Operations Planning Guide

VDOT
Virginia Department of Transportation

Operations Planning Guide:

Leveraging ITS Architecture and Systems Engineering

Virginia Department of Transportation
Northern Region Operations

DRAFT Version 4.0 - May 2014

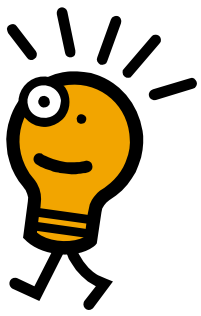


Table of Contents

DRAFT Version 4.0 will be updated in the future

ACKNOWLEDGMENTS

The development of this guide was initially conceived by Amy McElwain, NRO Planning and Programming Section Manager, to address the need for a comprehensive operations planning process that satisfies federal requirements, minimizes project risks and considers regional mobility goals and objectives. Ms. McElwain served as the Project Manager for development of the initial (August 2006) version of this guide. She was supported by Battelle under contract with Wilbur Smith Associates. Liz Liverman served as the graphics designer and provided the overall layout of the guide.

This version (June 2009) of the guide includes updates from J.D. Schneeberger, NRO Operations Planner, and was prepared by Iteris. The Project Manager for this update, James Witherspoon, would like to thank all of those previously mentioned for their invaluable guidance.

1.0 Preface

The Virginia Department of Transportation (VDOT) Northern Region Operations (NRO) has established a successful Intelligent Transportation Systems / Operations (ITS / Operations) program. Consistent with U.S. Department of Transportation (U.S. DOT) guidelines and rules, VDOT NRO has developed a framework (regional architecture) that will guide regional ITS planning, project development, and implementation to achieve increased integration of the region's transportation system. In addition to the regional architecture, VDOT NRO has developed a comprehensive process for ITS/operations project planning and program delivery, including several easy-to-use checklists, templates, databases and websites.

However, a gap exists between the knowledge of the business process and its application to ITS project development. This Operations Planning Guide is intended to address the gap and is primarily intended for the groups of stakeholders identified below.

- Project Managers – who plan, develop and deploy ITS projects
- Section Managers – who are responsible for overall project management within their sections,
- NRO Management – who are responsible for overall ITS / Operations in the region
- FHWA Representative – who is responsible for Federal oversight
- Planning Staff – who are responsible for overall ITS / Operations program direction and deployment
- Contract Administration Staff – who are responsible for the administration of contracts
- VDOT Roadway Project Managers – who are responsible for roadway projects
- Local ITS Project Managers – who are responsible for managing local ITS project within their jurisdiction

This guide was created to familiarize project managers in the Northern Region with the components and the requirements of Northern Virginia ITS architecture and to assist the project managers in the development of ITS projects and proposals. It describes the ITS architecture in VDOT's Northern Region including non-VDOT stakeholders and systems. The guide can be used by any stakeholder in the Northern Region.

Please visit ***www.vdot-itsarch.com*** to view the Northern Virginia ITS Architecture.

2.0 Operations Planning Guide Organization

This Operations Planning Guide provides readers with answers to the following questions and more:

- *What is an ITS Project?*
- *What are the FHWA Rule requirements for ITS Architecture?*
- *What is VDOT NRO's Planning and Program Delivery Process?*
- *How does one use the architecture and other NRO tools to develop projects?*
- *How does one use the systems engineering process to develop projects?*
- *How to access and use the regional architecture?*

The guide is organized into seven (7) sections to meet the needs of the stakeholders identified in Section 1 who are looking for guidance at various steps in a project's development process, as well as to provide background information on ITS architecture and U.S. DOT rule requirements. Most material in the sections can be categorized as either Definitions / Background () or as activities/ steps to be performed. ()

Guidance	Location (Section)	Type of Information	Description
Preface, Organization	1,2		Information on purpose and the organization of the guide
Background	3,4		Information on definitions of ITS projects, Rule 940 requirements
VDOT NRO PPD Process	5		Information on how VDOT NRO plans and delivers ITS projects
Initiating, Developing and Deploying an ITS Project	6		Guidance for project managers looking to initiate, develop and deploy projects in conformance with FHWA Rule 940 using systems engineering principles
Guidance on accessing the architecture	7		Guidance on how to access the architecture website and supporting software tools as well as providing project information for regional architecture updates

3.0 What is Operations Planning

Transportation systems are more than pavement, highways, and transit facilities. Operating and maintaining a transportation system for moving people and goods efficiently, reliably and safely requires cooperation and coordination among many different organizations internally and externally to the operating agency.

Transportation system operations and maintenance cannot be properly done without planning and coordination of the system operations, the infrastructure implementation, and the maintenance of the various system components. Operations Planning involves collaboration among regional transportation system operators, evaluation of investment opportunities and priorities against regional goals, and coordination between operations and planning personnel to deliver transportation services that meet the needs of the traveling public. The result of this cooperation and coordination is projects that deliver the infrastructure components and transportation services that make efficient, safe and reliable transportation system possible.

In a resource-constrained environment with increased calls for accountability and growing mobility and safety needs, the delivery of the operations program requires VDOT NRO to make sound investment decisions between projects with competing priorities. To address this challenge, NRO developed a unique methodology for planning and delivery of its Operations Program. The process unifies strategic and tactical planning, project development, investment analysis, budgeting performance tracking and evaluation of the program. ITS projects are delivered through this process.

3.1 Definition of an ITS Project

An ITS project is any project that, in whole or in part, funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS user services as defined in the National ITS Architecture. Developed by the U.S. DOT, the National ITS Architecture is a common framework for planning, defining, and integrating intelligent transportation systems. It is a mature product that reflects the contributions of a broad cross-section of the ITS community.

User services are the part of the National ITS Architecture that document what ITS should do from the user's perspective. A broad range of users are considered, including the traveling public as well as many different types of system operators. The initial user services were jointly defined by U.S. DOT and ITS America, with significant stakeholder input, and were documented in the National Program Plan. New or updated user services have been, and will continue to be addressed, by the National ITS Architecture over time.

Tip: The latest version of the National ITS Architecture is version 6.1. Definitions for user services can be found on the National ITS Architecture website: ***www.iteris.com/itsarch***

Given the broad definition of "ITS" and the wide range of transportation technology projects covered under User Services, many, if not most, transportation technology projects will be considered ITS projects. The scope of a project determines whether a project can be termed an ITS project or not. As a rule, a project can be classified as an ITS project if it: addresses a user service in the National ITS Architecture and uses technology to solve the transportation problem. The project examples on the following page show how the scope can determine whether a project can be termed an ITS project or not.

With ITS applications becoming a common part of traffic operations, it is also important to distinguish between routine projects and non-routine projects from an ITS planning standpoint. Routine projects are typically replacement or maintenance projects which have been previously carried out by VDOT NRO and involve little to no interaction with any other external agencies. Examples of such projects could be camera replacements and expansion, installation of sensors, traffic signal optimization, etc. For such projects, VDOT NRO's Project Managers are familiar with the requirements, the design, and the implementation strategy and can follow the systems engineering process easily.

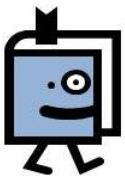
Routine Project: Replacement or maintenance projects, following similar prior deployments with little or no interaction with other agencies.

Non-Routine Project: Integration or expansion type project involving several external agencies and stakeholders.

Non-routine projects, on the other hand, are typically integration and expansion type projects, involving several external agencies and stakeholders. For such projects, development of a concept of operations, requirements identification, detailed design, and implementation often are major tasks. Often, these projects also have regional implications requiring collaboration across multiple jurisdictions and agencies. For these projects, systems engineering is a vital activity that occurs throughout the project lifecycle. Examples of such projects include new software for advanced transportation management systems (ATMS), Computer Aided Dispatch (CAD) integration, video clearinghouses, archived data management systems, etc.

Is it an ITS Project?

- New computers for STC engineers
  – No. Does not directly address a specific transportation problem.
- Electronic fare collection equipment for transit buses
  – Yes.
- Real-time traveler information system
  – Yes.
- Data management software to assist in payroll
  – No. Does not address transportation problem.
- Maintenance management software
  – May be an ITS project if it involves technologies to track assets, vehicle maintenance, operations, etc.
- Software to monitor drug and alcohol testing program
  – No. Does not address a transportation problem.
- Traffic signal timing optimization
  – Yes, if scope includes adaptive or centralized control. No, if scope involves retiming of isolated signals.
- Buying new vehicles for Safety Service Patrol
  – Yes, if SSP vehicle procurement includes communication technologies.
- Replace signal control at an isolated intersection
  – Yes, if a new or upgraded controller is installed or connected to a centralized system. No, if an isolated signal controller unit is replaced with another one.
- Re-striping city roads
  – No, this is traditional routine infrastructure maintenance.



Tip: When you are in doubt about whether a project is an ITS project, contact the Federal Highway Administration (FHWA) ITS Specialists in the FHWA Division Office in Richmond. They will provide you with guidance and assistance to determine the ITS status of the project.

4.0 Federal Requirements for ITS Projects

Tip: VDOT NRO has developed a checklist for Rule 940 compliance. The checklist assists project managers in ensuring that they follow the National ITS Architecture Rule while designing and implementing their ITS projects. The use of the checklist will be described in Section 6 of this guide.

FHWA Rule 940 provides policies and procedures for implementing Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA–21), Public Law 105–178, 112 Stat. 457, pertaining to conformance with the National ITS Architecture and Standards.

The rule states that the final design of all ITS projects funded with Highway Trust Funds shall accommodate the interface requirements and information exchanges as specified in the regional ITS architecture. The regional ITS architecture is a specific application of the framework specified in the National ITS Architecture, tailored to the needs of the transportation stakeholders in the region.

If the final design of the ITS project is inconsistent with the regional ITS architecture, then the regional ITS architecture shall be updated. Compliance with the rule needs to be demonstrated prior to authorization of Highway Trust Funds for construction or implementation of ITS projects.

The rule also states that all ITS projects, funded in whole or in part with funding from the Highway Trust Fund, shall be based on a systems engineering analysis consisting of seven required elements. As shown in the Rule 940 requirements box below, systems engineering is a process that addresses the entire project life-cycle. Typical steps in the systems engineering approach include concept of operations, requirements analysis, design, testing, acceptance, and operations and maintenance.

While the use of the architecture and the systems engineering approach is mandatory for federally funded ITS projects, project developers are encouraged to use this approach for any ITS project using state or local funds, especially for projects that integrate with other systems in the region.

Detailed information regarding Rule 940 and its various components can be found at USDOT's website ***www.ops.fhwa.dot.gov/its_arch_imp/docs/20010108.pdf***

The rule requirements are applicable for all ITS projects funded through the Highway Trust Fund account. Thus, conformity with the Rule 940 requirements is required for both routine and non-routine projects. However, with routine projects, the effort and the scope of systems engineering analysis should be minimal. For non-routine projects, the scale of the systems engineering analysis depends on the scope of the project.

Rule 940 Requirements

1. Identification of portions of the regional ITS architecture being implemented (or if a regional ITS architecture does not exist, the applicable portions of the National ITS architecture)
2. Identification of participating agencies roles and responsibilities
3. Requirements definitions
4. Analysis of alternative system configurations and technology options to meet requirements
5. Procurement options
6. Identification of applicable ITS standards and testing procedures
7. Procedures and resources necessary for operations and management of the system

5.0 VDOT NRO Planning and Program Delivery (PPD) Process

The VDOT NRO Planning and Program Delivery (PPD) Process integrates the use of the regional ITS architecture and federal systems engineering requirements into a traditional transportation planning framework for ITS projects. In doing so, VDOT NRO has realized opportunities to mainstream ITS into legacy VDOT PPD Processes. The VDOT NRO PPD Process leverages regional and statewide transportation related goals and objectives in order to prioritize investments and maximize returns on those investments. The process unifies strategic and tactical planning, project development, investment analysis, budgeting, performance tracking, and program evaluation. The process conforms to FHWA Rule 940, emphasizing the Systems Engineering Process.

The VDOT NRO PPD Process consists of the 5 steps illustrated in Figure 1 and discussed in the following sections. The process is cyclical and temporally constrained by the VDOT fiscal calendar and other milestones. Each year, NRO Planning documents are updated based on accomplishments made over a fiscal year. Updated planning documents are considered in the development of the program for the subsequent year. This interaction is represented at the pinnacle of the cycle and can be considered as the starting point of the process.

Each step of the process has activities. The process steps apply particular steps in the systems engineering process as seen by the blue highlighting of the systems engineering diagram in each process step in Figure 1. Each activity is executed by specific NRO staff. The discussions that follow are intended to provide a general understanding of the process and who is involved.

Figure 1 VDOT NRO PPD Process

VDOT's Fiscal Year starts on July 1st and ends on June 30th; In September of each year, Program Development for the next fiscal year begins.

5.1 Planning

The Planning step addresses NRO's "long-range" planning and represents the cornerstone from which the annual NRO Program is developed. The suite of NRO "long-range" planning documents includes:

- *NRO Strategic Plan*
  The NRO Strategic Plan charts the direction for NRO by establishing a vision for regional transportation operations and identifying needs, goals and objectives that address the established vision and performance measures used to evaluate progress toward achieving the vision.

- *Northern Virginia ITS Architecture*
  The Northern Virginia ITS Architecture identifies planned and existing regional ITS systems, interfaces and services and provides a framework for the deployment of interoperable regional ITS. A NRO Operations Concept is also defined within the Northern Virginia ITS Architecture.

- *NRO ITS Device Master Plans*
  NRO ITS Master Plans provide a roadmap for the expansion of ITS throughout the region based on operational needs. Operational needs were identified through the development of Concepts of Operation for core ITS devices (e.g. DMS, CCTV cameras and detection devices), telecommunications infrastructure, and services.

Tip: The latest versions of the NRO Strategic Plan and the NRO ITS Device Master Plans are available on the Northern Virginia ITS Architecture website under the Documents and Files link.

These plans are developed to guide the strategic direction and delivery of the region's operations program over a 4-6 year planning horizon and are maintained regularly based on annual accomplishments.

Activity	Initiator(s) / Actor(s)
1. Annually update NRO suite of long-range planning documents based on accomplishments.	NRO Planning Staff

5.2 Program Development

Program Development involves the annual identification and prioritization of projects that support NRO long-range plans. This step in the NRO PPD Process includes three primary activities: Project Development, Annual Strategic Focus Development and Project Prioritization.

Project Development – Candidate ITS projects are proposed by VDOT NRO Management and NRO Planning Staff. NRO Management submits Project Proposals to request project funding in a standard format. A Project Proposal Template has been developed and

provided as Appendix A to assist NRO Management with the development of candidate ITS projects. Project Proposals include information that demonstrates how a project supports NRO long range plans. Of particular note, Project Proposals map candidate ITS projects to NRO Strategic Plan goals and objectives.

In addition to new project ideas submitted by NRO Management and Planning Staff, unfunded, partially funded and deferred projects from previous fiscal years are considered. These projects and new project ideas are compiled by NRO Planning staff to form a list of candidate ITS/operations projects.

Activity	Initiator(s) / Actor(s)
2. Solicit project ideas from staff	NRO Planning Staff
3. Develop project proposals (using project proposal template) 4. Submit project proposal to Operation Planning staff	NRO Management/ NRO Planning Staff
5. Review project proposals; primarily to verify completeness and consistency with NRO long range plans 6. Prepare draft list of candidate ITS/Operations Projects	NRO Planning Staff

Annual Strategic Focus Development – NRO hosts an annual Operations Planning workshop. During this workshop, NRO Management is asked to weight the goals and objectives presented in the NRO Strategic Plan based on current internal and external trends and influences. The weighted goals and objectives form the NRO Annual Strategic Focus and provide a basis for determining how NRO will allocate resources in the upcoming fiscal year.

Activity	Initiator(s) / Actor(s)
7. Plan and facilitate NRO Annual Planning Workshop	NRO Planning Staff
8. Rank goals and objective presented in the NRO Strategic Plan based on internal and external trends and influences	NRO Management

Project Prioritization – Leveraging the Annual Strategic Focus and the mapping of candidate ITS projects to NRO Strategic Plan goals and objectives included in Project Proposals, a prioritization score is determined for each candidate ITS project. The formula below is used to calculate prioritization scores. This formula is evolving and in, in the future, it should include cost/benefit and performance measure factors.

$$\textbf{Prioritization Score} = \frac{[\Sigma G_i * (\Sigma O_{ij})]}{100} + RF$$

Where:

G_i = ***Goal Score (weighted value assigned at the Planning Workshop)***
O_{ij} = ***Objective Score (weighted value assigned at the Planning Workshop)***
RF = ***Regional Operations Director (ROD) Factor***

Prioritization scores are used to prioritize candidate ITS projects.

Activity	Initiator(s) / Actor(s)
9. Determine prioritization score for candidate ITS/Operations projects	NRO Planning Staff
10. Prepare list of prioritized candidate ITS/Operations projects	NRO Planning Staff

5.3 Fiscal Programming

The Annual Strategic Investment Program Plan is accessible under the Documents and Files link on the Northern Virginia ITS Architecture website.

The Fiscal Programming Phase is the third step in the PPD process. The intent of the Fiscal Programming Phase is to

- prepare various funding needs packages based on the prioritized, candidate list of projects and programs,
- request those responsible for, or capable of influencing, funding allocation decisions to consider providing or advocating for funding allocations to fund NRO's package of needs, and
- make a best-fit match between the allocations received and NRO's prioritized list of candidate programs and projects.

In an input/output context, the Fiscal Programming Phase is the process that matches input from the Program Development Phase (NRO's candidate list of prioritized projects and activities) to NRO's Strategic Investment Program Plan (SIPP). The SIPP documents the PPD Process, identifies NRO's Work Plan for the forthcoming fiscal year, details

NRO's Funding Plan for the forthcoming fiscal year, and tabulates NRO's unmet funding needs.

Due to resource limitations, not all candidate ITS projects will be funded. Unfunded candidate ITS projects are placed in the Unfunded Project Pool and will be considered for funding as it becomes available. If funding is not available, the project will be considered during a future PPD cycle.

In an attempt to mitigate potential contracting issues, contracting/procurement options are considered for funded projects.

In an attempt to mitigate potential fiscal programming issues, it is verified that funded projects are included in the TIP/STIP.

TIP: Transportation Improvement Program

STIP: State Transportation Improvement Program

Activity	Initiator(s) / Actor(s)
11. Identify funding sources and determine eligibility of prioritized projects to qualify for funding	NRO Programming Staff
12. Prepare and submit funding requests	NRO Programming Staff
13. Receive information on draft allocations[1]	NRO Programming Staff
14. Prepare draft NRO Work Plan	NRO Programming Staff
15. Receive information on final allocations	NRO Programming Staff
16. Finalize Work Plan and prepare SIPP	NRO Programming Staff
17. Add unfunded candidate ITS projects to the Unfunded Project Pool	NRO Programming Staff
18. Identify contracting/procurement options for funded ITS projects	NRO Contract Administrator
19. Ensure all funded projects are included in the TIP/STIP and VDOT's programming systems	NRO Programming Staff

[1] If draft allocations do not satisfy funding needs, then funding sources may be solicited for additional funds.

5.4 Program Delivery

Once the NRO Work Plan receives final approval, the Program Delivery step in the NRO PPD Process is initiated.

NRO Program Kick-Off – The annual NRO Program is initiated with a series of Kick-Off Meetings. During Kick-Off Meetings:

- The approved NRO Work Plan is presented to project and section managers and
- Federal requirements and contracting/procurement options for each funded project are discussed.

Activity	Initiator(s) / Actor(s)
20. Schedule and facilitate Kick-Off meetings.	NRO Programming Staff
21. Attend Kick-Off meetings	NRO Planning and Programming Staff/NRO Project Managers/NRO Management/NRO Contract Administrator
22. Begin addressing outstanding federal requirements and determining ideal contracting/procurement approach	NRO Project Managers/NRO Management/NRO Contract Administrator
23. Propose and facilitate funding reallocation during the fiscal year.	NRO Programming Staff

Project Initiation & Implementation – At this point projects are ready to be initiated and implemented. NRO projects initiated and implemented in accordance to federal and state requirements. Of particular note, the requirements of FHWA Rule 940 are specifically considered for all NRO ITS projects.

Project implementation is not considered complete until the project is officially closed out. Project close-out involves the compiling of pertinent fiscal and technical project documentation to demonstrate that all fiscal and technical project requirements have been satisfied. Project closeout documentation should (at minimum) include SE process documentation, an updated project Rule 940 Checklist, C-5 Form, and (if appropriate) as built drawings.

Activity	Initiator(s) / Actor(s)
24. Hold Project Initiation (or Kick-Off) Meeting	NRO Project Manager/NRO Management/NRO Contract Administrator/ FHWA Rep/NRO Planning and Programming Staff
25. Prepare detailed project scope 26. Enter project into CEDAR and seek required environmental approvals 27. Complete Rule 940 Checklist and seek FHWA approval for PE phase	NRO Project Manager/NRO Planning and Programming Staff
28. Initiate and complete PE phase of the project	NRO Project Manager/NRO Planning and Programming Staff/ NRO Contract Administrator
29. Update Rule 940 Checklist and seek FHWA approval for CN phase	NRO Project Manager
30. Initiate and complete CN phase of the project	NRO Project Manager/NRO Staff/ NRO Contract Administrator
31. Submit all project documentation to appropriate NRO Staff for project close-out. Submit C-5 Form and Rule 940 Checklist to close project in VDOT systems and request financial closeout.	NRO Project Manager/NRO Planning and Programming Staff

Tip: The three main tools available to NRO project managers to assure conformance to the federal requirements for ITS architecture are the Northern Virginia ITS architecture website (**www.vdot-itsarch.com**), the Turbo database for the Northern Virginia ITS architecture, and the Rule 940 checklist. The checklist can be downloaded from the website.

CEDAR: Comprehensive Environmental Data & Reporting System

Additional detail of the Program Delivery step of the NRO PPD Process is presented in Section 6.0.

5.5 Program Evaluation

During the Program Evaluation step of the NRO PPD Process, project documentation for all projects completed in a given fiscal year are compiled and assessed to determine progress made towards the NRO Vision and to assess the project's contribution to the current fiscal year's goals.

Based on the assessment of compiled project documentation, a Year End Report is produced. The Year End Report provides a snapshot of accomplishments achieved during a given fiscal year.

Activity	Initiator(s) / Actor(s)
32. Compile and assess project documentation from all projects completed within a given fiscal year. Collect and compile performance measure data and financial spending data.	NRO Planning and Programming Staff
33. Interview NRO Section and Project Managers to determine significant fiscal year accomplishments	NRO Planning and Programming Staff/NRO Section Managers/NRO Project Managers
34. Prepare Year End Report	NRO Planning and Programming Staff

To "close the loop" or complete the cycle, Year End Reports are ultimately used as input to the maintenance of the suite of NRO long-range planning documents.

6.0 Initiating, Developing, and Deploying an ITS Project

Section 5 presented an overview of the NRO PPD Process, which includes ITS project development, initiation and implementation elements. This section addresses the details associated with ITS project development, initiation and implementation, and presents tools to help maximize ITS project integration options consistent with ITS plans in the region.

6.1 Project (Concept) Development

As noted in Section 5, project development is accomplished within the Program Development step of the NRO PPD Process. This section provides details for activities 2 – 6. Through Rule 940, USDOT requires the use of the systems engineering process to develop ITS projects. Figure 2 illustrates the systems engineering V diagram that USDOT encourages use of in pursuit of Rule 940 compliance. The following sections will present the project development process and NROs application of the Systems Engineering process. To initiate the process, a need or problem must be defined which requires a solution to resolve it. The definition of some problems/needs was done in the PPD steps in the Planning Process in Section 5. The problems/needs initiate the systems engineering V diagram activities from the far left side.

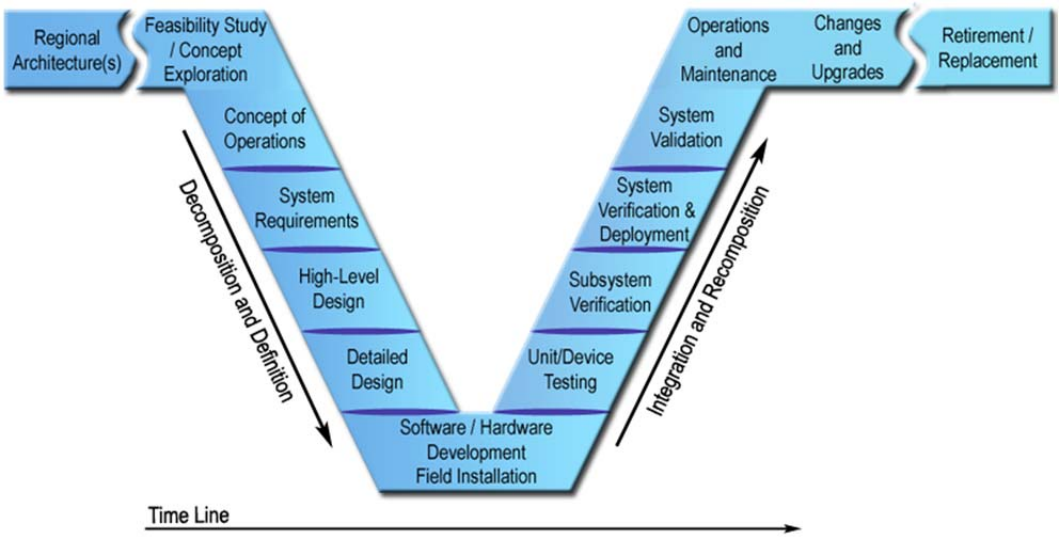


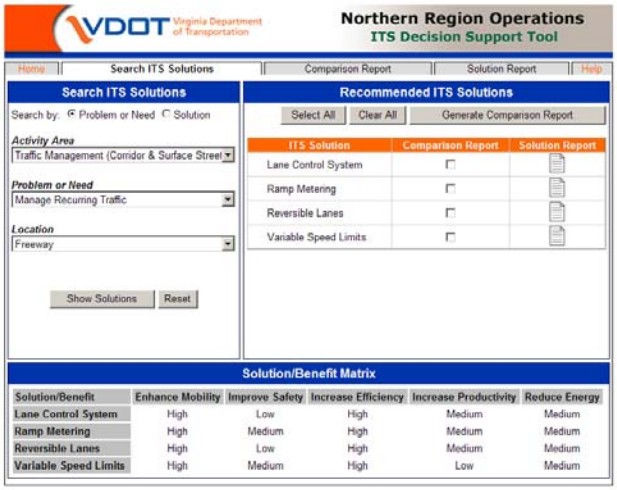
Figure 2 USDOT's System Engineering Process

Tip: The systems engineering V diagram starts with Regional Architecture as a separated step in the process. This separation is illustrates that the Regional Architecture already exists as a resource to draw upon for the systems engineering process. It should be used as a starting point for the project concept, scoping, and requirements.

The ITS Decision Support Tool can be accessed through the Northern Virginia ITS Architecture website.

Problems/Needs Addressed - Ultimately, a project is addressing a particular problem or need. The problem or need must be clearly defined and documented. In some cases it may be difficult to single out the problem being addressed or what particular project will address the issue. To assist project developers with problem definition, VDOT NRO has developed an ITS Decision Support Tool (ITS-DST) to aid in defining the issue as well as promoting solutions to be considered. The ITS-DST may not be needed when the project manager has a clear vision for the problem and its solution.

The ITS Decision Support Tool is a web-based application developed to assist transportation professionals in identifying ITS Solutions. Beginning with a problem, users can answer a series of questions that will lead them to a list of potential ITS solutions that may be able to solve the problem. Once a solution is identified, the user is provided with a detailed ITS Solution report providing:



- A description of the ITS Solution;
- Equipment and supporting infrastructure to deploy the ITS Solution;
- Traceability to the National ITS Architecture;
- Benefits of the ITS Solution; and
- Cost information.

The definition of the problem that needs to be solved initiates the project development process. The alternative solutions identified by the project developer or produced by the ITS-DST, will be analyzed by the project developer and the best alternative selected. Outputs of the ITS-DST can be used to populate the initial project proposal template. This is done during the feasibility study or concept exploration step early in the systems engineering process. When selecting the alternative, the Northern Virginia ITS Architecture should be used to determine the solution with the best integration opportunities. You might ask why the regional architecture is the first step in the systems engineering V diagram but we just indicated that feasibility studies are first. If you notice the regional architecture step is not directly connected to the V diagram. The architecture has already been developed and the diagram shows that it is a ready reference for the systems engineering process. It is most applicable to the systems engineering activities on the left hand side of the V diagram. The architecture application will be discussed in the following steps.

Project Proposal – Following the alternatives analysis and the selection of a proposed solution, a project proposal must be developed. ITS-DST outputs can be used to populate project proposals. Appendix A provides a template to develop the Project Proposal. The proposal includes a description, identification of the problem to be addressed by the project, mapping of the project to the Northern Virginia ITS Architecture, the NRO Strategic Plan, and the NRO Master Plans. NRO Master Plan GIS files should be used when appropriate to describe the scope of the project. Links to these plans can be found under the Documents and Files link at the Northern Virginia ITS Architecture website (www.vdot-itsarch.com). The plans can be downloaded and the architecture explored from this site. In addition, the Northern Virginia ITS Architecture database can be accessed to determine the stakeholders, inventory, services, information flows and standards associated with the proposed project. Section 7 provides detail on how to access the Northern Virginia ITS Architecture. Attention should be given to the interfaces with other ITS systems in the architecture to maximize the integration opportunities of the project. These mappings are important to the overall ITS program at NRO to maintain consistency and track progress against the various plans and guides. The roles and responsibilities of the primary stakeholders and the interdependencies of the project with other projects or existing systems is key to involving the appropriate stakeholders and those operating related systems as the project development is initiated. A plan for evaluation of the project is required as well to properly validate the project performance and deployment objectives.

The project proposal provides information to NRO planning staff to better understand the scope and components of the project. Proposed projects form the basis for the development of the NRO Work Plan for the upcoming fiscal year. The use of the Northern Virginia ITS Architecture as a reference is very important in this step in that it provides insight into the scope of the project and the integration opportunities that should be considered. With these high-level pieces of information, it is time to get into the project details.

Tip: Use the **Architecture website** to review and identify stakeholders and subsystems that are applicable to your project.

Use **Turbo Architecture** to develop project architecture. Create the project architecture within your copy of the Northern Virginia ITS Architecture so you can easily modify it as your concept evolves. When your project architecture is complete, print or save the diagram from the reports menu to include in your project proposal.

6.2 Project Initiation

This section provides detail and context for the Program Delivery step of the NRO PPD Process. More specifically, activities 24 - 31 (as presented in Section 5) are considered. At this point in the process, funds have been allocated to projects and the Systems Engineering process is used as the basis for the development of a detailed project scope. NRO has developed the Rule 940 Checklist

1. to assist with the development of detailed ITS project scopes,
2. to track project deployment,
3. to facilitate stakeholder acceptance of project documentation, and
4. to facilitate transition between systems engineering process steps.

FHWA has produced 2 Guidance Documents for Systems Engineering. The *Systems Engineering for ITS Handbook* provides an overview of the systems engineering process and can be found at: **www.ops.fhwa.dot.gov/publications/seitsguide/index.htm**

The *Systems Engineering Guidebook for ITS* provides an in depth and detailed guide to systems engineering and can be found at: **www.fhwa.dot.gov/cadiv/segb/**

Rule 940 Checklist – The Rule 940 Checklist in Appendix B walks the project manager through the requirements of Rule 940 for the development of a project using systems engineering. It is important to note that systems engineering is broader than the Rule 940 requirements. By following the systems engineering process, you are going to meet the requirements of Rule 940. Each step in the Rule 940 Checklist prompts the user for information that must be gathered to properly execute the project. By assembling the information in the checklist, the next step of executing the project and developing the system is made much more effective.

The Rule 940 Checklist will be a living document that is completed over a period of time as information is gathered, analysis is completed and the development of the system begins. It is not something that is filled out at one sitting. The checklist is a guide for project managers to determine what documents, steps, and analyses need to be developed over the life of the project. The checklist is broken down into 11 sections (figure 3) which were adapted from the federal guidance on using systems engineering for ITS projects. Most of the activities on the checklist are self-explanatory and will require minimal effort on the part of Project Managers.

VDOT NRO's Planning Staff will initiate the checklist based on information already available to them in the project proposal, and then send the checklist to the project managers for completion. For projects utilizing no federal funds, it is recommended that a similar process be followed if the project is non-routine, that is, projects which involve new technology or integration with new systems. Examples of such projects include integration of computer-aided dispatch systems among various law enforcement agencies and with traffic management agencies, or setting up a video clearinghouse for regional traveler information.

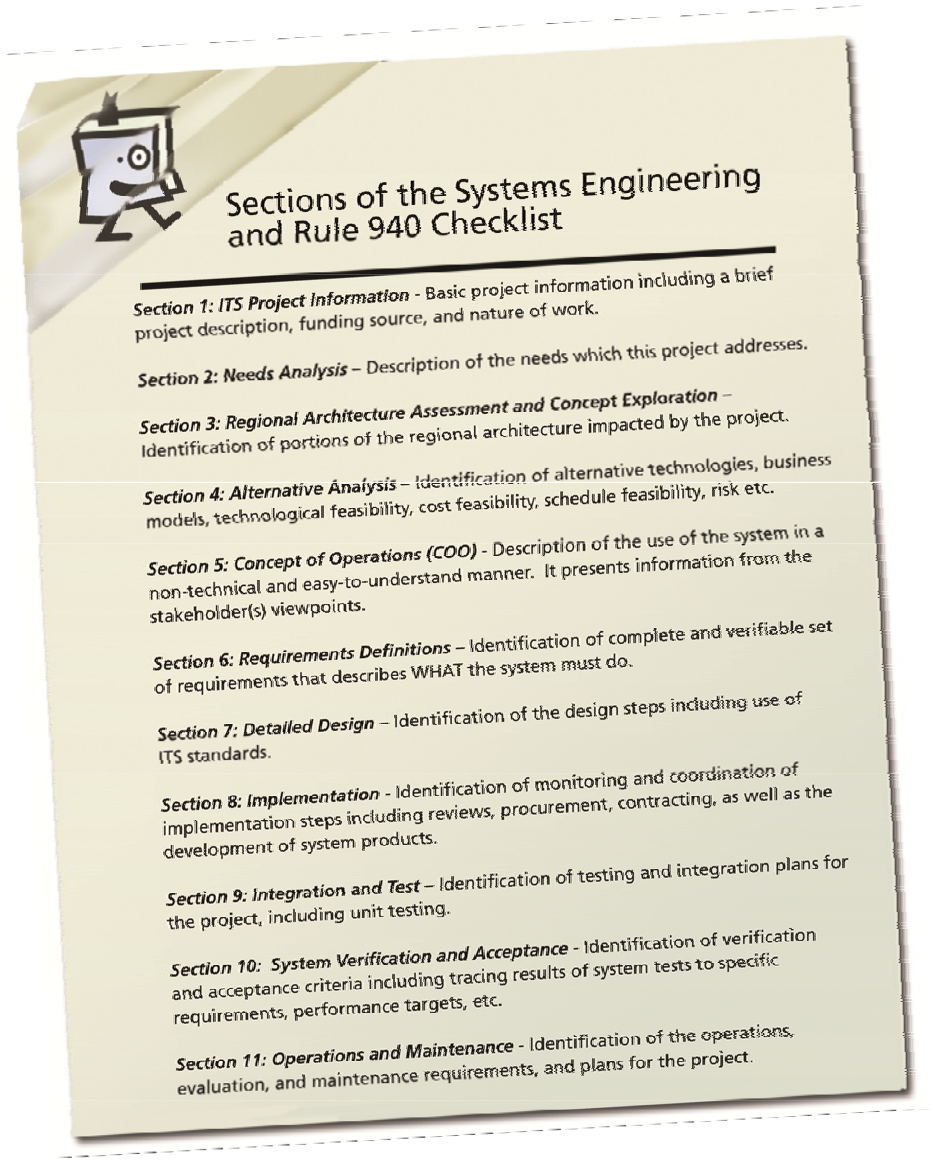


Figure 3 Rule 940 and the Checklist

VDOT NRO's Project Managers will receive a partially completed checklist from the NRO Planning Staff. Information from the Project Proposals is used by NRO Planning Staff to complete sections 1 – 4 of the Rule 940 Checklist. Project Managers are responsible for completing the remaining sections. At this point, project managers have the option of indicating that the remaining sections of the Rule 940 checklist will be satisfied during the Preliminary Engineering (PE) or Construction Phases (CN) of the project.

6.3 Project Implementation

This section provides detail and context for the Program Delivery step of the NRO PPD Process, more specifically activities 27 - 29 (as presented in Section 5).

Once the initial version of the Rule 940 Checklist has been approved by FHWA, project implementation can commence. Project implementation is broken into two phases:

1. Preliminary Engineering (PE) Phase
    - For ITS projects, the PE Phase addresses sections 5 -7 of the Rule 940 Checklist
2. Construction (CN) Phase
    - For ITS projects the CN Phase addresses section 8 – 10 of the Rule 940 Checklist.

The Turbo Architecture software is available as a free download from the USDOT National ITS Architecture website at:

www.iteris.com/itsarch/html/turbo/turbomain.htm

6.3.1 Preliminary Engineering Phase

Project managers can utilize the Northern Virginia ITS Architecture and/or the Northern Virginia ITS Architecture Turbo database to help address section 5 – 7 of the Rule 940 Checklist. Details about how to access the Northern Virginia ITS Architecture are presented in Section 7.

Concept of Operations Development

> ***Section 5: Concept of Operations (COO)*** - Description of the use of the system in a non-technical and easy-to-understand manner. It presents information from the stakeholder(s) viewpoints.

Section 5 of the Rule 940 Checklist addresses Concept of Operations development. The Concept of Operations provides a vision of what the project will produce or how the system is envisioned to be operated and maintained to address the issues it is desired to resolve. The Concept of Operations is a narrative description from the users' perspective and provides scenarios to illustrate how the system will operate in various situations. The Concept of Operations will be used to develop the Validation Plan that will be referred to after the system is implemented to validate that the system solves the issues it was built to address.

As stated earlier, the Northern Virginia ITS Architecture can be used to assist concepts of operation development. Additionally, NRO has developed a Concept of Operations Template (available under Documents and Files on the Northern Virginia ITS Architecture Website) to guide concepts of operation development. The Concept of Operations Template and Guidance Document can be accessed via the Northern Virginia ITS Architecture website. The development of Concepts of Operations involves the definition of a project architecture. A project architecture should be consistent with the regional architecture. It is made up of the components of the regional architecture that

are required to deliver a transportation service so it includes subsystems and information flows that the project will be implementing. From this functional architecture stakeholders and interfaces are identified so that conversations among the involved stakeholders can be conducted to facilitate proper planning and system engineering development of the project. Section 7 provides detail about how the Northern Virginia ITS Architecture can be accessed to assist with project architecture development.

System Requirements Development

Section 6: Requirements Definitions – Identification of complete and verifiable set of requirements that describes WHAT the system must do.

From the Concept of Operations, Requirements are generated. Requirements are "shall" statements that document what the system will do and how well and under what conditions it will perform its duties. The requirements are placed under configuration control and are included in a traceability matrix which will link each requirement to the concept of operations as well as forward to a design feature of the system. A sample traceability matrix is provided in Appendix C. The requirements will be used to develop the system design and to test the system components as the system is assembled to verify that the requirements have been satisfied. The requirements should include operations and maintenance needs that the system must accommodate.

Design

Section 7: Detailed Design – Identification of the design steps including use of ITS standards.

The requirements are used to develop the design of the system. The design will include a high-level design which allocates the functions to be performed by the system to primary components or subsystems. This provides a structure for the system. A detailed design is then executed to specifically define the functionality and interfaces of the systems. Standards are often used and encouraged for interface development to make the system as open as possible for future expansion if required or to connect the system to other systems in the region for coordination and operational purposes. Detailed specifications will be produced which will guide the system development. The design elements should be linked to their related requirements through the traceability matrix.

At the conclusion of the PE Phase, the Rule 940 Checklist should be updated and submitted to FHWA with project documentation. Upon FHWA approval of the updated Rule 940 Checklist and CN funding authorization, the CN Phase shall commence.

Tips:

Concept of Operations: Use the Northern Virginia ITS Architecture website to review stakeholders' roles and responsibilities as well as the market packages or services to examine the relationships between systems in the region.

Requirements: The requirements for the inventory elements (subsystems) in the architecture are located at the bottom of each inventory elements' webpage. In Turbo Architecture the Requirements tab provides the same requirements information which can be more quickly traversed.

Design: The market packages on the website and in the Turbo Architecture database provide diagrams and lists of information exchanges identified for ITS services. In Turbo Architecture, look under the Services tab for this information.

6.3.2 Construction Phase

Section 8: Implementation - Identification of monitoring and coordination of implementation steps including reviews, procurement, contracting, as well as the development of system products.

Section 9: Integration and Test – Identification of testing and integration plans for the project, including unit testing.

Section 10: System Verification and Acceptance - Identification of verification and acceptance criteria including tracing results of system tests to specific requirements, performance targets, etc.

Section 11: Operations and Maintenance - Identification of the operations, evaluation, and maintenance requirements, and plans for the project.

As the system components and devices are built, they are tested individually and then assembled into larger subsystems until the system has been fully integrated. The testing of the system is guided by the verification plan based on the requirements. When the system becomes operational, the validation plan which is based on the concept of operations, is used to validate that the system addresses the problems/needs it set out to. The validation plan was initially defined in the Concept of Operation.

With the system installed and validated, operations and maintenance begins. A System Operations Plan (SOP) guides the daily operations of the system with step-by-step instructions. A Maintenance Plan documents the regular maintenance processes for the system to maintain its performance.

The systems engineering process provides a structured approach to system development. Per Rule 940, the process should be scaled to be commensurate with the scope of the project. That doesn't mean skipping process steps for smaller projects. It means scaling the process steps to the level of activity required for the complexity of the system.

7.0 Accessing the Northern Virginia ITS Architecture

Regional stakeholders and project managers are encouraged to access the Northern Virginia ITS Architecture to confirm their understanding of how Northern Virginia transportation systems are interconnected currently as well as the expectations for their interfaces in the future. The architecture definition provides insights into stakeholder interactions and what information they are exchanging and the services they are providing. The Northern Virginia ITS Architecture can be accessed in two ways:

1. Through the website for architecture exploration
2. Through the use of the Turbo Architecture software tool to examine architecture details or to develop and tailor a project architecture

The choice between the two approaches depends entirely on the nature of the project. If the number of systems and / or stakeholders is less than three or if the project is a routine project, the use of the website is sufficient. Examples of such projects could be camera or dynamic message signs, replacements or new installations, or traffic monitoring device installation. If the number of stakeholders and / or systems is greater than three or if the project is one-of-a-kind involving new technology or systems, the use of the Turbo Architecture software tool is strongly encouraged.

As a general rule, as project complexity increases, it is easier to use the Turbo Architecture database to fill out sections of the checklist. However, Project Managers are strongly encouraged to take a training class in the use of Turbo Architecture prior to using the database. VDOT NRO's Planning Staff can also provide guidance and support if the Turbo Architecture option is selected.

Tip: The Market packages in the Northern Virginia ITS Architecture address the breadth of each transportation service identified in the architecture. The use of the market packages when developing an ITS project provides a valuable project scoping tool which aids in the assessment of the project's impact on other systems in the region which maximizes integration opportunities.

7.1 Using the Website for Project Architectures

The Northern Virginia ITS Architecture website is located at www.vdot-itsarch.com. The architecture content can be accessed through four different pathways depending on the user's interest. All of the pathways lead to the same information and they are:

- **Stakeholders** – View the architecture from an agency's perspective (example – VDOT NRO)
- **Inventory** – View the architecture from a system perspective (example – VDOT NRO MPSTOC)
- **Market Package** – View the architecture from a services perspective (example – Regional Traffic Control)

- **Entity** – View the architecture from a "subsystem" or functional perspective. Sub-systems are types of centers, field equipment, vehicles involved in a function such as traffic management or traveler information. (example – Traveler Information)

The following is a simple, hypothetical example to illustrate the use of the website by the Project Manager for developing project architecture using the market package pathway. Consider that VDOT is interested in upgrading its Closed Circuit Television Cameras to a newer model from the same vendor. The process that the Project Manager would follow is:

1. Go to the Navigating the Architecture section of the website and click on the Market Packages View –
   - Identify ATMS04 – Freeway Control as a service or market package of interest and click on the Freeway Control – VDOT NRO MPSTOC link.
2. A description of the market package provides insight into the scope and functions performed.
3. Click on the Market Package Diagram link to examine a diagram noting the inventory elements and stakeholders involved
   - VDOT NRO MPSTOC – TOC
   - VDOT NRO MPSTOC – TOC CCTV Cameras
   - VDOT NRO MPSTOC – TOC Detection
4. Examine the information flows on the diagram and note whether they are within the scope of the project.
5. For further information about the information flows, click the back button to return to the Freeway Control – VDOT NRO MPSTOC page.
6. Click on the inventory element that is a source or destination for the information flow of interest from the diagram.
7. Scroll down the page to the Information Flows to/from VDOT NRO MPSTOC-TOC header – click on the element pair that matches the interface in the diagram and see if the information exchanges suggested by the architecture are accurate and include the project scope.

Tip: The Northern Virginia ITS Architecture is also available as a Turbo Architecture Version 4.1 database. Turbo Architecture is an interactive software program that assists transportation planners and system integrators, both in the public and private sectors, in the development of regional and project architectures using the National ITS Architecture as a starting point.

For first-time users of the website, VDOT NRO's Planning Staff can help with a walkthrough of the website for the project.

7.2 Using Turbo Architecture to Define Project Architectures

As projects get more complex, the use of the website may become cumbersome. Also, the website is easier for routine projects for which information exchanges are already captured in the architecture. With access to the Turbo Architecture software tool, the regional architecture can be viewed in a database format, and, as the software provides several features that simplify the design of an architecture, more complex project architectures can be developed. Using the software tool facilitates consistency with the regional architecture and with the National ITS Architecture. The software also does the

"homework" on identification of ITS Standards and their applicability to the particular project.

To the inexperienced, viewing the architecture using Turbo Architecture can be intimidating. However, once experience is gained, Turbo Architecture is easy to use, with powerful reporting capabilities. VDOT NRO's Project Managers who manage ITS projects should avail themselves of training opportunities on Turbo Architecture within VDOT NRO and elsewhere.

To begin using Turbo Architecture, the Project Manager needs to download the Virginia Northern Region ITS Architecture Turbo Architecture database from the website. To download the database, click on the "Turbo db" icon on the website or look for the database under the Documents and Files link. The Project Manager should also have Turbo Architecture Version 4.1 or higher installed on their computer. This latest version of Turbo Architecture can be downloaded from the National ITS Architecture website at www.iteris.com/itsarch/html/turbo/turbomain.htm .

Development of a project architecture using Turbo Architecture involves the user going through a series of selections (tabs) on the software. The process requires the user to identify which systems are involved in the project (inventory), to identify which ITS user services the project will provide or help provide (services), to specify high-level requirements, and to identify the systems with information exchange connections (build & customize). Turbo Architecture reports can be attached to the checklist. These reports can also be used in developing RFPs, or addressing ITS standards. See the "suggested reports" table below for useful outputs from Turbo.

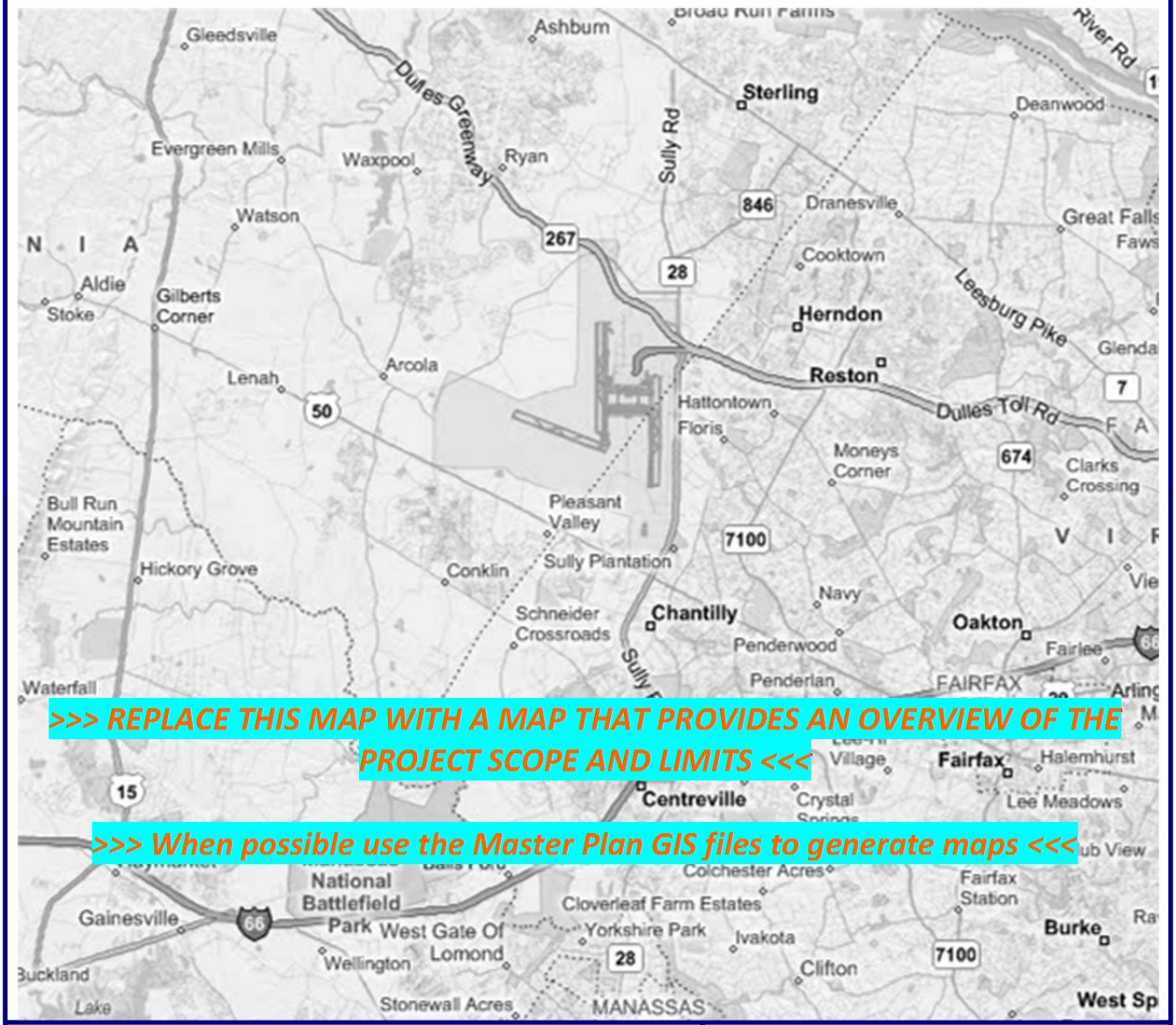
Suggested Turbo Reports to attach with your Rule 940 Checklist

Rule 940 Checklist Section	***Turbo Architecture Report***
3.2	• Stakeholder Report
3.3	• Inventory Report
3.4	• Project Architecture Report • Interconnect and flow diagrams
3.6	• Region to Project Comparison (tabular form)
5.0	• Market Packages Report • Roles and Responsibilities Report
6.0	• Functional Requirements Report
7.3	• Standards Report
8.0	• List of Agreements

Appendix A: Project Proposal Template

PROJECT TITLE

SUBTITLE



ITS COMPONENTS		COST ESTIMATE
☐ CCTV Cameras: #	☐ Dynamic Message Signs: #	Total: $
☐ Detectors: #	☐ Telecom: # LF	Preliminary Engineering: $
☐ Other Devices: #	☐ Software: Yes or No	Construction: $
(Please Specify) _____		

Appendix A: Project Proposal Template

PROJECT OVERVIEW

DISTRICT:	NoVA	**PROGRAM AREAS:**	TBA
REGION:	Northern Region		
JURISDICTION:	Counties		
PROJECT DESCRIPTION:	Short description (e.g. This project will deploy "core ITS infrastructure" on Route 28 in Loudoun and Fairfax Counties. Core ITS infrastructure includes closed circuit television (CCTV) cameras, detection, dynamic message signs (DMS), and communications.)		
ROAD SYSTEM:	PRIMARY/SECONDARY	**PRIMARY UPC:**	UPC
ROUTE:	ROUTE	**PE COST:**	$
FROM:	START	**CN COST:**	$
TO:	FINISH	**TOTAL:**	$

ALLOCATIONS AND PROJECTED FUNDING

PROJECT PHASE		PREVIOUS ALLOCATION	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
PE	Scoping/ConOps	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Pre. Field Review	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Utility Review	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Permits	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Soil Survey	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Design (PS&E)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
CN	Procurement	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Installation	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CEI	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Integration	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

PRELIMINARY CN ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
1	Dynamic Message Sign (DMS)	Each	0	$ 350,000	$
2	Dynamic Message Sign (DMS) Upgrade	Each	0	$ 350,000	$
3	Closed Circuit Television (CCTV) Camera	Each	0	$ 55,000	$
4	CCTV Upgrade with Existing Structure	Each	0	$ 20,000	$
5	Road Weather Information System (RWIS)	Each	0	$ 100,000	$
6	Detection	Each	0	$ $30,000	$
7	Lane Control Signals (LCS)	Each	0	$ 35,000	$
8	Video Incident Detection (VID)	Each	0	$ 30,000	$
9	Communication (96 Strands)	LF	0	$ 50.00	$
TOTAL CONSTRUCTION ESTIMATE					**$**

Appendix A: Project Proposal Template

1 PROJECT OVERVIEW

PROVIDE PROJECT OVERVIEW TEXT HERE INCLUDING PROJECT PURPOSE, LIMITS AND EXPECTED OUTCOMES

2 GOALS AND OBJECTIVES

PROVIDE SUMMARY TEXT OF STRATEGIC PLAN GOALS AND OBJECTIVES MET BY THIS PROJECT

VDOT's vision for the region and also for the Project Corridor is to:

Make Roadway Travel Safe, Efficient, and Reliable.

To meet this vision, VDOT NRO plans to achieve through this project by: (example below)

- Serving the public by providing them with the information they need to make good travel decisions;
- Monitoring real-time traffic conditions and the condition of its infrastructure;
- Proactively and rapidly identifying problems, including traffic congestion, crashes, and other mobility and safety needs;
- Taking rapid and effective action to address current and developing problems, appropriately applying a range of methods including physical improvements and advanced technologies;
- Sharing information, coordinating responses, and planning jointly with its partner agencies.

Goals and objectives met by this project include:

FOR EASE OF USE, PLACE AN "X" IN THE CELLS TO THE LEFT OF THE GOALS AND OBJECTIVES THAT WILL BE ADDRESSES BY THIS PROJECT

	GOALS AND OBJECTIVES [Mark the goals and objectives that apply to this project with an "X"]	**EXPECTED BENEFITS**
	Goal #1: Reduce Congestion	• Reduction in travel times • Reduction in delay (vehicle hours) • Reduction in incident duration • Improved travel time reliability
	1.1 Reduce travel times and delays for all modes along identified major corridors	
	1.2 Improve travel time reliability on major corridors	
	1.3 Actively manage travel demand on NRO facilities	
	1.4 Reduce delays due to work zones and planned special events	
	1.5 Reduce incident clearance times	
	Goal #2: Improve Safety	• Reduction in incidents
	2.1 Reduce vehicular crashes	
	2.2 Reduce pedestrian and bicyclist crashes	

	Goal #3: Enhance Communications with Travelers	• Improved customer satisfaction
	3.1 Provide proactive, timely, and accurate information and responses to the traveling public	
	Goal #4: Promote Environmental Responsibility	• Reduction in fuel consumption
	4.1 Reduce energy consumption and environmental costs of transport operations	
	Goal #5: Preserve and Manage an Integrated Traffic Management System	• Improved field infrastructure reliability • Improved data availability to support operations and performance monitoring
	5.1 Maintain field infrastructure so that it operations reliably	
	5.2 Improve information gathering on freeways and arterials	
	Goal #6: Improve Emergency Management	• Improved emergency management coordination • Reduction in critical asset vulnerability
	6.1 Enhance coordination of regional emergency management	
	6.2 Reduce NRO critical asset vulnerability	
	Goal #7: Improve the NRO Business Process	• Reduction in project delivery time • Enhanced relationship between NRO investments and strategic goals and objectives • Increased SWAM business utilization • Improved percentage of projects completed on-time and within-budget
	7.1 Optimize operations planning, programming and project delivery time	
	7.2 Make the rationale for all NRO investments clear and consistent	
	7.3 Make performance-based decisions	
	7.4 Utilize equal employment opportunity practices in hiring and	
	7.5 Minimize project cost and schedule overruns	
	Goal #8: Improve Regional Operations Coordination and Efficiency	• Improved day-to-day regional operations coordination • Increased application of operations solutions to regional transportation problems
	8.1 Encourage application of technology-based operations solutions in all relevant construction projects	
	8.2 Improve operations planning with regional operations partners	
	8.3 Improve day-to-day information exchange with regional operations partners	

	Goal #9: Enhance and Develop NRO Workforce Capabilities	• Improved NRO workforce knowledge-base • Improved NRO workforce retention • Reduction in workforce accidents
	9.1 Enhance Workforce needs planning to prepare for the future operations	
	9.2 Support and sustain a learning environment for NRO staff	
	9.3 Attract and retain a diverse talented workforce	
	9.4 Reduce workplace accidents	

3 EXISTING CONDITIONS

PROVIDE TEXT DESCRIBING EXISTING CONDITIONS WITHIN WHICH THIS PROJECT WILL BE IMPLEMENTED (e.g. existing traffic condition, agency operation environment (software, personnel, operating facility, regional cooperation), ITS deployment (device and telecom) on the proposed and adjacent roadways, and recommendations from existing planning documents or research findings)

4 OPERATIONAL NEEDS

PROVIDE TEXT DESCRIBING OPERATIONAL NEEDS THAT THIS PROJECT WILL ADDRESS. Many operational needs have been identified through a series of ITS Master Planning efforts led by the VDOT NRO Planning & Programming Section. This Plan reflects input from planning, engineering, operations, maintenance, and research staff. It is recommended to use the Master Plan as the basis for developing the operational needs of the proposed project.

5 SYSTEM OVERVIEW

PROVIDE TEXT CONVEYING AN OVERVIEW OF THE SYSTEM/RECOMMENDATIONS FOR DEPLOYMENT; INCLUDE INFORMATION ABOUT THE PRIMARY COMPONENTS, THEIR LOCATION AND ANY SPECIAL CAPABILITIES. Based on the needs identified above, this section should address the specific ITS Recommendations for the proposed project. One should list the recommended ITS subsystem one at the time. Include a map illustrating the recommended device locations is highly recommended.

6 PROJECT ARCHITECTURE

PROVIDE INFORMATION RELATED TO THE COMPONENTS OF THE NORTHERN VIRGNIA ITS ARCHITECTURE THAT ARE ASSOCIATED WITH THIS PROJECT. The Project Architecture provides a framework that identifies the institutional agreement and technical integration necessary to interface the ITS project with other ITS projects and systems. It addresses the application of the proposed system with a focus on integration and operation of the system(s). The NRO Regional ITS Architecture (www.vdot-itsarch.com/Default.htm) should be used as the basis for generating the project architecture. The section should summarize key stakeholders (e.g. VOT NRO, Private Sector ISPs, MATOC, Video Clearinghouses), elements (e.g. VDOT NRO MPSTOC – TOC CCTV Cameras, VDOT NRO MPSTOC – TOC Detection, VDOT NRO MPSTOC – TOC DMS, and VDOT NRO MPSTOC – TOC, etc.), and ITS Market Packages description and interconnect diagram impacted by the proposed project.

"Key" Regional Stakeholders Impacted

The following stakeholders will be directly impacted and/or benefit from this project:

- *LIST THE STAKEHOLDERS FROM THE ARCHITECTURE ASSOCIATED WITH THIS PROJECT*

"Key" Elements Impacted

The following elements will be directly impacted and/or benefit from this project:

- *LIST THE ARCHITECTURE ELEMENTS/SUBSYSTEMS ASSOCIATED WITH THIS PROJECT*

"Key" ITS Market Packages

The project impacts the following ITS Market Packages:

- *LIST THE MARKET PACKAGES, DESCRIPTIONS, AND DIAGRAMS FROM THE ARCHITECTURE ASSOCIATED WITH THIS PROJECT*

7 ITS STANDARDS

PROVIDE A LIST OF THE ITS STANDARDS IDENTIFIED FROM THE NORTHERN VIRGINIA ITS ARCHITECTURE OR OTHER SOURCES THAT ARE RECOMMENDED FOR THIS PROJECT

8 IMPLEMENTATION RECOMMENDATION

DESCRIBE THE SEQUENCE OF THE PROJECT DEVELOPMENT AND IMPLEMENTATION, IDENTIFY OTHER PROJECTS OR ACTIVITIES THAT HAVE IMPACT ON THE PROPOSED PROJECTS (TECHNICALLY OR FINANCIALLY), AND OTHER CRITICAL FACTORS THAT WOULD INFLUENCE A SUCCESSFUL IMPLEMENTATION OF THE PROJECT.

Appendix B: Rule 940 Checklist

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

for

Project Title:

This Checklist to be filled out by VDOT NRO's Planning Staff and the Project Manager

Checklist Status as of (MM/DD/YYYY)

Section	Status	Name
1 Project Information	☐ Complete	
2 Needs Assessment	☐ Complete	
3 Regional Architecture Assessment and Concept Exploration	☐ Complete	
4 Alternatives Analysis	☐ Complete	
5 Concept of Operations	☐ Complete	
6 Requirements	☐ Complete	
7 Detailed Design	☐ Complete	
8 Implementation	☐ Complete	
9 Integration and Test	☐ Complete	
10 System Verification and Acceptance	☐ Complete	
11 Operations and Maintenance	☐ Complete	

Appendix B: Rule 940 Checklist

CHANGE LOG		
PROJECT TITLE		
DATE CREATED/MODIFIED	**CREATOR/MODIFIER NAME**	**NOTES**

Appendix B: 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

☐ 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

☐ ECCB Approval
☐ TIP/STIP Amendment
☐ Environmental Clearance, if applicable
☐ FHWA PE Authorization
☐ FHWA CN Authorization

1.12 IS THERE A DOCUMENT FOR THIS PROJECT WITH TASK BREAKDOWN?

☐ No ☐ Yes, provide document reference ☐ To Be Developed

Please provide document reference here.

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?

☐ 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.

SECTION 3 – Regional Architecture Assessment and Concept Exploration

3.1 WHAT ARCHITECTURES WERE EXAMINED FOR INPUTS TO THIS PROJECT?

☐ Northern VA ☐ VA Statewide ☐ DC Regional (MWCOG) ☐ Maryland Statewide ☐ Other VA Regional

3.2 STAKEHOLDERS FROM ARCHITECTURE INCLUDED IN PROJECT

Turbo Architecture "Stakeholder Report" ☐ Attached ☐ Unavailable

3.3 INVENTORY ELEMENTS FROM ARCHITECTURE INCLUDED IN PROJECT

Turbo Architecture "Inventory Report" ☐ Attached ☐ Unavailable

3.4 INTERFACE IMPACTS (I.E. INFORMATION EXCHANGES) DUE TO PROJECT. IDENTIFY PORTIONS OF ARCHITECTURE BEING IMPLEMENTED BY PROJECT.

Turbo Architecture "Project Architecture Report" ☐ Attached ☐ Unavailable

Turbo Architecture "Interconnect and Flow Diagrams" ☐ Attached ☐ Unavailable

3.5 OTHER REGIONAL ARCHITECTURES IMPACTED BY PROJECT

☐ VA Statewide ☐ DC Regional (MWCOG) ☐ Maryland Statewide ☐ Other VA Regional

Impact communicated to appropriate architecture maintenance agencies? ☐ Yes ☐ No

3.6 CHANGES RECOMMENDED TO NORTHERN VIRGINIA AND/OR OTHER ITS ARCHITECTURES?

☐ Yes ☐ No

If "Yes", please specify and attach detail

Turbo Architecture "Region to Project Comparison Report" ☐ Attached ☐ Unavailable

SECTION 4 – Alternatives Analysis

4.1 WERE ALTERNATIVE CONCEPTS/IDEAS/SOLUTIONS TO ADDRESS THE PROBLEM CONSIDERED DURING FEASIBILITY ANALYSIS OR CONCEPT EXPLORATION?

☐ Yes ☐ No

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?

☐ Yes ☐ No ☐ 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
- Operational Description (Stakeholder Roles and Responsibilities)	☐ Yes	☐ No
- Operational Needs	☐ Yes	☐ No
- System Overview (System Description, Project Architecture)	☐ Yes	☐ No
- Operational and Support Environment	☐ Yes	☐ No
- Operational Scenarios	☐ Yes	☐ No
- Next Steps	☐ Yes	☐ No

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

5.3 HAVE ALL STAKEHOLDERS AFFECTED BY THIS PROJECT REVIEWED AND ACCEPTED THE CONCEPT OF OPERATIONS?

☐ Yes ☐ No

5.4 IF "No" WAS SELECTED, WHICH STAKEHOLDERS HAVE NOT BEEN INVOLVED?

5.5 PLEASE PROVIDE COO DOCUMENT REFERENCE IF AVAILABLE

Turbo Architecture – "Roles and Responsibilities Report" ☐ Attached ☐ Unavailable

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

6.1 ARE HIGH-LEVEL FUNCTIONAL REQUIREMENTS WRITTEN AND DOCUMENTED?

☐ Yes ☐ No ☐ To Be Developed

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

Turbo Architecture "Functional Requirements Report" ☐ Attached ☐ Unavailable

6.3 WERE REQUIREMENTS DERIVED FROM OTHER SOURCES SUCH AS ITS MASTER PLANS? ☐ Yes ☐ No

SECTION 7 – Detailed Design

7.1 IS THERE A DESIGN DOCUMENT AVAILABLE?

☐ Yes ☐ No ☐ 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 any of the boxes, please specify a reason

7.3 DOES THE DESIGN INCORPORATE NATIONAL ITS STANDARDS?

☐ Yes ☐ No

If "Yes", please list what ITS Standards are being incorporated

Turbo Architecture "Standards Report" ☐ Attached ☐ Unavailable

7.4 DOES THE DESIGN INCORPORATE ANY VDOT ENTERPRISE STANDARDS?

☐ Yes ☐ No

If "Yes", please list the VDOT Enterprise Standards being incorporated

SECTION 8 – Implementation

8.1 PROCUREMENT DETAILS (include type of procurement, reason this approach taken, etc.)

8.2 IF USING AN EXISTING CONTRACT VEHICLE, ARE THERE ANY CONTRACT LIMITATIONS SUCH AS PERIOD OF PERFORMANCE, BUDGET CEILINGS, SCOPE OF WORK, ETC.?

☐ Yes ☐ No

If "Yes", please identify the Contract Limitations

8.3 REFERENCE DOCUMENTS (if any)

SECTION 9 – Integration and Test

9.1 IS THERE AN INTEGRATION PLAN?

☐ Yes ☐ No ☐ To Be Developed

If "Yes", please provide reference

9.2 IS THERE A TEST PLAN?

☐ Yes ☐ No ☐ 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)

☐ Yes ☐ No ☐ 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 any boxes, please provide reason

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?

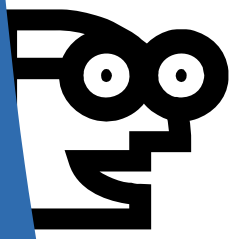
11.4 WILL TRAINING BE PROVIDED WITH THE NEW SYSTEM? ☐ Yes ☐ No

11.5 WILL THE SYSTEM OPERATING PROCEDURES (SOP) BE UPDATED? ☐ Yes ☐ No

Appendix C: Sample Traceability Matrix

Appendix C: Sample Traceability Matrix

User Need	ConOps Section	High-Level Requirement Number and Title	High-Level Requirement
		1.0 - Functional Requirements	
Ability to monitor and compare parallel arterials that can support diversion during an incident and report on congestion	4.1.1.1.b	1.1 – Video Wall & Monitors	Operators should have the ability to select and view single or multiple CCTV locations on either their computer monitor or the PSTOC video wall.
		1.2 – Corridor Bundle Camera Groups	ATMS should support device groupings for parallel routes in support of incident management diversion corridors.
Create low bandwidth copy of TMC video feed and make available to general public via internet sites such as VDOT 511 webpage	4.1.1.3.a	1.3 – Low Quality Video	CCTV encoders and/or software shall be capable of producing a lower quality/lower bandwidth copy of each camera feed.
		4.1 – Equipment Compatibility With Other Agencies	Defined in High Level Requirement 4.1 - Equipment Compatibility With Other Agencies.
Disable public feeds during emergencies, security events, or other events of a sensitive nature (i.e., fatalities)	4.1.1.3.c	1.4 – Cutting Video Feeds	Operators should have the ability to disable selected low bandwidth video feeds to designated agencies, public, or media during justified events. The feed(s) should remain disabled until the operator reactivates the feed(s). Primary video feeds for ATMS operators should remain active at all times.
Visually verify incident reports from other detection means such as Virginia State Police Computer Aided Dispatch (VSP CAD), Traveler Calls, and the SSP	4.1.2.1.d	1.5 – Pan/Tilt/Zoom Controls	Cameras shall be able to pan/tilt/zoom. Operators will be able to control the cameras from the PSTOC, or the backup TMC.
		2.1 – Freeway Spacing	Defined in High Level Requirements 2.1 – Freeway Spacing.
		2.2 – Arterial Spacing	Defined in High Level Requirements 2.2 – Arterial Spacing.
		4.3 – ATMS Software Compatibility	Defined in High Level Requirements 4.3 – ATMS Software Compatibility.
Ability to select displayed camera feed	4.1.2.1.f	1.1 – Video Wall & Monitors	Previously defined.
Potential for automatic notification of incidents: VID	4.1.2.1.g	1.6 – Video Incident Detection	ATMS shall have the ability (where specified by design plans), through predefined algorithms, to detect a possible event from CCTV video feeds and notify the appropriate operator. These events include, but are not limited to accidents, stalled vehicles, unusual congestion and wrong-way vehicles.
Ability to monitor planned events entailing lane or interchange closures or route diversion, such as long-term construction, parades and festivals, and the Marine Corps Marathon	4.1.2.2.a	1.2 – Corridor Bundle Camera Groups	Previously defined.
		2.1 – Freeway Spacing	Defined in High Level Requirements 2.1 – Freeway Spacing.
		2.2 – Arterial Spacing	Defined in High Level Requirements 2.2 – Arterial Spacing.



2009 Commonwealth of Virginia