placed in or along the roadways
- Vehicle Classification System (VCS): Subsystem used to categorize vehicle types through piezo detectors installed in pavement
- Ramp Metering System (RMS): Signals used to regulate flow of traffic from on-ramps onto mainline freeways
- Highway Advisory Radio (HAR): System for broadcasting travel and roadway condition related messages to motorists via AM radio
- Smart Traffic Signal System (STSS): System that provides ability to monitor status and adjust timings of VDOT maintained and operated traffic signals in region
- Other ITS Systems:
    - Call Box System: Emergency telephones installed along Dulles Toll Road for motorist convenience
    - Truck Rollover System: Monitoring / warning system to alert speeding trucks on sharp curves
    - Storm Sentry System: Weather radar alert system, produced by DTN
    - Rosslyn Tunnel Control System: Ventilation, lighting and communications infrastructure used to ensure safe travel of vehicles through Rosslyn Tunnel

All of these are captured by the VDOT NOVA STC field equipment element in the architecture.

Task B.1.2 examined the best practices in incident detection schemes and identified the data required in order to implement such a detection scheme. Based on the results of this investigation, it was recommended that VDOT continue its practice of obtaining information from police CAD systems as the primary incident detection source. In fact, this mechanism should be enhanced by:

1. Linking the NOVA STC software with the all of the local and state police CAD systems so that incident reports are automatically entered into the NOVA STC software without manual re-entry.
2. Providing a mechanism for police CAD systems to become aware that NOVA has verified a reported incident through the use of CCTV cameras.
3. Providing a mechanism for police CAD systems to become aware of new incidents that the NOVA STC has detected.
4. Continuing and enhancing efforts to educate the public on how to best notify authorities of incidents.
5. Ensuring that all high priority areas are adequately covered with CCTV cameras.

It was also recommended that NOVA supplement the CAD information with the following incident detection technologies:

1. Integrated operations with the SSP – The STC should be able to monitor the location of SSPs at any time and the SSPs should notify the STC of any incident it discovers, preferably electronically.
2. Continued monitoring of police scanners –While this is relatively low tech, it has proven to be an effective and inexpensive means to monitor operations.
3. Manual investigation of areas that are experiencing traffic anomalies through the use of CCTV cameras – The system should identify and rank areas that are experiencing abnormal traffic conditions so that the STC operator can investigate the locations in a logical order.

In the architecture, updates were made to ensure that all NOVA Police and Fire Agencies are connected to STCs with future CAD integration data flows. Data exchanges (especially of video data) are currently modeled through the video clearinghouse.

Included in Task B.2, Software (Sharing and Portal Integration) is the Strategic Assessment of several key initiatives currently under way in the metropolitan Washington region and the Northern Virginia District of the Virginia Department of Transportation. These impact several stakeholders and inventory elements that are part of the architecture. The conclusions and the recommendations (changes made to the architecture) are listed in the following table

The architecture update ensured that all the regional clearinghouse components including a proposed Virginia Statewide Clearinghouse are captured correctly.

2.1.3 Subtask D Updates

The scope of Task D was to develop a NOVA ITS Program Plan including a regional operating concept. Draft reports on the website, as well as the Operating Concept Workshop held on 24th October, 2005 have provided information on Roles and Responsibilities and well as operational scenarios.

The architecture was updated with the enhanced roles and responsibilities from the Operational Concept document of the Program Plan. These are reflected in the Turbo Architecture database. The website was also updated with the eleven program areas identified in NOVA ITS Program Plan.

2.2 Validation Interviews and Meetings

Once the architecture was updated with inputs from subtasks A,B, D, it was reviewed by the NOVA ITS Section Manager and the NOVA team to ensure that there are no "grey" areas that needed additional validation. Through the review, the NOVA team identified a few stakeholders that needed updates to the architecture flows and roles and responsibilities to ensure that are depicted correctly in the architecture. The additional validation was performed either through phone interviews or meetings. The summary of the interviews and the meetings and the updates performed to the architecture based on the validations is discussed below.

2.2.1 Archived Data Management (ADMS) Validation - Ken Earnest, VDOT and Cathy McGhee (Smart Travel Lab)

Interviewed Ken Earnest, VDOT Central Office and Cathy McGhee, University of Virginia (UVA) on validating the flows associated with VDOT Mobility Data Store and Smart Travel Lab inventory elements currently in the NOVA ITS Architecture. The interview with Ken and Cathy was conducted to ensure that the interfaces and the information flows listed in the architecture, relevant to Archived Data Management System (ADMS) functions are still the same, and also to gather any new/updated interfaces.

It was mentioned that Smart Travel Lab currently operates the VDOT ADMS. In the future, VDOT ADMS is expected to be a subset of a future VDOT Mobility Data Store. In addition to data collected by Smart Travel Lab (traffic and incident archive data from STCs, SSP, and VSP), the mobility data store will contain archived traditional traffic count data, weather data, transit data, and traveler data and serve a wider variety of users. Smart Travel Lab will continue to develop and integrate various pieces of the mobility data store but organizationally, the mobility data store will be a part of the VDOT Central Office.

It is also expected that the Mobility Data Store will be the primary method of providing data back to all interested users. Currently, archived data requests are handled by the Smart Travel Lab.

2.2.2 Electronic Toll Collection (ETC) Validation -Russ Keck, VDOT

Interviewed Russ Keck with the EZ Pass program to validate the flows associated with electronic toll collection. No changes were recommended to the architecture except renaming Virginia Toll Facility Centers to Other Toll Facility Centers. It was also

mentioned that VSP has office space in Greenway and plans to have a similar facility in Dulles Toll Road in the future. These are already modeled as connections between the VSP and the toll roads in the architecture.

2.2.3 Transit and Parking Management Validation

On December 2nd, 2005, a NOVA ITS Architecture validation meeting was held at NVTC offices to discuss and validate the current depiction of VDOT NOVA interactions with parking management and transit agencies in version 2.0 of the NOVA ITS Architecture. The meeting was held from 9.00 am to 12.00pm. Representatives from NOVA local transit agencies, Washington Metropolitan Area Transit Authority (WMATA), Northern Virginia Transportation Commission (NVTC), and Metropolitan Washington Council of Governments (MWCOG) attended the meeting.

A background of the NOVA ITS Architecture, its purpose, and an overview of the NOVA systems and subsystems that interact with local transit and parking management stakeholders was presented. The validation meeting then focused on each of the stakeholders and discussed their current interactions with NOVA systems from two main perspectives:

- Roles and Responsibilities
- Information Flows

For each of the stakeholders, a printout of their current roles and responsibilities and information flows was used to discuss, validate, and obtain any new information that was represented. Listed below are the changes and action items:

1. Made changes to the stakeholder names and their representation in the architecture as listed in the table below. Also included in the table are the points of contact at the respective agencies:

Stakeholder Group/Agencies	Representation in Arch.
NOVA Local Transit - PRTC - Ed Marx - City of Alexandria – DASH – Al Himes - City of Fairfax – CUE – Alex Versoza - Fairfax County - Fairfax Connector Transit, FASTRAN – Rolo Eckston - Arlington County - ART and STAR – Jim Hamre - Loudoun (LCT and VRTA) – Nancy Gourley - City of Falls Church Bus (GEORGE) – Wendy Block Sanford	-NOVA Local Transit Centers -NOVA Local Transit Vehicles
VRE - Dave Synder, Wendy Lemiuex	VRE Center

Stakeholder Group/Agencies	Representation in Arch.
WMATA – Jeff Anderson, Dan Epps, Tom Herrington (ITS Planning), Peter McNeehan (ITS Planning), Beck Pack, Al Pittard (CSC), Brian Heanue	-WMATA Operations Centers -WMATA In-station displays/kiosks -WMATA SmarTrip card -WMATA Transit Vehicles -WMTPD Operations Control Center -Regional SmarTrip Fare Payment Clearinghouse (**NEW**) -Regional Transit Database (**NEW**)
MWAA -	MWAA Center
NVTC – Adam Mcgawock	NVTC Center
Regional Transit Electronic Clearinghouse – **Removed as a separate stakeholder.**	Regional Transit Electronic Clearinghouse-(**Replaced with two elements under WMATA)**

2. For transit signal priority, add center to center approach. Center to Center approach could include
    a) Transit Vehicle to STC/STSS to field or
    b) Transit Vehicle to Transit Centers to STC.to field.
    c) Transit Vehicle to Transit Centers to field.

    Transit Signal Priority is being discussed between Transit Agencies and NVTC can provide VDOT with any required information about transit signal priority.

3. For all Archived Data from NOVA Local transit agencies, the data will come from a Regional Transit Database – being championed by WMATA. The regional transit database is still in planning stages. It was mentioned that this is the right time for other stakeholders to participate in helping define requirements.

4. It was mentioned that RITIS will also include transit data

5. Made changes to information flows for NOVA local transit including
    a) Adding parking information, maintenance and construction information,
    b) Changing archived data flows (no direct connection to VDOT ADMS but rather through regional transit database and RITIS)

6. Made changes to information flows for NVTC regarding archived data use (through regional transit database and RITIS).

7. Made changes to information flows for WMATA.
    a) Change several flow statuses to “existing”.
    b) Remove connections from VDOT NOVA Parking Management to SmarTrip. (no payment required for VDOT lots).

c) Remove connections from event promoters to WMATA (outside the scope of the architecture)
d) Make all bus related flows in WMATA similar to NOVA local agencies.
e) Contact Brian Heanue (202-962-2109) regarding interfaces between WMATA Police Control Center and STC. Typical process is that transit vehicles call the WMATA Police Control Center and WMATA Police Center calls appropriate jurisdictions.

8. No validation of VRE flows. However, made VRE roles and responsibilities same as NOVA local transit agencies.

9. No validation of MWAA flows.

10. Investigate the use of PRTC Express Bus AVL location data on I-66 and I-95.for HOV condition monitoring.

2.3 Deliverables

- Strawman Architecture Version 2.1 Diagrams
- NOVA ITS Architecture Turbo Database Update – Version 2.1
- NOVA ITS Architecture Web Site Update
- NOVA Planning Process Memorandum Update
- NOVA Project Development Process Update
- NOVA ITS Architecture version 2.1 Final Report

2.3.1 Planning Process Memorandum

The NOVA Architecture team updated the planning process documentation (from Task C.1.2.2 report) to reflect the changes to the NOVA organization and to fulfill the FHWA rule requirements. This included updates to ensure that the Systems Engineering Checklist and the regional architecture are integrated within the planning processes that VDOT project managers currently follow. This updated document is included in Appendix A.

2.3.2 Project Development Memorandum

The NOVA Architecture team updated the project development documentation (from Task C.1.2.3) to meet the FHWA rule 940 requirements. This included the integration of the Systems Engineering Checklist and the regional architecture to ensure that all the project development steps are followed throughout the life cycle of the project.

The document highlights the process required by project managers to develop project architectures using systems engineering analysis steps and the use of the NOVA

Architecture Turbo Database to comply with FHWA Rule. Defining a project using the systems engineering (SE) checklist and process and the NOVA ITS Architecture maximizes the integration opportunities available by examining the interfaces that the project should accommodate. This updated document is included in Appendix B.

3 2005 Architecture Changes

3.1 Updates to Stakeholder List

The following stakeholders were deleted from the architecture:

- Deleted Electronic Payment Smart Tag Clearinghouse. VDOT Central Office is the primary stakeholder for Smart Tag Systems.
- Deleted Maryland Transit Administration (MTA). The stakeholder may reappear in future updates if VDOT NOVA anticipates any interactions with MTA.
- Deleted VA Park Services. This was intended to represent the Virginia operations of the National Park Service. To avoid confusion in the stakeholder list, it was decided to have a single National Park Service stakeholder with two separate inventory elements instead.
- Deleted Generic VDOT Stakeholder. All VDOT functions are captured through either the central office, or through the districts.

The following stakeholders were renamed in the architecture:

- Regional ISPs to Private Sector ISPs to emphasize the private sector participation.
- VDOT Central Office Stakeholder was split into three stakeholders: VDOT Central Office - Administration, VDOT Central Office - Operations, VDOT Central Office - Emergency Operations.

The following stakeholders were added to the architecture:

- Added Private High Occupancy Toll (HOT) Operators as a stakeholder with impending HOT lanes in NOVA.

3.2 Updates to System Inventory

The following elements were deleted from the architecture:

- Virginia Transportation Information Portal as this element represents only a pilot project with no direct interactions with NOVA

The following elements were renamed in the architecture:

- Adjacent VDOT STCs to VDOT Adjacent STCs to ensure a consistent naming convention (VDOT elements start with "VDOT XXX XXXX")
- DC Public Safety and Emergency Center to DC Public Safety and Emergency Centers - Typo
- DCDOT ITMS/TOC to DDOT ITMS/TOC - Typo
- Laptop Computers to VDOT Remote Operations – Laptop Computers was a misnomer and VDOT Remote Operations better represents the functionality of this element.
- Mobile Unified Command to VSP Mobile Unified Command Center – naming convention.

- National Park Services to National Park Service Centers DC-MD – Representing operations in DC and Maryland including the BW Parkway
- NOVA Sections to VDOT NOVA Sections - to ensure a consistent naming convention (VDOT elements start with "VDOT XXX XXXX")
- Other STCs to VDOT Other STCs - to ensure a consistent naming convention (VDOT elements start with "VDOT XXX XXXX")
- Regional Transit Electronic Clearinghouse to Regional SmarTrip Fare Payment Clearinghouse based on validation meeting with transit agencies
- RWIS to VDOT RWIS - to ensure a consistent naming convention (VDOT elements start with "VDOT XXX XXXX")
- Smart Tag Center to VDOT Smart Tag Center - to ensure a consistent naming convention (VDOT elements start with "VDOT XXX XXXX")
- Statewide 511 Virginia to VDOT Statewide 511 - to ensure a consistent naming convention (VDOT elements start with "VDOT XXX XXXX")
- Virginia National Park Service Center to National Park Service- VA representing the Virginia operations of the national park service including operations on GW parkway.
- Virginia Toll Facility Centers to Other Toll Facility Centers – based on meeting with Russ Keck (VDOT)
- WMATA Transit Bus (BRTA) to WMATA Transit Vehicle – based on validation meeting with transit agencies.

The following elements were added to the architecture:

- HOT Traffic Management Centers representing the traffic operations of the future HOT lanes.
- National Capital Region 511 representing future 511 service in the national capital region.
- Regional Transit Database – based on meeting with transit agencies
- Maryland Local Public Safety and Emergency Management Centers – to ensure consistency with similar flows as NOVA Local Public Safety and Emergency Management Centers.

3.3 Updates to Market Packages

No changes were made to the market packages in this update of the architecture.

3.4 Updates to Standards

Architecture standards have been identified in detail in Version 1.0 of the architecture. The website provides standards information for each architecture flow. Each element page has a link of all information flows associated with it; each of these information flows are linked to a page with standards information.

3.5 Updates to Information Flows

With significant changes to the system inventory, entity mapping and market package associations, Turbo was used to build the information flows and the interfaces. Various new flows and interconnections were customized based on information gathered during validation meetings and from other tasks. (Section 2.0)

All the information flow diagrams were recreated and the operational concept for each of them revised and updated. These were summarized in a PowerPoint presentation as well as on the website.

4 Ongoing and Future Activities affecting Regional ITS Architecture

4.1 Ongoing Architecture Maintenance

It is intended that the NOVA ITS Section will continue to update and maintain the regional architecture at least annually to ensure that new projects and regional efforts are integrated into the current version of the architecture. The architecture will also be updated as and when newer versions of the National ITS Architecture and the Turbo Architecture database become available.

4.2 Ongoing Architecture Training

As part of Subtask C.3, the NOVA team updated training materials and provided a comprehensive all day training course on the ITS Architecture, the FHWA Rule and hands-on exercises using the Turbo Architecture. This training was provided on 2 days (December 14th and 15th, 2005) and was attended by NOVA staff who are involved in the implementation of ITS Projects. It is intended that the NOVA ITS Section will continue to offer this training course at least once annually based on updates made to the architecture.

APPENDIX A: PLANNING PROCESS MEMORANDUM

Using the Architecture

Introduction

The work done to develop the NOVA ITS Architecture is valuable only if it contributes to improving the integration of transportation systems in Northern Virginia, particularly VDOT systems. VDOT transportation planning is a process that involves project definition, review, prioritization, approval, funding allocation, and incorporation into the transportation plan. The path a project follows in the planning process is dependent on the funding source being sought for the project. There are several basic funding sources that the planning process supports: ITS Earmark funds, Federal, State, Congestion Mitigation and Air Quality (CMAQ), Surface Transportation Program (STP) funds, and Special Grant funds. The planning process was examined in light of these various funding sources to determine how the NOVA ITS Architecture, and other pertinent documents like the strategic plan and the concept of operations could be used as a reference in the pursuit of integration opportunities.

The general process required to define a project in VDOT's NOVA District is discussed below. The points where the NOVA ITS Architecture, Systems Engineering (SE) Checklist, ITS Strategic Plan, Concept of Operations, and the Regional ITS Architecture will be beneficial are highlighted.

The goal of this effort is not to impose more work upon the NOVA Staff managing the ITS project development, but to ensure that the projects are defined with integration in mind. Each project should consider all potential integration possibilities. FHWA policy requires the definition of ITS projects that are consistent with a regional plan or architecture to better support integration. The architecture, systems engineering checklist, strategic plan and the concept of operations provide a guide to integration opportunities among VDOT systems and between VDOT and regional stakeholders. Projects defined without considering integration opportunities will be found to be more costly in the long run due to the cost of redesign in the future. These tools will allow VDOT to better financially plan ITS investments and assist VDOT managers in understanding the priorities of ITS deployment in the NOVA District.

Process for Defining, Planning and Implementing Projects

Ideally, the NOVA ITS Architecture should be used at the very beginning of this process when projects are first being defined. This may be an evolutionary step to be taken in the future as the use of the architecture in the process becomes more mature.

A benefit of using the NOVA ITS Architecture in this process will be more comprehensively defined projects with attention being paid to integration opportunities. By referencing a larger plan for ITS in the NOVA District, projects may be able to take advantage of other information that exists or will be made available in the future. In addition, a more focused plan will be made

available across the District and those VDOT organizations from outside of NOVA that are involved in the project planning process will be able to make more informed decisions based on the information available in the architecture.

The general process for defining, planning, and implementing projects involves several VDOT and non-VDOT organizations. In short, a project is defined at a high level and a cost estimate is associated with it. The various funding sources for different projects present variations on the general project initiation process. The rest of the document details the general process with relation to three main funding sources: Six Year Improvement Program (SYIP), ITS Earmark Funds, and Special Grant Funds. The processes and the illustrations for these funding sources highlight the areas where the NOVA ITS Architecture should be used and relates this process to the project development documentation. There are three stages in all the processes that the NOVA ITS Architecture should be used:

- Stage 1 – Before Funding is identified
- Stage 2 – When Funding is Available
- Stage 3 – After a Project has been completed during the Maintenance phase.

These three stages and "how and what" needs to be done from using the NOVA ITS Architecture is "briefly" described in each of the funding processes below. Additional detail on the specific architecture requirements for the three stages in provided in the "project development" documentation.

SYIP Process

Before Funding

The first variation is the SYIP process as illustrated in Figure 1. The proposed projects for the NOVA District are initially prioritized by the NOVA ITS team and approved by the NOVA Operations and Administration team. As projects are initially defined, the project initiators use and submit work plans to the NOVA ITS Section. The project managers can use the architecture (website) to define a project architecture to better illustrate the project definition and include this information in the submitted work plan. The ITS section collects projects throughout the year from the NOVA operational functional area managers and maintains a project pool. This project library is used by the ITS team to prioritize and generate a list of projects along with sequencing of when these projects will be funded and implemented. This project pool is a "living document" and will be updated as and when new projects are provided. The project library is also prioritized using the program plan as a guide to strategize and phase the project deployment using the deployment plan of the ITS strategic plan.

The NOVA project managers can use the architecture website to examine subsystems/stakeholders and their interfaces to define the project scope. This information is sent to the NOVA ITS section before the projects are sent to the VDOT Central Office (and Transportation Board) for assessment.

The VDOT Central Office sends the projects to the Smart Travel Oversight Board for approval, and then defines the projects for programming, scheduling and allocation of funds. The projects are then sent to the Commonwealth Transportation Board for another approval before entering the approved projects into the 6 year plan.
When CMAQ and RSTIP funds are used, the projects are sent to the Northern Virginia Transportation Authority (NVTA) for approval and then forwarded to the VDOT Central Office for programming and scheduling. Also, these projects are further reviewed and follow one of two paths. If the ITS project is being implemented by a VDOT agency, then the project manager starts the process of implementing the project. If the ITS project is being implemented by a local non-VDOT agency, but being administered by VDOT, the local agency signs an agreement with VDOT for implementing the project.

After Funding

The approved projects that make up the SYIP are sent back to the District offices. Each project manager who is responsible for a project in the 6-year plan develops a project scope and implements the project. The project managers will develop "project architectures" that provide greater detail on the specific components of the architecture. It is at this time, that the project managers use the SE checklist to ensure that their project is in compliance with the FHWA Rule 940. Several items of the checklist can be completed using the architecture from the NOVA Regional ITS Architecture Turbo database. They would download the NOVA Turbo database from the web site and access the database and application software to develop project architectures based on the NOVA ITS Architecture. These project architectures along with information regarding their projects' relationship to NOVA ITS Strategic Plan and Concept of Operations are sent to the NOVA ITS Section for review and approval. For local government projects receiving funding for ITS projects that will have interface or integration with VDOT, the local government project manager will use the NOVA ITS Architecture Turbo Database. When other agencies are involved with the local government projects, the local governments are encouraged to use the Regional ITS Architecture Turbo Database to define their project interfaces. The Project Manager will then implement the project using the ITS Architecture and the systems engineering process as defined in the "project development" document.

Maintenance

Following project implementation, the final project architecture reflecting the actual state of the project implementation is provided to the NOVA ITS Section for incorporation into the NOVA ITS Architecture. The project manager will use the NOVA Architecture website to send the project architecture information for inclusion into the into the NOVA ITS Architecture definition to reflect its implementation and make sure its other projects are aware of the interfaces and information that is available from the implemented system. There is also a concurrent process to incorporate the project into the Metropolitan Washington Regional ITS architecture to ensure consistency. In the future, when a Virginia Statewide Architecture is developed, the project architectures will be incorporated into that database to ensure consistency.

The completion of this cycle makes the most accurate architecture data available to the NOVA District, reflecting what exists and what is planned for future project definition and planning.

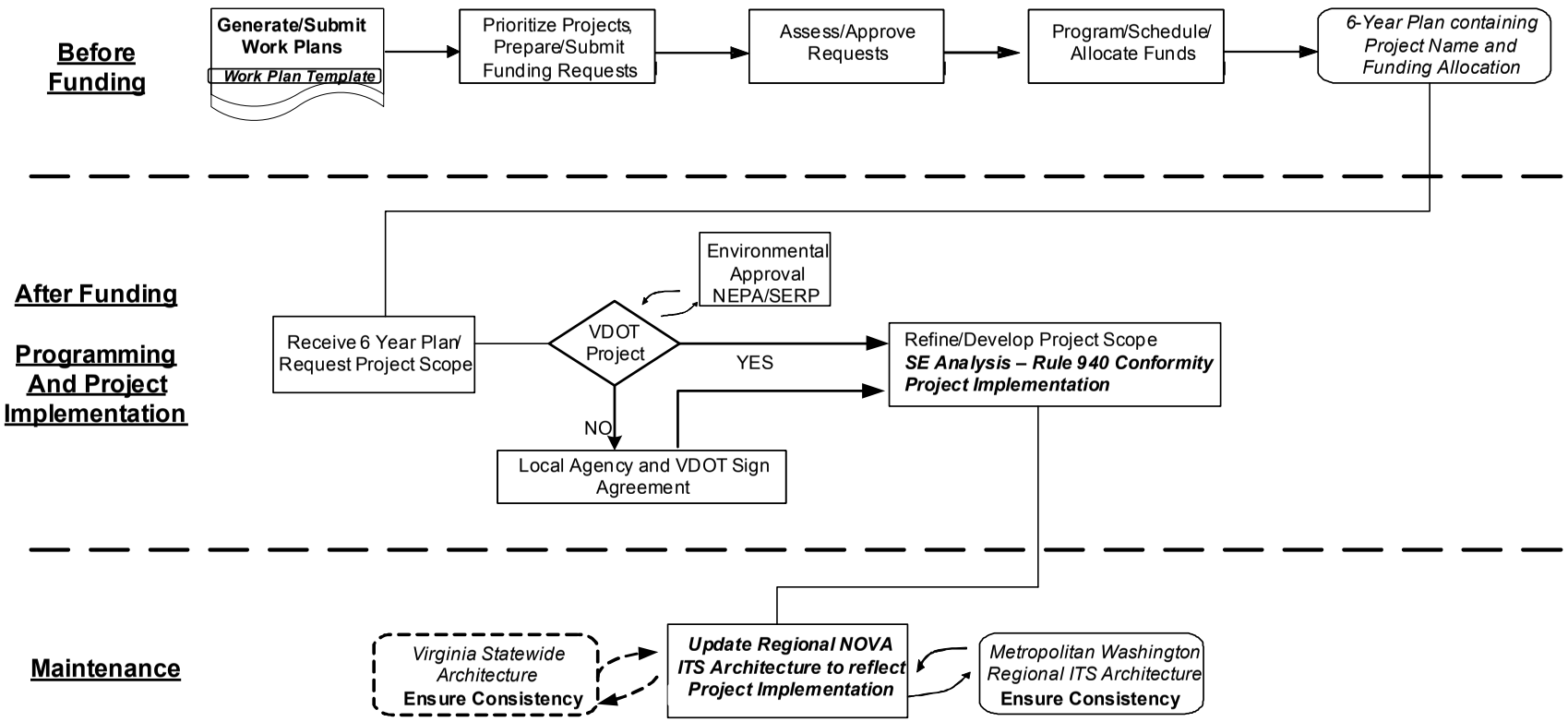

Figure 1: VDOT NOVA District ITS Project Initiation Process through the Six Year Improvement Plan

ITS Earmark

Before Funding

Figure 2 illustrates the Project Initiation Process for ITS Earmark Funds. In this process, once the Congress approves earmark funds, FHWA notifies VDOT Central Office. VDOT then requests the fund-receiving agency to provide high level scope, a financial plan and a draft schedule. The fund receiving agency can use the NOVA Architecture website to define this high level architecture. The central office then adds the earmark funds into the VDOT system and assigns it a project number and sends it to the VDOT Planning and Programming for TIP and STIP requirements.

After Funding

Once the TIP and STIP are amended the projects are then evaluated by the FHWA and VDOT ITS Section. These projects are further reviewed and follow one of two paths. If the ITS project is being implemented by a VDOT agency, then FHWA and VDOT sign a partnership agreement pending FHWA final approval. If the ITS project is being implemented by a local non-VDOT agency, but being administered by VDOT, the local agency signs an agreement with VDOT for implementing the project. Similar to the SYIP process, the project managers use the NOVA ITS Architecture to scope and define their projects. It is at this time, that the project managers use the SE checklist to ensure that their project is in compliance with the FHWA Rule 940. Several items of the checklist can be completed using the architecture from the NOVA Regional ITS Architecture Turbo database. They have access to the Turbo Architecture database and application software to develop project architectures based on the NOVA ITS Architecture. For the VDOT projects, project managers are also expected to provide information of their projects in relationship to the NOVA ITS Strategic Plan and the Concept of Operations as they would with the SYIP process.

Maintenance

Following implementation, the final project architecture reflecting the actual state of the project implementation will be provided to the NOVA ITS Section for incorporation into the NOVA ITS Architecture. There is also a concurrent process to incorporate the project into the Metropolitan Washington regional ITS architecture to ensure consistency. In the future, when a Virginia Statewide Architecture is developed, the project architectures will be incorporated into that database to ensure consistency.

The use of the NOVA ITS Architecture in the development of an earmark project should highlight the integration opportunities and make them evident to the US DOT that the earmark funds are being targeted to a worthwhile project.

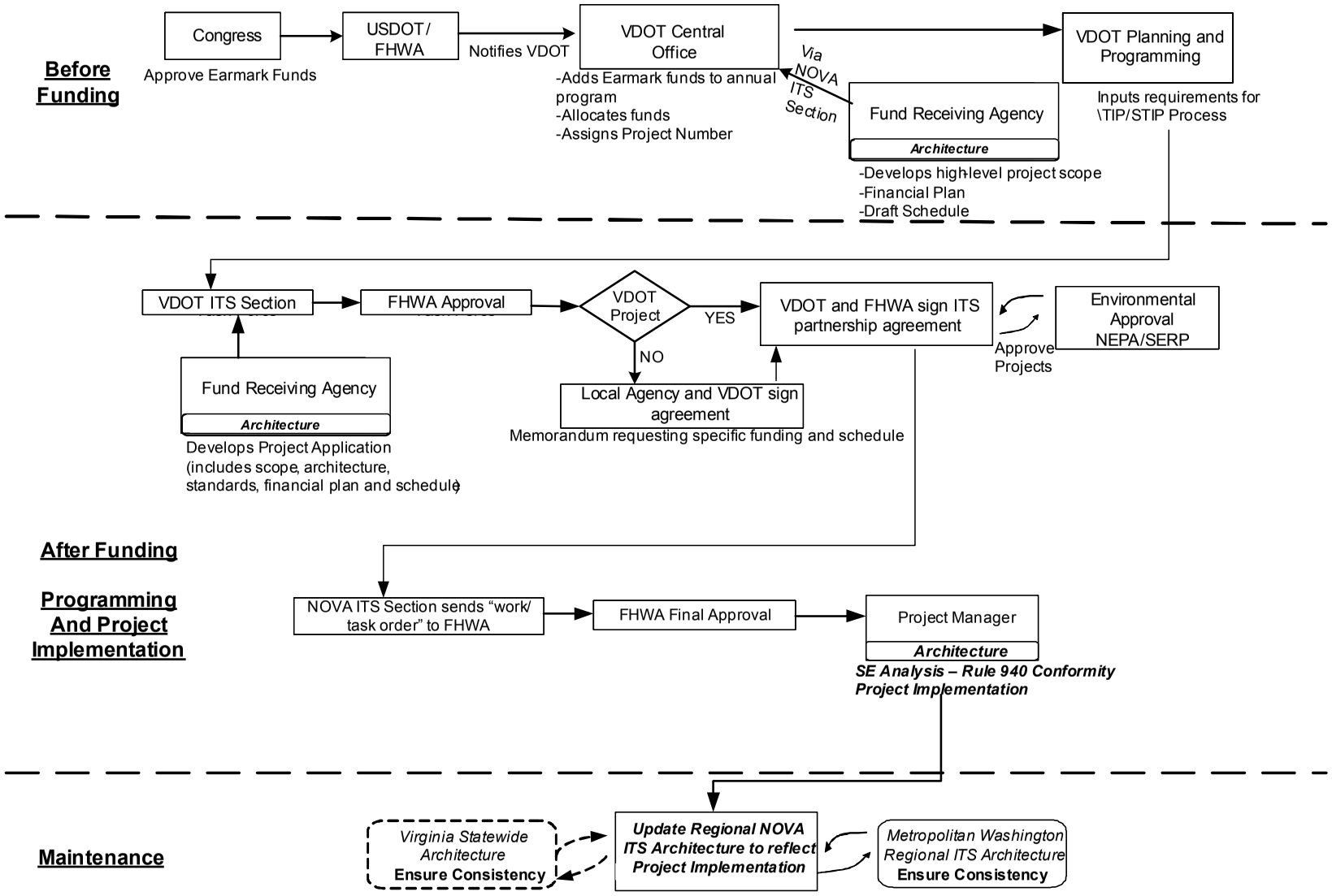
Before Funding
Congress
Approve Earmark Funds
USDOT/ FHWA
Notifies VDOT
VDOT Central Office
-Adds Earmark funds to annual program
-Allocates funds
-Assigns Project Number
Via NOVA ITS Section
VDOT Planning and Programming
Inputs requirements for \TIP/STIP Process
Fund Receiving Agency
Architecture
-Develops high-level project scope
-Financial Plan
-Draft Schedule
VDOT ITS Section
FHWA Approval
VDOT Project
YES
NO
VDOT and FHWA sign ITS partnership agreement
Environmental Approval NEPA/SERP
Approve Projects
Fund Receiving Agency
Architecture
Develops Project Application (includes scope, architecture, standards, financial plan and schedule)
Local Agency and VDOT sign agreement
Memorandum requesting specific funding and schedule
After Funding
Programming And Project Implementation
NOVA ITS Section sends "work/ task order" to FHWA
FHWA Final Approval
Project Manager
Architecture
SE Analysis – Rule 940 Conformity
Project Implementation
Maintenance
Virginia Statewide Architecture
Ensure Consistency
Update Regional NOVA ITS Architecture to reflect Project Implementation
Metropolitan Washington Regional ITS Architecture
Ensure Consistency

Figure 2: VDOT NOVA District ITS Project Initiation Process for ITS Earmark Fund

Special Grant

Before Funding

Figure 3 illustrates the Project Initiation Process for Special Grant Funds. This process is not as involved as the previously discussed processes. Projects are proposed to the NOVA ITS Section from all the NOVA operational functional areas based on the submitted work plan. The ITS Section endorses NOVA priority, and the NOVA Grant Development team gets the projects approved by the VDOT Central Office, Regional Stakeholders, and the NOVA Operations and Administration team. This team reviews and approves the projects that receive the grant funding. Every grant may have special requirements and involve more stakeholders in the grant development, this process should be used as a guide only and incorporate each grant's requirements.

After Funding

The rest of the process is similar to the first two processes.

Maintenance

The rest of the process is similar to the first two processes.

As can be seen in each of these process variations, the NOVA ITS Architecture is consistently applied at key steps of the project definition and implementation.

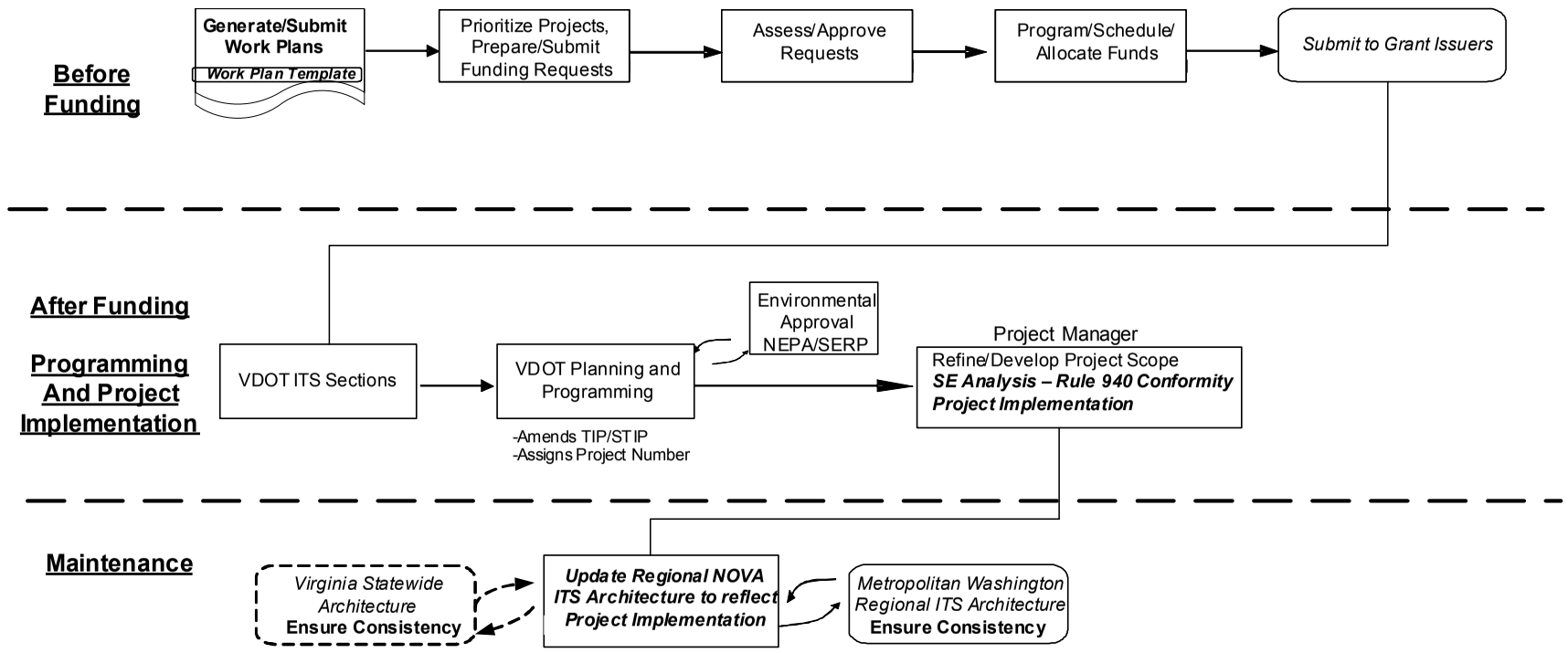

Figure 3: VDOT NOVA District ITS Project Initiation Process for Special Grant Fund

APPENDIX B: PROJECT DEVELOPMENT MEMORANDUM

PROJECT DEVELOPMENT

INTRODUCTION

The NOVA ITS Architecture Version 2.1 describes subsystems, interconnects, and information flows necessary to deploy an integrated transportation system in NOVA. The architecture is used by VDOT project managers to define ITS projects that implement portions of the architecture in a phased manner. Based on priorities established by VDOT concerning the immediate goals for ITS in the NOVA District, projects are defined that incrementally deploy the required elements over time. Prior to using the architecture, it is recommended that the project manager reviews the planning process memorandum which describes in detail the necessary steps for project definition, review, prioritization, approval, funding allocation, and incorporation of VDOT projects into the transportation plan. The planning process documentation describes several paths a project follows dependent on the funding source being sought for the project. The planning process document also highlights where the NOVA ITS Architecture, Systems Engineering (SE) Checklist, ITS Strategic Plan, Concept of Operations, and the Regional ITS Architecture will be beneficial during the planning process based on three stages of a life cycle of a project. This document follows the same three stages and elaborates the specific components of the architecture process that comprise of a project architecture to comply with the Federal Rule on ITS Architecture and Standards.

The NOVA ITS Architecture can be used for many purposes from gathering information about a particular subsystem to planning and generating requirements for a project. The NOVA ITS architecture is available through the web page (www.vdot-itsarch.com) and also through the Turbo Database. In the overall life cycle of a project, the NOVA project manager can benefit from using the NOVA Architecture during three phases as follows:

Stage 1 – Before funding

The architecture is useful when a project's scope has not been defined and funding has not been estimated. To define the scope, the lead agency that would like to implement the project can use the VDOT NOVA web site to identify a high-level project architecture that will include subsystems or stakeholders that best match their organization. Figure 1 illustrates the process in using the website to generate a high-level project architecture. Using the subsystems or the system inventory, the project manager can select the appropriate subsystems and view their relationship or interfaces to other subsystems. This will provide a better understanding of the proposed project's scope and interface requirements. This will also allow the project manager to develop a high-level concept of the overall system that can be used initially to gain consensus from stakeholders on the project scope, interfaces, and integration opportunities prior to implementation.

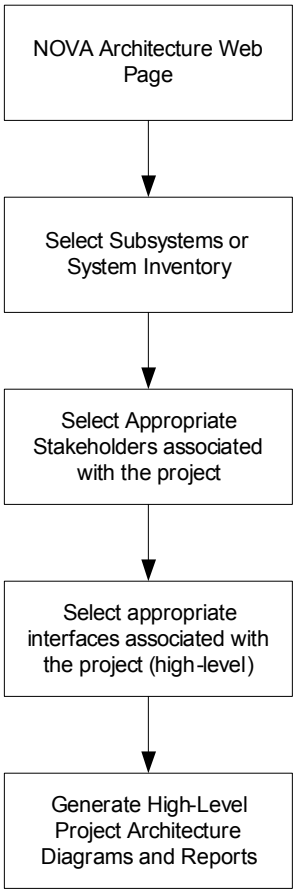

Figure 1: Process to develop High-level Project Architecture (Before Funding)

Stage 2 - Development of a Detailed Project Architecture - Project Implementation with Secured Funds

The ideal use of the NOVA ITS Architecture is to define Project Architectures when funding for a project has been identified. Based on the stakeholders that are involved in the project, the project manager can use the NOVA Architecture and/or the Metropolitan Washington Regional ITS Architecture as a starting point. For developing the detailed project architecture, it is recommended that the project managers use the NOVA Architecture Turbo Database and follow a systems engineering process as required by FHWA Rule 940.

The systems engineering (SE) process is an inter-disciplinary approach to procurement and implementation of a successful project. The process enables the implementer to identify and document all of the project requirements, to effectively manage the results of steps during implementation of the project and to verify that the requirements are thoroughly and correctly implemented. The use of this process assures that all phases of a system's lifecycle are addressed, from conception through design, installation and testing, and operations and maintenance. Figure 2, more commonly termed as the "V" diagram

illustrates the various steps of a generic systems engineering process. This process is well-established and will allow NOVA project implementers a consistent approach to facilitate integration and ensure that they adhere to the federal rule and requirements on ITS architecture. Defining a project using the SE process and the NOVA ITS Architecture maximizes the integration opportunities available by examining the interfaces that the project should accommodate.

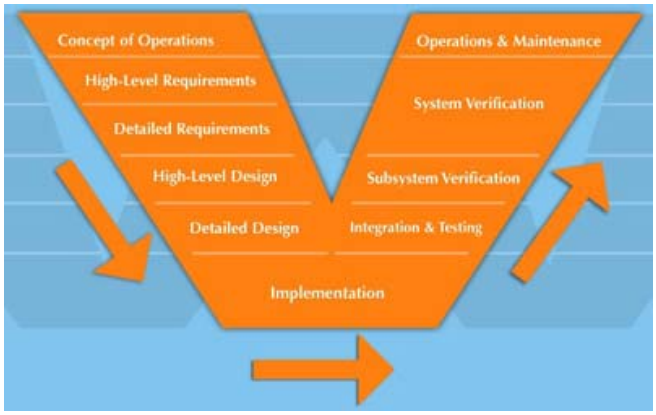

Figure 2: Typical Systems Engineering Process "V" Diagram

To enable project managers to follow the system engineering process, the NOVA ITS Section has developed a Systems Engineering (SE) Checklist. This checklist includes basic information from a submitted work plan and provides the project manager a systematic and structured process to "check" and ensure that SE process is followed throughout the life cycle of the project and ensuring that FHWA Rule 940 requirements are met. Figure 3 illustrates the process to develop the detailed project architecture using the NOVA Turbo Database and the systems engineering checklist/process. To start the process, the project manager should download the NOVA Turbo Architecture database from the website. This database allows the project manager to enter details of the project architecture. Using the project scope (previously defined in a high-level project architecture prior to funding in the submitted work plan), the project manager can initiate the project architecture by entering appropriate information into the Turbo database.

Each of the Turbo Architecture steps illustrated in the figure can be entered directly into the database to generate a project architecture. The steps illustrated in the process combine the Turbo Architecture products and the steps of the systems engineering checklist to implement a project. The steps that requires the use of both the architecture and the systems engineering process is highlighted in the figure. This combined process allows the project manager to efficiently track and use a systematic approach to fulfill the Rule requirements and implement a successful project.

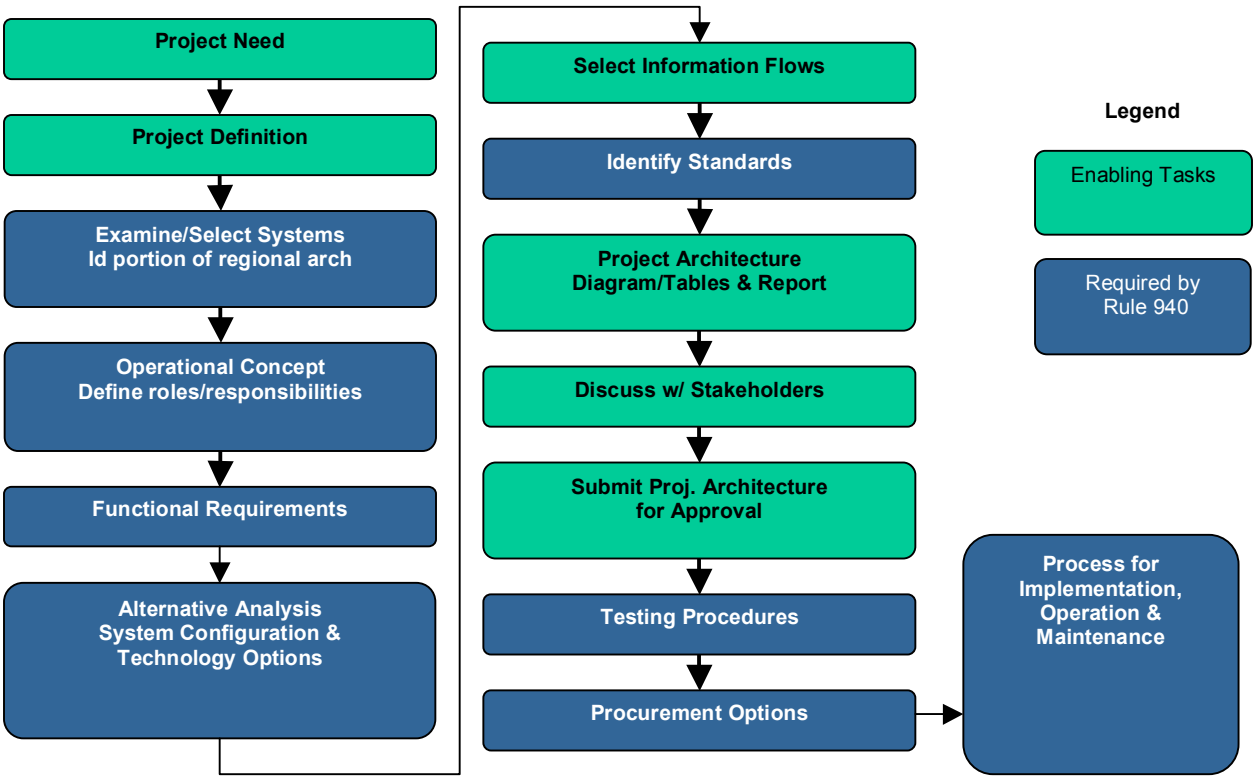

Figure 3: Process to develop Detailed Project Architecture (After Funding Approval)

Once the project definition has been initiated in the Turbo Database, the project manager must select the appropriate systems and subsystems that need to be included in the project. It is also at this stage that the project manager will identify the portions of the regional architecture that is being implemented. After selecting appropriate systems and subsystems, the project manager needs to identify an operational concept that would define the roles and responsibilities of the stakeholders included in the project. It is recommended that the project manager also review the NOVA Concept of Operations document for additional reference. The next step in the process is the identification of functional requirements for selected project elements from the system inventory. Following this step, an analysis of alternative system configurations and technology options should be considered for identified requirements.

Following the requirements phase, detailed information flows and interfaces with other subsystems for inclusion in the project to maximize system integration within the region need to be developed. The project manager needs to also review the list of current ITS standards that are applicable for the systems being deployed and consider any that can be used for project implementation. After completing all the entries and selecting the appropriate systems, the Turbo Architecture database provides the project manager with the capability to generate several reports, produce diagrams and tables to convey the

architecture to others for review and approval. The detailed project architecture is then discussed with participating stakeholders and submitted to the approval agency.

Following the approval, the project manager develops testing procedures and other design requirements to implement, operate and maintain the project.

By creating a project Architecture in this manner, the Project Manager is using the NOVA ITS Architecture, the systems engineering checklist to make informed decisions about the integration boundaries of the project in the initial implementation and what will need to be supported in the future.

STAGE 3 -Submit Project Architecture after Project Implementation

It is important that the NOVA ITS Architecture definition remain accurate. As each project is implemented or deployed, the "as deployed" project architecture should be submitted to the NOVA ITS Section. The NOVA ITS Section is responsible for the update and maintenance of this architecture along with ensuring that there is consistency between the NOVA architecture and the Metropolitan Washington Regional ITS Architecture. To assist the NOVA ITS Section and to ensure that the architecture reflects the updated and current NOVA projects, the project manager can send architecture details by selecting the Submit Project Architecture in the NOVA architecture website. Figure 4 illustrates the process to enable project managers to send their architectures. This process requires that the project manager fill in specific information on the project including scope, stakeholders, inventory systems, standards, and other federal requirements that are necessary while implementing ITS projects. The submitted project architecture will be incorporated into the NOVA ITS Architecture periodically during the maintenance phase. This process allows for the evolution of the NOVA architecture and maintains its usefulness to other stakeholders.

Once the project architecture has been submitted, the NOVA ITS Section will share this information with the Council of Governments (COG) staff for inclusion of the project in the Metropolitan Washington Regional ITS Architecture and also the future Statewide Architecture (planned). This will ensure consistency with the NOVA and the regional architectures.

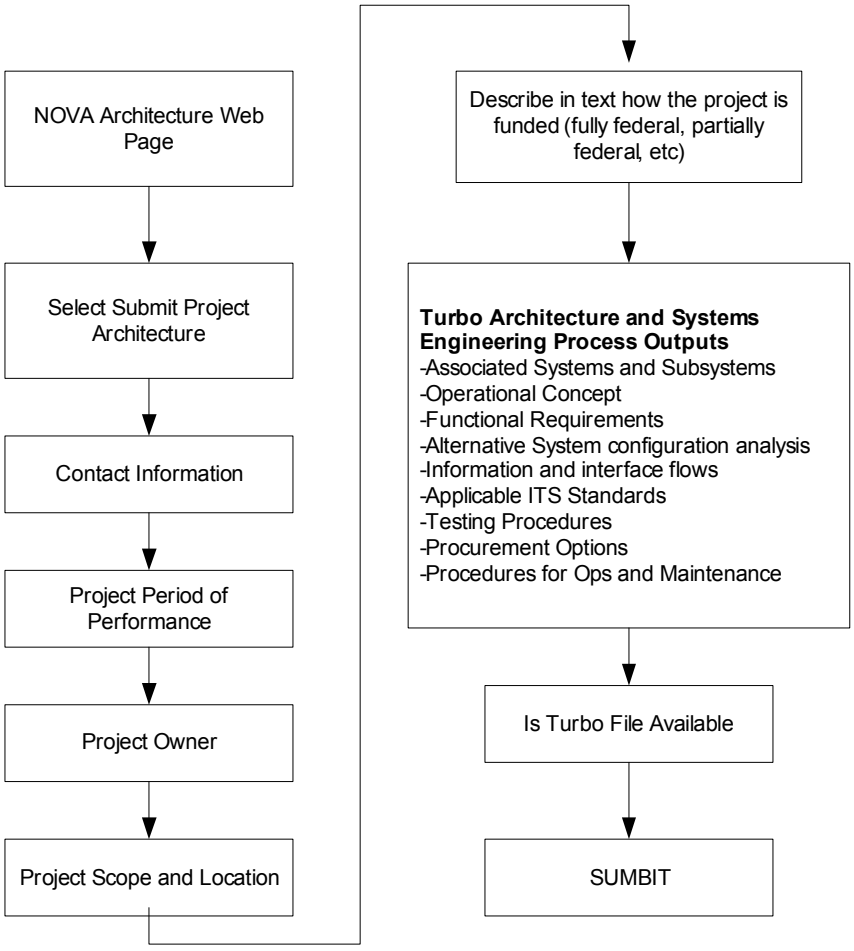

Figure 4: Process for Submission of Project Architecture

Maintaining the NOVA ITS Architecture

As mentioned in the previous section, it is very important that the NOVA ITS Architecture be kept as up-to-date so that the project managers using the architecture to define projects in the NOVA District have the most accurate information available. To maintain the accuracy of the NOVA ITS Architecture definition, each project manager must provide the NOVA ITS Section with project architectures that reflect the projects implemented state when the project is completed. These project architectures should be defined using Turbo Architecture and the resulting database will be imported into the master NOVA ITS Architecture that is under the control of the NOVA ITS Section. The NOVA ITS Section is responsible for making the NOVA ITS Architecture database available to all Project Managers and sending out notification about any updates.

The NOVA ITS Architecture website at www.vdot-itsarch.com will also be updated with the latest NOVA ITS Architecture definition, Strategic Plan, Concept of Operations and other relevant documents as well as alternative methods for quickly examining the Architecture database information. This site is interactive and allows the user to examine architecture subsystems, information flows, and related elements.

The NOVA architecture will also be maintained and updated as and when additional NOVA Go-Forward strategic assessment tasks are performed to ensure that the results of the activities are accurately reflected and are consistent with the ITS Architecture.

APPENDIX C: SYSTEMS ENGINEERING AND RULE 940 COMPLIANCE CHECKLIST

ITS Projects – Systems Engineering and Architecture Compliance (Rule 940) Checklist

The Checklist needs to be filled out by the ITS PPA and Project Manager. Please refer to the guidance document accompanying the checklist for information on the checklist items as well as a completed example.

Date	Name of Person Filling/Modifying the Form	Notes

ITS Projects – Systems Engineering and Architecture Compliance (Rule 940) Checklist

SECTION 1 – Project Information	
1.1 PROJECT TITLE	**1.2 PROJECT NUMBER** ☐ New Project ☐ Modification to existing Project

1.3 BRIEF DESCRIPTION/PURPOSE

1.4 CONTACT PERSON/GROUP	1.5 PROJECT LOCATION	1.6 PERIOD OF PERFORMANCE	1.7 BUDGET & FUNDING SOURCE

1.8 NATURE OF WORK (Double Click appropriate box and Change Default Value to Checked)

☐ Scoping ☐ Design ☐ Software/Integration ☐ Implementation ☐ Operations ☐ Evaluations ☐ Others (Please Specify)

If Other, Please Specify

1.9 RELATIONSHIP TO OTHER PROJECTS AND PHASES

1.10 EQUIPMENT TO BE PURCHASED WITH PROJECT FUNDING

1.11 STATUS	
☐ STOB Approval	☐ TIP/STIP Amendment
☐ Environmental Clearance, If applicable	☐ FHWA Authorization

1.12 IS THERE A WORK PLAN FOR THIS PROJECT WITH TASK BREAKDOWN?

☐ No
☐ Yes, Provide Document Reference
☐ To Be Developed

SECTION 2 – Needs Assessment

2.1 WHAT IS/ARE THE PROBLEM(S) WITH THE CURRENT SITUATION?

2.2 WHAT NEEDS DOES THIS PROJECT ADDRESS?

2.3 HOW WERE THESE NEEDS IDENTIFIED? (Double Click appropriate box and Change Default Value to Checked)

☐ Internal VDOT Assessment ☐ Stakeholder Involvement ☐ From Technical Reviews or other studies ☐ Other

Please provide details on how needs were identified – If other documentation was used as reference, please identify it here.

ITS Projects – Systems Engineering and Architecture Compliance (Rule 940) Checklist

SECTION 3 – Regional Architecture Assessment and Concept Exploration

3.1 STAKEHOLDERS IN VDOT REGIONAL ARCHITECTURE INCLUDED BY PROJECT

3.2 INVENTORY ELEMENTS IN VDOT REGIONAL ARCHITECTURE INCLUDED BY PROJECT

3.3 INTERFACE IMPACTS (I.E DATA EXCHANGES) DUE TO PROJECT. PORTIONS OF ARCHITECTURE BEING IMPLEMENTED

3.4 OTHER REGIONAL ARCHITECTURES IMPACTED BY PROJECT

☐ DC Region (MWCOG) ☐ Maryland ☐ Other VDOT Districts ☐ VDOT Statewide ☐ Other

Changes communicated to appropriate architecture maintenance agencies ☐ No ☐ Yes

3.5 CHANGES RECOMMENDED TO VDOT NOVA and/or REGIONAL ARCHITECTURES

☐ No ☐ Yes

If "Yes", Please Specify and provide detail

SECTION 4 – Alternative Analysis

4.1 WERE ANY ALTERNATE CONCEPTS/IDEAS CONSIDERED? ANY OTHER SOLUTIONS TO THE PROBLEM?

☐ No ☐ Yes

Please Specify how the best concept was selected

4.2 REFERENCE DOCUMENTS (IF ANY)

SECTION 5 – Concept of Operations

5.1 IS THERE A CONCEPT OF OPERATIONS (COO) FOR THIS PROJECT?

☐ No ☐ Yes ☐ To Be Developed

If "No" was selected, please specify reason

5.2 IF "Yes" WAS SELECTED, PLEASE FILL OUT THE FOLLOWING

COO Contains:

- Scope (Geographic, Timeframe, Region etc) ☐ Yes ☐ No
- Description of what the project/system is expected to do ☐ Yes ☐ No
- Roles and Responsibilities for all stakeholders ☐ Yes ☐ No
- Operational Scenarios ☐ Yes ☐ No
- Project/System Impacts ☐ Yes ☐ No

If "No" was checked in any of the boxes, please specify reason

5.3 PLEASE PROVIDE COO DOCUMENT REFERENCE IF AVAILABLE

SECTION 6 – Requirement Definitions (High-Level and Detailed)

6.1 ARE HIGH-LEVEL FUNCTIONAL REQUIREMENTS WRITTEN AND DOCUMENTED

☐ No ☐ Yes ☐ To Be Developed

6.2 IF "Yes" WAS SELECTED, PROVIDE REQUIREMENTS DOCUMENT REFERENCE IF AVAILABLE

SECTION 7 – Detailed Design

7.1 IS THERE A DESIGN DOCUMENT AVAILABLE

☐ No ☐ Yes ☐ To Be Developed

Please provide reference to design document

7.2 IF "YES" WAS SELECTED, PLEASE FILL OUT THE FOLLOWING

Are the design details well documented	☐ Yes ☐ No
Do the details of the design trace to requirements definitions	☐ Yes ☐ No
Are boundaries and interfaces of the system clearly identified	☐ Yes ☐ No
Is there a process for Configuration Control	☐ Yes ☐ No

If No was checked in above boxes , please provide an explanation

7.3 DOES THE DESIGN INCORPORTATE NATIONAL ITS STANDARDS

☐ No ☐ Yes

IF YES, Please mention what ITS Standards are being used

7.4 DOES THE DESIGN INCORPORTATE ANY VDOT ENTERPRISE STANDARDS

☐ No ☐ Yes,

IF YES, Please mention what VDOT Enterprise Standards are being used

SECTION 8 – Implementation

8.1 PROCURMENT DETAILS

8.2 REFERENCE DOCUMENTS (IF ANY)

SECTION 9 – Integration and Test

9.1 IS THERE AN INTEGRATION PLAN

☐ No ☐ Yes ☐ To Be Developed

If "Yes" Please provide reference

9.2 IS THERE A TEST PLAN

☐ No ☐ Yes ☐ To Be Developed

If "Yes" Please provide reference

SECTION 10 – System Verification and Acceptance

10.1 IS THERE A SYSTEM VERIFICATION AND ACCEPTANCE PLAN (verification of the entire system and acceptance criteria)

☐ No ☐ Yes ☐ To Be Developed

If "Yes" Please provide reference

10.2 IF YES, PLEASE FILL OUT THE FOLLOWING

- Is there a clear criteria for completion ☐ Yes ☐ No
- Are there clear performance metrics for system acceptance ☐ Yes ☐ No
- Will there be adequate system documentation for all users and maintainers ☐ Yes ☐ No

If No was checked in above boxes , please provide an explanation

SECTION 11 – Operations and Maintenance

11.1 WHO WILL MAINTAIN THE SYSTEM

11.2 IS THERE A SCHEDULE FOR UPGRADES/ENHANCEMENTS TO THE SYSTEM

11.3 WILL THERE BE AN EVALUATION OF THE SYSTEM