NRO Concept of Operations

Outline

VDOT Virginia Department of Transportation

Northern Region Operations

Companion Document to the User Guide • June 2007

Virginia Department of Transportation: Northern Region Operations

Concept of Operations

Purpose

The Concept of Operations is a description of how the system will be used. It is non-technical, and presented from the viewpoints of the various stakeholders. It provides a bridge between the often vague needs that motivated the project to begin with and the specific technical requirements. There are several reasons for developing a Concept of Operations:

- Get stakeholder agreement identifying how the system is to be operated, who is responsible for what, and what the lines of communication are;
- Define the high-level system concept and justify that it is superior to the other alternatives;
- Define the environment in which the system will operate;
- Derive high-level requirements, especially user requirements; and
- Provide the criteria to be used for validation of the completed system.

The Concept of Operations is a critical first step that sets the stage for the remainder of the system development process. Additionally, it is continuously used to validate the system once it has become operational. Figure 1 captures the relationship that the Concept of Operations maintains with the systems engineering process. It is clear that the best development practice that assures all goals are achieved would be to incorporate the Concept of Operations at every phase of development. This keeps the stakeholders' needs at the forefront in each step of the development process.

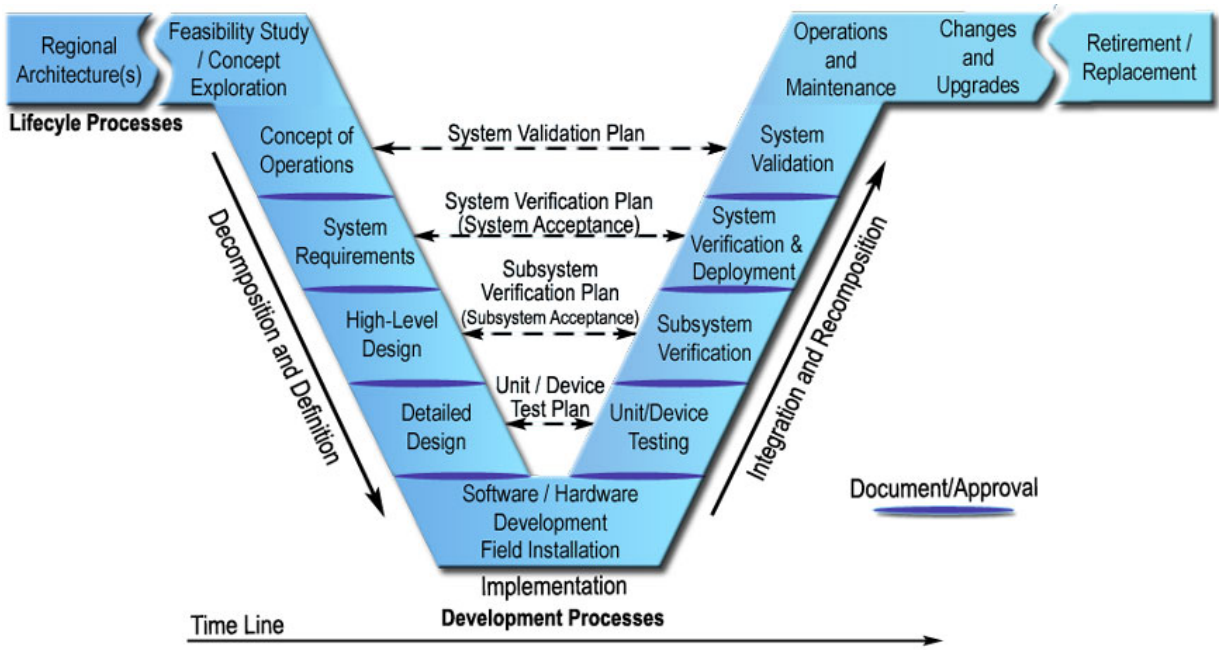

Figure 1. The Systems Engineering "V" Diagram

What is a Concept of Operations?

The Concept of Operations should be a document available, and relevant, to all stakeholders in the system, no matter what their background or role within the system. It should be as readable and relevant to high-level decision makers as it is to the project manager as it is to the system operator. The Concept of Operations answers the who, what, when, where, why, and how for the new or existing system:

What – What are the known elements and the high-level capabilities of the system?

Where – What are the geographical and physical extents of the system?

When – What is the time sequence of activities that will be performed?

How – What resources do we need to design, build, or retrofit the system?

Who – Who are the stakeholders involved with the system?

Why – What does your organization lack that the system will provide?

What are the Elements of a Concept of Operations?

There are two recommended ITS Standards for developing a Concept of Operations. These standards include the ANSI / AIAA standard (G-043-1992) and the IEEE standard (P1362 V3.2). These Concept of Operations standards contain similar information, but are packaged in a different manner. Overall, a Concept of Operations includes eight (8) elements depicted and discussed in more detail below:

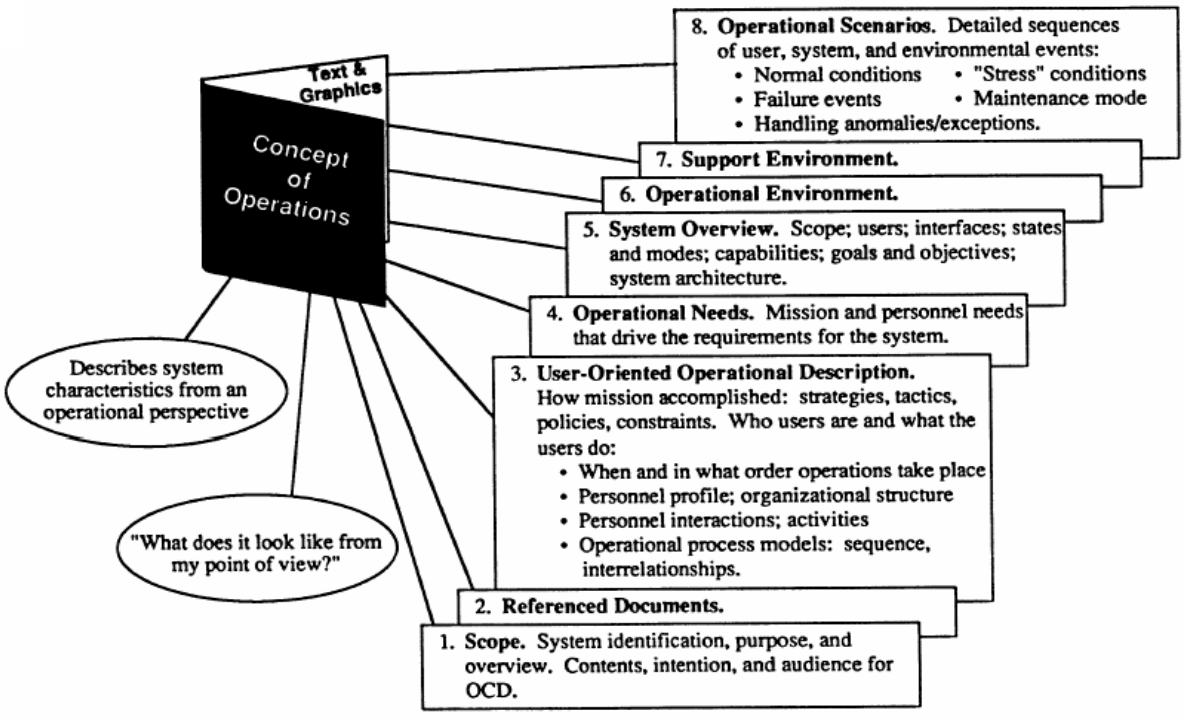

Figure 2. Elements of the Concept of Operations

Tailoring the Concept of Operations to the Project

The greater the expected impact on operations, the more detailed the Concept of Operations needs to be. For example, automating operations that were formerly manual or integrating activities that were formerly independent will require the involvement of the various operators, clear and detailed description of their new procedures, and possibly examination of alternative approaches. This is especially true when building a regional system by integrating existing local systems. Local operations will usually change after integration, for compatibility and to take advantage of newly available regional resources.

For a simple system that requires little operator involvement and no coordination, this document may only be a couple of pages long.

Proposed VDOT NRO Concept of Operations Outline

EXECUTIVE SUMMARY *(Optional)*

1. **SCOPE.** This section provides an overview of the entire Concept of Operations. *(Rule 940 VDOT NRO Checklist: Section 5 – Concept of Operations)*

   1.1. Identification

   1.2. Concept of Operations Role Within the Systems Engineering Process

   1.3. System Overview

   1.4. Goals and Objectives *(relate to the NRO Smart Travel Program Goals and Objectives)*

   1.5. Vision for the System

2. **REFERENCED DOCUMENTS.** This section identifies resources used when developing the Concept of Operations. Types of references typically include:

   - Business Planning Documents
   - Concept of Operations for related systems
   - Studies to identify Operational Needs
   - System development meeting minutes

3. **USER-ORIENTED OPERATIONAL DESCRIPTION.** This section focuses on how the goals and objectives are accomplished currently. Specifically, it describes strategies, tactics, policies, and constraints. This is where the stakeholders are described. It includes who users are and what the users do. Specifically, it covers when, and in what order, operations take place, personnel capabilities, organizational structures, personnel & inter-agency interactions, and types of activities. This may also include operational process models in terms of sequence and interrelationships. *(Rule 940 VDOT NRO Checklist: Section 5 – Concept of Operations)*

   3.1. Description of the Existing System(s) or Situation

   3.2. Identification of Stakeholders, Roles & Responsibilities

   3.3. Operational Sequence

4. **OPERATIONAL NEEDS.** This section details agency- and region- specific needs that will drive the requirements for the system. This section is attempting to answer the question of what is necessary for the agency or region that would complement and improve the existing system. Operational Needs are developed independent of technologies / systems. For major construction projects, operational needs should be considered during and after construction. *(Rule 940 VDOT NRO Checklist: Section 2 – Needs Assessment)*

   4.1. Operational Needs During Construction (*optional*)

   4.2. Operational Needs After Construction (*optional*)

5. **SYSTEM OVERVIEW.** This section provides a high-level description of the interrelationships of key subsystems, focusing on their interrelationships. *(Rule 940 VDOT NOR Checklist: Section 4 – Alternate Analysis and Rule 940 VDOT NOR Checklist: Section 6 – Requirement Definitions)*

5.1. Subsystem A (i.e., RTMS system)

5.1.1. Equipment Locations

5.1.2. Communications

5.1.3. Software

5.1.4. System Architecture, High Level Requirements, ITS Standards

5.1.5. Other Projects that May Affect this Component

5.2. Subsystem B (i.e., CCTV system)

5.2.1. Equipment Locations

5.2.2. Communications

5.2.3. Software

5.2.4. System Architecture, High Level Requirements, and ITS Standards

5.2.5. Other Projects that May Affect this Component

5.3. Subsystem C (i.e., DMS system)

5.3.1. Equipment Locations

5.3.2. Communications

5.3.3. Software

5.3.4. System Architecture, High Level Requirements, and ITS Standards

5.3.5. Other Projects that May Affect this Component

6. OPERATIONAL AND SUPPORT ENVIRONMENT. This section describes the environment or "world" in which the system will operate including information about the system's environment. This section will answer the following questions.

6.1. Personnel – Who will operate the system? Will the new systems require additional personnel? Will consultant staff need to be procured?

6.2. Facilities – Where will the systems be housed?

6.3. Hardware and Software – What are the limitations to the existing hardware and software? Does new hardware / software need to be purchased?

6.4. Operating Procedures – Will the new system(s) require new / updated standard operating procedures?

6.5. Maintenance – Who will maintain the system(s)? How should the equipment be installed to make it safer for maintenance activities and to minimize traffic disruptions?

7. OPERATIONAL SCENARIOS. In this section, the authors place themselves in the users' position and detail how the new system would impact their activities under differing conditions. *(Rule 940 VDOT NRO Checklist: Section 5 – Concept of Operations)*

7.1. Scenario 1 (i.e., normal morning rush hour – no incidents)

7.2. Scenario 2 (i.e., planned road work)

7.3. Scenario 3 (i.e., incident causing two blocked lanes)

8. NEXT STEPS. This section identifies the next steps in the System Engineering Process and assigns VDOT NRO Section responsibility for each step.

8.1. Detailed Requirements. The stakeholder needs identified in the Concept of Operations are reviewed, analyzed, and transformed into verifiable requirements that define *what* the system will do but not *how* the system will do it. Working closely with stakeholders, the requirements are elicited, analyzed, validated, documented, and baselined. *(Rule 940 VDOT NRO Checklist: Section 6 – Requirements Definition)*

8.2. System Design. A system design is created based on the system requirements including a high-level design that defines the overall framework for the system. Subsystems of the system are identified and decomposed further into components. Requirements are allocated to the system components, and interfaces are specified in detail. Detailed specifications are created for the hardware and software components to be developed, and final product selections are made for off-the-shelf components. *(Rule 940 VDOT NRO Checklist: Section 7 – Detailed Design)*

8.3. Software / Hardware Development Field Installation. Hardware and software solutions are created for the components identified in the system design. Part of the solution may require custom hardware and/or software development, and part may be implemented with off-the-shelf items, modified as needed to meet the design specifications. *(Rule 940 VDOT NRO Checklist: Section 8 – Implementation)*

8.4. Unit / Device Testing. The components are tested and delivered ready for integration and installation. *(Rule 940 VDOT NRO Checklist: Section 9 – Integration and Test)*

8.5. Subsystem & System Verification and Acceptance. The software and hardware components are individually verified and then integrated to produce higher-level assemblies or subsystems. These assemblies are also individually verified before being integrated with others to produce yet larger assemblies, until the complete system has been integrated and verified. *(Rule 940 VDOT NRO Checklist: Section 10 – System Verification and Acceptance)*

8.6. System Validation. After the ITS system has passed system verification and is installed in the operational environment, the system owner/operator, whether the state DOT, a regional agency, or another entity, runs its own set of tests to make sure that the deployed system meets the original needs identified in the Concept of Operations.

8.7. Operations & Maintenance. Once the customer has accepted the ITS system, the system operates in its typical steady state. System maintenance is routinely performed and performance measures are monitored. As issues, suggested improvements, and technology upgrades are identified, they are documented, considered for addition to the system baseline, and incorporated as funds become available. An abbreviated version of the systems engineering process is used to evaluate and implement each change. This occurs for each change or upgrade until the ITS system reaches the end of its operational life. *(Rule 940 VDOT NRO Checklist: Section 11 – Operations and Maintenance)*