7 RECOMMENDED DEVELOPMENT PROCESS

The *CVISN Guide to Top-Level Design* and the *CVISN Guide to Program and Project Planning* describe fundamental principles and generic processes. This chapter applies and tailors this guidance to the electronic screening area. Some states may already have a well-documented methodology for system development and integration. If so, the state should follow that process, possibly making some adjustments to incorporate any ideas included here that are not reflected in the state's standard procedures.

The first section in this chapter provides an overview of the entire process. Subsequent sections address each successive phase of the process, including these topics:

- Phase Process
- Phase Products
- Factors to Consider
- List of Key Decisions (refer to Chapter 5 for a description of each)
- Advice and Lessons Learned

A final section addresses requirements specification, a topic that impacts all phases.

7.1 Development Process Overview

The *Introductory Guide to CVISN* outlined a model development process for implementing CVISN capabilities. Figure 7-1 is repeated from that document as a reminder of the model.

Deploying CVISN Level 1 capabilities is a major undertaking that typically takes several years. In order to reduce risk, it is strongly recommended that states use an incremental deployment approach. It is critical that this large program be broken into a series of 3 to 6 month time periods called program phases. Specific results or products are defined for each phase. These are defined in detail for each phase just before it begins, and more broadly for subsequent phases. The use of phases allows a big job to be broken into small, manageable pieces. If a state completes the first couple development phases on time and meets all the objectives, this provides assurance that the plan is realistic. If not, it allows the state to revise the plan and take other corrective actions prior to committing extensive resources to a program that is not properly structured for success. Incremental development and measurable milestones ensure stakeholder participation and feedback and real visibility into program progress.

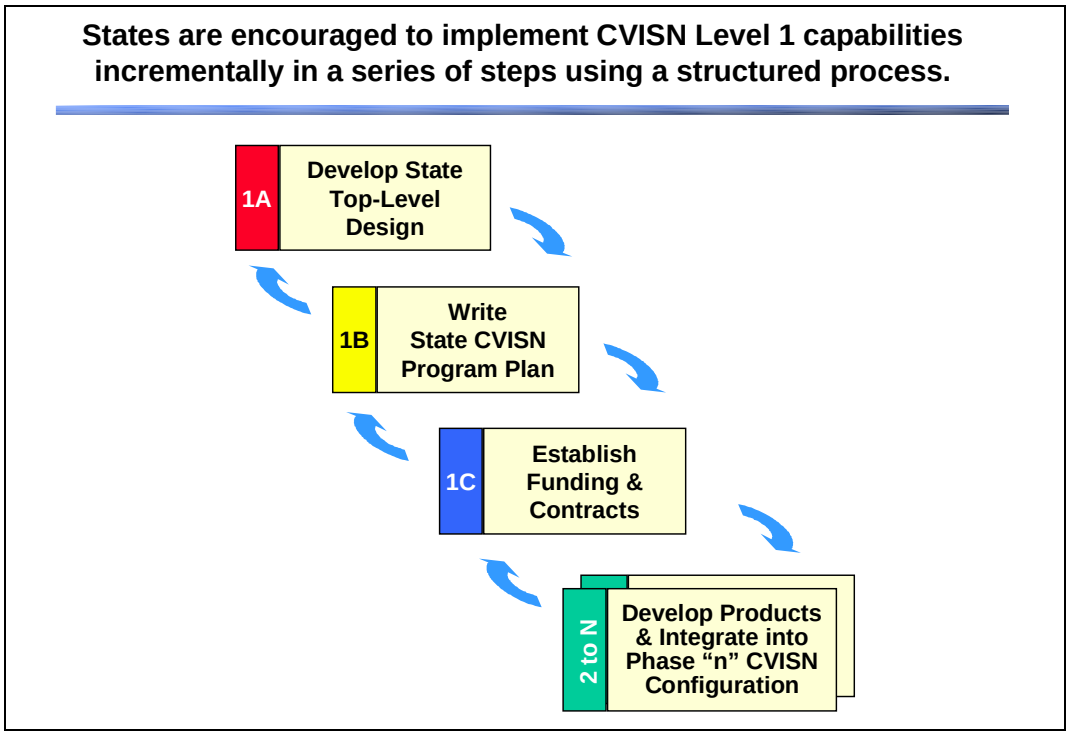

Figure 7–1. Overview of CVISN Deployment Process

The figure shows that the first phase is devoted to developing the state top-level design, preparing the State CVISN Program Plan, establishing full funding for the program, and issuing major contracts for products and technical services. Each subsequent phase is a development phase that results in some type of demonstration or operational capability. More information on phases is provided in the *CVISN Guide to Program and Project Planning* and the *CVISN Guide to Phase Planning and Tracking*.

This *CVISN Guide to Electronic Screening* has been prepared with the experience of early CVISN deployments in mind. It assumes that states will have to do considerable requirements analysis and state-specific planning. As time goes on and CVISN moves into the mainstream, this will be less the case. Some of the aspects of CVISN will become routine. This may be true for your state even now.

For example, both the HELP, Inc. PrePass™ system and the North American Preclearance and Safety System (NorPass) systems are investigating making changes that would incorporate the features and design characteristics required for conformance with the CVISN architecture and national interoperability. If these programs eventually conform to the architecture and your state is already a participant in one of them, you can move quickly through these processes and eliminate some of the detailed requirements analysis.

The approach defined herein assumes that your state is providing some level of system integration. If you decide to subcontract the role of system integrator, you may not follow the detailed steps outlined herein. Most likely, your system integrator will propose an approach

based on previous methodology. Nevertheless, the material herein can help you to understand what they must accomplish.

7.2 Top Level Design Phase

Top-Level Design Phase Process

The *CVISN Guide to Top Level Design* describes the general process for developing a top-level design. Figure 7-2 describes this process.

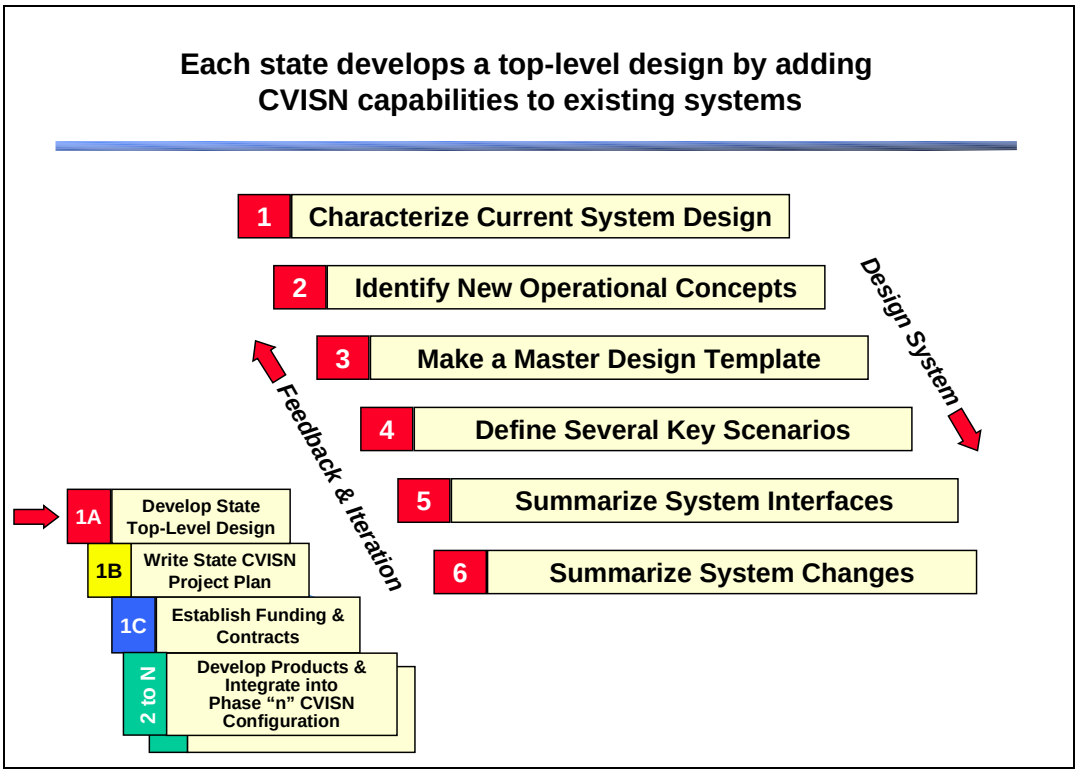

Figure 7–2. Top-Level Design Process

Even though the steps are shown as sequential, the process actually involves a great deal of feedback and iteration. Throughout the process, identify issues, actions and decisions. At the end of this process, your state will have decided what products it wants to develop or acquire, what modifications it wants to make to existing systems, and how it wants to interface systems to each other. This phase establishes the technical framework for everything that follows.

Top-Level Design Phase Products

A State CVISN Top-Level Design Description that shows how electronic screening fits into the statewide CVISN design. It should include:

- System Requirements
  - State-specific goals
  - *CVISN Operational and Architectural Compatibility Handbook (COACH) Part 1* tables from Chapters 2, 3, 4, 5, 6
  - *CVISN COACH Part 4* tables
  - Other state requirements
- System Design
  - Allocation of requirements to system components
  - *CVISN COACH Part 3* tables, tailored as needed
  - Description of functions for each new component
  - System Interface Summaries
  - Top-Level Physical System Design
- System Change Summary
- Operational Scenarios
- Issues

In addition to the State CVISN Design Description, your state may want to prepare a separate, more detailed Electronic Screening Specification document based on information included in this guide. This document should include the following information:

- Screening algorithm
  - Bypass/pull-in criteria
  - Data elements and source
  - Sensor information
- Snapshot data flow from SAFER and state credential system to the roadside
- Real-time information flow as vehicle approaches and passes through station
- Basic site layout and components
- Assessment of existing roadside equipment

Factors to Consider in the Top-Level Design Phase

The electronic screening area is different from the other two CVISN Level 1 capability areas in that it involves several sensors and real-time embedded computer systems. This mix of sensors and computer hardware and software requires a different type of system integration experience and skill than in the other areas.

Correlation of multiple sensors and timing issues are likely to be a problem in e-screening system design. The system must collect inputs from a series of sensors in a specific sequence and respond within fixed time limits determined by the movement of the vehicle being screened and the basic physics of the situation. You must do a careful analysis of timing, considering sensor requirements, interface speeds and computer processing requirements, and operator reaction time.

Remember that although CVISN Level 1 requires only one weigh station, you want to position yourself to duplicate this functionality at other weigh stations in your state. You should keep this goal in mind and develop a modular approach for hardware and software elements that can be reconfigured to meet the needs of various sites without significant redesign.

Key Decisions

- Do you already belong to or will you join an existing screening program?
- Will screening be performed at fixed sites? Mobile sites? Or both?
- Which site will you upgrade first to handle electronic screening?
- At what other sites will electronic screening be deployed?
- Will you deploy WIM on the mainline? On the ramp? Both? Neither?
- Will you screen using both carrier and vehicle data?
- What screening factors will you use?
- Will you have an open enrollment policy?
- Will the safety and credential checks be made at the roadside or at a central site?
- How will you carry out the electronic screening enrollment function?
- How will you share enrollment information with other programs?

Advice and Lessons Learned

- Visit e-screening sites in several other states early in your project.
- Develop requirements in multiple levels of detail. Use clear, concise, top-level, testable requirements as the basis for procurements and contracts. Develop more detailed screening process descriptions as required by each phase as the work proceeds. (Please see section 7.6 Requirements Specification for more discussion.)
- Separating the processing to be performed into two computers, the ROC and the Screening Computer, has proven to be a useful concept. It allows the more time critical functions to be isolated into the Screening Computer. It allows the ROC to be more site-independent and reusable at multiple sites with minimal changes.
- It is important to think about operation and maintenance in designing the e-screening system. Sensors exposed to the highway environment are prone to failure. The

system should be designed from the outset to support self-tests, status monitoring, and fault isolation.

- Do an analysis of the processing load on the e-screening computer systems. There may be tens of thousands of vehicle and carrier snapshot records in the system. Your screening algorithm will have to operate on each of these. This process needs to operate quickly, in a manner of minutes. If it is not done carefully, it may take hours.
- Remember that e-screening enrollment can be a complex process in its own right. It is essentially a new credentialing process. Make sure to address it in your design. You may want to consider treating it as a new credentialing process and incorporating it into your credentials administration plan.

7.3 Project Planning Phase

Electronic Screening Project Planning Phase Process

The *CVISN Guide to Program and Project Planning* describes the general process for developing a project plan and organizing the project. Figure 7-3 portrays this process.

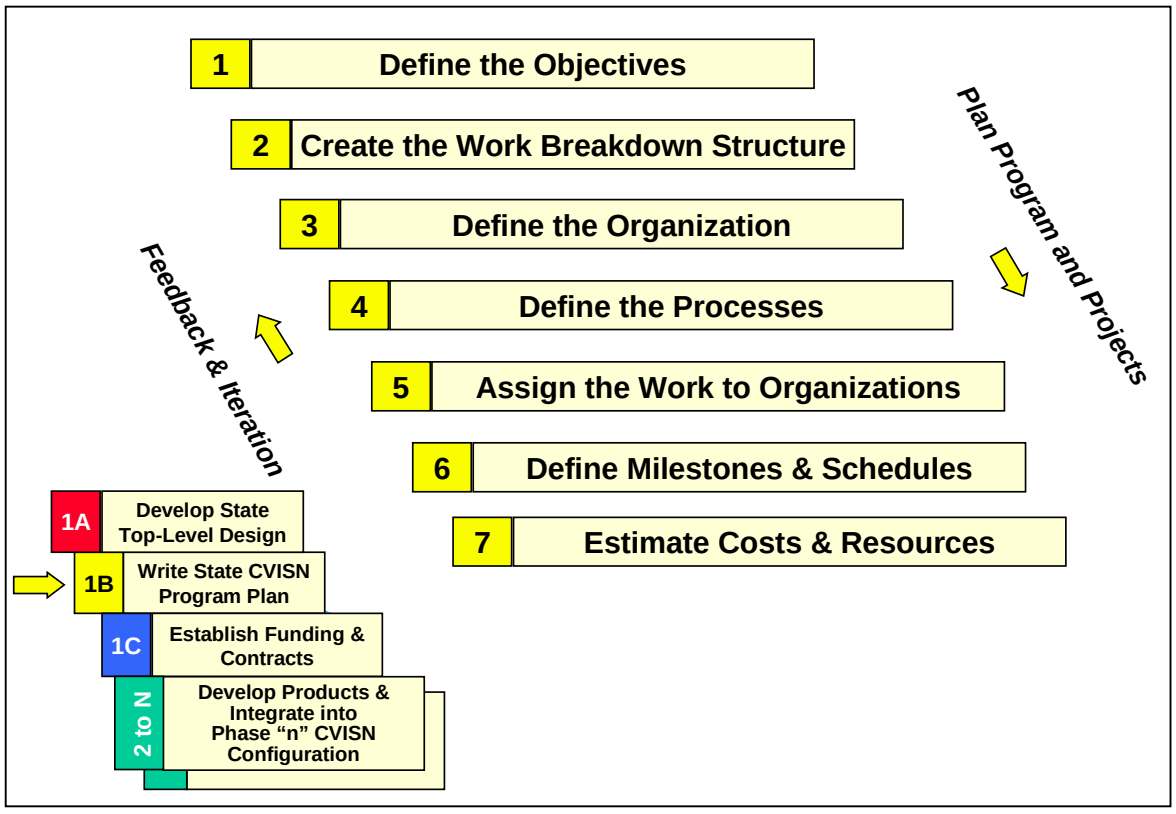

Figure 7–3. Project Planning Process

Planning Phase Products

- A completed electronic screening project plan that reflects the results of all the decisions made in this step. The top-level plan for electronic screening should be reflected in the State CVISN Program Plan.
- Documents necessary to support acquisition of full project funding. The plan should support this, but other proposals and state-specific documents may be required.
- Preliminary Phase Schedule for electronic screening systems and capabilities.

Factors to be Considered in the Project Planning Phase

What other projects are going on in your state that may impact the electronic screening project. For several of the pilot states, Y2K efforts had such a high priority that resources were not available for CVISN tasks. Are there any major projects ongoing in your state that will compete for resources? Are major upgrades already taking place in the computer systems that support weigh station operations? Are major upgrades planned in the sensor and communications systems that will support the weigh station operations?

Does your state have a program to network together state facilities over a wide area network? Can you get high-speed connections to your weigh stations via such a program?

If you are modifying existing systems in-house, will state staff be able to dedicate sufficient time to accomplish the modifications? Does this project have sufficient priority among all the on-going efforts? Does the management structure support the project?

What type of internal methodology has your state used in the past for system development in the screening area? Is the process outlined in the CVISN guide series compatible with that approach? Are there any special requirements for feasibility studies or cost/benefit analysis studies?

What is the typical procurement cycle in your state? What steps are required? How long does it take? What can be done to expedite this?

What have other nearby states done towards implementing electronic screening? Can you leverage what they have done, learn from them or partner with them in some way?

Key Decisions

- What state agency will be the lead during development of electronic screening?
- What strategy will you use to build a sufficient population base of transponders?
- What new equipment do you need to support electronic screening?
- Who is the system integrator?
- Will sole source or competitive contracting be used?

Advice and Lessons Learned

- Conducting a marketing program for enrolling motor carriers and distributing transponders is a major undertaking. You should strongly consider joining a national program or partnering with other states in your region to accomplish these tasks.
- If you join a national or regional program, be sure they have demonstrated conformance to the CVISN architecture before you make a final commitment.

7.4 Funding and Contracts Phase

Funding and Contracts Phase Process

The *CVISN Guide to Program Project Planning* describes the general process for the funding and contracting phase. Figure 7-4, which portrays this process, is repeated below as a reminder. The process for this phase is very dependent on state specific details. The figure is intended to give a conceptual framework and starting point. You should develop a specific process that meets the needs of your state.

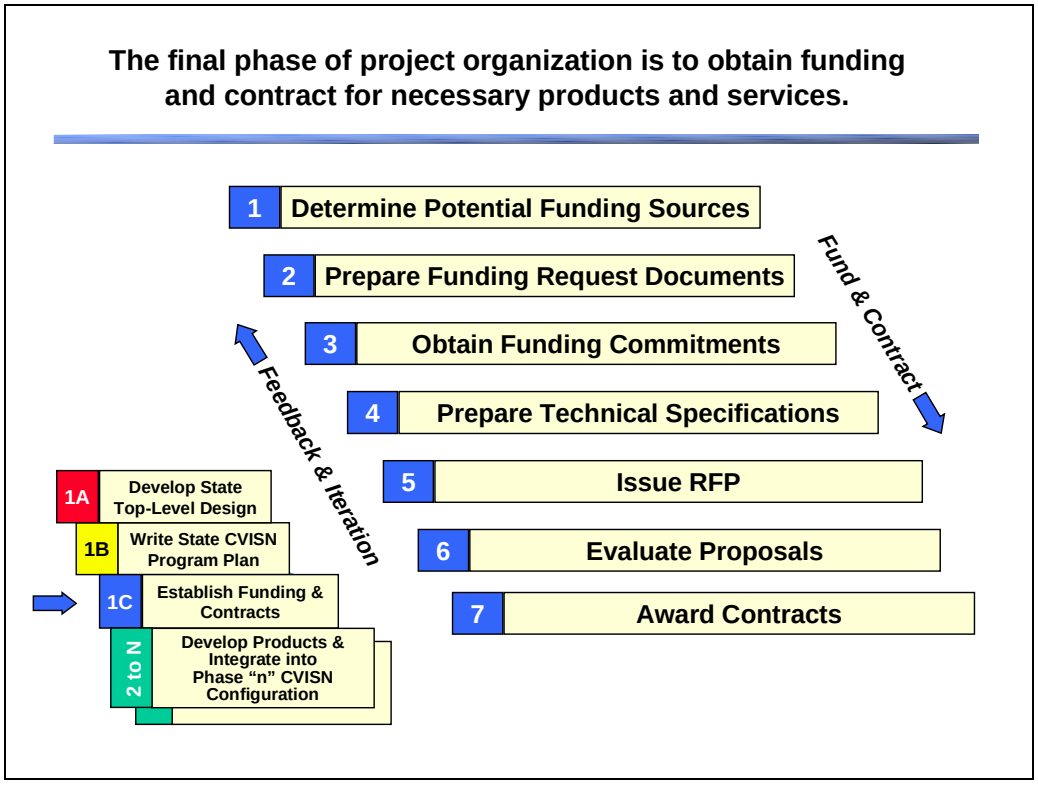

Figure 7–4. Funding and Contracts Phase Process

Funding and Contracts Phase Products

- Documents needed (PR material, feasibility studies, cost/benefit studies, grant applications or proposals) to obtain funding
- Commitments for funding from state, federal and private sources on a schedule that meets project cash flow requirements.
- Procurement documents (e.g., request for proposal (RFP), evaluation plan, feasibility study, and sole source justification) to acquire hardware and software products as well as software development, system integration, communication, and verification and validation services.
- Flexible contract mechanisms are in place to support a team of contractors as required to complete all aspects of the project.

Factors to be Considered in the Funding and Contracts Phase

- The electronic screening area involves contracting for multiple hardware, software and communications products and services. It includes facility work and probably roadwork. Procurement and contract management are key activities in this area.
- Consider hiring a system integrator to do the whole job. Generally, they are much better positioned to do the subcontracting necessary to acquire and install all the required pieces.
- Be sure to include measurements of performance and remedies for non-performance in contracts.
- Be sure to account for operations and maintenance in the budget estimates.

Key Decisions

These are issues that must be faced during the funding and contracting phase of the project. They are not unique to electronic screening.

- How much funding is required to complete the project?
- Where will the funding be obtained?
- How will operation and maintenance (O & M) costs be funded?
- What type of procurement should be used for each product or service?
- What can be done to expedite procurements?
- What type of incentives and remedial mechanisms should be included in the contracts?
- What software rights should be included in the contracts?

Advice and Lessons Learned

- If possible, set up some type of indefinite delivery/indefinite quantity (ID/IQ) contract vehicle with your systems integration agent and software services vendors. This allows you to define specific task orders as the work proceeds. It lessens the need to have a "frozen" set of requirements up front. It allows the team a lot more flexibility in solving problems. It allows adapting to changes in technology as the project proceeds.
- To assure architecture conformance, be sure to require that vendors prove that their deliverables conform to the architecture through the execution and analysis of interoperability tests. Also require design reviews so that the state's Conformance Assessment Team can check the design for conformance.
- When states decide to follow a mostly commercial off-the-shelf (COTS) approach, they expect the costs to be very small. This expectation is often not met. For example, if your state uses screening software based on an existing site in another state, it is likely to require substantial modification and customization to fit in your site-specific situation. Your state may have slightly different or additional requirements. Roadwork and installation may still cost hundreds of thousands of dollars. Nevertheless, it is still cost effective when compared to a development from scratch.

7.5 Development Phase "n"

Development Phase "n" Process

The CVISN Guide to Phase Planning and Tracking describes the general process for developing and maintaining a Phase Plan and tracking progress as the phase proceeds. Figure 7-5, which portrays this process, is repeated below as a reminder.

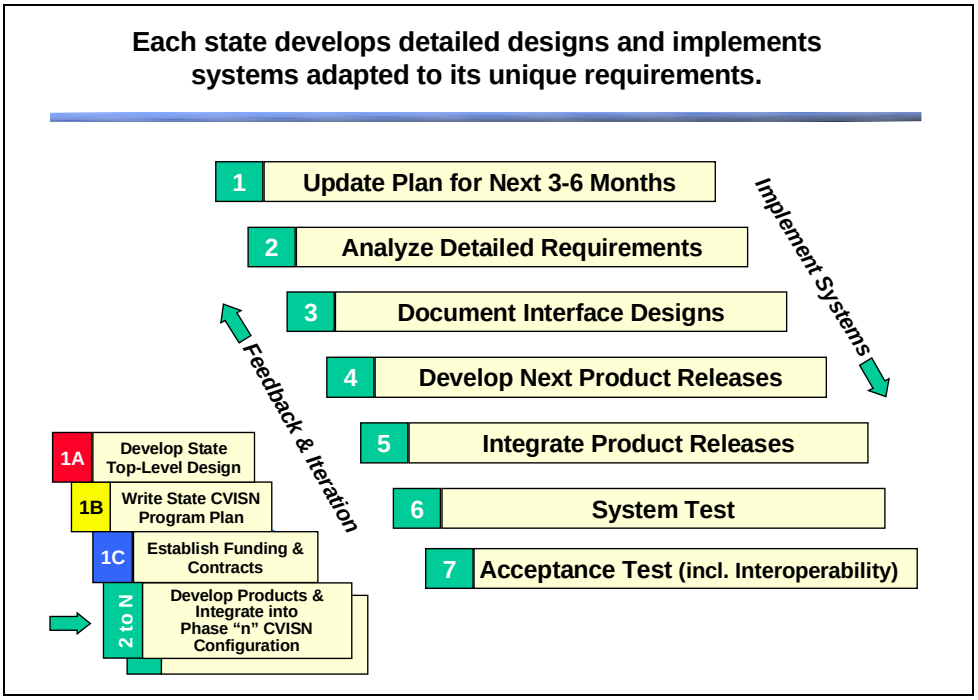

Figure 7–5. Development Phase "n" Process

Development Phase "n" Products

- Working products (e.g., screening computer, ROC)
- Products integrated into the operational environment
- Test documentation showing proof that products worked as required
- Operation and maintenance documentation
- Net result: New operational capabilities

Factors to be Considered in Development Phase "n"

You need to be able to incrementally define details. Specific hardware configuration and interface requirements may not be known until the vendor/component selection process is complete. Timing and sensor correlation issues will not be fully understood until the equipment has been installed. Allow time in the schedule to integrate components and to document the details of specific hardware interface requirements at the beginning of each phase.

As components are developed, tests should be executed to verify that the components meet the design. As components are integrated, interoperability tests should be executed to verify that the standard interfaces were implemented correctly, and that the components and products work together correctly.

Configuration management becomes very important when integrating products from multiple vendors. A change management process must be in place. As changes are made to interface designs, everyone must be kept informed of changes and planned updates. Updates to systems on each end of the interface must be synchronized. Version numbers must be systematically assigned to all products and version description documents prepared to coordinate updates and make sure that compatible versions are installed together.

Key Decisions

- How should the initial design be modified based on the experience gained in each phase?
- How should the initial phase plan be modified based on progress actually made in each phase?

Advice and Lessons Learned

- Incremental deliveries reduce the risk for both the state and the vendor. Use them.
- Assuming that you are doing incremental development, allow time at the beginning of each phase for a quick re-study of just the processes and requirements for that phase. Think about lessons learned from the prior phase and incorporate them. Allow a few days to define detailed processes. Also, refine the interface specifications at this time. Finalize any state specific details related to sensor or communications interface design at this time. This “just-in-time” analysis will present topics to the development team when they are ready to handle them and need the results. It will avoid “warehousing” a thick specification on a shelf to gather dust.
- An early delivery that shows tangible progress is critical to building the team, establishing forward momentum, establishing credibility, and securing funding. For example, Maryland installed a Roadside Operations Computer (ROC) at its West Friendship and Perryville sites as a first step, even though no WIM, DSRC or other sensors were available. This first step allowed site personnel to understand the type of information they would get from SAFER snapshots and to see screens used to monitor e-screening in a site at another state (e.g., Stephens City, Virginia). It was a good first

step, because it allowed site personnel to really understand the system and validate requirements with a relatively small investment.

- Plan to do testing at multiple levels: unit, integration, and complete system. There are lots of components and interfaces involved and each must be tested individually before trying to get the entire system to work. Diagnostics should be built into the design to help in the integration process, as well as to support maintenance of the final system.
- Schedule management is especially important in the electronic screening area because of the need to coordinate multiple vendors. The state needs an integrated schedule that has top level milestones and any external dependencies among the various vendors and organizations involved. The system architect needs to have clear authority to adjust the schedule details in response to technical issues. However, everyone must make a firm commitment to meet major milestones.
- The screening area will probably require close coordination among a number of vendors. Vendors will be dependent on each other for achieving their goals. These external dependencies need to be identified and carefully managed. When problems come up (as they always will, even in the best programs) there will be a tendency for everyone to blame the problem on someone else. You need a strong system integrator and problem resolution process to deal with this.
- An early indicator of a vendor's ability to perform is to check the level of effort being applied. There is no substitute for a visit to the vendor's development facility. Ask to meet the people working on your system. Ask what other assignments they are working on. Step back and perform a "sanity check" on staffing levels. Ask yourself if it is realistic to expect the work you want with the effort that is being applied.
- Hopefully, careful planning will allow things to go well with your vendors. But be sure to have contractual remedies in place just in case they don't. These can include progress payments based on performance, incremental funding, and cancellation clauses.
- Test data can be time consuming to prepare. Build on existing test data (e.g., the CVISN interoperability test suite package) when possible. Lack of test data can cause insufficient testing and allow problems to go undetected until systems are put into production.
- Changes in requirements can kill project schedules and cause cost overruns. An effective configuration management (CM) process is necessary to ensure that changes are only made when the impacts on cost and schedule are understood and approved. For more information about CM, please see Reference 19.

7.6 Requirements Specification

Development of accurate requirements specifications that are detailed enough (but not too detailed) is a critical success factor in an electronic screening project. It is discussed here as a separate topic because it is a consideration that has impact on all phases of the development process, from top-level design through final acceptance testing. Several alternatives to specifying requirements are discussed below.

Alternative A: Simplified Requirements Specification Document.

Generating a detailed requirements specification for an electronic screening project prior to commencing development is difficult. Specific hardware configuration and interface requirements may not be known until the vendor/component selection process is complete. Planning the site layout requires detailed information about existing equipment and facilities along with the requirements of the new hardware components. Timing and sensor correlation issues will not be fully understood until the equipment has been installed. Software requirements are dependent on all of the factors above.

Consider not writing a very detailed electronic screening requirements specification up-front. Some folks think that a thick, detailed requirements document will ensure that the contractor will produce what you want. Experience has shown that this is not necessarily the case. Instead, a concise requirements document that states the end results and leaves the details to be developed as part of the phased development process is more likely to succeed. Remember that your objective is to produce a top-level requirements specification that limits the project scope and is concise, testable, and provides a basis for establishing and managing a contract.

One suggested approach is to use your State CVISN Top-Level Design Description and a State Electronic Screening Specification (both described in Section 7.2) as the sources for requirements. The system design description should include the completed sections of the various parts of the COACH:

- COACH Part 1, Operational Concept and Top-Level Design Checklists
- COACH Part 3, Detailed System Checklists
- COACH Part 4, Interface Specification Checklists

Review and edit these, filling them out and customizing them as required to meet the needs of your state.

Your request for proposal (RFP) should refer to specific sections of these documents relevant to the product or services being procured. It can also reference these guides and any other state specific documentation (e.g., strategic plans) that provide background or describe your concept of operations. The RFP should require that the product pass the interoperability tests. Please see the COACH Part 5 (Reference 15) and the CVISN Interoperability Test Suite Package (References 20-22) for further information. The RFP should require that as part of the project, the vendor perform systems analysis and develop more detailed process descriptions and related requirements with operations personnel during each phase of the project. These process

descriptions may be done in joint application design sessions using participant flows or some equivalent method and diagramming technique. When evaluating proposals, pay particular attention to the vendors' experience and proposed approaches to working with your team to develop these detailed process designs.

Alternative B: Delta Requirements

If your state electronic screening system is to be based on the software and design of an existing system, such as HELP PrePass™, NorPass, MD CVISN Prototype system at Perryville, or VA CVISN Prototype system at Stephens City, you may wish to consider a variation on Alternative A. Prepare the simplified requirements specification based on your State System Design Description and Electronic Screening Specification as described above. Then define a "delta" (i.e., difference) requirements specification that just describes the changes to be made to the software and system design. Work with the contractor to adapt the system design to the specific site and define the hardware configuration.

Preparation of the delta requirements is in lieu of a detailed description of the electronic screening method. If you are basically satisfied with the process as it exists, there is no need to spend a lot of effort reinventing or documenting it.

Alternative C: Comprehensive Requirements Specification Document

Traditional software life cycle models advise having comprehensive, detailed, requirements nailed down in a requirements specification before the project starts. We have noted some problems with this approach, including:

- Developing the document is costly and time consuming
- Processes change and the document quickly becomes obsolete
- If the people developing the document aren't the ones developing the system, much of the investment remains locked in the heads of the analysts who wrote the specs and is not transferred to the developers. The developers will likely want to redo this work themselves and get the users' perspective first hand.
- User personnel often don't have time to invest in really studying requirements documents and making sure the documents reflect their needs
- It is very difficult for even the most dedicated user personnel to review the documents and actually understand what they are getting. When they finally see the system, they will realize that there were lots of things they wanted that didn't occur to them when reviewing the specs.
- Specific hardware configuration and interface requirements may not be known until the vendor/component selection process is complete.
- Timing and sensor correlation issues will not be fully understood until the equipment has been installed.

However, if your state has worked successfully with comprehensive, detailed requirements specifications before and this is what you want on this project, consider issuing a partial draft of the requirements specification as part of your RFP. Then have the successful bidder complete

the draft as part of their contract. The contractor should update the draft based on a detailed site evaluation and using the specific hardware components to be installed. Have them finalize sections with each phase of the project as it proceeds.

In Maryland, a functional specification (Reference 23) was initially drafted which included the following information:

- Site description and proposed layout
- High level software functional design
- Functional description of hardware components
- If known, identification of specific hardware vendor and component model or configuration
- Specification of electronic screening algorithm and data elements
- Roadside operational scenarios
- Roadside data flow
- Snapshot-based information flow

During the development process, the document was revised to contain additional detail and reflect hardware component selection and the design decisions being made. Additional documents such as detailed site layouts, wiring diagrams, and software design were also generated, when required.