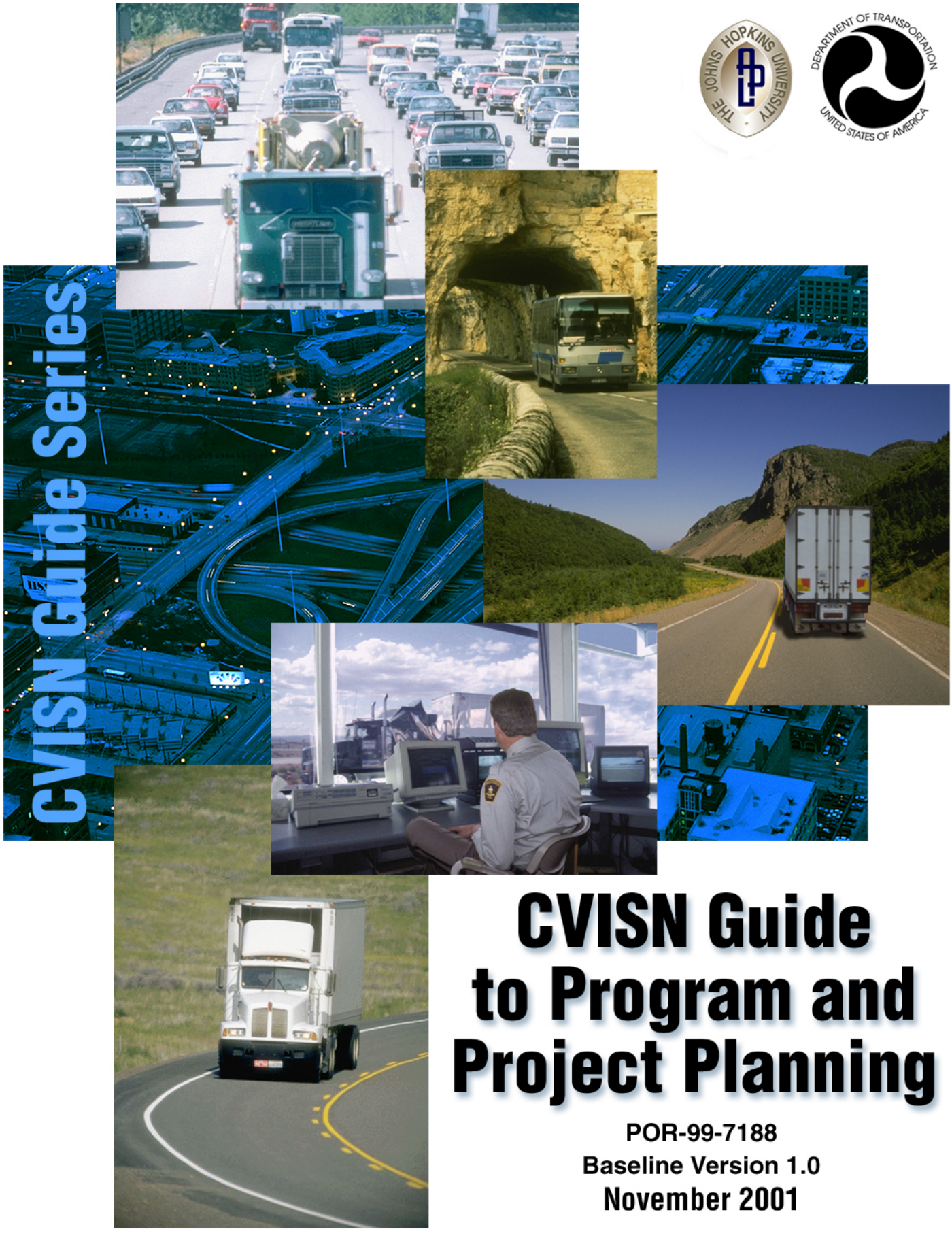

CVISN Guide to Program and Project Planning

POR-99-7188
Baseline Version 1.0
November 2001

Top 10 Reasons Not to Plan

#10. "You can't plan new development; things change."

A plan is a record of what you were thinking at the time you wrote it. Later when that thinking has changed, you can better reshape the work product and assess its effects on schedule and cost.

#9. "No one reads the plan."

The process of preparing and having the team review/concur with the plan is arguably more valuable than the plan itself.

#8. "We're more efficient the less management we do."

Customers expect management products that instill confidence, and provide feedback and control mechanisms until the technical products are finally delivered.

#7. "It'll be done when it's done."

Maybe we can't say for certain when it will be done, but at least we can agree on a defined series of activities that have to happen.

#6. "It'll cost whatever it costs."

There are management decisions to be made which trade off among cost, schedule, and product performance.

#5. "We cannot afford the time and money to plan."

The savings that result from good planning are often hidden in events that didn't happen, such as delays, additional staff, and extra meetings to resolve problems.

#4. "Plans just tie my hands and slow down change."

Plans focus energy.

#3. "Just give us the money!"

Let's agree on cost, schedule, and technical performance first.

#2. "If only we got rid of the bean counters."

We operate in a regulated environment; informed bean counters are less troublesome than misinformed bean counters.

#1. "We don't need a plan"

You'll wonder how you ever got along without one!

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November 2001

Authors:
James J. Peter
Valerie B. Barnes

Note

The Motor Carrier Safety Improvement Act was signed into law on December 9, 1999. This act established a new Federal Motor Carrier Safety Administration (FMCSA) within the U.S. Department of Transportation (DOT), effective January 1, 2000. Prior to that, the motor carrier and highway safety program was administered under the Federal Highway Administration (FHWA).

The mission of the FMCSA is to improve truck and commercial passenger carrier safety on our nation's highways through information technology, targeted enforcement, research and technology, outreach, and partnerships. The FMCSA manages the Intelligent Transportation Systems (ITS) / Commercial Vehicle Operations (CVO) program, a voluntary effort involving public and private partnerships that uses information systems, innovative technologies, and business practice re-engineering to improve safety, simplify government administrative systems, and provide savings to states and motor carriers. The FMCSA works closely with the FHWA ITS Joint Program Office (JPO) to ensure the integration and interoperability of ITS/CVO systems with the national ITS program.

Acknowledgements

The authors are grateful for material and inspiration provided by Kim Richeson; for comments and suggestions from John Hardy, Tim Erickson, and Warren Dunham; for reviews by Nancy Magnusson and Mary Stuart; and for production support from PCA Graphics, Theresa Nester, and Beverly Greenwald. This Guide draws liberally from the principles and lessons-learned published in the key references cited. In that sense, this Guide recounts and conveys the ideas of hundreds of people, and we are grateful for their help in smoothing the way.

Baseline Issue

This is a baseline document, which has completed internal and external reviews of previously published drafts and preliminary versions. All comments received to date have been incorporated or addressed.

It is disseminated in the interest of information exchange. Johns Hopkins University Applied Physics Laboratory (JHU/APL) assumes no liability for its contents or use thereof. This document does not constitute a standard, specification, or regulation. JHU/APL does not endorse products or manufacturers. Trade and manufacturer's names appear in this report only because they are considered essential to the objective of this document.

This and other CVISN-related documentation are available for review and downloading from the JHU/APL CVISN site on the World Wide Web. The URL for the CVISN site is:
http://www.jhuapl.edu/cvisn/

Please Provide Comments

The authors would appreciate any and all feedback about this document, from modest typos to egregious errors. We are especially interested in hearing from you if you find a topic is missing or if our emphasis is wrong.

Jim Peter
Johns Hopkins Applied Physics Laboratory
11100 Johns Hopkins Rd
Laurel, MD 20723
Jim.Peter@jhuapl.edu
443-778-5958

CVISN Guide to Program and Project Planning

Table of Contents

1. INTRODUCTION

This CVISN (Commercial Vehicle Information Systems and Networks) Guide describes how to plan a state CVISN program and its underlying projects.

It is one in a series of guides. All guides are available from the CVISN website [14]. Acronyms are defined in Appendix A of the *Introductory Guide to CVISN* [3] and explained in detail in the *ITS/CVO CVISN Glossary* [24].

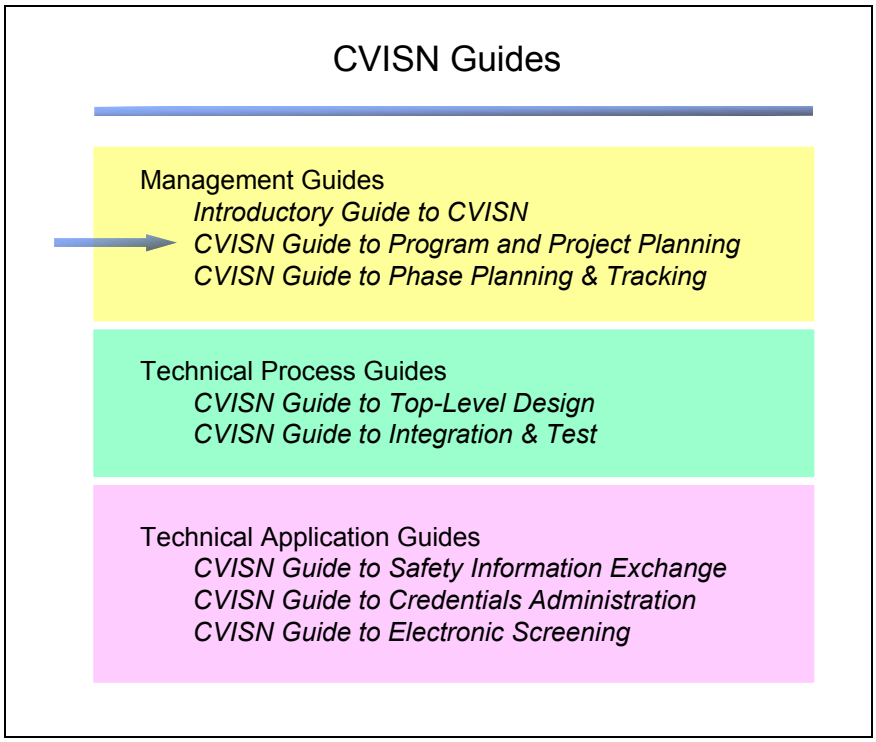


Figure 1–1. CVISN Guides

1.1 "Program" versus "Project"

This Guide emphasizes CVISN project planning principles which when applied will produce your CVISN program plan. Although "program" and "project" sound like synonyms they have very different formal meanings. Is it worth taking time to clear up terminology? Yes – so that document authors and readers, workshop speakers and attendees, each conjure up the same meanings underlying these words we use as symbols. As well, we take care so as not distract you with sloppy or unnecessarily-duplicative terminology.

The Project Management Institute (PMI) defines [1]:

> Program – A group of related projects managed in a coordinated way to obtain benefits not available from managing them individually. Programs usually include an element of ongoing activity. For example, publishing a newspaper is a program; each individual issue is a project.
>
> Project – A temporary endeavor undertaken to create a unique product or service. To further clarify: organizations perform work. Work generally involves either *operations* or *project*s, although the two may overlap. Operations and projects share many characteristics; for example they are: performed by people; constrained by limited resources; and planned, executed, and controlled. However, operations and projects differ primarily in that operations are ongoing and repetitive while projects are temporary and unique.

When a state takes on the CVISN Program, it sets in motion a mixture of projects that deploy utility and performance in the three major functional areas, as illustrated in Figure 1–2 (adapted from [16]).

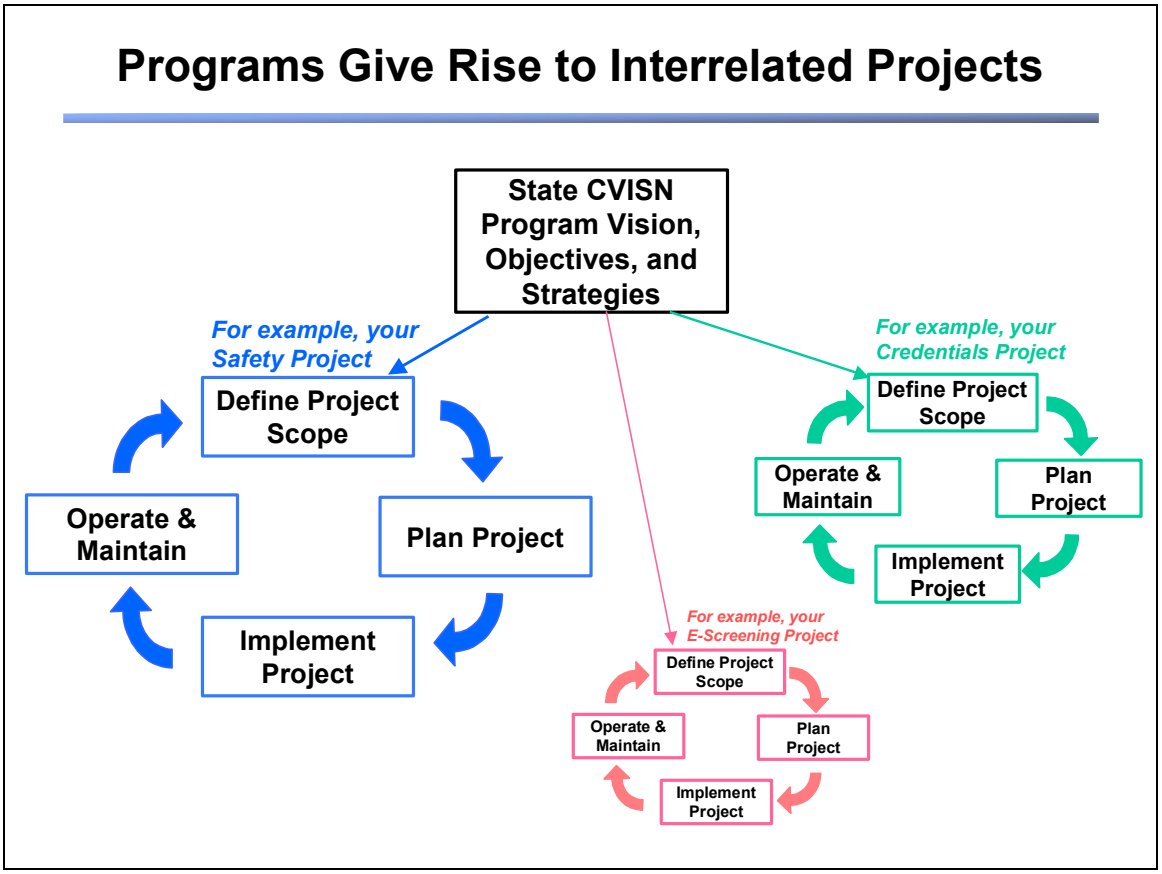


Figure 1–2. A Program Gives Rise to Interrelated Projects

What is a Program Manager as opposed to a Project Leader? The Program Manager provides strategic leadership over an array of projects, and may personally lead one or two projects. The Project Leader provides tactical leadership on one project.

PMI goes on to define [1]:

> Project Management – The application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project.

State CVISN Level 1 programs might include **projects** such as:

- Safety
- Credentials
- Electronic Screening

You could choose to define your projects more narrowly. For instance you might have one project that focuses on the International Registration Plan (IRP) and another project focused on the International Fuel Tax Agreement (IFTA). It's up to you.

1.2 Purpose of the Guide

This Guide will assist you by distributing the information, knowledge, insight, and experience of others who have traveled a comparable path. It describes CVISN-specific project planning principles, processes, tools, and their resulting products. It suggests how to tailor the processes to accommodate your particular situation. It is written for the Program Manager, Project Leaders, and everyone else directly associated with writing a Program Plan or a Project Plan, or managing CVISN projects on a day-to-day basis.

This Guide assumes that your state has funds available to, at a minimum, plan and organize the CVISN program; that you have attended the introductory training courses [15,16,17]; and that you have documented the top-level system design upon which to base this plan.

This Guide is just that – a guide; it is not a set of management requirements or specifications. Ordinarily, states do not have the luxury to set up offices that are 100% assigned to the CVISN Program. More likely, experienced people are assigned to CVISN development tasks along with their many on-going operational tasks. Therefore it may not be practical for your CVISN team to produce every table, chart, and diagram to the level of detail shown in this Guide. The content, not the format, is what ultimately matters. What is truly imperative is a grasp of the underlying fundamental principles and processes.

1.3 What is a Program Plan?

A State CVISN Program Plan establishes the management framework for the program. The development of the Program Plan starts with the beginning of the program, and usually precedes the development of any project plans. As the shape of the program emerges projects are identified more clearly. The Program Plan gives the program team and upper management a picture of:

- What the program is trying to accomplish.
- How the work will be done.
- What organizations will support the effort, and who the leaders will be.
- How much funding is needed and where it will come from (e.g., state revenues or federal programs).
- Where the connections are across projects.
- What integrated capabilities will be developed in each phase.
- How to assess whether the program is on track.

1.4 What is a Project Plan?

PMI provides this working definition [1]:

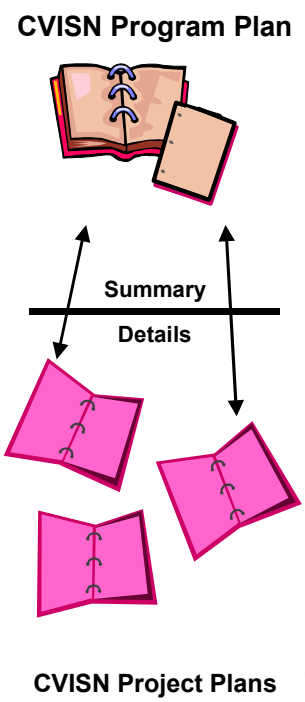
> *A Project Plan is a formal, approved document used to guide both project execution and project control. The primary uses of the Project Plan are to document planning assumptions and decisions; to facilitate communication among stakeholders; and to document approved scope, cost, and schedule baselines. A Project Plan may be summary-level or detailed.*

In practice, a Project Plan may be published formally at the beginning of each project, and then maintained as an informal "living" plan focused on the phased development of incremental capabilities. As such, the Project Plans often evolve into a collection of historical information, fairly short-term plans, and current status. The material from one phase becomes "historical" as the phase is completed. Keeping track of history makes you a better planner for the future, so it's a good idea to save the records throughout the project.

1.5 How are the Program Plan and Project Plans Related?

When projects become clearly defined, project planning can commence. The relatively more detailed results of project planning typically feed back to the higher-level program planning process as project needs and staff are adjusted, as phases are re-defined, and most importantly, as reality sets in. The program planning process, of necessity, involves top-down decrees. Conversely, the project planning process involves bottom-up assessments. After project leaders have addressed the reality of working-level costs and schedules, the top-down Program Plan must often be repaired.

Figure 1–3 shows the chapters in the Program versus Project Plans. Although both plans contain the same chapter names, the Program Plan is at a summary level, whereas the Project Plan is at a working-detail level.



Topic	Program Plan	Project Plan(s)
Executive Summary	▤	Highlights
Introduction	▤	▤
Objectives	▤ (& Projects)	▤
Requirements & Design (mostly by reference to System Design Description)	▤	▤
Work Breakdown Structure	▤	▤
Organization Structure	▤ (Agency and Program Charts)	▤ (Project Charts)
Work Assignments (based on WBS)	▤	▤
Procurement Strategy	▤	
Processes	▤	Deltas from Program Standards
Schedule & Milestone Information	Phases & Critical Milestones	Detailed Schedule & Milestones
Financial Information	Known Funding Sources, Program Budget	Project Budget Details
Products	▤	▤
Issues	▤	▤

Figure 1–3. The CVISN Program and Project Plans Address Nearly Identical Topics but at Different Levels of Detail

1.6 Planning Prerequisites

Before you begin to write the Program Plan, please read this *CVISN Guide to Program and Project Planning* all the way through, as well as its companion, the *CVISN Guide to Phase Planning and Tracking* [44].

Also complete the scenarios and design framework begun at the CVISN Scope Workshop that you attended. You cannot write a comprehensive Project Plan unless you have a good grasp of the technical scope of your project.

Concurrent with development of the Program Plan, you need to fill out the COACH Part 2 (Management) Checklists [70].

If you haven't already, start a Program Library. Review and retain the state's strategic plans, business plans, and any information systems plans which affect the systems in the CVISN design, or conversely, which CVISN might affect.

Sketch out a rough draft phase schedule, so that you have a notion of the "big picture" for development and deployment.

Begin to recruit individuals – from all segments : state, private industry, universities – who will support CVISN development and deployment. This encompasses not only the program team members, but also the steering committee, carrier organizations, and any other structures needed to assure project success.

Write a Memorandum of Agreement among all participating state agencies. A sample is provided on the JHU/APL CVISN website [14].

You will need to understand your state's legislative and budget cycle. Later you will need to utilize your state's procurement process for off-the-shelf items, and your state's contracting process for development items, so you need to understand them too. (Contracting issues are notorious for slowing down the startup of a project.)

It is not too early to prepare a rough draft of a Request for Proposal (RFP) for each envisioned contract.

Most importantly, secure the funding sources for the CVISN program. The major job of the Program Manager, besides staffing leadership positions, is to keep the program "alive" with funding.

2. CVISN PROJECT CONTEXT AND ORGANIZATIONAL ENVIRONMENT

When referring to a professional discipline the literature uses "Project Management" not "Program Management". For example, the name of the professional organization "Project Management Institute" [2]. The processes associated with the professional discipline of project management apply to program management as well, but at a higher level of abstraction and with a longer time horizon. To avoid cumbersome terminology in this Guide we will just say "Project Management" with the intention of broadly embracing "Program / Project Management".

2.1 CVISN Project Management Processes

CVISN project management shares many of the same challenges as management of any other type of project (especially ITS projects). Any of the numerous project management textbooks (see Appendix A) will be beneficial supplementary reading. Reference [1] by the Project Management Institute is thorough yet surprisingly concise, and is available without charge. Reference [8] is very readable. Figure 2–1 portraying the lifecycle of project management processes is adapted from these references.

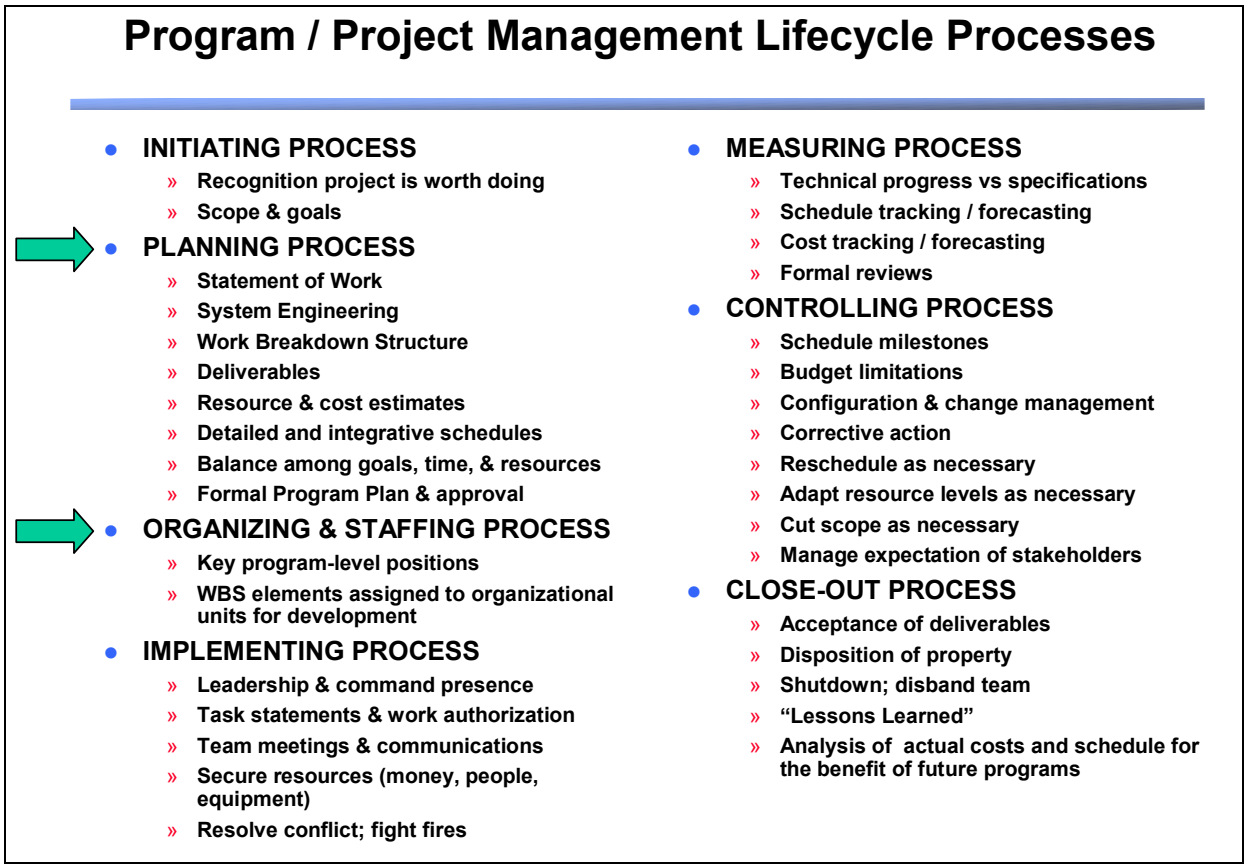


Figure 2-1. Planning and Organizing Is Just One Part of the Lifecycle

This Guide mostly focuses on the planning portion of the lifecycle. In this chapter we also discuss briefly some concepts related to organizing and staffing the program and projects.

Besides the stresses common to any project, CVISN project management presents unique challenges:

- Operating within the legislated and regulated environment of state government (which, for example, can slow down the process of getting developers under contract).
- Working within a line organizational structure, as opposed to a projectized or matrixed organizational structure.

In the next section, we will discuss conceptual models of staff organization structures, because the "matrix" organization of CVISN program and project teams may be a new concept, and because staffing is so critical to success.

2.2 CVISN May Introduce Matrix Management for the First Time

The recommended CVISN project management approach may introduce unfamiliar matrix management concepts into your state culture for the first time. People will need to adjust to this new way of thinking – that of project-focus rather than organizational-focus and of reporting to two or more chains of command. People may have trouble adapting when they have multiple managers, multiple role identities, and multiple priorities.

Organizations can be defined as groups of people who must coordinate their activities in order to meet organizational objectives [53]. The resulting staff structure determines the formal channels of authority, responsibility, and accountability. Organizations are continually restructured to meet the demands imposed by the environment.

Management textbooks identify three principal staff organization structures [8,53,58]:

- "Functional" or "Line" Organization
- "Projectized" or Product-Specific Organization
- "Matrixed" Organization

2.2.1 "Functional" or "Line" Organizational Structure

Under the traditional functional or line structure shown in Figure 2–2, specialists are grouped permanently by skill and role. The classic example is the military (thus the synonym "command-and-control" structure). State governments are organized this way, having a hierarchy of line management through departments and branches that can remain stable for decades. This serves extremely well for the delivery of stable on-going services, and when each project is clearly the responsibility of one department. On the other hand, the integration of activities that cross functional lines becomes a difficult chore, and top-level executives are forced to get involved with the daily routine to resolve conflict. There is no customer-facing focal point.

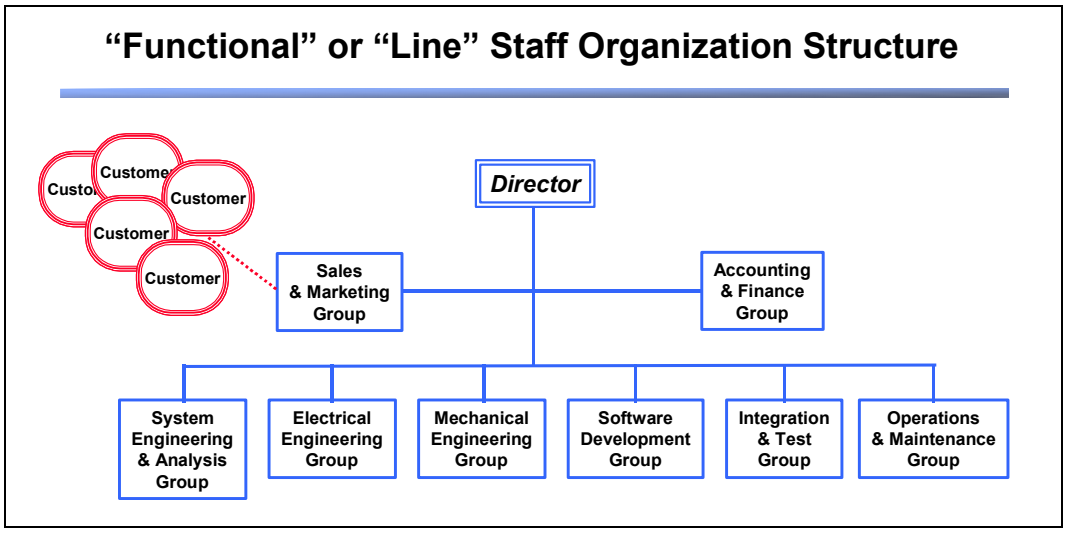


Figure 2-2. Illustrative "Functional" or "Line" Org Chart

2.2.2 "Projectized" or Product-Specific Organizational Structure

The product or projectized staff structure shown in Figure 2–3 evolves naturally when an organization has core long-duration product lines (such as aircraft engines), or long-duration projects (such as environmental cleanups lasting 20 years as opposed to information systems lasting only 2 years). Its advantages include quick reaction times and a strong customer-facing focal point. On the other hand, it is disruptive and inefficient when projects end because functional personnel do not "have a home" to return to.

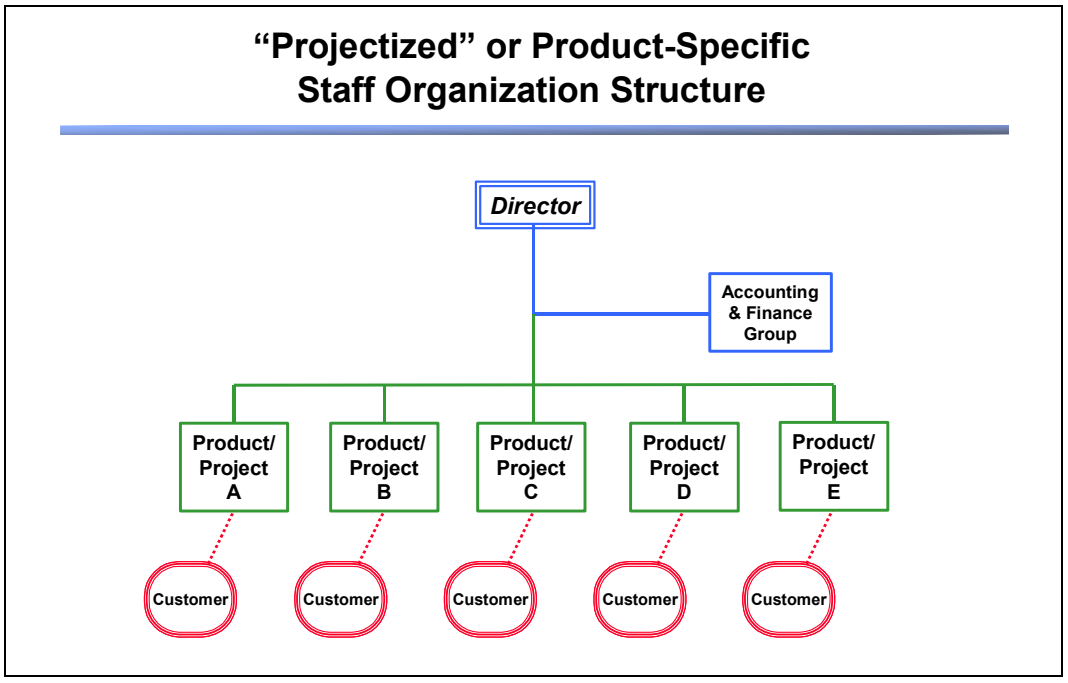


Figure 2-3. Illustrative "Projectized" or Product-Specific Org Chart

2.2.3 "Matrixed" Organizational Structure

Matrix management as shown in Figure 2–4 is an attempt to capture the advantages of both the pure functional structure and the pure product/project organization structure. With this strategy individuals are permanently assigned to specialty-focused stable "home" groups. Then for every project a dedicated but temporary project team is formed with individuals drawn from these specialty groups, thereby crossing organizational boundaries. Staff may be assigned full-time to one project, or part-time to several. The underlying assumption is that the enterprise has many simultaneously-active projects in various stages of their lifecycle. Engineering services companies are typically organized in this manner. Now a new staff senior assignment emerges, that of the full-time Project Manager (or "leader") who has total responsibility, authority, and accountability for project success. Functional groups retain responsibility for staffing, developing personnel, and assuring the technical quality of the work done by those personnel. **You know you are in a matrixed organization when you have two bosses:** the project manager who provides day-to-day tasking, and the functional manager (or "line supervisor") who handles career growth and evaluation, hiring and firing. A powerful advantage is that the project team can include all necessary areas of expertise ideally spanning the product's lifecycle – for example, staff specializing in test or operations can be involved part-time right up front in the requirements and design phase. (This lifecycle approach is also called an Integrated Product Development Team.) Although not shown, a Program Manager may have oversight of several related projects.

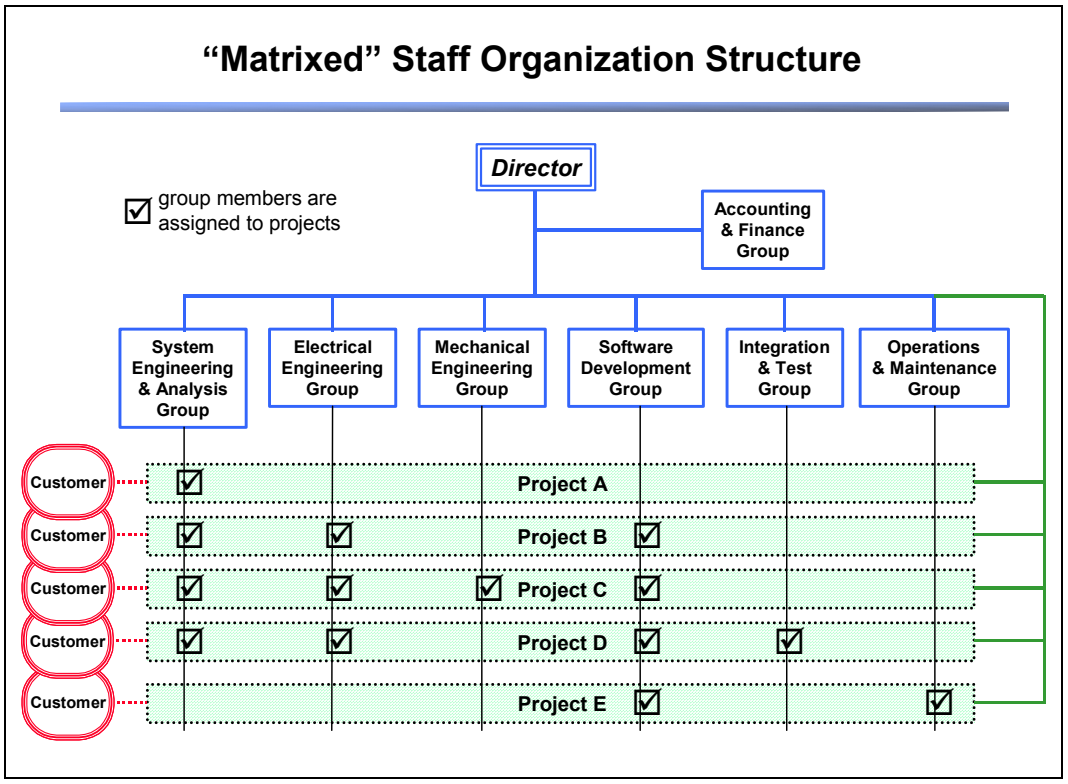


Figure 2-4. Illustrative "Matrixed" Org Chart

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3. CVISN System Development Overview

3.1 Top-Level Design Leads Into Program Plan

The *Introductory Guide to CVISN* [67] describes a model development process for implementing CVISN capabilities. Figures 3–1 and 3–2 are repeated here as a refresher.

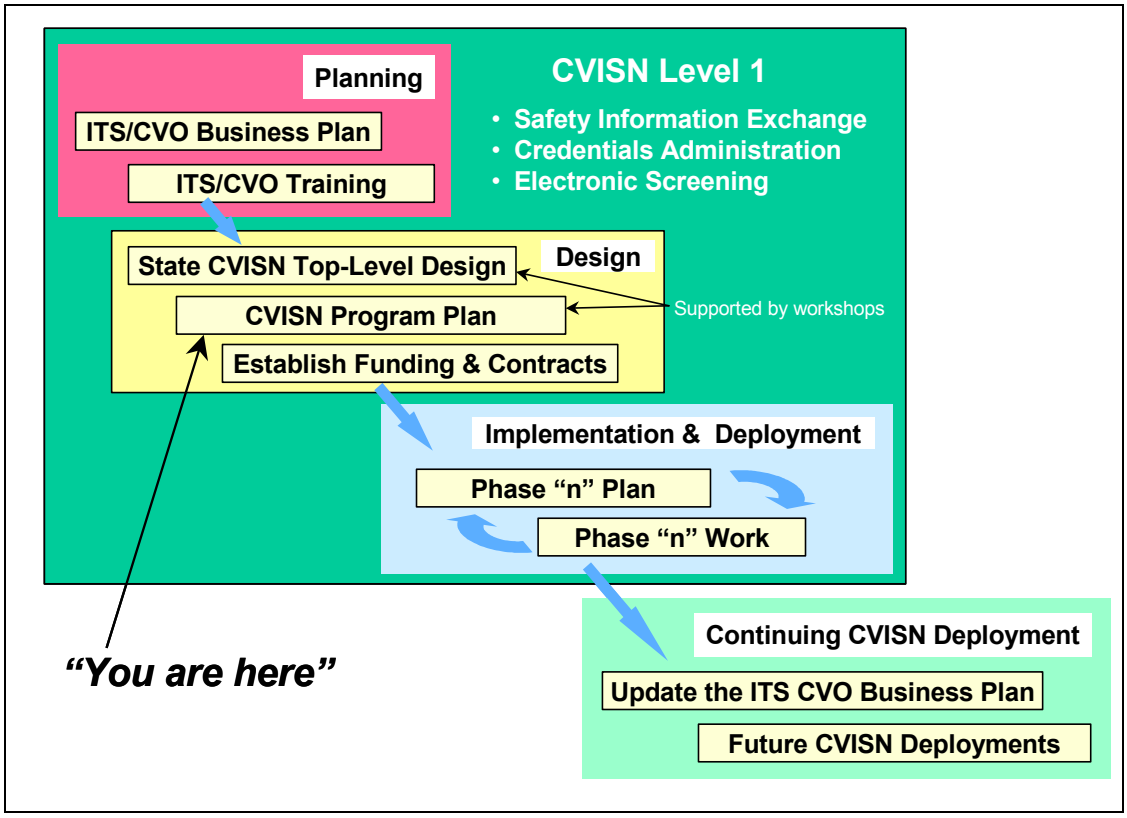

Figure 3-1. Each State Deploys CVISN Capabilities Incrementally Starting with Comprehensive Management and Technical Planning

The recommended Level 1 deployment process shown in Figure 3–1 builds on the CVISN Prototype and Pilot states' experience. Business planning and team training precede design. Top-level design precedes program planning.

The *CVISN Guide to Top-Level Design* [62] describes the principles and processes for reaching the starting-point for developing the program plan.

Figure 3–2 is the format for the phased approach steps described in the remaining sections of this chapter.

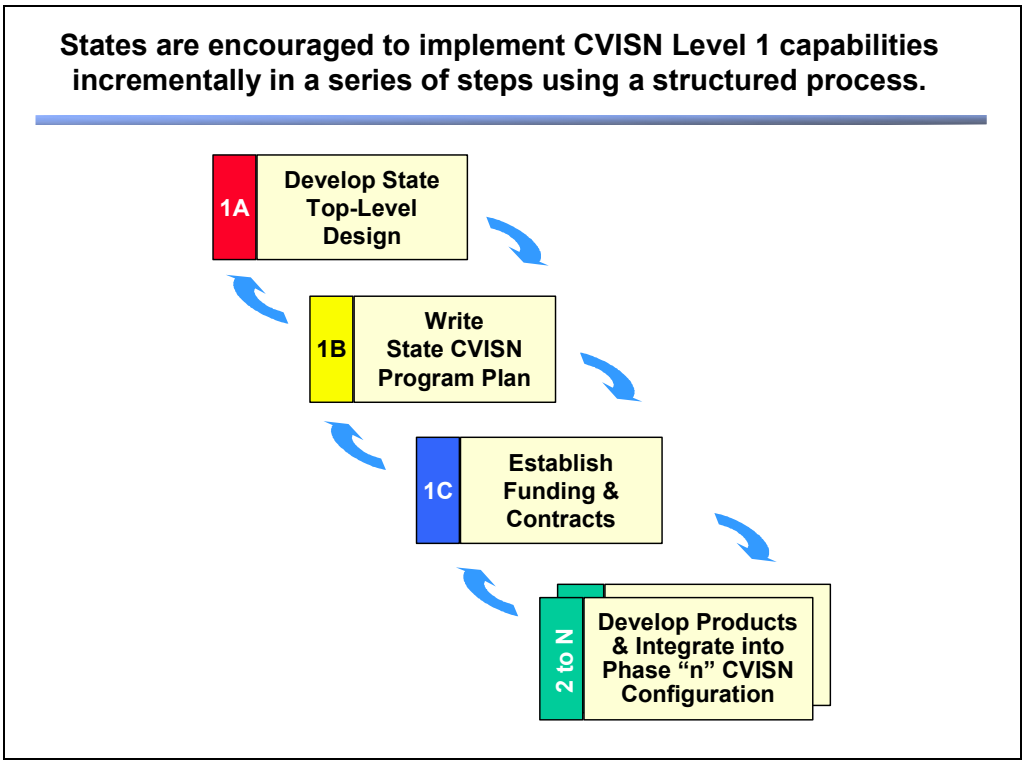

Figure 3-2. CVISN Incremental Deployment Approach

3.2 Take a Flexible Risk-Reducing Phased Approach

Deploying CVISN capabilities is a major undertaking. In order to reduce risk, you should use an incremental development and deployment approach called **phase planning**. We define a phase as a period of calendar time specified for planning purposes to allow incremental delivery of a complex system. Planning and implementing by phases mitigates risk, such as funding delays or shortfalls; a failed technical approach; a subcontractor who never performs and is replaced; the loss of a major stakeholder; or sooner-than-expected termination of development.

The guiding principles for phase planning are detailed in the *CVISN Guide to Phase Planning and Tracking* [44]. They are:

- Mentally switch from a linear development model to a spiral development model. The essence of the spiral model is first to establish a baseline plan and an overall vision of the architecture; and then to deploy the products incrementally by successive iterations through design, build, test, and next-phase planning.
- Plan, develop, and release products incrementally, such that useful end-to-end functionality is delivered with each phase, upon which subsequent phases can build.

- Maintain stakeholder commitment via visibility into progress by physical demonstrations of useful capability, and by regular management status reporting.
- Sustain a system perspective – a vision of the overall CVISN architecture, deployment strategy, and interdependency of products.
- Schedule, schedule, schedule.

Figure 3–2 illustrates that Phase 1A is devoted to the state top-level design, begun at the Scope Workshop. Phase 1B is devoted to writing the Program Plan.

This guide has been prepared with the experiences of early CVISN deployments in mind. The approach defined in this chapter assumes that your state is providing some level of system integration. If you decide to subcontract the entire role of system integrator, you may not follow the detailed steps outlined herein. Nevertheless, the material presented within this guide can still help you to understand what they must accomplish.

3.3 The Program Planning Phase

Figure 3–3 shows the seven steps within Phase 1B.

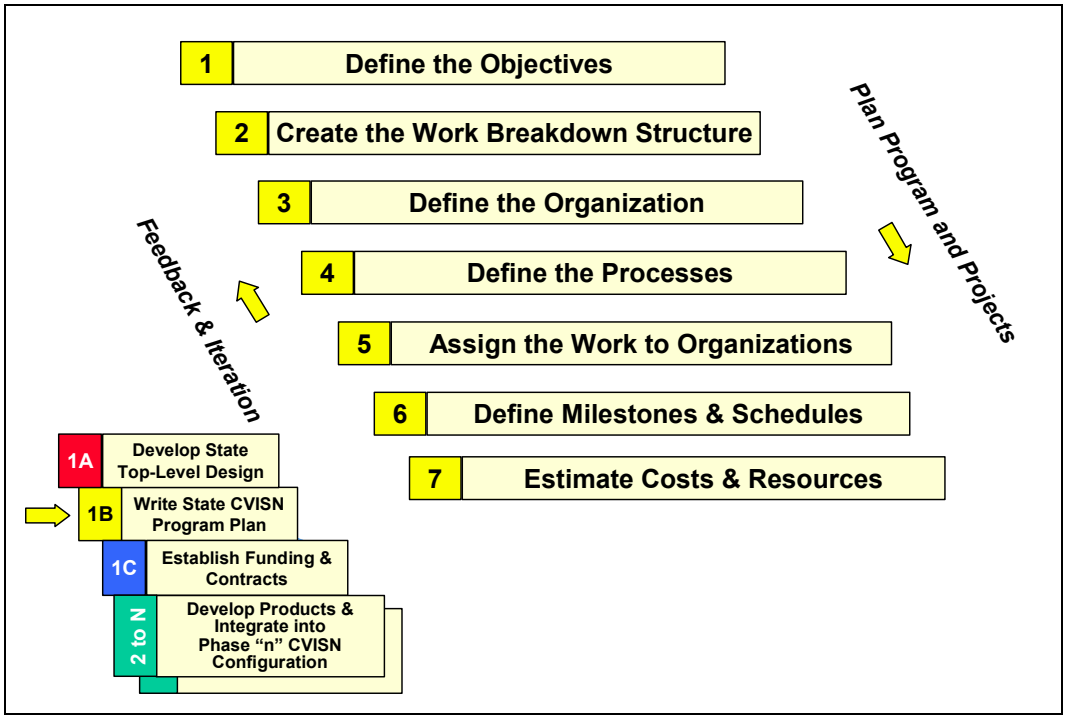

Figure 3-3. A Mature Planning Process is Necessary to Plan the Work and Communicate Among Team Members

At the end of the planning phase you will have:

- A completed program plan that reflects all of the decisions made in this step.
- Documents necessary to support acquisition of full program funding.
- Preliminary phase charts encompassing all three CVISN functional areas.

3.3.1 Factors to be Considered in the Program Planning Phase

- What other projects are going on in your state that may impact the CVISN program? For example, in 1999 "Y2K" preparation efforts had such a high priority that no resources were available for CVISN tasks in several states. Are there any major projects in your state that will compete for resources, such as a replacement payroll system?
- Are major upgrades planned in the hardware and communications systems that provide the state's CVISN infrastructure?
- Is there a program in your state to actively promote "electronic government" and deliver more services over the Internet and the Web? Can you leverage on that initiative?
- Can you leverage with neighboring states? For example, by agreeing on common business processes and then partnering in an acquisition.
- Be sure to understand and appreciate the procurement cycle in your state. It evolved over years for valued purposes and in response to problems, and must not be subverted. Note the procurement steps required and how long they typically take, especially for innovative approaches.

3.3.2 Key Decisions

- What is the CVISN Program organizational structure?
- Who will fill the key roles, such as Program Manager, System Architect, and Project Leaders?
- What is the program Work Breakdown Structure (WBS)?
- Will the state update current legacy systems? Re-compete? Re-develop?
- Will the state participate in regional and national programs such as PRISM?
- What are the priorities and sequence for implementing capabilities?
- Should the state build or buy each subsystem?
- Who is the system integrator? The state, or a contractor?
- Should the state have an independent verification and validation (V&V) agent?
  Note: "Verification" refers to the set of activities that ensure that software correctly implements a specific function. "Validation" refers to a different set of activities that ensure that the software that is built is traceable to customer requirements. Verification answers the question "Are we building the product right?"; validation answers the question "Are we building the right product?".

3.4 The Funding and Contracts Phase

Figure 3–4 portrays the general process steps for the funding and contracting phase; it is intended to give a conceptual framework and starting point. You should customize as necessary a specific process that meets the requirements of your state. It is not too early to start putting in place indefinite delivery / indefinite quantity task-order type contracts (called ID/IQ contracts) that will establish a contracting vehicle for information system hardware, network infrastructure, and support services. Look far ahead, some items have very long lead times – you may wish to begin drafting preliminary Requests for Proposals (RFPs) now.

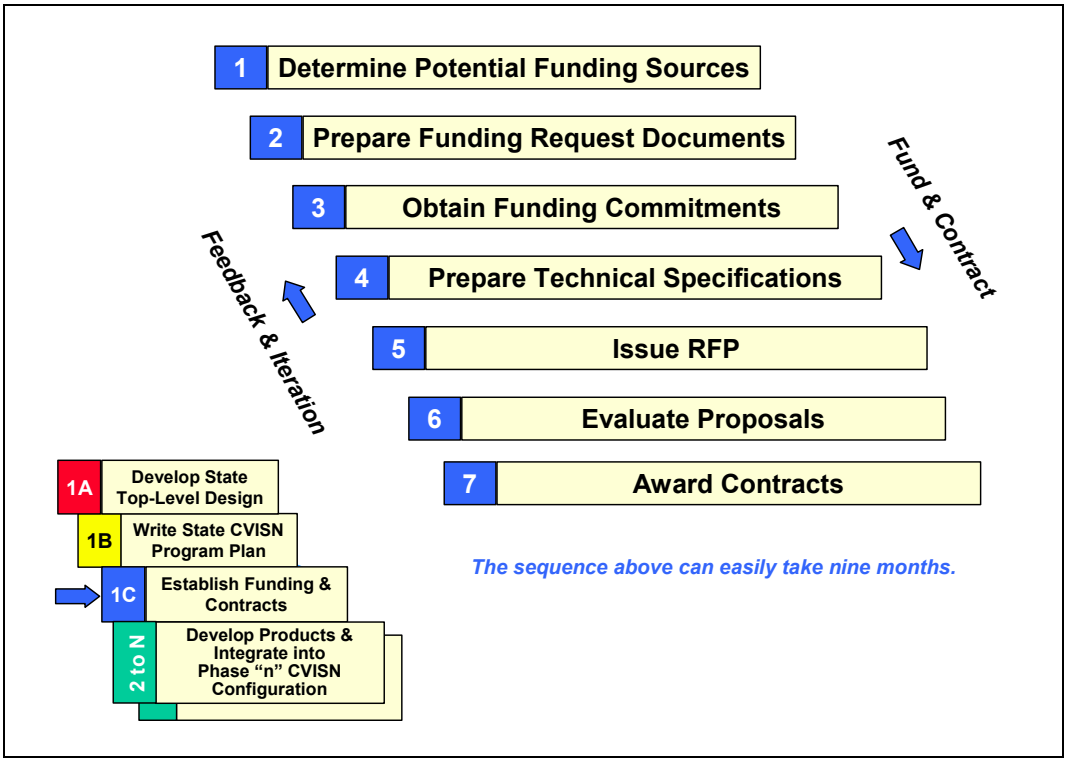

Figure 3-4. The Final Phase of Program Organization is to Obtain Funding, and to Contract for Necessary Products and Services

3.4.1 Factors to be Considered in the Funding and Contracts Phase

- Use contractual vehicles that allow work to be defined and costed at a high level before all the details are known. The contractual mechanism must also have the flexibility to define detailed process and system design as the work proceeds.
- In particular, consider using some type of indefinite delivery/indefinite quantity (ID/IQ) contract vehicle with your systems integration agent, network support, and software services vendors. This allows you to define specific task orders as the work proceeds. It allows the team a lot more flexibility in solving problems. It allows adapting to changes in technology as the project proceeds.

3.4.2 Key Decisions

- How much funding is required to complete the project?
- Where will the funding be obtained?
- What type of procurement should be used for each product or service?
- Do any funding sources have restrictions on how they can be contracted or used?
- What terms and conditions related to software, intellectual property rights, or other copyrighted products should be included in the contracts?

3.5 Development Phase "n"

The *CVISN Guide to Phase Planning and Tracking*[44] describes the process for planning and tracking progress as each phase proceeds. Figure 3–5 below is taken from that document.

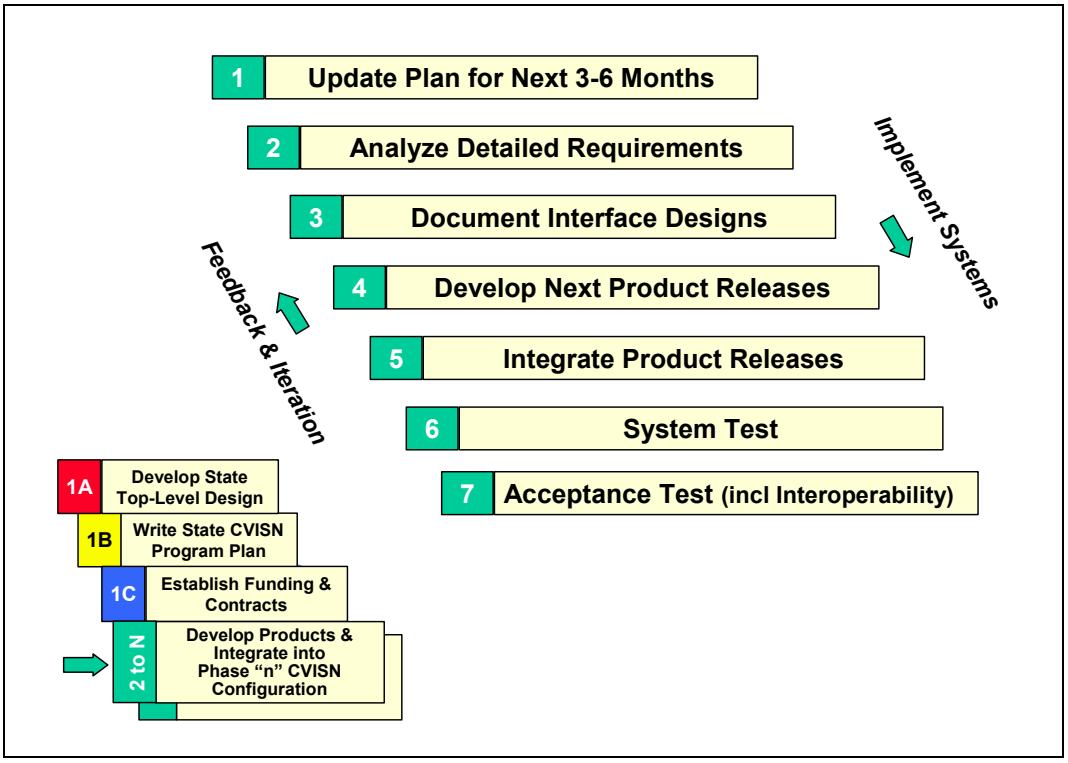

Figure 3-5. During Each Phase "n" a State Incrementally Develops Detailed Designs and Implements Systems Adapted to its Unique Requirements

3.5.1 Outcomes from Each Development Phase "n"

- Working products integrated into the operational environment.
- Test documentation showing proof that products worked as required.
- Operation and maintenance documentation.
- Net result: incrementally new operational capabilities.

3.5.2 Factors to be Considered in Development Phase "n"

- Allow time in the schedule for developers to analyze business practices, and to define more operational scenarios at the beginning of each phase.
- Allow time to document the state-specific interface requirements (e.g., EDI, XML). Some states have discovered that EDI or XML data element mapping takes more time, resources, and expertise than initially imagined.
- Functional tests: As components are developed, tests should be executed to verify that those components perform as envisioned.
- Interoperability tests: As components are integrated, tests should be executed to verify that the industry standard interfaces were implemented correctly.
- Configuration management: A change management process must be in place. When changes are made to interface designs, all stakeholders must be kept informed. 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 ensure that compatible versions are installed together, and so that field support personnel know "what's out there".

At this point, you may wish to take a look at the planning chapters in each of the three CVISN application guides (Safety Information Exchange [64], Credentials Administration [63], and Electronic Screening [65]). There you will find generic project planning principles applied specifically to those technical areas.

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4. CVISN Planning Principles & Concepts

Management is what you do to get the right things done by other people. In this chapter, we list and discuss some principles on which the CVISN planning process is based. Then we discuss important planning concepts. Principles are "rules" to follow. Concepts are "abstract ideas" that are generalized from particular instances or experience and can be applied to new situations. The intent is that states will incorporate these principles and concepts into their own processes and procedures.

4.1 Planning Principles

The guiding principles for program and project planning are very similar. Those for program planning are related to the program's wider vision, and those for project planning reflect the project's narrower scope. Figure 4–1 lists the principles for program and project planning.

Remember that you don't need the perfect plan in place before you start making progress. Also remember the "Pareto Principle" which asserts that you get 80% of the effects from 20% of the causes! Be sure you leave time and energy to do "real work".

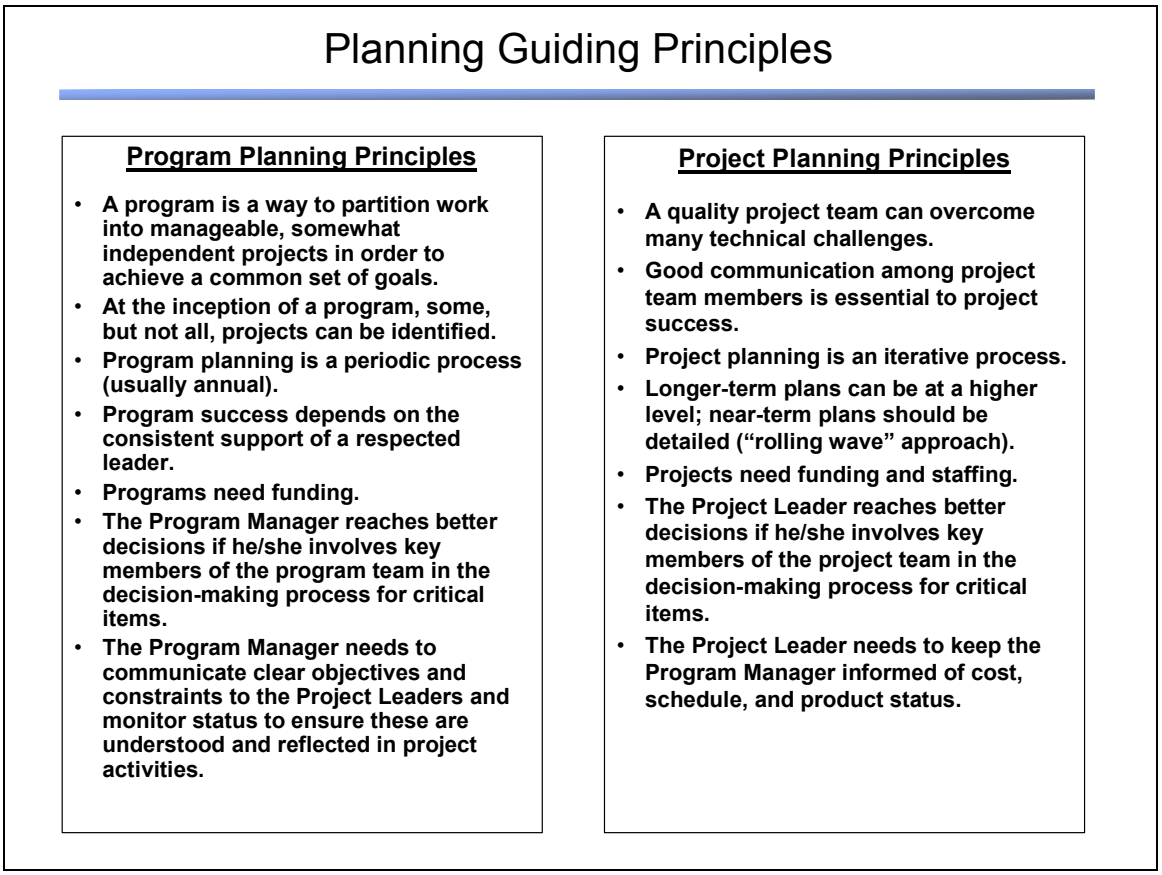


Figure 4-1. Planning Principles for Programs and Projects

4.1.1 Program Planning Guiding Principles

1. **A program is a way to partition work into manageable, somewhat independent projects in order to achieve a common set of goals.** Key here are two notions: that programs can be partitioned into separately-managed projects, and that those projects are partially dependent on each other. What ties the projects together are the common goals for the program, and the need for interoperability.

2. **At the inception of a program, some, but not all, projects can be identified.** As an Intelligent Transportation System program, CVISN is focused on improving safety and operations using technology. Technology changes rapidly. At the start of a CVISN Program in a state you can define the initial projects you want to undertake, but you need to be open to new opportunities such as when chances to make other improvements arise, and as technologies emerge and mature.

3. **Program planning is a periodic process (usually annual).** Program planning is typically tied to enterprise funding cycles. Most funding cycles are annual.

4. **Program success depends on the consistent support of a respected leader.** The program needs a champion who genuinely believes in the program's objectives, who can rally the project teams, and who can get the needed political support and funding. Success depends on the program manager's consistent support from both above and below.

5. **Programs need funding.** Programs can't accomplish anything without financial support. You always want to keep the funding stream one step ahead of the expense stream so that a project team doesn't get erratic direction, or worse, shut down for temporary lack of funding.

6. **The Program Manager reaches better decisions if he/she involves key members of the program team in the decision-making process for critical items.** Many heads are better than one. Involving key team members in the decision-making process not only results in better decisions, but also gives those folks a sense of ownership and self-respect. The Program Manager can't accomplish anything on their own. The projects get the work done.

7. **The Program Manager needs to communicate clear objectives and constraints to the Project Leaders, and monitor status to ensure these are understood and reflected in project activities.** The program's objectives must influence every project's objectives and goals. Every program operates under constraints such as schedule, cost, and resource availability. The Program Manager must communicate the wider objectives and real-life constraints to the Project Leaders.

4.1.2 Project Planning Guiding Principles

1. **A quality project team can overcome many technical challenges.** If you get quality people onto the project team, and they are committed to the project's success, they will overcome almost every technical challenge they face. There is nothing more important to a properly-funded project than having the right people on the team.

2. **Good communication among project team members is essential to project success.** There are many tools today to make it easier for team members to stay in touch. Use them. If everyone knows what is going on, it is easier to work together for the common goals.

3. **Project planning is an iterative process.** Projects get the work done. Keeping things on track is a continuous process of re-evaluating priorities, re-assigning resources, checking for and resolving problems, and keeping a few steps ahead of the current activities. This continuous planning and evaluating occurs as part of phase planning and tracking [44].

4. **Longer-term plans can be at a higher level; near-term plans should be detailed ("rolling wave" approach).** You need to know where you are headed (the longer-term plans) and how to get there. But to be sure you hit the milestones along the way you also need to know how the activities over the next few months must be interwoven to achieve the near-term targets.

5. **Projects need funding and staffing.** Projects can't do anything without staff. Staff won't be assigned unless funding is allocated.

6. **The Project Leader reaches better decisions if he/she involves key members of the project team in the decision-making process for critical items.** As at the program level, many heads are better than one. Involving key team members in the decision-making process not only results in better decisions, but it gives those folks a sense of ownership and self-respect. The project leader can't accomplish much on his or her own.

7. **The Project Leader needs to keep the Program Manager informed of cost, schedule, and product status.** Funding usually originates at the program level, and the Program Manager is ultimately responsible for all the projects. The Program Manager delegates responsibility to the Project Leaders, but must be kept informed about how the projects are progressing. Project Leaders should be able to report status honestly so that the Program Manager gets a clear picture of problem areas.

4.2 Planning Operational Concepts

The practical operational concepts that apply the above principles are very similar for both program and project planning. Those for program planning are related to the broader program-level activities, and those for project planning reflect the project's product-oriented focus. Figure 4–2 lists the concepts for program and project planning.

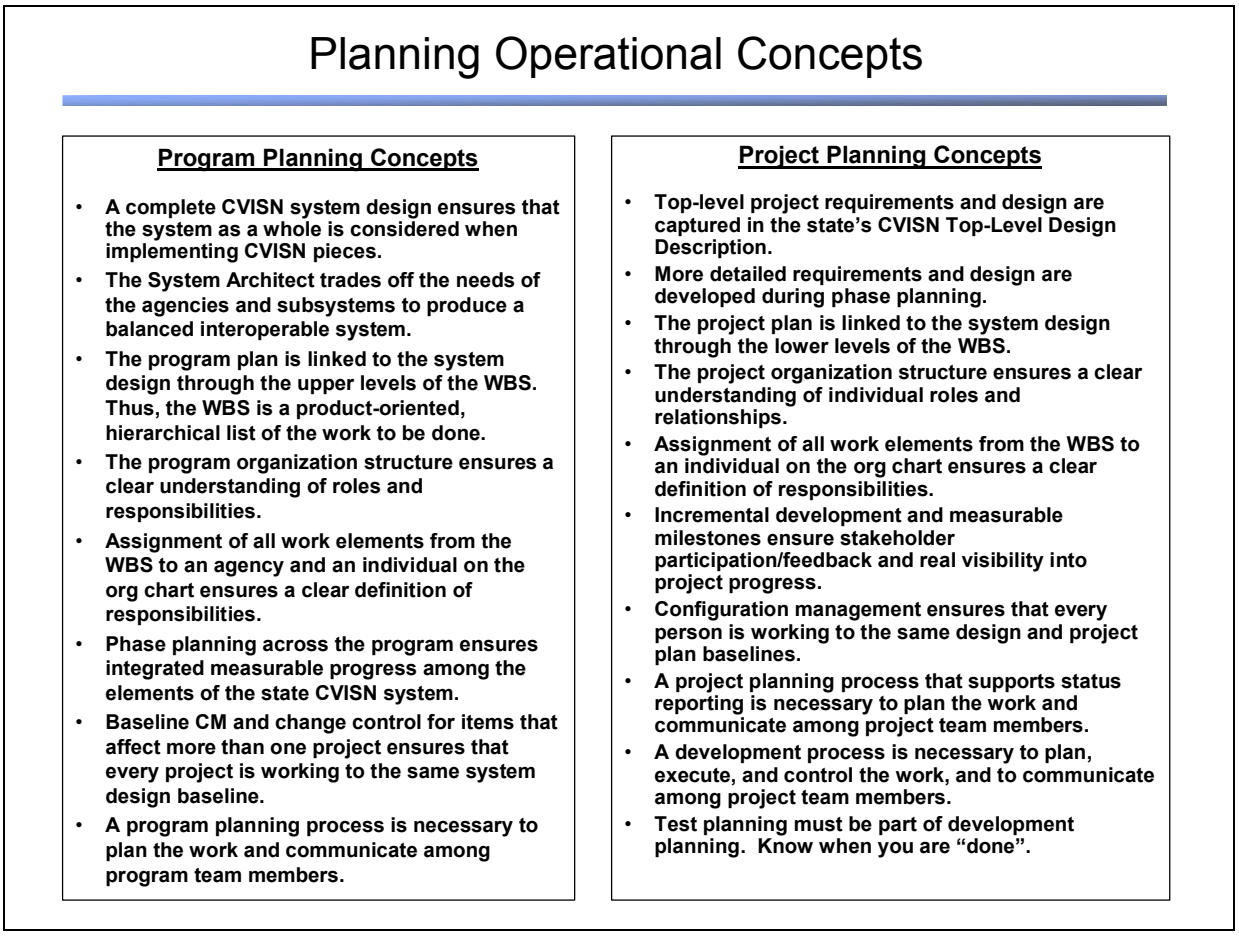


Figure 4-2. Planning Concepts for Programs and Projects

4.2.1 Program Planning Operational Concepts

1. **A complete CVISN system design ensures that the system as a whole is considered when implementing CVISN pieces.** During top-level design, the System Architect works with the technical leads of the project teams to establish a design that meets the program's and projects' objectives; defines end-to-end processes that make it possible to exchange information more effectively; and provides a common language and framework for discussing the CVISN projects. Your state's objectives and the system design define the scope of the CVISN Program and its resulting deployment projects. This is why the Scope Workshop precedes the Planning Workshop. Never lose sight of the system design!

2. **The System Architect trades off the needs of the agencies and subsystems to produce a balanced interoperable system.** As the top-level design emerges, it reflects the natural give-and-take of any group activity. The final design must be made robust enough to tolerate modest changes to requirements and the emergence of new technologies. The System Architect's job is to balance the demands from the project and the requirements associated with each system component, and then derive a system design that makes it possible for the parts to work together but be developed independently. A **balanced system** is a system in which no subsystem area is emphasized at the expense of the system as a whole. An **interoperable system** is a system in which all related systems and subsystems use common standards for data interchange and work together to accomplish shared processes.

3. **The program plan is linked to the system design through the upper levels of the WBS. Thus, the WBS is a product-oriented, hierarchical list of the work to be done.** If you could do only one planning task, it should be the Work Breakdown Structure. The classic definition of the WBS is **"a hierarchical breakdown of goods and services"** – goods in the sense of deliverable products; services in the sense of level-of-effort tasks such as system engineering and quality assurance. Figure 4–3 illustrates how the WBS links the system design to the program plan.

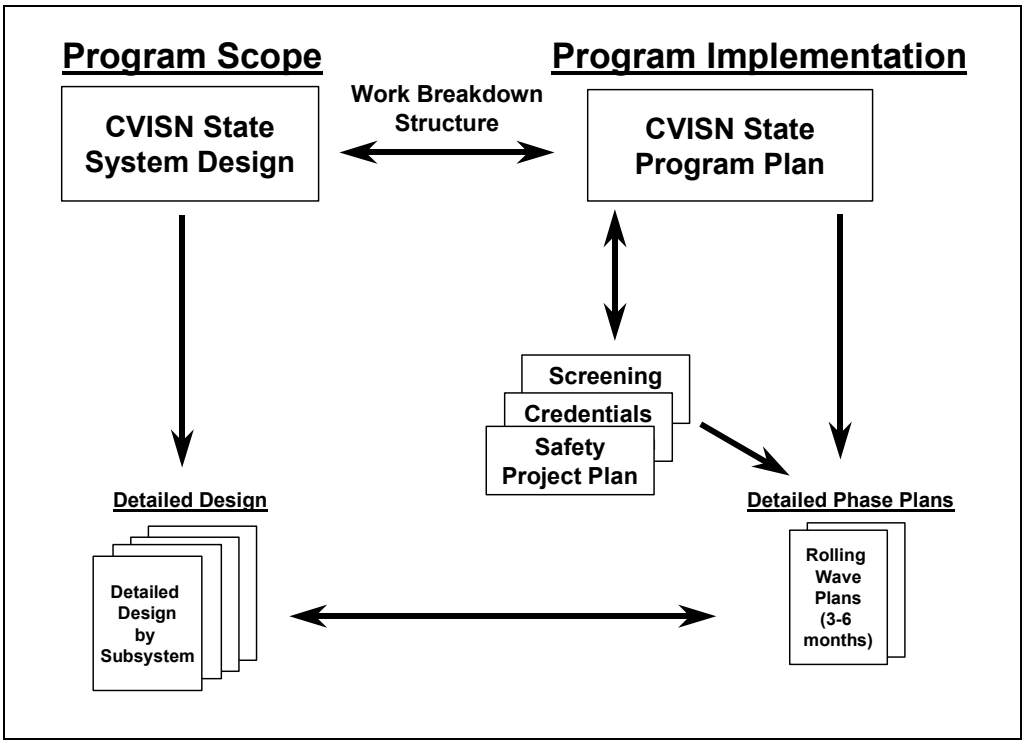


Figure 4-3. The Program Plan is Linked to the System Design Through the WBS

4. **The program organization structure ensures a clear understanding of roles and responsibilities.** The program organization structure is typically displayed using an organization chart in the form of an inverted tree. It is intended to be completely distinct from the state agencies' permanent reporting structure. The chart shows who is responsible for each project in the program, and what program-wide infrastructure support is needed. Please see chapter 5 for an example.

5. **Assignment of all work elements from the WBS to an agency and an individual on the org chart ensures a clear definition of responsibilities.** Mapping the top levels of the work breakdown structure to the agencies represented on the program organization chart captures which agency is responsible for each aspect of the program. Delegating responsibility helps to gain commitment to the program.

6. **Phase planning across the program ensures integrated measurable progress among the elements of the state CVISN system.** Coordinate the development schedules across the projects by grouping tasks into phases to achieve early benefits from the CVISN Program. For example, if one part of the system provides needed data to another part, everyone understands what the program can accomplish as a whole. Reference [37] has many heuristics for deciding what kind of tasks to combine and what to keep separate.

   Each planning level (program, project, and product) may have its own independent phases. Figure 4–4 illustrates this concept.

Phases and Deliveries

A "phase" is a management convenience – a period of calendar time specified for planning purposes to allow incremental delivery of a complex system. A "phase" is not a WBS element, but rather a portrayal of how the WBS elements are developed over time.

Each planning level (program, project, product) can have its own independently-established phases.

In a . . . ⇩	A Phase is Called	What is Being "Delivered" Is Called
Program	Program Phase	Integrated Capabilities
Project	Project Phase	A Build
Product	Product Phase	Version or Deployment

Each "build" is an operational version of a system that incorporates a specified subset of the capabilities that will ultimately be provided.

A product's "version" identifies its particular configuration at the time of distribution.

Product "deployment" means the installation of a version for customer use. Typically not every version is deployed; some are for internal use only.

Figure 4-4. Development Phases and Product Deliveries

In the software development world "build" is not only a verb but also a noun used to describe a software entity. We use "build" to mean an integration of particular versions of products into a working system.

Phase planning involves two key components: establishing the schedule for each phase, and defining the objectives for each phase. Figure 4–5 illustrates a sample program phase chart. Phases need not be the same length, but are typically 3–6 months long. They do not overlap.

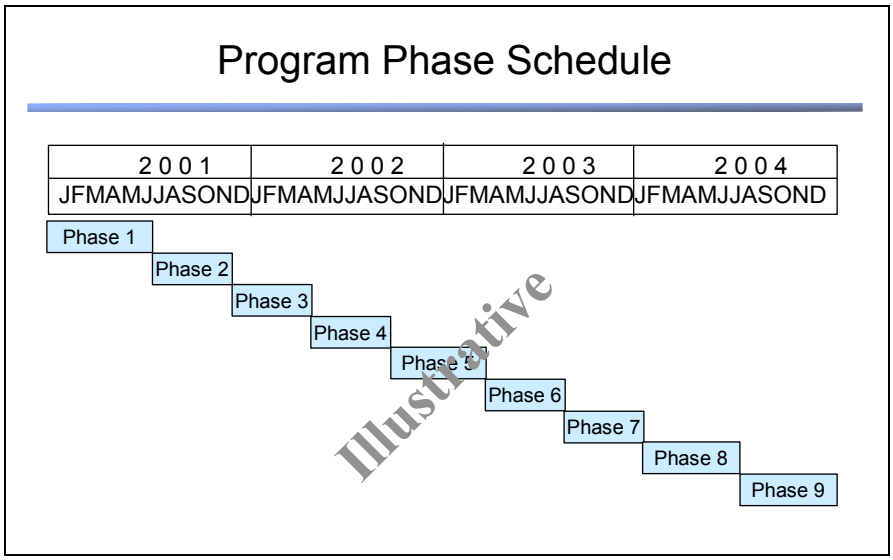


Figure 4-5. Illustrative Program-Wide Phase Chart

Figure 4–6 shows sample objectives for one phase. A similar list of objectives would be developed for each phase.

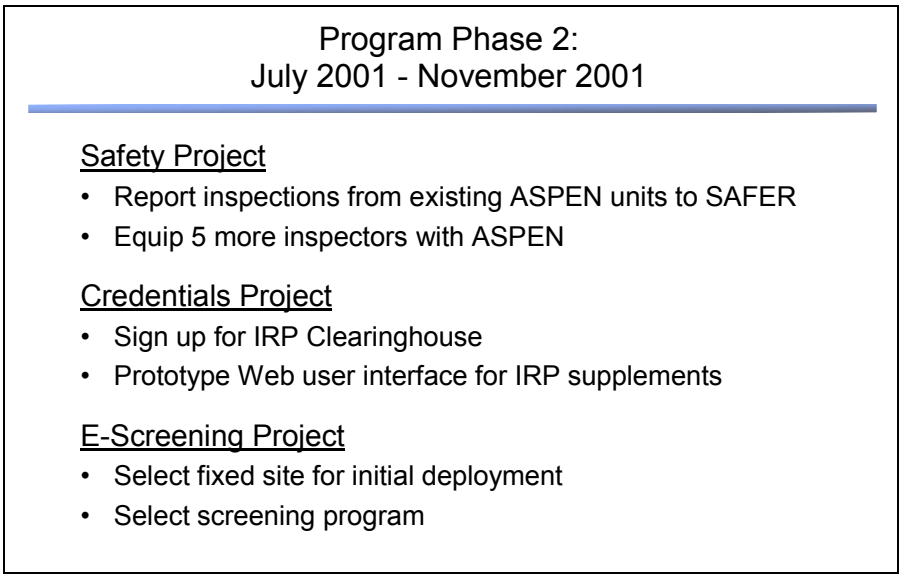


Figure 4-6. The Definition of Program-Wide Phases Encourages Incremental Integration and Interoperability Across Projects

7. Baseline configuration management and change control for items that affect more than one project ensures that every project is working to the same system design baseline. Configuration management is a discipline for managing the evolution of the program's products. Since many products are being developed incrementally and in parallel, you must have a way to keep track of requests for changes to requirements and how they might impact the design, costs, and schedules. You should establish a program-level configuration control board (CCB) chaired by the System Architect and consisting of technical representatives from all the projects to manage change requests that impact more than one project.

8. **A program planning process is necessary to plan the work and communicate among program team members.** The process of planning the program builds the program team; opens the lines of communications across projects; and defines a common set of expectations. When the CVISN Program involves multiple agencies, the open nature of the planning process should also improve communications at managerial levels among those agencies.

4.2.2 Project Planning Operational Concepts

1. **Top-level project requirements and design are captured in the state's CVISN Top-Level Design Description.** By putting the top-level requirements and design in the state's CVISN Top-Level Design Description, projects are assured of a baseline top-level design that is consistent and handles everyone's high-level requirements.

2. **More detailed requirements and design are developed during phase planning.** In the recommended spiral development model (described in the *CVISN Guide to Phase Planning and Tracking* [44]), the system is deployed incrementally by successive iterations through design, build, test, and next-phase planning. Detailed requirements analysis and design occur in each phase. This carries the risk that some "hard" requirement is identified at the detailed level that cannot be accommodated by the baseline top-level design. The program-level configuration control board should address such problems. The advantage of this approach is that some capability is available at the end of each phase, and end-users see what the developers are going to provide. That early end-user evaluation allows their feedback to influence future phases. Also, in each phase the designers have an opportunity to take advantage of new technologies.

3. **The project plan is linked to the system design through the lower levels of the WBS.** The WBS is the vehicle to divide work into tasks that are:

- Manageable – Team leaders and staff can direct themselves within the confines of technical, cost, and schedule goals and limitations.
- Independent – Self-guided development teams perform with the peace of mind that well-defined interfaces were created via the system engineering skills of the System Architect, so they need not worry day-to-day what other teams are doing.

- Measurable – Technical specifications and acceptance criteria are available so that developers know that they are on target.
- Integratable – Elements come together physically and functionally to form a working system.

4. **The project organization structure ensures a clear understanding of individual roles and relationships.** The project organization structure is typically portrayed in the form of an inverted tree. (It is intended to be completely distinct from the state agencies' permanent reporting structure.) The chart shows the task leaders in the project context. Please see chapter 5 for an example.

5. **Assignment of all work elements from the WBS to an individual on the organization chart ensures a clear definition of responsibilities.** Work gets done when real individuals are assigned specific tasks. WBS element task leader will likely delegate execution of lower-level activities to a specific team member. The assignment process includes the development of detailed schedules and commitment of resources.

6. **Incremental development and measurable milestones ensure stakeholder participation/feedback and real visibility into project progress.** With adequate funding and proper coordination, work products will unfold. Identifying critical milestones in each phase helps you measure whether the phase is on track or not. Figure 4–7 is a high-level view in which milestones are like teeth in the gears of the "program machine".

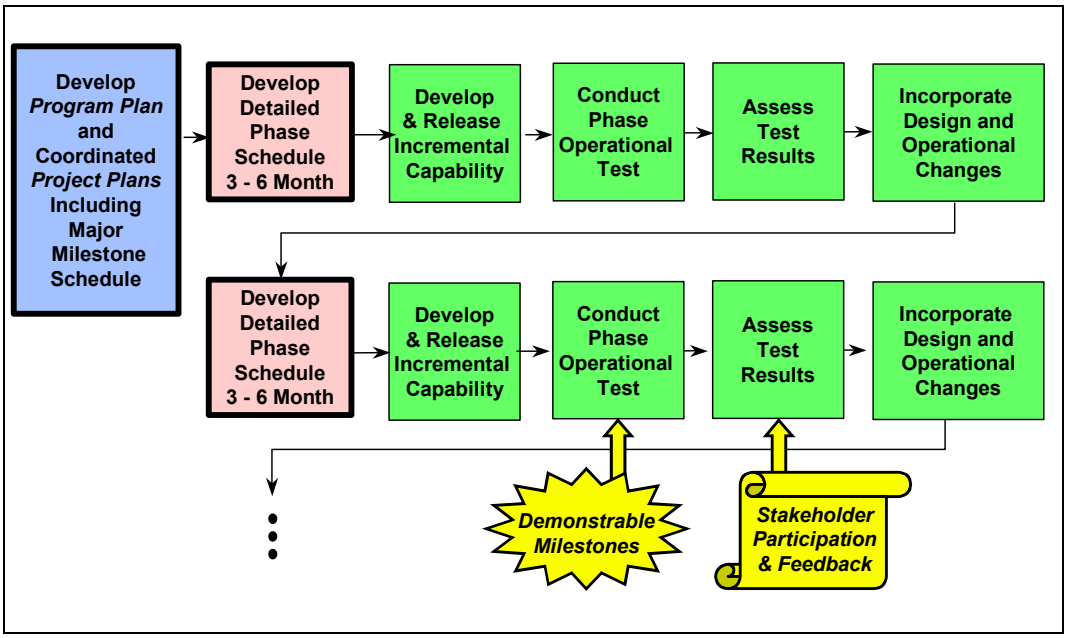


Figure 4-7. Demonstrable Milestones in Each Phase

7. **Configuration management ensures that every person is working to the same design and project plan baselines.** As you make incremental deliveries of products, you need to be able to identify all the components in each delivery, and keep track of problems detected in one phase so that you can control how, when, and where proposed resolutions are implemented.

   Figure 4–8 shows the relationships among phases, builds, and product versions. Each program phase is associated with a set of defined operational builds within each functional area. Each project's build is a set of specific versions of products ("releases") that have been integrated and tested together, to provide specified capabilities in a functional area. Every product release gets a version number and associated description. All of the preceding are under configuration management.

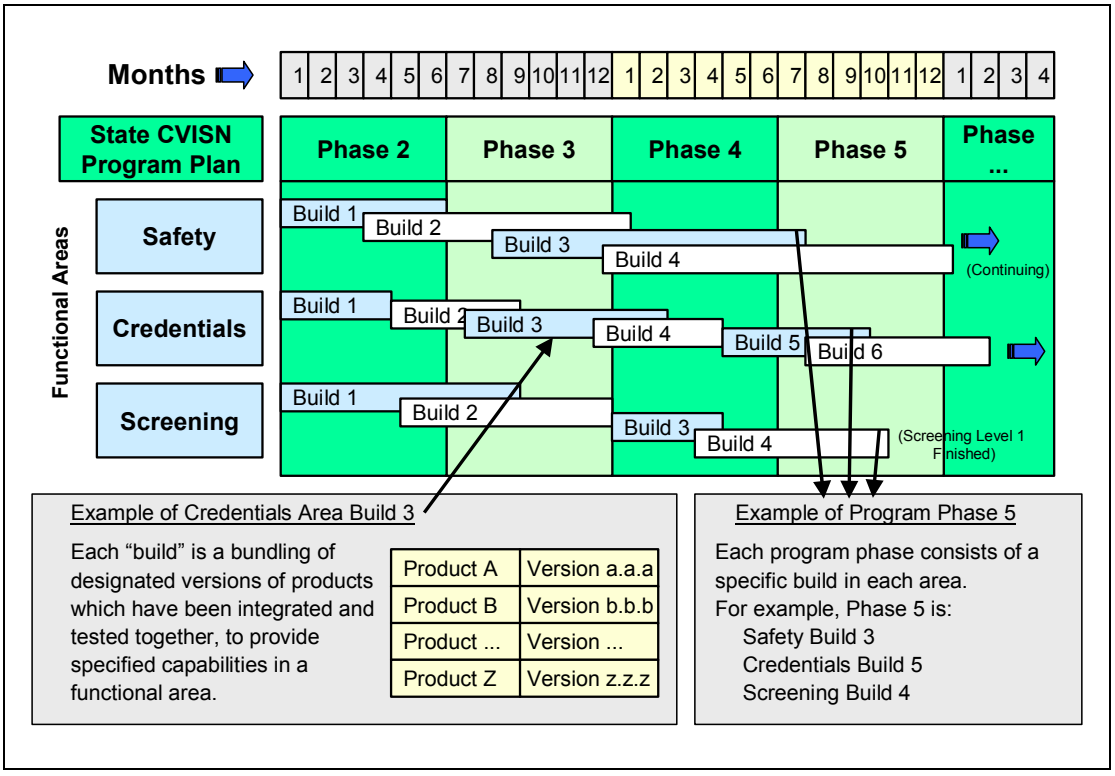


Figure 4-8. Relationship Among Phases, Builds, and Product Versions

8. **A project planning process that supports status reporting is necessary to plan the work and communicate among project team members.** The project team will be focused on getting work done. Interrupting them to collect status should be minimized. If both the planning and the status reporting processes can be integrated so that planning vehicles are updated to report status, both processes will be as painless as possible. The *CVISN Guide to Phase Planning and Tracking* [44] discusses this in more detail with examples.

9. **A development process is necessary to plan, execute, and control the work, and to communicate among project team members.** Product development is a team effort. So that each member of the team can work effectively, you need to put in place clear and simple procedures and processes for how the team will accomplish the development. For instance, there should be some common scheme for identifying and describing versions of software. Figure 4–9 shows how versions might be related to builds for phases.

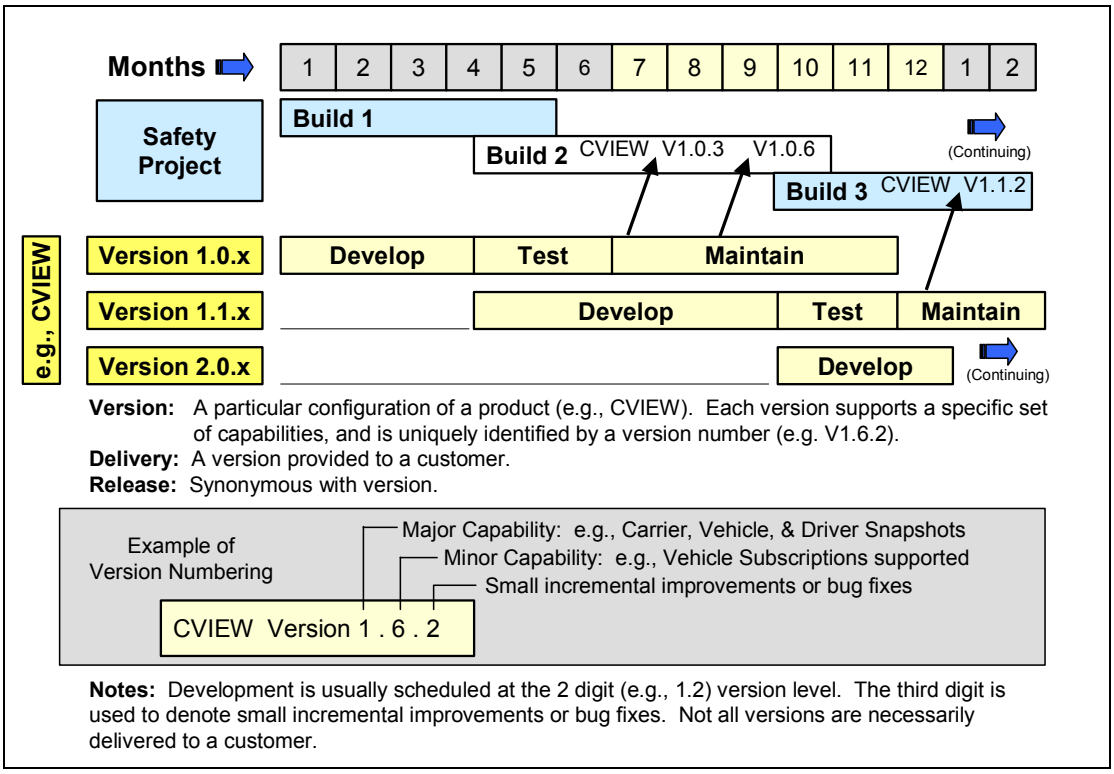


Figure 4-9. Version Identification is One Typical Development Process

Figure 4–9 depicts that at any point in time, different products are likely to be in different stages of their development lifecycle. Other development processes should also be nailed down so that everyone can communicate and get their own part of the whole job done effectively.

10. **Test planning must be part of development planning. Knowing when you are "done" is important!** Testing is the way you demonstrate that you have actually accomplished the system development you set out to do. To have a successful demonstration though, the test criteria must mesh with the project requirements; test procedures must reflect how the system actually operates in production use; and realistic test data sets must be available. The system must be designed for testability in the first place.

5. CVISN State Program and Project Planning Process Steps

"Planning seems intuitively obvious. Why do we need to articulate a process for it?"

5.1 Why Do We Need a Planning Process?

A rigorous planning process is necessary to efficiently and effectively discover and formalize the work to be done; and then to communicate that among team members and other stakeholders. Such a planning process:

- Portrays the scope via the Work Breakdown Structure (WBS).
- Identifies key milestone events.
- Defines all tasks and responsibilities.
- Identifies interfaces.
- Provides master budgets.
- Provides many effective communication devices.
- Should involve those who will carry out the plan.

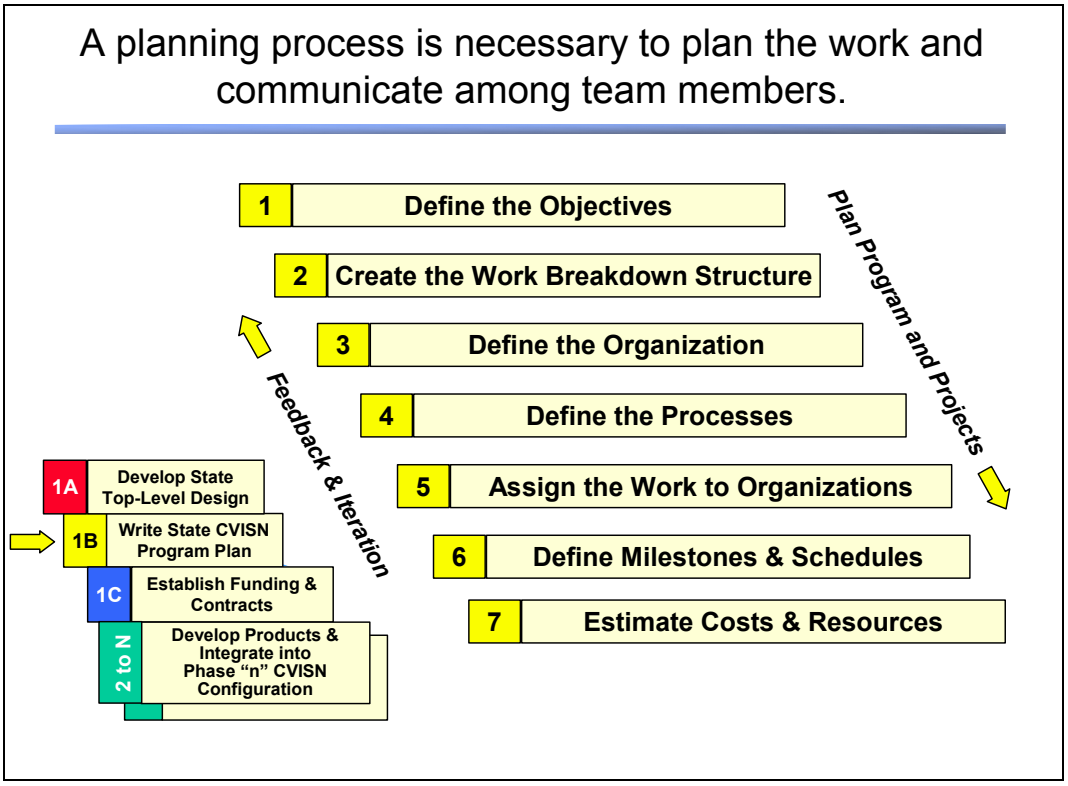


Figure 5-1. Planning Process Steps

The steps in the planning process are portrayed in Figure 5–1 sequentially, but in practice iteration of the steps is necessary in order to converge on an acceptable final plan. During this iteration period a continuous review by the Program Manager, the System Architect, and the leads of all participating agencies culminates with approval and sign-off.

The planning process described in this chapter applies to both the overall CVISN program and to its subordinate projects. In general, you should plan what you can at the program-level first, and then do project-level planning to flesh out the details. **Based on the experiences of the CVISN prototype and pilot states, it works best to develop a program plan that is supported by a coordinated set of project plans.** Let the program plan steer the project planning, and then feed back the results of project planning to the program plan. Chapter 1 of this document summarized the purposes for those two levels of plans.

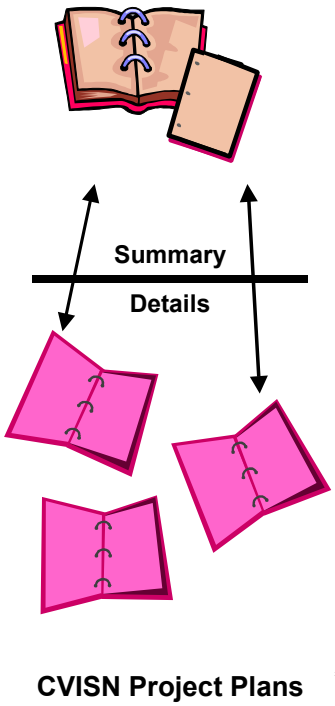
This chapter describes the program and project planning processes. The results of these planning activities should be captured in a written plan. Something magic happens when responsible people actually have to sign off on it.

The planning process is most effective when the key players on the project team are closely involved. That means that the Program Manager should involve the Project Leaders, System Architect, facilitator/administrator, and other key members of the team. But don't forget to stay in touch with the oversight bodies that have been established, so that the plans don't stray too far from the common understanding of what you are doing in the state.

Visualize assembling several notebooks – one for the program, and one for each project. Some pages are duplicated in both the program plan and the project plans. Some pages in the program plan summarize what all the project plans say.

Figure 5–2 depicts the recommended chapters in a plan document. Whereas both plans contain the same chapter names, the Program Plan contains summary information and the Project Plans contain details. Appendix B of this Guide is an annotated outline for a Program Plan. Appendix C is an annotated outline for a Project Plan.

In the sections that follow there is guidance for program planning, project planning, and how the two activities inter-relate. When there is no specific qualifier, the advice applies equally to both program and project planning.



Topic	Program Plan	Project Plan(s)
Executive Summary	▤	Highlights
Introduction	▤	▤
Objectives	▤ (& Projects)	▤
Requirements & Design (mostly by reference to System Design Description)	▤	▤
Work Breakdown Structure	▤	▤
Organization Structure	▤ (Agency and Program Charts)	▤ (Project Charts)
Work Assignments (based on WBS)	▤	▤
Procurement Strategy	▤	
Processes	▤	Deltas from Program Standards
Schedule & Milestone Information	Phases & Critical Milestones	Detailed Schedule & Milestones
Financial Information	Known Funding Sources, Program Budget	Project Budget Details
Products	▤	▤
Issues	▤	▤

Figure 5-2. The Program and Project Plans

5.2 Define the Objectives (Step 1)

The ITS/CVO Strategic Business Plan for your state should be the starting point for your CVISN **program** planning process. The Strategic Business Plan establishes a 5-year perspective for ITS/CVO objectives. (You started with those objectives and refined them at the CVISN Scope Workshop.) The objectives are the starting point for your top-level design. You ought to be able to fit the objectives on a single page. They specify the expected results of implementing the projects that will be spun out of the program. Listing the objectives should be the first step in identifying the projects that make up the CVISN program in the state.

Next, as **projects** are identified you set out specific objectives for each one. The project objectives should support the top-level objectives for the overall program.

State the objectives in terms that everyone can understand – from the user's point of view, not from the developer's point of view! Often the list of objectives will be used to justify funding. Everyone wants to know "what's in it for me?"

5.3 Create the Work Breakdown Structure (Step 2)

5.3.1 Product-Oriented Hierarchical Decomposition

The WBS is a way of organizing and portraying the tasks to be done in a **product-oriented hierarchical decomposition** such that the full scope and limits of the program and its subsidiary projects can readily be seen at every level. The WBS is displayed graphically as an inverted tree with the root at the top, or written as an indented list. All envisioned efforts should have a home somewhere in the WBS.

The WBS is the common framework for planning and control. For example, numeric codes assigned to WBS elements are written onto time cards and purchase requisitions.

Figure 5–3 presents a sample state CVISN Work Breakdown Structure in the form of an inverted tree. Personal computer "organization structure" software packages can produce this diagram automatically.

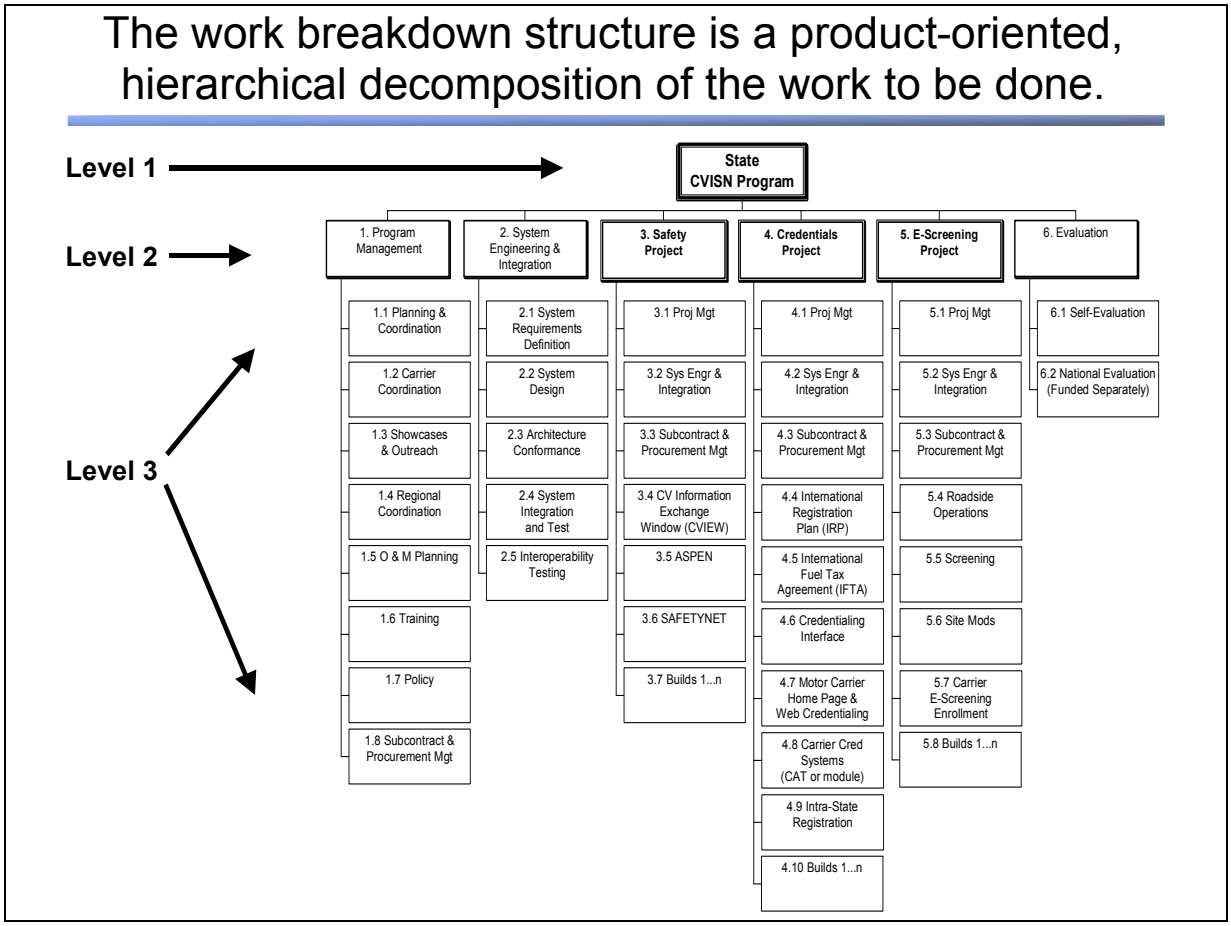


Figure 5-3. Sample CVISN WBS in Tree Format to Level 3

The 3 core deployment projects appear at the second level of this WBS, where they have been emphasized with highlighted boxes. In the discipline of major national defense project planning – where the WBS had its origin – these core projects would be called the "prime mission equipment". The WBS must be taken to further levels of detail as part of the project planning process. The Program Manager creates the top-levels of the WBS and then delegates the creation and maintenance of the lower levels to the various projects.

Note that there is a special requirement for assessment and evaluation of federally-funded ITS projects [76], hence its inclusion as a separate top-level WBS element.

Subsequent levels of detail are usually shown on separate diagrams. Deliverable products and services need to be itemized, including hardware/software systems, documentation, training, user support, and maintenance/upgrade services. Note that support functions such as project management and system engineering are explicitly included.

The WBS is intended to be a working tool. As such, it becomes the basis for:

- Cost estimates and budgets.
- Milestones and schedules.
- Responsibility assignment.
- Allocation of resources.
- Schedule vertical (milestone) and horizontal (dependency) traceability.
- Risk assessment and mitigation.
- Concurrence of participants.
- Integrating the total project effort.
- Summarizing costs, schedules, and tracking status.
- Forcing the manager to think through all elements of the project.

The WBS sets the stage for all other aspects of project planning.

5.3.2 Indented List Adds Detail

To include information attributes on the WBS, or to extend it below level 3, requires portraying it in indented list format. Common desktop "spreadsheet" software packages, and "project management" packages, can produce this indented list; they have the additional advantage of automatic rollup to different levels as shown in Figures 5–4 through 5–7.

WBS	Task
	State CVISN Program
1.0	Program Management
2.0	System Engineering & Integration
3.0	Safety Project
4.0	Credentials Project
5.0	Electronic Screening Project
6.0	Evaluation

Figure 5-4. Sample CVISN WBS in List Format to Level 2

WBS	Task
1.0	**Program Management**
1.1	Planning & Coordination
1.2	Carrier Coordination
1.3	Showcases & Outreach
1.4	Regional Coordination
1.5	O&M Planning
1.6	Training
1.7	Policy
1.8	Subcontract & Procurement Mgt
2.0	**System Engineering & Integration**
2.1	System Requirements Definition
2.2	System Design
2.3	Architecture Conformance
2.4	System Integration & Test
2.5	Interoperability Testing
3.0	**Safety Project**
3.1	Project Management
3.2	System Engineering & Integration
3.3	Subcontract & Procurement Mgt
3.4	CV Information Exchange Window (CVIEW)
3.5	ASPEN
3.6	SAFETYNET
3.7	Safety Build 1
3.8	Safety Build 2
3.9	Safety Build n

WBS	Task
4.0	**Credentials Project**
4.1	Project Management
4.2	System Engineering & Integration
4.3	Subcontract & Procurement Mgt
4.4	International Registration Plan (IRP)
4.5	International Fuel Tax Agreement (IFTA)
4.6	Credentialing Interface (CI)
4.7	Motor Carrier Home Page & Web Credentialing
4.8	Carrier Credentialing Systems (CAT or module)
4.9	Intra-State Registration
4.10	Credentials Build 1
4.11	Credentials Build 2
4.12	Credentials Build n
5.0	**Electronic Screening Project**
5.1	Project Management
5.2	System Engineering & Integration
5.3	Subcontract & Procurement Mgt
5.4	Roadside Operations
5.5	Screening
5.6	Site Mods
5.7	Carrier E-Screening Enrollment
5.8	E-Screening Build 1
5.9	E-Screening Build 2
5.10	E-Screening Build n
6.0	**Evaluation**
6.1	Self-Evaluation
6.2	National Evaluation (Funded Separately)

Figure 5-5. Sample CVISN WBS in List Format to Level 3

WBS	Task
3.0	**Safety Project**
3.1	**Project Management**
3.2	**System Engineering & Integration**
3.3	**Subcontract & Procurement Mgt**
3.4	**CV Information Exchange Window (CVIEW)**
3.4.1	Product Mgmt
3.4.2	Subcontract & Procurement
3.4.3	Operations & Maintenance
3.4.4	Communications
3.4.5	Version 1.0.x
3.5	**ASPEN**
3.5.1	Product Mgmt
3.5.2	Subcontract & Procurement
3.5.3	Operations & Maintenance
3.5.4	Communications
3.5.5	Deployment 1
3.5.6	Deployment 2
3.5.7	Deployment 3
3.6	**SAFETYNET**
3.6.1	Product Mgmt
3.6.2	Subcontract & Procurement
3.6.3	Operations & Maintenance
3.6.4	Communications
3.6.5	Deployment 1
3.7	**Safety Build 1**
3.8	**Safety Build 2**
3.9	**Safety Build n**

Figure 5-6. Portion of Sample CVISN WBS in List Format to Level 4

WBS	Task
3.0	**Safety Project**
3.1	**Project Management**
3.2	**System Engineering & Integration**
3.3	**Subcontract & Procurement Mgt**
3.4	**CV Information Exchange Window (CVIEW)**
3.4.1	Product Mgmt
3.4.2	Subcontract & Procurement
3.4.2.1	XYZ Subcontract Administration
3.4.3	Operations & Maintenance
3.4.4	Communications
3.4.5	Version 1.0.x
3.4.5.1	Requirements
3.4.5.2	Design
3.4.5.3	Implementation
3.4.5.4	Version testing
3.4.5.5	Bug fixes
3.4.5.6	Deployment
3.4.5.7	Training
3.5	**ASPEN**
3.5.1	Product Mgmt
3.5.2	Subcontract & Procurement
3.5.3	Operations & Maintenance
3.5.4	Communications
3.5.5	Deployment 1
3.5.5.1	Installation
3.5.5.2	Test
3.5.5.3	Training
3.5.6	Deployment 2
3.5.6.1	Installation
3.5.6.2	Test
3.5.6.3	Training
3.5.7	Deployment 3
3.5.7.1	Installation
3.5.7.2	Test
3.5.7.3	Training
3.6	**SAFETYNET**
3.6.1	Product Mgmt
3.6.2	Subcontract & Procurement
3.6.3	Operations & Maintenance
3.6.4	Communications
3.6.5	Deployment 1
3.6.5.1	Installation
3.6.5.2	Test
3.6.5.3	Training
3.7	**Safety Build 1**
3.8	**Safety Build 2**
3.9	**Safety Build n**

Figure 5-7. Portion of Sample CVISN WBS in List Format to Level 5

As an illustration of including information attributes, Figure 5–8 is a portion of the sample WBS, this time with additional status columns.

Cost	Sched	Tech	WBS	Task	Schedule for Completion	Notes
G	Y	G	**3.0**	**Safety Project**		
			3.1	**Project Management**	ongoing	
			3.2	**System Engineering & Integration**		
			3.3	**Subcontract & Procurement Mgt**	ongoing	
G	**Y**	**G**	**3.4**	**CV Information Exchange Window (CVIEW)**		
G	G	G	3.4.1	Product Mgmt		
G	G	G	3.4.2	Subcontract & Procurement		
G	G	G	3.4.2.1	XYZ Subcontract Administration		
			3.4.3	Operations & Maintenance	2003	
G	G	G	3.4.4	Communications	Jan-01	Initial testing successful
G	Y	G	3.4.5	Version 1.0.x		
			3.4.5.1	Requirements	Sep-00	Complete
			3.4.5.2	Design	Dec-00	Complete
G	Y	G	3.4.5.3	Implementation	Apr-01	Down one staff member
G	Y	G	3.4.5.4	Version testing	Start May-01	Testing delayed - staffing
			3.4.5.5	Bug fixes	Complete Jul-01	
			3.4.5.6	Deployment		
			3.4.5.7	Training	Aug-01	

Figure 5-8. Portion of Sample CVISN WBS in Status Assessment Format

This table now has columns for cost / schedule / technical status, and comments. The System Architect and Project Leaders update it monthly and use it for status presentations. Only the rows (WBS items) in which there is or should be some current activity are marked with the Red / Yellow / Green status indicators. This example shows the power of the WBS as both a planning and status-tracking tool. The message here is that it's worth it to get the WBS right, because it can be used for many purposes.

5.3.3 How Do You Know if You Have a "Good" WBS?

The WBS forms the core of the planning process. Utilizing the WBS, tasks are assigned to individuals and organizations; costs are estimated; and schedules are set. Developing the WBS is usually iterative. The trick is to pick the right decomposition at the higher levels *so that rearrangement occurs within projects rather than across projects*.

Developing a "good" WBS is both an art and a science. Some tests for a good WBS are:

- ☑ Product-oriented hierarchy of goods and services.
- ☑ Basis for understanding and communication.
- ☑ Identifies and defines all effort to be expended.
- ☑ Basis for cost estimating, project organization, task scheduling, and status reporting.
- ☑ Assigns responsibility.
- ☑ Reflects the way the work is managed and performed.
- ☑ Based on system engineering.
- ☑ Each element is "manageable".
- ☑ Sufficiently low level to establish adequate visibility and confidence for cost estimating, project planning, and project control.
- ☑ Technical/cost/schedule can be integrated at every level for each element.
- ☑ Eliminating one product element will delete the associated costs.
- ☑ Segregates recurring from non-recurring costs.
- ☑ Top level reflects any WBS requirements imposed by sponsor.

It is cleanest if only one individual is responsible for each element in the WBS. It can be different individuals at different levels: typically higher-level managers at higher levels of the WBS. When element responsibility is shared, confusion often results.

The WBS can also be used to define the work to be done in each phase. Recall that a phase is a fixed period of calendar time (usually 3 to 6 months long) specified for planning purposes to allow incremental delivery of a complex system. Items at the lowest level of the WBS are allocated to different phases, with that group of WBS items constituting the detailed definition of each phase. Knowing that the work should be short enough to complete in a phase helps the Project Leader to decide how far to decompose the work.

5.4 Define the Program and Project Organization (Step 3)

5.4.1 Developing Organization Charts

Organization charts are intended to portray the downward flow of responsibility from the perspective of the CVISN program and projects, and may span state agency and contractor boundaries. The org chart at the **program level** has two views: entities and people. The entity-view shows the agencies and contractors supporting the program, from within their own hierarchical context. The people-view specifies the programmatic authority lines; such reporting lines may be temporary for only the duration of the program ("Matrix Management" as explained in Section 2.2), or they may mirror the state's permanent command and control hierarchy.

A sample entity-view org chart is shown in Figure 5–9. This chart depicts the permanent relationships among state agencies, with thicker borders used to highlight those agencies with major roles in the CVISN program.

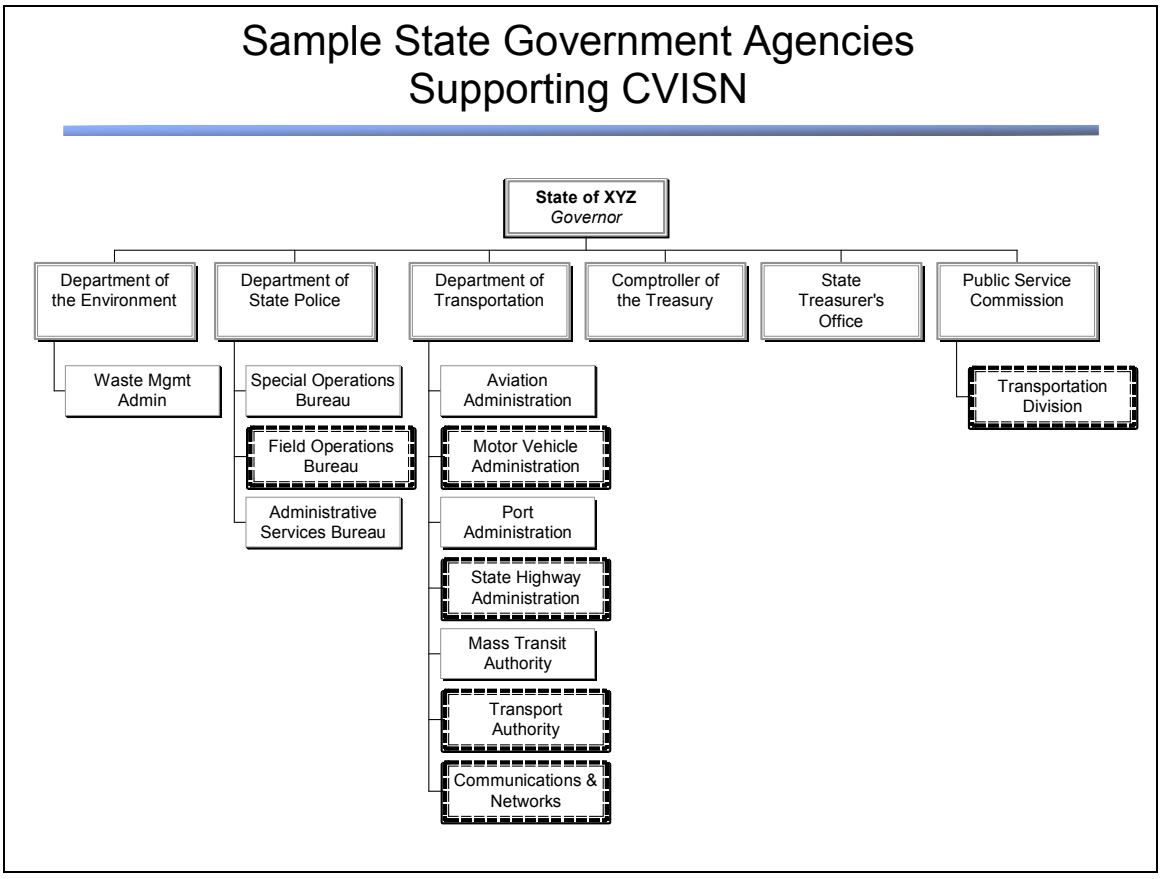


Figure 5-9. Sample State Government Organization Chart Highlighting Entities Supporting CVISN Program

Once the entity-view is established, you should develop a program-specific people-view org chart that identifies the Program Manager, System Architect, Project Leaders, state agency points-of-contact, members of the steering committee and the like. Figure 5–10 is an example. When there are many agencies supporting CVISN, formation of an Inter-Agency Coordinating Council is a way to knock down institutional barriers and foster teamwork at the highest levels. In Maryland, for example, the coordinating council is lead by an Assistant to the Secretary of Transportation, and meets as needed to address programmatic issues that cannot be resolved within an agency. Support from this group has been essential to making progress in Maryland.

Lastly at the **project level**, you'll need project-specific org charts showing who reports to whom – thereby defining the flow of authority and responsibility. Please see Figure 5–11 for an example of a project org chart. Be sure to include the key technical support and liaison positions. For example, if the project intends to install weigh-in-motion equipment at a roadside site, the "facilities" person (who must support the requirements definition, procurement, and installation of the equipment) should be shown on the project team.

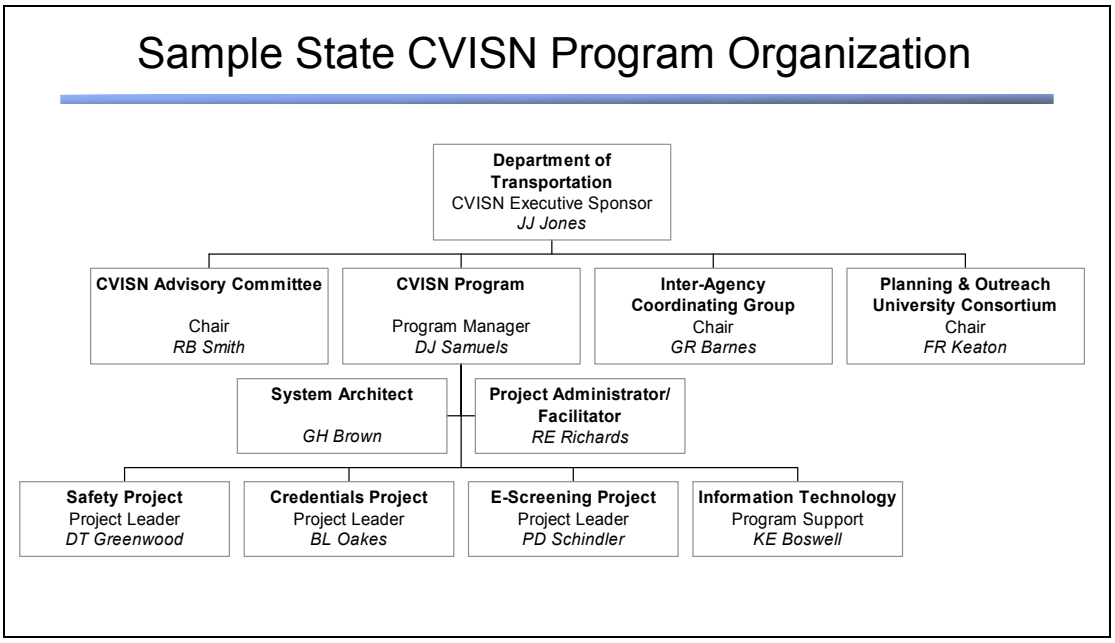


Figure 5-10. Sample CVISN Program Organization Chart Showing Programmatic Lines of Authority

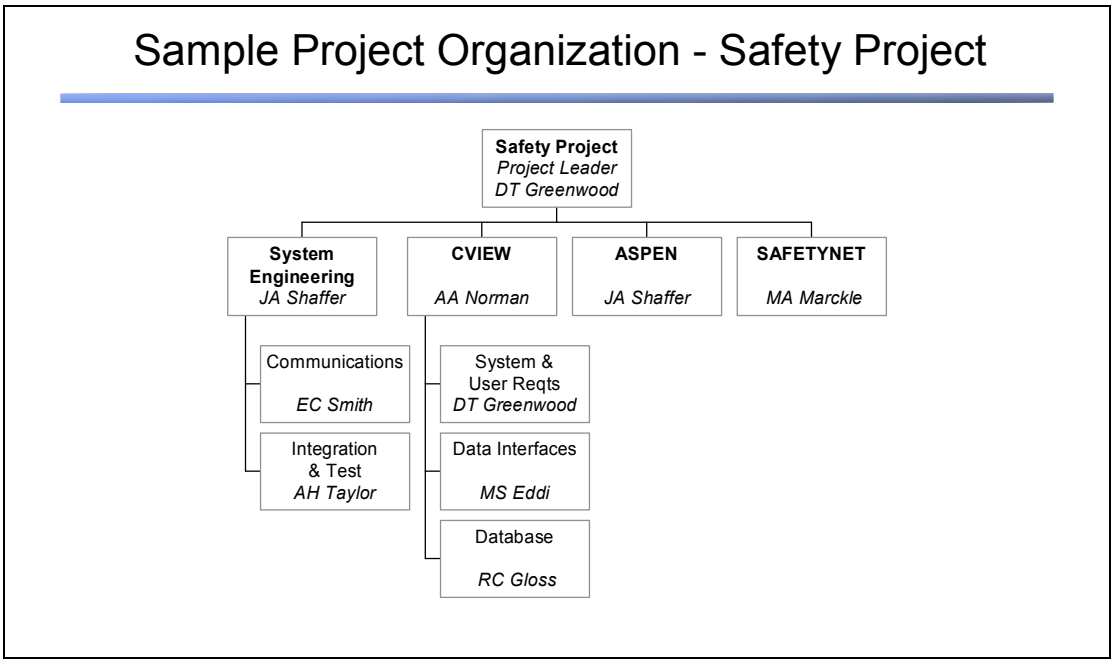


Figure 5-11. Sample Project Organization Chart

Try to avoid fragmented assignments; that is, tasking people with part-time assignments for long periods. You are better off with one person working full-time than four people working quarter-time because of people's shifting priorities and the inherent inefficiency of shuffling back and forth from one task to another.

Having each team draw up a "team charter" is one way to impart additional meaning to the teams [3]. When members put into words the team's purpose and goals, and their own individual roles and responsibilities, they get their project started on firmer footing.

5.4.2 Name Lead Individuals Whenever Possible

As soon as possible name lead individuals and define responsibilities for assignments such as.

- Program Manager
- System Architect
- Project Leaders
- Facilitator/Administrator
- Financial Manager
- Procurement and Contracting Representative
- Network & Infrastructure Representative
- Enforcement Community Representative
- Credentials Community Representative

Appendix D provides sample descriptions for some of the key positions. The Project Leaders should appear on the program organization chart. The Task Leaders should appear on the project organization charts.

In most cases the CVISN Program Manager is not free to assign individuals unilaterally. Those individuals' functional supervisors will assign or approve them. For example, the agency Information Technology Manager will assign the staff member to be the point-of-contact for network issues.

Ramping up team staffing takes a great deal of calendar time, normally months. Start early.

The preceding was looking "below the program". Also look "above the program". Ask the Director of the Department of Transportation to formally appoint an Executive Sponsor. This person will function as a champion in the innermost circles of power. He or she needs to be a believer in CVISN.

Identify roles and individuals on the Inter-Agency Coordinating Council. These will typically be agency heads. There will be occasions when decisions need to be made that cross major jurisdictional areas and this is the venue.

Recruit carriers and individuals for the Carrier Advisory Council and consult with them on key decisions and to help set priorities. Identify trial participating carriers and their points-of-contact.

5.4.3 When Lead Individuals Cannot Be Named Yet

At least show the slot and identify TBD (to be determined) as the person responsible for filling it. Be sure you revisit the organization charts during the planning for each phase to remind yourself of any empty slots that need to be filled.

5.4.4 Harness Team Power

You will happily discover that a cohesive team is far more than the mere sum of its members. Interactions build upon themselves with multiplicative power. You can harness this by seeking input, collaboration, and review on what might otherwise be a single-person activity such as writing detailed plans. For example, harness team power on a document by:

- Starting the task well in advance of the deadline, for example 2 months.
- Circulate an outline for review and comment.
- Review a crude draft with a close colleague.
- Circulate a preliminary copy for review and comment.
- Finally conduct a page-by-page walkthrough.

Develop and post working-level schedules. Peer pressure can be harnessed as the hidden hand of management.

5.4.5 Provide Staff Training

FMCSA has supported the development of four courses:

- "Introduction to ITS/CVO" [15]
- "ITS/CVO Technical Project Management for Non-Technical Managers" [16]
- "Understanding ITS/CVO Technology Applications" [17]
- "CVISN and Safety Planning Processes" [79]

Folks on your team may have already attended these courses. Consider sending new team members to future training opportunities, or at least lend them a copy of the course material.

Professional organizations such as the Project Management Institute [2], and commercial training vendors, also provide very practical project management training. Training on specific technologies is available from local colleges or from commercial training vendors.

New staff will benefit from reading the *Introductory Guide to CVISN* and the other CVISN Guides. Please consult the reference list in Appendix A.

5.5 Define the Processes (Step 4)

Your **program** should have defined processes for the activities you want to be common across all projects. When state agencies and contractors use common processes for common activities, it helps ensure effective and clear coordination and communication. For instance, you may choose to make these processes common across the program:

- Project planning. This chapter describes the program and project planning processes, and can be used as a reference. The *COACH Part 2, Management Checklists* [70] is a way to measure your commitment to the principles and processes described in this document.
- Procurement. Chapter 6 describes the funding and contracts processes, which includes procurement.
- Phase planning and tracking. Described in the *CVISN Guide to Phase Planning and Tracking* [44].

If you want to make such processes common in your state, you already have process descriptions that you can reference. Start with what is in this guide, the COACH Part 2, or the CVISN Guide to Phase Planning and Tracking; then tailor it to your specific needs.

Even though you may not choose to make all system development processes common, recall that one of the key concepts for CVISN program planning is that a complete system design ensures that the system as a whole is considered when implementing CVISN pieces. The *CVISN Guide to Top-Level Design* [62] describes the top-level design process. The *CVISN Guide to Phase Planning and Tracking* [44] describes the activities that occur in each subsequent development phase.

You probably already have configuration management processes in place in your organization. Use them. If you need to re-evaluate your existing configuration management processes, consider the IEEE standard on the subject [68].

The references listed above provide a solid starting point for process definitions. When you need to, tailor the processes to fit your program. Document the differences between the references and your own processes in a chapter of the program plan, and make sure the project teams are aware of their responsibilities to follow the processes. Not all processes need to be common across projects; pick the processes that support key project information exchanges and make them as simple and useful as possible.

Processes unique to program-level activities should also be documented in the program plan. Be clear about which processes apply to all projects, and which apply only to the program-level efforts.

Even for common processes, sometimes one project has a good reason to do things a little differently. The project can tailor the standard program process by describing what they want to do differently (in their project plan), and getting approval for the tailored process. Projects may also need to define processes not addressed by the program plan. For instance, a project may use a particular tool to assist in the design and code-management processes.

Encourage cross-project communications and lessons-learned about processes. If one project meets with success using their processes, make sure the other Project Leaders hear about it. Consider promoting successful project-level processes program-wide.

5.6 Assign the Work to Organizations (Entities) and People (Step 5)

5.6.1 Assign Responsibility to Entities and Execution to Individuals

Project management textbooks call this “mapping the WBS to the org chart”. It also ought to symbolize accountability since the acceptance of an assignment should include caring about its success or failure. Accountability is assigned to entities because those are permanent when compared to the coming and going of individual staff members.

Eventually real work gets done when actual individuals get assigned self-referencing tasks. “Self-referencing” means everything that needs to be known is either already known (by training or experience) or can be readily derived (from documentation and through analysis). Everything up to that point has been planning.

The Program Manager will first **assign responsibility** for each one of the elements captured in the Work Breakdown Structure to an organizational unit such as a state agency or contractor. Next the Project Leader or Task Leader at each agency or company will **assign execution** of each task to a specific individual. This could be portrayed in the form of a task table identifying the lead organization and person for each task.

Figure 5–12 shows a portion of the high-level WBS mapped to organizations (or contractors). The Program Manager works with the Project Leaders to make this mapping.

Figure 5–13 shows a portion of the more detailed WBS mapped to organizations and individuals. The Project Leader works with his/her team to make this mapping.

WBS	Task	Responsible Organization
1.0	**Program Management**	Motor Veh Admin (MVA)
1.1	**Planning & Coordination**	MVA
1.2	**Carrier Coordination**	MVA
1.3	**Showcases & Outreach**	MVA
1.4	**Regional Coordination**	MVA
1.5	**O&M Planning**	MVA
1.6	**Training**	MVA
1.7	**Policy**	MVA
1.8	**Subcontract & Procurement Mgt**	MVA
2.0	**System Engineering & Integration**	MVA Subcontract - VGU
2.1	**System Requirements Definition**	MVA Subcontract - VGU
2.2	**System Design**	MVA Subcontract - VGU
2.3	**Architecture Conformance**	MVA Subcontract - VGU
2.4	**System Integration & Test**	MVA Subcontract - VGU
2.5	**Interoperability Testing**	TBD
3.0	**Safety Project**	Field Ops Bureau
3.1	**Project Management**	Field Ops Bureau
3.2	**System Engineering & Integration**	Field Ops Bureau
3.3	**Subcontract & Procurement Mgt**	Field Ops Bureau
3.4	**CV Information Exchange Window (CVIEW)**	Field Ops Bureau
3.5	**ASPEN**	Field Ops Bureau
3.6	**SAFETYNET**	Field Ops Bureau

Figure 5-12. Sample Program Work Assignments

WBS	Task	Responsible Organization	Assigned to
3.0	**Safety Project**	Field Ops Bureau	(Project Leader) DT Greenwood
3.1	**Project Management**	Field Ops Bureau	DT Greenwood
3.2	**System Engineering & Integration**	Field Ops Bureau	AA Norman
3.3	**Subcontract & Procurement Mgt**	Field Ops Bureau	DT Greenwood
3.4	**CV Information Exchange Window (CVIEW)**	Field Ops Bureau	AA Norman
3.4.1	Product Mgmt	Field Ops Bureau	AA Norman
3.4.2	Subcontract & Procurement	Field Ops Bureau	AA Norman
3.4.2.1	XYZ Subcontract Administration	Field Ops Bureau	AA Norman
3.4.3	Operations & Maintenance	Field Ops Bureau	TBD
3.4.4	Communications	Field Ops Bureau	JD Morgan
3.4.5	Version 1.0.x	Field Ops Bureau	AA Norman
3.4.5.1	Requirements	Field Ops Bureau	AA Norman
3.4.5.2	Design	Field Ops Bureau	AA Norman
3.4.5.3	Implementation	Subcontract - XYZ Software	JA Doe
3.4.5.4	Version testing	Subcontract - XYZ Software	JA Doe
3.4.5.5	Bug fixes	Subcontract - XYZ Software	JA Doe
3.4.5.6	Deployment	not applicable	not applicable
3.4.5.7	Training	Subcontract - XYZ Software	TBD

Figure 5-13. Sample Project Work Assignments

As always when assignments are made, the line organization must support the tasking. If a line supervisor not directly involved in your project objects to their staff working on your project, that staff member probably won't meet your project's schedules. Be sure to confirm and reconfirm commitment from line management.

The sample project work assignments shown above is a fragment of the master WBS for the program. Not shown are other rows that correspond to other projects or program-wide tasks. Also not shown are columns that support the process of developing a procurement strategy. Those additional columns are shown in the next section.

5.6.2 Build or Buy?

Part of assigning work is making decisions about alternative approaches to obtaining products. The "Build or Buy" decision-making process involves deciding what tasks or products will be performed or developed by state staff, and what tasks or products will be procured.

As those decisions are made you should capture them as part of the procurement strategy in your program plan. You will assign procurement activities to different organizations based on such factors as what must be procured, what stakeholders should be involved in the procurement, what items might be grouped together in a single procurement, and what procurement processes and regulations must be followed.

5.6.3 Procurement Strategy

You may recall a discussion from the "Understanding ITS/CVO Technology Applications" training course [17] about making decisions regarding building or buying information system components. That material is repeated here as food for thought.

While you debate your options for implementing functionality, consider these alternatives:

- Build from scratch (either using your own staff or paying a contractor).
- Assemble commercial off-the-shelf (COTS) components and add custom software components.
- Modify an existing package.
- Buy a complete COTS software package and configure it.

You should define criteria and analyze each option in making your "Build vs. Buy" decision for each system. You might conduct a trade-off study to decide what approach to take. Figure 5–14 shows some rules of thumb.

Approach	Cost	Schedule	Risk	Quality	Maintain-ability	Other
Build	High-est	Longest	Often high risk of not producing a useful product	Unknown. Depends on process & team	Highest. Must have in-house maintenance staff	Staff availability?
Assemble	High	Long	Risk that pieces may not fit together	Partially unknown	High	System integration experience?
Modify	Lower	Moderate	Known	Known. Probably similar to existing system	Lower	Quality of legacy system?
COTS	Low-est	Shortest	May not be able to meet all critical requirements	Need to make compromises to preferred business processes	Lowest. Vendor spreads costs over many customers	Available choice of packages?

Figure 5-14. Build versus Buy Decision Table for Information Systems

You need to select an approach that is best for you considering local circumstances. You may also decide to subcontract for technical services such as a system architect, system integrator, or software developer.

The build versus buy, and own-staff versus subcontractor decisions must be made early, since they influence the work breakdown structure, schedules, and costs.

As you identify what you need to buy, characterize the items so you can develop an overall strategy for procurement. **To characterize the "buy" items, make note of:**

- What you need to buy.
- Category (for example: infrastructure design, infrastructure construction, commercial off-the-shelf, software development, systems integration, personal services/consulting, communications services).
- Funding source, if known; it may have restrictions.
- Lead technical organization/person for requirements.
- Potential vendors, if known.

Figure 5–15 shows a supplementary table to the WBS, which adds the procurement characterization columns to those WBS elements having one or more procurement items.

WBS	PROCURE-MENT ITEM	WHAT	CATEGORY	FUNDING SOURCE	TECHNICAL LEAD FOR REQTS	POTENTIAL VENDORS	PROC NOTES
3.5.5	ASPEN-1	ASPEN - SAFER connectivity	Communications Services	MCSAP	Field Ops Bur - EC Smith		
3.5.6	ASPEN-2	ASPEN Laptops	COTS	MCSAP	Field Ops Bur - EC Smith		Verify latest version ASPEN on Windows XP
3.5.6	ASPEN-3	Additional connectivity with SAFER	Communications Services	MCSAP	Field Ops Bur - EC Smith		
3.5.7	ASPEN 4-?	May need to upgrade some computers	COTS	MCSAP	Field Ops Bur		

Figure 5-15. "Buy" List Based on WBS

Once you have a fairly good idea of what you need to procure, you can develop a strategy for how you are going to accomplish the procurements. This strategy will serve as a procurement roadmap. Your goal in developing the strategy is to make the procurement process as flexible, simple, and timely as you can. See which items you can bundle together in one procurement. Determine what kind of contracting approach best fits each procurement. See if you have adequate staff to accomplish the procurements. **Your procurement strategy should consider:**

- What items are being bundled into each procurement.
- Who will accomplish each procurement. Often you'll need to assign a team. For instance, the team might consist of someone who knows the procurement process, technical folks who can specify requirements, and an administrator to track status. If the items to be purchased are being funded by different agencies, authorization to make purchases may have to be granted to someone outside several of those agencies.
- The contracting approach for each procurement.
- Type (for example: architecture/engineering design, construction, non architecture/engineering and services, innovative contracting).

- Options (for example: design-bid-build, design-build, systems integrator, public-private partnership).
- Methods of award (for example: sealed bids, two-step sealed bids, competitive negotiations, sole source contracting, unsolicited proposals).
- Pricing methodologies (for example: cost reimbursable, competitive fixed price, published price, unit pricing).

Figure 5–16 illustrates a worksheet for defining your procurement strategy. After the worksheet has been completed, you should update the WBS to show the procurement tasks as work items assigned to an organization and individual.

Procurement Item Group	Description of Procurement	Procurement Item List (from "Buy" List)	Category	Contracting Approach			Procurement Team (list leader first)	Earliest Need Date	Notes
				Type	Profit Incentive	Method of Award			
Safety-1	New ASPEN laptops & upgrades to existing laptops	ASPEN-2, ASPEN-4	COTS	Non A/E	Indefinite Quantity	Sealed Bid	JA Shaffer	Safety Build_2	
Safety-2	ASPEN - SAFER and ASPEN - CVIEW connections	ASPEN-1, ASPEN-3	Communica-tions services	Non A/E	Options	Two-Step Sealed Bid	JD Morgan; JA Shaffer	Safety Build_1	

Figure 5-16. Procurement Strategy Worksheet

Looking at all the forecasted procurements up-front makes it possible for you to establish a plan of attack that will benefit the program. Please see Appendix E and the many documents it references for more information about procurement strategies.

5.7 Define Milestones and Schedules (Step 6)

5.7.1 Begin with High-Level Objectives

In **program** planning, at this step you define the integrated capabilities you intend to demonstrate in development and deployment phases, and identify critical milestones that will help you measure progress towards completing those phased program objectives.

You will be segmenting your program into development and deployment phases of, say, 3-6 months duration. Program phases of that length are recommended because it is difficult to accomplish anything in less than three months, and for a phase longer than 6 months resource availability is difficult to forecast. Breaking the objectives down into smaller steps means that you are able to show progress at the end of every phase. Everyone – from upper management to the real workers – can see and feel good about what has been accomplished in a 3-6 month program phase.

Working with the System Architect, the Program Manager and Project Leaders set high-level objectives for each program phase by defining the program-wide capabilities that are to be achieved. The notion is that each program phase builds upon the previous phase to achieve all of the program's objectives by the end of the last program phase. The build-up of partial capabilities in program phases allows customer feedback before the capability is completed and provides visibility into progress. There is an example of objectives for a program phase in Chapter 4, Figure 4–6.

In the "Define Milestones and Schedules" step at the **project** level, you want to define project-specific objectives for each build, slightly more detailed schedules for accomplishing those objectives, and milestones to measure the project's progress. The timing of one project's phases need not line up with another project's phases or with the program's phases. That may occur because the project may not be able to finish all the work that makes sense to group together in its build in the same time window allotted at the program phase level. Or, the project may be able to finish two builds during a single program phase (and, hence, the project may get through two phases within a single program phase). Figure 5–17 illustrates how program and project phases may be related.

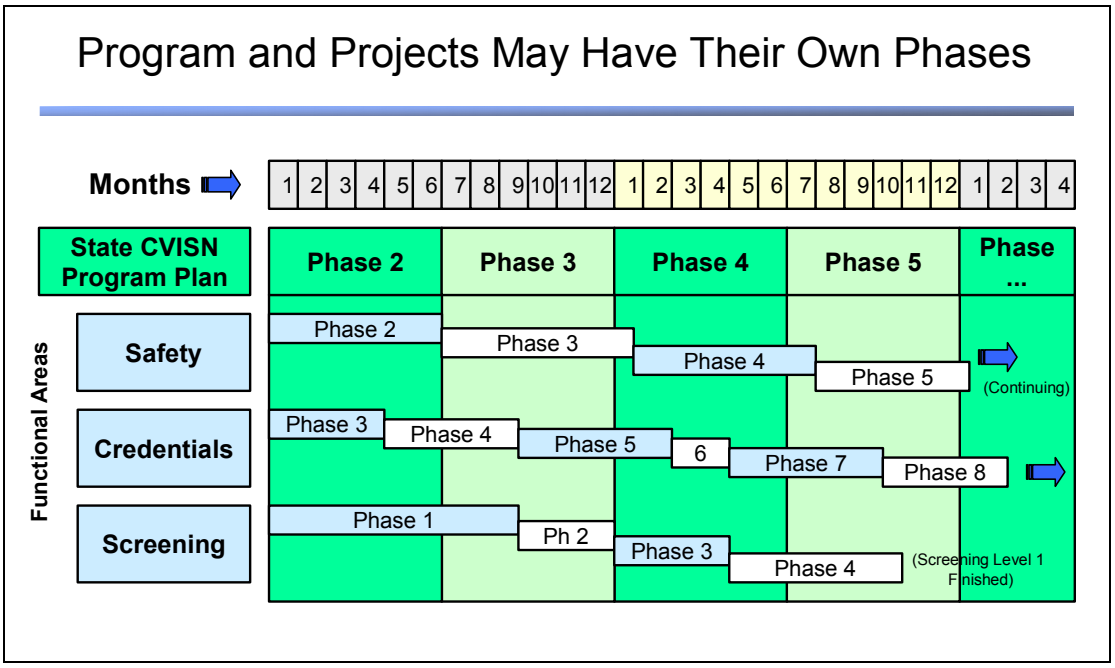


Figure 5-17. Phases are Defined for the Program and its Projects

The process of defining a more detailed schedule for a project phase occurs close in time to the phase itself, and is described in the *CVISN Guide to Phase Planning and Tracking* [44].

Phase objectives can be shown in the same format (a bulleted list) for a project's phase as they are shown for the program. Figure 5–18 is an example.

Credentials Project Phase 3:
September 2000 - February 2001

IRP Clearinghouse connection

- Send recaps to the IRP Clearinghouse
- Check remittance netting reports & send corrections

IRP

- Accept an electronic IRP Supplement, Add Vehicle application via the Web site
- Invoice the carrier via the Web site
- Notify the carrier via the Web that the credential has been issued
- Update the vehicle snapshot in CVIEW

Figure 5-18. Sample Objectives for a Project Phase

The program-level objective for a particular phase might be to demonstrate end-to-end processing of International Registration Plan (IRP) credentials. By that, the program means that a carrier will be able to submit some IRP application electronically, the IRP system will handle it electronically and send an electronic response, and the roadside will know about the credentialing action. For the credentials **project**, the detailed objectives might be as shown above. The credentials project's objectives are more specific than the program's objectives. They limit the "end-to-end processing" to one kind of IRP transaction, and clarify what processing must be electronic. These objectives do not preclude utilizing Electronic Funds Transfer (EFT), nor do they preclude an immediate update from the IRP system to CVIEW. On the other hand, they do not require EFT processing, and they allow for some manual intervention to accomplish the snapshot update in CVIEW such as temporarily re-keying some data elements.

5.7.2 Bottom-Up Sanity Check

Once you have identified the capabilities you'd *like* to achieve in each program phase, it's wise to do a sanity check. An effective approach is to ask each Project Leader to identify the tasks from his/her project that are associated with achieving each set of the program's phase objectives. During this exercise they may realize that you're hoping for too much in too short a period of time, and ask that the program phase objectives be made more realistic (i.e., de-scope the phase), or ask that the time allotted to the program phase be extended. This is almost always sound advice; listen to what they say – they know the details about what needs to be done to meet the objectives. On the other hand you need to keep an eye on the end target for the program; if you adjust the objectives downward for every program phase you may not be able to achieve the end results everyone agreed to. Either the over-all objectives for the program were too ambitious in the first place, or the planning for each phase is too conservative. Sometimes you have to aim high, hope for some good luck, and push progress forward. Other times you have to realize you're asking too much. As a Program Manager it's your job to work with the System Architect and Project Leaders to figure out what can be achieved on a realistic schedule. You want everyone on the team to feel confident, proud, and appreciated. You want every part of the team to accomplish as much as they can. Expect to iterate the process of setting objectives and dates for each program phase.

5.7.3 Establish Milestones

You don't want to wait until the end of a program phase to realize that it's in trouble. Defining major milestones for each program phase helps you keep a handle on progress during the phase**. A milestone consists of three components: a measurable event, a planned date, and an actual date**. External dependency milestones can be used to mark when the program needs something that is not under its control to happen. For example you may be planning to use next-generation ASPEN and want to schedule computer upgrades and CVIEW development activities to coincide with its delivery. But you cannot control when next-generation ASPEN will actually be made available. In your phase planning, you make an assumption about when you will be

able to use ASPEN (based on what its developers tell you), and use that assumption to plan related activities. Dependencies like this, especially ones that are external to the program, need to be identified, assumptions about them made clear, and impacts made visible.

Other key events are also good candidates for program-level milestones. Some examples of critical milestones are: the delivery of a product requirements or design document; demonstration of initial interface capability via testing; or the completion of the first of a series of training classes. Taking credit for having reached a milestone should be completely objective. A milestone that is poorly defined will have less significance than one that is clear and unambiguous to everyone.

Project milestones for a project phase should be used to indicate dependencies across projects, dependencies that are external to the program, and project-internal accomplishments necessary to achieve the project phase's objectives. It is handy to have at least one milestone each month. During initial project planning, it may not be possible to define that many milestones. The definition of most milestones is deferred until planning for each project phase. However, some milestones are obvious even during the initial project planning: completion of testing, having a contract in place for needed facilities or software support, or legislative approval for some proposed addition to a standard form.

Procurement schedules must be tied to the tasks and functions the procurements will support. Lead times for procurement should be accounted for in setting the schedules.

5.8 Estimate Costs and Resources (Step 7)

5.8.1 Top-Down Cost Estimates

At the **program level** cost estimates are used to secure funding and to allocate received funding to projects. At the **project level**, detailed cost estimates are used to supply information to the program, and to identify staffing or procurement needs.

Cost estimates included in the **program** plan are usually developed "top-down" based on rough ideas of the effort and procurement required to accomplish the objectives. These resource estimates are needed for each element in the WBS at level 3. In addition, each estimate ought to include a written rationale called the *basis of estimate*. The basis of estimate indicates whether the estimate is inferred from past experience, analogy, expert judgment, or built up from further breakdown of the element. Later, actual costs and personnel utilization can be accumulated at the end of a phase and compared to the original estimates. Estimates for the remaining phases are adjusted accordingly.

The steps in developing a program-level cost estimate are:

- Estimate the effort and procurements associated with each project.
- Estimate the effort and procurements associated with program-level support items.
- Call the above "base" costs. Add 15% of labor base for system integration.
- Add 10% of labor base for program management.
- Add and hold aside 10% of labor base and procurement costs for management reserve.
- Allocate costs to fiscal years.
- In each fiscal year, allocate the costs to the program-level WBS items and to the projects identified in the WBS.

Unless required to do otherwise, for simplicity and convenience the Program Manager may choose to leave state employee labor estimates in units of manpower rather than convert them into dollars. The informal distinction is made between the "soft dollars" of salaries that would have been paid anyway, versus the "hard dollars" of procurement costs that represent additional outflow from the state treasury.

The Program Manager, Administrator/Facilitator, System Architect, and Project Leaders usually work together to develop the cost estimate for the program.

5.8.2 Bottom-Up Cost Estimates

Cost estimates included in the **project** plan are usually developed "bottom-up" from lower levels of detail that have been "rolled up" to the appropriate WBS level. The steps in developing a project-level cost estimate:

- Estimate the labor required to implement each WBS element
  - break the labor into internal and external labor
  - option: break internal estimate into estimates by agency
- Estimate the dollars needed to implement each WBS element
  - purchase costs
  - services costs
  - external labor costs
  - travel expenses
- Provide a basis for the estimated costs
  - vendor quote
  - previous experience
- Then roll up the costs to estimate costs at the project-level WBS element

The detailed schedule information supports the cost estimates, and vice versa. The combination of the schedule and estimated effort are used to define staffing requirements and to make assignments. Staff availability and the salaries of the assigned team members affect costs.

The costs associated with the procurement of specific hardware, networking services, and commercial software products are usually best estimated at the project level. The project team members know what is needed, and often have the contacts to estimate costs quickly and accurately enough.

As each phase is begun it is a good idea to revisit that phase's budget estimates and make sure there are no surprises or new costs that are not accounted for in the project's funding allocation for the phase.

5.8.3 Funding Allocation

The next step is to match known funding sources to the estimated program needs. Be sure the program team understands any spending guidelines and restrictions that apply to the moneys allotted to the program.

Follow those guidelines as you allocate program funds across projects and across phases. As available funds are allocated, look for strategies to mitigate risks associated with potential future funding problems, uncertainties associated with the technologies, and other "known unknowns". For instance, be sure you get something finished with the initial funding increment, rather than getting lots of things started but nothing finished. The phased development strategy is specifically geared towards this goal.

Prepare charts that graphically illustrate the funding allocation to answer two different questions:

- Where is the money coming from?
- To what projects is the money allocated?

It is often the case that you don't have all the funding sources identified at this stage of the program. That's okay. You can use the plan you're developing to help secure new funding. Please see the next chapter! If that new funding doesn't materialize over time, you'll have to revisit the planning process and de-scope the program objectives.

5.9 Maintaining the Plans

5.9.1 Iteration All Over Again

At the start of this chapter we noted that the planning processes are iterative. It's worth saying it again. The planning processes, especially those related to defining the work (developing the WBS), defining the organization, assigning work to organizations, developing a procurement strategy, setting milestones and schedules, and estimating costs must be revisited again and again as you learn more from subsequent steps that affect earlier ones. For instance, you may draw up an organization chart based on projects and program-wide support functions and think that step is finished. But as you work on your procurement strategy, you may realize that it makes sense to group several procurement items under one procurement, and that you need a new organizational entity to coordinate the procurement. Be willing to revisit earlier steps in the planning process as you work through the later steps.

At a minimum review, refresh, and update all plans at least once a year, typically to coincide with the annual budget cycle. It is preferable to update plans sooner, at the end of every phase. But you can hold off formally publishing the documents – see the next section.

5.9.2 Publicizing Plans

After the program and project plans are written, there is a tendency to put them on the shelf and forget about them. It seems to be a universal experience that as soon as you finish a plan, it's out of date!

But if you've followed the advice in this guide, you've constructed your plans to be useful not only for planning, but also for tracking progress. You'll be motivated to maintain the parts that are most useful to you. Here is some general advice:

- It is not necessary to republish an updated plan on any fixed schedule. Rather, republish when the previously-published document is hopelessly out of date, and when external forces and circumstances require you to do so. For instance, a typical external circumstance for republishing a program plan is the approaching end of a funding cycle.
- Integrate the planning and status-reporting processes. Use the plan for tracking status at a comfortable level of detail. Use it as the basis for reporting status to management. (Considerably more is said about this in the *CVISN Guide to Phase Planning & Tracking* [44].)
- Make it a point to keep up-to-date the parts that you use over and over. Derive formal reports (for example, monthly or quarterly status report) from the plan. If you can't currently use the plan directly for reporting, consider revising the plan contents/format so that you can.
- Keep an electronic copy of the all the plans on a program-wide server so that team members can view them and can update the details.

- The Program Manager should keep a working copy of the Program Plan. Redline it. Add to it. Build the program history as you go.
- The Project Leader should keep a working copy of the Project Plan. Redline it. Add to it.
- Reconfirm commitment to the program and its projects as often as needed to maintain forward momentum.
- Archive the project history as you go, especially any reasons for changes in scope and schedule. Should the worst happen, be prepared to defend your side of it in a formal dispute.
- Keep track of issues somewhere, somehow. It's important to avoid re-opening issues on which you reached solid consensus. It's also important not to lose an issue that you aren't ready to face now, but must face later.

Don't get bogged down with unnecessary document maintenance. You wrote them to help you manage the program and projects. See the *CVISN Guide to Phase Planning & Tracking* [44] for suggestions about balancing the need for written plans versus the need to get the job done.

6 CVISN FUNDING & CONTRACTING PROCESS

6.1 Look for Opportunities to be Flexible and Innovative

The process model for securing funding and establishing contracts to support the CVISN program in the state are illustrated in Figure 6–1 (repeated from Chapter 3).

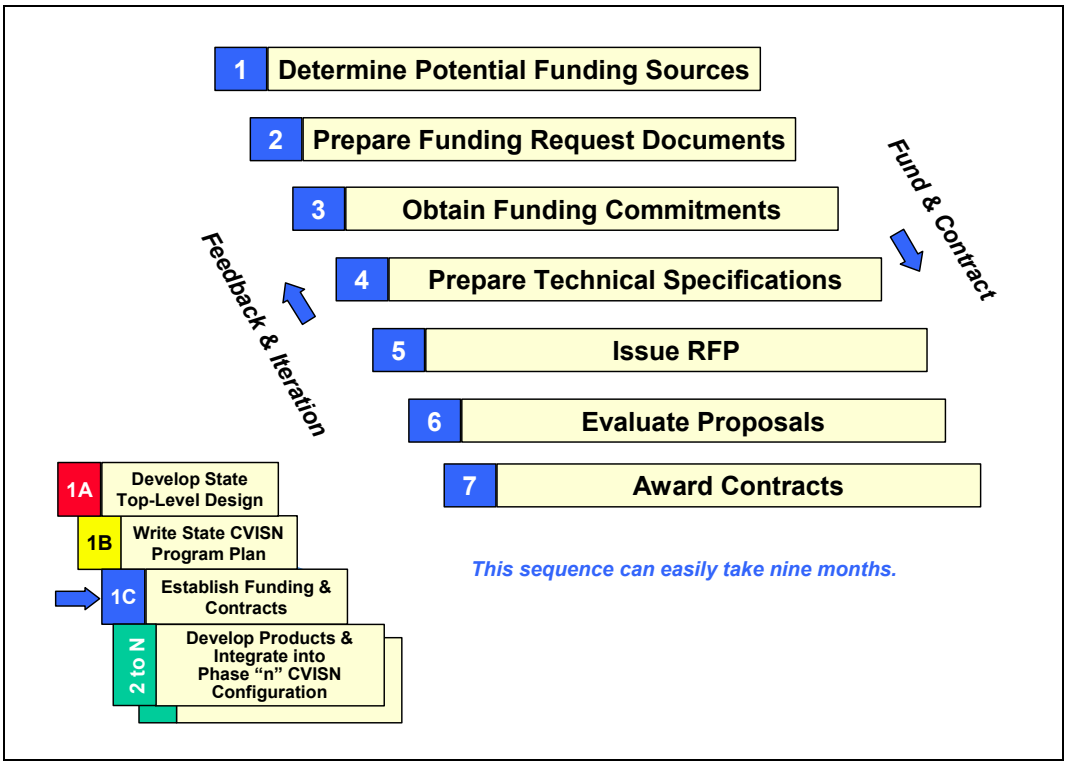


Figure 6-1. Funding & Contracting Process

References given in Appendix A include excellent sources that offer suggestions about the funding and contracting processes. **Appendix E summarizes new and innovative approaches to funding and contracting**. The message from ITS deployment experience is to be as creative and flexible as you can within the constraints of state and federal regulations. Those constraints are not as draconian as you might think.

Some CVISN states have found that the funding and contracting process can easily take nine months. You should plan for a typical process duration, not one based on heroics.

6.2 Determine Potential Funding Sources (Step 1)

Reference [69] identifies funding sources in three main categories: Federal; state and local; and private. There are many models for successful ITS funding. Public-private partnerships are prevalent in the electronic screening programs. Federal funding was used to prototype several electronic credentialing systems. States are using the Internet to provide ever-increasing citizen services. Tap into statewide communication infrastructure improvement initiatives that provide connectivity bandwidth and computer upgrades.

In this first step, the Program Manager actively pursues funding sources. During the development of the State Strategic Business Plan, initial funding is identified. Once the program is underway, the Program Manager continues to cultivate those and additional sources, and incorporates the ITS/CVO project planning in standard state budget planning activities.

Identifying stable and adequate funding is critical to any development program's success.

6.3 Prepare Funding Request Documents (Step 2)

Funding request documents should be based upon credible needs assessments such as historical experience or bottom-up estimates.

Typical cost ranges for implementing CVISN Level 1 are summarized in Table 6–1.

Table 6-1.
State Costs to Implement CVISN Level 1

Functional Area	Low-End Costs	High-End Costs
Safety Information Exchange	$0.25M	$1M
Credentials Administration	$0.5M	$2M
Electronic Screening	$0.5M	$1.5M
Total Cost Range	$2.25M	$6.5M

These costs are based on the experiences of the early states to deploy CVISN and is subject to change. It is given here solely to provide a ballpark estimate.

Use the WBS as the framework to accumulate cost estimates for the program. The spreadsheet in Figure 6–2 is a sample format for bottom-up cost estimates. In addition to this view that displays costs versus tasks, you should also prepare a view that shows costs across calendar time.

The funding request documentation should reference the Program Plan. It is often helpful to extract summary information like program goals, the program organization chart, and preliminary phase plans so that the funders have a clear picture about what it is that you are asking them to support.

WBS	Task	Internal Hours	External Hours	Computed External Costs	Purchases	Services	Travel	Other Costs	Basis of Estimate
	State CVISN Program								
1.0	**Program Management**								
1.1	Planning & Coordination								
1.2	Carrier Coordination								
1.3	Showcases & Outreach								
1.4	Regional Coordination								
1.5	O&M Planning								
1.6	Training								
1.7	Policy								
1.8	Subcontract & Procurement Mgt								
2.0	**System Engineering & Integration**								
2.1	System Requirements Definition								
2.2	System Design								
2.3	Architecture Conformance								
2.4	System Integration & Test								
2.5	Interoperability Testing								
3.0	**Safety Project**								
3.1	Project Management								
3.2	System Engineering & Integration								
3.3	Subcontract & Procurement Mgt								
3.4	CV Information Exchange Window (CVIEW)								
3.5	ASPEN								
3.6	SAFETYNET								
3.7	Safety Build 1								
3.8	Safety Build 2								
3.9	Safety Build n								
4.0	**Credentials Project**								
4.1	Project Management								
4.2	System Engineering & Integration								
4.3	Subcontract & Procurement Mgt								
4.4	International Registration Plan (IRP)								
4.5	International Fuel Tax Agreement (IFTA)								
4.6	Credentialing Interface (CI)								
4.7	Motor Carrier Home Page & Web Credentialing								
4.8	Carrier Credentialing Systems (CAT or module)								
4.9	Intra-State Registration								
4.10	Credentials Build 1								
4.11	Credentials Build 2								
4.12	Credentials Build n								
5.0	**Electronic Screening Project**								
5.1	Project Management								
5.2	System Engineering & Integration								
5.3	Subcontract & Procurement Mgt								
5.4	Roadside Operations								
5.5	Screening								
5.6	Site Mods								
5.7	Carrier E-Screening Enrollment								
5.8	E-Screening Build 1								
5.9	E-Screening Build 2								
5.10	E-Screening Build n								
6.0	**Evaluation**								
6.1	Self-Evaluation								
6.2	National Evaluation (Funded Separately)								

Figure 6-2. Cost Spreadsheet Template

6.4 Obtain Funding Commitments (Step 3)

Obtaining funding commitments is a combination of legal activities and good-faith agreements. Informal agreements may be all that you can achieve for out-year funding. For near-term funding formal, legally-binding commitments are required.

Once funding commitments have been made, you also need to get staffing commitments from the organizations that will be supporting the work.

Partnership agreements can be used for securing both funding commitments and staffing commitments, with internal and external groups [9]. In the partnership agreement the organization providing funding and/or staffing agrees to certain goals, roles, and responsibilities. What the program is promising is also called out.

6.5 Prepare Technical Specifications (Step 4)

Technical specifications define at least what you intend to develop, its interfaces, internal processing requirements, constraints about the operating environment, training to be provided, and maintenance requirements. The technical specifications may be for services, software products, hardware, supporting documentation, or some combination.

Many samples of technical specifications for CVISN are available from individual states. Also see the *CVISN Guide to Credentials Administration* [63], *CVISN Guide to Safety Information Exchange* [64], and *CVISN Guide to Electronic Screening* [65] for guidance about documenting requirements at the functional level in more detail.

You will probably prepare several specifications for the program. Most will be associated with particular system components for particular projects. You may decide to contract for some services for the program as a whole. For example, you may decide to procure services of a System Architect to perform system engineering and integration services for the program as a whole.

Through technical specifications you define what you want from a vendor. The vendor may be the typical external commercial provider, or may be an internal source via an inter-agency agreement. The degree of formality in the specification depends on the associated risks. **Be sure to be specific enough to have recourse** if the vendor does not perform to your satisfaction. You can get out of a contract based on a technical specification only if the specification has clear, unambiguous, measurable statements.

You may want to write fairly high-level technical specifications for the program or for individual projects at the start. Then during each phase you would define specific requirements the vendors should satisfy for that phase.

The technical specification should be reviewed by the technical team, the end-users, and, for external vendors, by your legal agency. There should be enough wiggle room in the specification for the vendor to apply creativity where you want it, but not so much that you are kept in the dark about what you will be getting. Specify where you want them to use standards and where they are optional. Remember that the contract is there for when everyone is upset with one another; otherwise you wouldn't need one.

6.6 Issue the RFP (Step 5)

The Request for Proposal (RFP) officially disseminates the technical specification to prospective bidders, and tells them what they must do to get and keep the job. The RFP sets the parameters and criteria for evaluating proposals. The RFP is often also used to set the parameters for measuring progress.

In the RFP, you usually ask respondents to list relevant experience. The RFP is also a place to specify "quality" factors (reliability, availability, maintainability, etc.). You should explain what kind of technical documentation you want, and the review process you'll use to make sure the vendor is on track.

Planning for system testing is part of every stage of the lifecycle, including this one. Include test requirements in the RFP. If vendors know up front what tests the product(s) must pass at the end, they will do a better job of estimating cost and providing a satisfactory product.

The vendors' responses should include the kind of information that you included in your program and project plans. You need to be able to evaluate the proposals and make a choice about who will do the job, so be sure to ask for sufficient information to make that decision.

6.7 Evaluate the Proposals (Step 6)

The process of evaluating the responses to your RFP should be expedient, well-defined, and very organized. The evaluation factors must be set out as part of the RFP. The evaluation process should address cost, schedule, performance, and technical factors. The evaluators should be part of the program team, and have a vested interest in making sure that the "best" proposal wins. You should have a scorecard that each evaluator fills out.

Usually, evaluation criteria involve both objective and subjective factors. Both kinds of factors should have objective scoring systems. Subjective factors let you consider "fuzzy" vendor attributes such as experience, past performance, and a demonstrated understanding of your CVISN needs. As long as the subjective factors are evaluated with integrity, the evaluation process and results will be defensible.

In the process of evaluating proposals you often need to go back to one or more respondents to get clarifying information. Be careful that you are not being unfair to one vendor during that phase. It is tempting to ask leading questions if you have a better feeling about one proposal than another. Don't! Keep the process open, above-board, and free of bias.

Employ skepticism and common sense in evaluating the proposals. If you think a vendor is promising to do more than is possible for a certain price or in a certain time period, capture that concern in the evaluation process. If that vendor wins the job, be sure the contracting vehicle gives you a way to measure progress and take action if performance isn't what it needs to be.

Part of evaluating proposals is to check with current and previous customers. You wouldn't contract with the electrician who took three times longer than planned to re-wire your neighbor's house; similarly don't contract with a vendor who left every other state dissatisfied. But be sure to ask fair questions when you check with current and previous customers. Pose the kinds of questions you'd be willing to answer about your own vendors. Ask questions that will give you a fair reading about the long-term performance, not just a snapshot of yesterday's frustrations or last week's triumphs.

6.8 Award Contracts (Step 7)

Several of the references [18-20, 22-24] have excellent advice about how to write contracts for ITS services and products. Be sure to review them before you get to this step. Appendix E captures many key points from those references. The bottom line is to pick the right contracting vehicle and manage risks. You are paying, and should be in control; set up the contract to keep you there.

6.9 Take Advantage of Lessons Learned

Chapter 7 summarizes published CVISN and ITS lessons learned.

Please also see Appendix G which includes lessons learned from early CVISN states.

7. PUBLISHED STATE LESSONS LEARNED, TIPS, AND PITFALLS

Experience is the hardest kind of teacher.
It gives you the test first and the lesson afterwards.

So begins Rechtin's compendium [37] of 180 "heuristics" he elegantly generalized from the system architecting experiences of numerous colleagues. Similarly, enough time has gone by for well-documented lessons learned to be published specific to Intelligent Transportation Systems (ITS) and CVISN. The lessons learned extracted below are from the report *Early Institutional Lessons from the CVISN Model Deployments* [7]; they were gathered from visits and structured interviews in California, Oregon, Washington, Kentucky, and Connecticut.

7.1 Address High-Level Policy, Organizational Structure, Laws and Regulations

- **Support high-level policies encouraging interagency cooperation, information technologies, and automation, and link the CVISN project to those policies.** The greater the commitment toward automation at the level of state elected and appointed officials, the fewer hurdles will need to be overcome in obtaining buy-in for CVISN, the greater the support will be during implementation, and the greater synergy can occur across departments and organizational units.
- **Separate commercial vehicle programs from related programs, then procedures addressing commercial vehicles could be precisely tailored resulting in better service.** Several of the states have recently moved registration of commercial vehicles out of the group that deals with passenger car registrations and into its own program unit.
- **Consolidate as many commercial vehicle functions into one organization as possible.** When a project can be done entirely within one organization, fewer interests need to be considered before consensus is reached. For example, Kentucky moved IRP and IFTA transactions to the same department in order to improve efficiency. Such effort has associated costs that may be warranted if existing organizational structures impede progress toward policy goals, such as improved customer service and efficiency.
- **Align the organization with statewide policy priorities.** For instance, Kentucky's move to consolidate IRP and IFTA functions in the same organization came from a statewide effort to automate processes and eliminate internal barriers to increase production and efficiency.
- **Review state laws and regulations for potential barriers, especially issues related to electronic transactions and protection of sensitive private company data.** State laws and regulations related to electronic transactions seem to create the most issues that need to be addressed. Several states noted that there are requirements for signatures on applications, and laws would need to be changed in order to accept electronic signatures. There may also be some difficulties in accepting electronic funds transfer without new legislation.

7.2 Cooperate To Take Advantage of Relative Strengths of All Partners and Interested Parties

- **Identify all interested parties and arrange working arrangements to accommodate the appropriate level of involvement for each party.** Washington has three agencies involved in the project; California has four; and Connecticut has six, although three primarily do the routine work. Connecticut has drawn in some of the agencies with peripheral interests that the other states are simply keeping informed.
- **Recognize the organization of a multi-agency (or multi-state) project and emphasize its strengths.** Including multiple agencies increases cross-pollination with other programs and the potential for a greater variety of contacts outside of the agency. In addition, it protects against loss of expertise by providing redundancy of knowledge when there is staff turnover. When multiple states are involved in CVISN, there are also state policies, procedures, and laws that are different. This can work in the project's favor by allowing activities to occur in the state where it is easiest and fastest. For instance, Washington took the lead in the Washington-Oregon pilot because Oregon's legislature would not be meeting soon enough for their approval to apply for federal funds to occur before the application deadline. Besides helping with procedural issues, the states can bring complementary expertise. Washington has experience with using laptop computers in enforcement, while Oregon has been involved in electronic clearance through operational tests such as the ITS/CVO Greenlight Project.
- **Take advantage of expertise, testing, and feedback available through cooperation with interested parties.**

Other state agencies or programs might be concerned about inspection of trucks for agricultural pests, or the possibility of electronic transactions with automobiles.

Local universities can play an important role. In Washington, the longstanding cooperation between the University of Washington and WSDOT was one factor leading to the use of advanced technologies to address congestion in the Seattle area. In Kentucky, the University of Kentucky Transportation Center plays an active role in the pilot. Prior to 1981, the transportation agency contained a Division of Research, which was renamed the Transportation Center and became part of the University's Department of Civil Engineering. The Center provides all transportation-related technical and project management support, as well as assistance with outreach and information dissemination functions.

National and regional organizations can address common issues. For example, the Western Association of State Highway and Transportation Officials (WASHTO) has helped resolve concerns related to roadside electronic clearance.

States cooperating in a region can benefit by saving resources through developing software once, rather than multiple times, and by resolving issues to make borders more transparent to commercial vehicles. Both Washington and Oregon were planning to use a new Over Size / Over Weight (OS/OW) system being developed by Utah.

State motor carrier associations can be valuable sources of political support, as well as insight into the needs of their members and resources for marketing new CVISN services. Connecticut has established a position of Industry Project Manager, held by the president of the most powerful trucking association in the state. The Industry Project Manager has been asked to set aside one day per week for project activities and is responsible for representing the industry's priorities at Council meetings and getting buy-in from carriers.

Individual carriers are needed to test the new procedures and systems before they go into widespread use. They benefit by obtaining access to the new services sooner. The public sector partners in Washington and Oregon are extending their relationship with industry to work with shipping lines to install transponders on shipments to allow tracking and U.S. Customs preclearance.

7.3 Recognize The Need For Proper Communications

- **At the start of the project, list all necessary communications and develop a strategy to ensure that they are carried out.** In states with multiple agencies involved, it can be easy to overlook a group unless responsibility for communications is assigned to an individual who is given the time to keep track of what is being done. In Washington State, attention was focused initially on management. Later, management realized that program staff were not receiving enough information to answer questions they were receiving from truckers and companies, and more emphasis was given to keeping program staff informed.
- **Allow additional time to obtain buy-in and consider assigning an individual to coordinate all "communications" or "marketing" if multiple agencies are involved.** In California, the larger number of actors resulting from the size of the government and consequent multiple agencies involved, and the resulting additional layers of approval needed, complicated and lengthened the task of gaining buy-in. In Connecticut, an early retirement program led to major loss of staff and changes in assignment of the remaining staff. As a result, a new effort to inform and educate management was required. The Management Coordinator, a staff person assigned to keep all project participants informed, played a major role in maintaining program continuity and buy-in during the major staff changes.
- **Maintain support for the project by reporting progress frequently to upper management and elected officials.**

- **Maintain regular communication with customer service staff**. Current staff can provide valuable input during the development of CVISN. CVISN is likely to change some current jobs. Communicating with staff about those changes can help allay fears about those changes or the potential for reductions in staff. In Washington, the Department of Licensing (DOL) marketed CVISN to staff by explaining the efficiencies that result. Consequently, the biggest hurdle in gaining staff buy-in was overcoming the perception that electronic data flow will result in a loss of jobs.
- **Keep industry associations "in the loop"** and take advantage of their contacts and business experience to market CVISN to motor carriers. Washington and Oregon are using the company SAIC, Inc. to be its Transponder Administrator, with Northwest Transporter, a regional trucking association, subcontracted to market transponders to motor carriers in those states. The project selected this team including Northwest Transporter in part because they believed this team understood their membership and would be best able to market the new service to it.

7.4 Plan Training For Both State CVO Staff And Motor Carrier Employees

- **Commercial drivers** need to understand when it is permitted to bypass a weigh station under electronic screening and clearance.
- **Motor carriers** beginning to apply for credentials electronically, or use transponders for electronic screening for the first time, need training on procedures.
- **For state staff, training in electronic credentialing, tax collection, and electronic funds transfer** will be needed when these new processes and technologies are involved. This training will need to be ongoing as information on updates to software becomes available.
- **For state staff, training will be needed on a range of associated topics, such as changes in state laws, regulations, policies, and procedures.** Training on policies related to release of data may become more important as more staff have access to more information.

7.5 Manage the Expectations of All Partners

- **It is important that all partners are aware of both the benefits and limitations of CVISN.** For instance, it should be made clear that roadside electronic screening can substantially reduce, but not eliminate, the number of times that a truck will be stopped.
- **The concerns of law enforcement** about inspecting trucks need to be balanced with the interests of motor carriers in getting the greatest benefit of participating in an e-screening program.

7.6 Lessons Learned from Lessons Learned – Nine Successful Approaches to Deploying a Metropolitan Intelligent Transportation System

One of the macro lessons learned from the published knowledge base (see References) is that ITS projects in every functional area face the same problems and wrestle with the same issues. This is not surprising when you consider all that they have in common:

- They are information systems with complex interacting software entities – some legacy, some COTS, and some newly developed.
- They rely on diverse and distributed databases, servers, and networks.
- They operate upon real-time information from a variety of sensors and input devices.
- They report information not only to an array of real-time displays but also to other independent software entities.

For this reason CVISN projects can look to other ITS projects for ideas, inspiration, and encouragement. The excellent ***Successful Approaches to Deploying a Metropolitan Intelligent Transportation System*** [33] is one such source. The Executive Summary is a "must read". Staff from the John A. Volpe National Transportation Systems Center visited and interviewed four ITS Model Deployment Initiative sites: AZTech (Phoenix), iTravel (NY-NJ-CT), Smart Trek (Seattle), and TransGuide (San Antonio). Nine key "successful approaches" were identified; the full report devotes one chapter to each. It also includes handy "deployment aids" – appendices with actual contract language from which the reader is invited to cut-and-paste; and tables of question-checklists to apply each of the report's major lessons learned to new projects.

The nine successful approaches documented in the Volpe study are summarized below.

Approach #1 Develop a Regional Perspective

- Build on Existing Relationships
- Involve Non-traditional Players
- Develop a Shared Vision
- Augment Existing Systems

Approach #2 Make ITS Visible

- Reach Out to the General Public
- Gain Support from Policy Makers and Upper Management
- Involve Metropolitan Planning Organizations
- Encourage Staff Involvement

Approach #3. Understand the Nuances of Partnering

- Recognize that Participants Have Differing Objectives
- Realize it Takes Time to Develop Trusting Relationships
- Define Explicitly the Roles and Responsibilities of the Parties
- Provide Incentives for Participating

Approach #4. Plan for Long-term Operations and Management

- Maintain the Support of Participants
- Build Support of Field Staff, Users, and Operators
- Facilitate Private Sector Involvement

Approach #5. Develop a Regional Management Structure

- Assign Roles Based on the Strengths of the Participants
- Identify a Full-time Project Manager and Give the Manager Authority
- Dedicate Other Support as Required
- Develop an Appropriate Committee Structure

Approach #6. Facilitate ITS within Your Organization

- Consider Organizational Changes
- Assess Skills and Staffing Requirements
- Address Training Needs

Approach #7. Identify Appropriate Procurement Mechanisms

- Be Flexible in Selecting Lead Procurement Agencies
- Be Flexible in Determining Contracting Mechanisms
- Develop Flexibility within the Contract

Approach #8. Address Intellectual Property Rights Issues Early

- Develop a Clear Policy Early
- Understand the Possible Areas of Concern

Approach #9. Develop Written Policies

- Address Equipment Issues
- Delimit the Use and Distribution of Data
- Address Legal Concerns
- Define Roles and Responsibilities

APPENDIX A. REFERENCES

Note: ITS-related references and other information are available on-line via U.S. DOT's **ITS Electronic Document Library [13].**

1. ***Guide to the Project Management Body of Knowledge,*** published by the Project Management Institute [2]. Available at http://www.pmi.org/publictn/pmboktoc.htm. *Your first line of defense for terminology and concepts; concise and precise. PMI is a reputable and authoritative organization.*

2. **Project Management Institute (PMI)**
Four Campus Boulevard
Newtown Square, PA 19073
610-356-4600
http://www.pmi.org
PMI conducts monthly meetings throughout the U.S.. Call to find the local chapter near you.

3. ***The Team Handbook*** Second Edition, by Oriel, Inc. (formerly Joiner Associates, Inc.) 1996.
ISBN 1-884731-11-2.
3800 Regent St.
Madison WI 53705
800 669-8326
Substantive, practical, and attractively packaged guidance for working in teams. Includes templates and exercises.

4. ***Safeware – System Safety and Computers, A Guide to Preventing Accidents and Losses Caused by Technology***, by Nancy G. Leveson. Addison-Wesley Publishing Company, 1995.
ISBN 0-201-11972-2. *The ultimate guide to building safe automated systems. From an author who won an award "For promoting responsible software and system engineering practices where life and property are at stake."*

5. **International Council on Systems Engineering** (INCOSE)
2150 N. 107th St., Suite 205
Seattle, WA 98133
800-366-1164
http://www.incose.org/intro.html
INCOSE conducts monthly meetings at local chapters throughout U.S. Call to find the local chapter near you.

6. ***CVISN Project Planning Workshop Notebook.***
Workshop sponsored by FMCSA and delivered by JHU/APL. Registration and materials available through [14].

7. ***Early Institutional Lessons from the CVISN Model Deployments: Checklists for Success,*** by John A. Volpe National Transportation Systems Center, October 1998. Publication No. FHWA-JPO-99-030. Available through [13] EDL document #7126.

8. ***The Complete Idiot's Guide to Project Management***, by Sunny and Kim Baker. Alpha Books, 1998. ISBN 0-02-861745-2.

9. ***ITS Procurement Resource Guide,*** provided by the ITS Joint Program Office [13]. *This is a packaged set that contains [18-20, 22-24], plus brochures on TEA-21 legislation, and a short report from VA DOT on public-private partnership procurement issues.*

10. ***A Guide to Federal-Aid Programs and Projects***, by Federal Highway Administration, Office of Program Administration, May 1999. Publication No. FHWA-IF-99-006. Available through [13] EDL document #9043. *Lists projects, federal funding available, eligibility, and point of contact for each. CVISN is on page 59. Another source for this guide and additional information about the TEA-21 legislation is at* http://www.fhwa.dot.gov/engineering/hng10/covert21.htm.

11. ***Software Acquisition Capability Maturity Model*****,** Version 1.02, April 1999, by the Software Engineering Institute at Carnegie Mellon University. Available free at http://www.sei.cmu.edu/arm/SA-CMM.html.

12. **ITS Joint Program Office**
Federal Highway Administration
U.S. Department of Transportation
400 7th St. SW
Washington, DC 20590
202-366-9536
http://www.its.dot.gov

13. **ITS Publications and Distribution**
ITS Joint Program Office
Federal Highway Administration
U.S. Department of Transportation
400 7th St. SW, HOIT-Rm. 3416
Washington, DC 20590
202-366-0722
ITS Electronic Document Library (EDL)
http://www.its.dot.gov/welcome.htm

14. **CVISN Website** hosted by the Johns Hopkins University Applied Physics Laboratory at http://www.jhuapl.edu/cvisn/.

15. ***Introduction to ITS/CVO***, training course prepared for FMCSA by JHU/APL. *1-1/2 days. ITS/CVO program's purpose, structure, components, current and future implementation, and technology.* Available through [13] EDL document #8103.

16. ***ITS/CVO Technical Project Management for Non-Technical Managers***, training course prepared for FMCSA by Booz-Allen & Hamilton. *2 days. Skills development for managing the design and implementation of ITS/CVO technology.* Available through [13] EDL document #8063.

17. ***Understanding ITS/CVO Technology Applications***, training course prepared for FMCSA by JHU/APL. *2 days. Overview of CVISN architecture, technology and standards, and how to apply them to ITS/CVO.* Available through [13] EDL document #8143. See also [78].

18. ***The Road to Successful ITS Software Acquisition Executive Summary.*** Prepared for FMCSA by Mitretek Systems, July 1998. Available through [13] EDL document #4132. (The Executive Summary is also included in [19].) *A must-read for CVISN project managers.*

19. ***The Road to Successful ITS Software Acquisition, Volume I: Overview and Themes***. Prepared for FMCSA by Mitretek Systems, July 1998. Publication No. FHWA-JPO-98-035. Available through [13] EDL document #4130. *A must-read for CVISN project managers.*

20. ***The Road to Successful ITS Software Acquisition, Volume II: Software Acquisition Process Reference Guide***. Prepared for FMCSA by Mitretek Systems, July 1998. Publication No. FHWA-JPO-98-036. Available through [13] EDL document #4131. *Includes comprehensive list of references. A must-read for CVISN project managers.*

21. ***Key Findings from the Intelligent Transportation Systems Program: What Have We Learned?***. Prepared for FMCSA by Mitretek Systems, September 1996. Publication No. FHWA-JPO-96-0036. Available through [13] EDL document #425. *From early ITS experience. Lessons learned are mostly technical, however "Cross-Cutting Findings" related to methodology and management appear in on page 29 of that document.*

22. ***FHWA Federal-Aid ITS Procurement Regulations and Contracting Options***, by FHWA Turner-Fairbank Highway Research Center, October 1997. Publication No. FHWA-RD-97-145. Available through [13] EDL document #3029. *A must-read for procurement. Lessons learned appear in on page 31 of that document.*

23. ***Innovative Contracting Practices for ITS, Executive Summary***. Prepared for FMCSA by L. S. Gallegos & Associates, Inc, April 1997. Available through [13] EDL document #1868. See [24]. *A must-read for procurement.*

24. ***Innovative Contracting Practices for ITS, Final Report***. Prepared for FMCSA by L. S. Gallegos & Associates, Inc, April 1997. Available through [13] EDL document #2859 (note: 363 pages, requires multiple downloads). *A must-read for procurement. Thoroughly researched and footnoted relative to federal/state legislation and case law; comprehensive and detailed, yet*

readily absorbed. Everything you always wanted to know about ITS contracting. Section II is a primer on federal highway funding. Section III covers types of contracts and methods of award, barriers and solutions for contracting on ITS programs. Appendices have case studies, and extracts of legislation and administrative directives. The lead author, Don Dempsey, can be reached at 970-726-4097 wpdon@rkymtnhi.com.

25. **Intelligent Transportation Society of America**
400 Virginia Avenue SW, Suite 800
Washington, DC 20024
202-484.4847
http://www.itsa.org
ITS America Bookstore
202-484-4548
The mission of the Intelligent Transportation Society of America (ITS America) is to foster public/private partnerships to increase the safety and efficiency of surface transportation through the application of advanced technologies. ITS America was mandated by the U.S. Congress in 1991 to coordinate the development and deployment of intelligent transportation systems in the United States. Sponsors conferences, training courses, and numerous working groups.

26. ***Software Development Capability Maturity Model*****,** Version 1.1 February 1993, by the Software Engineering Institute at Carnegie Mellon University. Available free at http://www.sei.cmu.edu/cmm/cmm.html.

27. ***Early Institutional Lessons from the CVISN Model Deployments: Checklists for Success***, by John A. Volpe National Transportation Systems Center, October 1998. Publication No. FHWA-JPO-99-030. Available through [13] EDL document #7126. Five *CVISN Pilot States were studied: CA, OR, WA, KY, CT. Results organized into five multi-level "checklists for success".*

28. ***Developing Intelligent Transportation Systems Using the National ITS Architecture – An Executive Edition for Senior Transportation Managers.*** Prepared for FMCSA by Mitretek Systems, Inc., July 1998. Available through [13] EDL document #3014. *Includes list of high-level references.*

29. ***Developing Traffic Signal Control Systems Using the National ITS Architecture*****.** Prepared for FMCSA by Mitretek Systems, and TransCore, Inc., February 1998. Publication #FHWA-JPO-98-026. Available through [13] EDL document #3015. *Chapter 4 contains lessons learned and best practices.*

30. ***Developing Traveler Information Systems Using the National ITS Architecture.*** Prepared for FMCSA by Mitretek Systems, and TransCore, Inc., August 1998. Publication #FHWA-JPO-98-031. Available through [13] EDL document #4163. *Chapter 4 contains lessons learned and best practices.*

31. ***Developing Freeway and Incident Management Systems Using the National ITS Architecture.*** Prepared for FMCSA by Mitretek Systems, and PB Farradyne, Inc., August 1998. Publication #FHWA-JPO-98-032. Available through [13] EDL document #4203. *Chapter 4 contains lessons learned and best practices.*

32. ***ITS Deployment Guidance for Transit Systems Technical Edition***. Prepared for FMCSA by PB Farradyne, Inc., April 1997. Available through [13] EDL document #4963. *Chapter 5 contains lessons learned and best practices.*

33. ***Successful Approaches to Deploying a Metropolitan Intelligent Transportation System***, by John A. Volpe National Transportation Systems Center, March 1999. Publication No. FHWA-JPO-99-032. Available through [13] EDL document #8483 or on CD-ROM. *The Executive Summary is a "must read". Volpe Center staff visited and interviewed four Model Deployment Initiative sites: AZTech (Phoenix), iTravel (NY-NJ-CT), Smart Trek (Seattle), and TransGuide (San Antonio). Nine key "successful approaches" identified; one chapter devoted to each. Report includes handy "deployment aids" -- appendices with actual contract language from which the reader is invited to cut-and-paste; and tables of question-checklists to apply each of the report's major lessons learned to new projects.*

34. ***Lessons Learned & Success Stories, AZTech ITS Model Deployment Initiative (Phoenix Metropolitan Area).*** April 1999. Available from:
AZTech ITS Model Deployment Initiative
2302 West Durango Street
Phoenix, AZ 85009
602-37-AZTECH
http://www.aztech.org
Not only lists thoughtful "lessons learned", but also contains 20 revealing "success stories" about what went right, such as story #18 which describes their multi-tiered decision-making authorities and 10 cross-jurisdictional product area working groups.

35. ***Proceedings of the Intelligent Transportation Society of America's Ninth Annual Meeting and Exposition*****,** Washington DC, April 19-22, 1999. *Available on CD-ROM from [25]. The CD's search engine identifies 18 papers with "lessons learned".*

36. ***Official Microsoft NetMeeting Book***, by Bob Summers. Microsoft Press, 1998. ISBN 1-57231-816-3.

37. ***The Art of Systems Architecting***, by Eberhardt Rechtin and Mark W. Maier. CRC Press, 1996. ISBN: 0849378362. *A must-read for the System Architect, especially Rechtin's "Heuristics for system-level architecting" in Appendix A. Chapter 10 discusses the relationship of politics to system architecting.*

38. ***Systems Engineering Guidebook – A process for Developing Systems and Products, by James J. Martin.*** CRC Press, 1997. ISBN 0-8493-7837-0.

39. ***Essentials of Project and Systems Engineering Management***, by Howard Eisner. John Wiley & Sons, Inc., 1997. ISBN 0-471-14846-6. See "the thirty elements of system engineering" on page 153.

40. ***Software Engineering -- A Practitioner's Approach***, 4th edition, by Roger S. Pressman. McGraw Hill, Inc., 1996. ISBN 0070521824.

41. ***Top ~~Ten~~ Eleven Ways to Manage Technical Risk***, by the Office of the Assistant Secretary of the Navy, 1998. Publication NAVSO P-3686. Available free at http://www.abm.rda.hq.navy.mil. *Context is military procurement, but the methods apply generally. Chapter 7 discusses key software measures.*

42. ***Never Confuse a Memo with Reality – and Other Business Lessons Too Simple Not to Know***, by Richard A. Moran. HarperCollins Publishers, Inc., 1993. ISBN 0-88730-669-1. *A concise and inexpensive compilation of tips and aphorisms to put the other references into perspective.*

43. ***Software User Interface Design***, by Deborah J. Mayhew. Prentice-Hall, Inc., 1992. ISBN 0-13-721929-6.

44. ***CVISN Guide to Phase Planning & Tracking***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

45. **CVISN Toolkit CD-ROM**. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. May be requested by e-mail at [14]. *A comprehensive set of technical documentation and planning tools assembled on a CD-ROM to assist new CVISN deployment states in the development of their CVISN Project Plans before, during, and after the CVISN Workshops. The documentation on the Tool Kit is linked to the CVISN Web Site for the user to browse and download the latest versions of material.*

46. ***State Fiscal Implications of ITS/CVO Deployment***. Prepared for FMCSA by the National Governors Association, 1998. ISBN 1-55877-299-5. Available through [13] EDL document #5484. *Estimated state savings-to-expenditure ratios for electronic credentialing, and for roadside management, in 8 representative states. Take care to read the whole report – the results are easily misinterpreted. For example, does not account for the FMCSA contribution to state CVISN costs; does not account for safety benefits.*

47. ***A Governor's Guide to Intelligent Transportation Systems / Commercial Vehicle Operations***. Prepared for FMCSA by the National Governors Association, 1997. ISBN 1-55877-273-5. Available through [13] EDL document #2886. *Historical overview of ITS/CVO; Governor's role.*

48. **On-Line ITS Glossary**, by ITS World magazine. http://www.itsworld.com/ITS101/itsglossary.htm

49. Reference deleted.

50. ***Information Technology Omnibus Procurement (ITOP) II Handbook***, by Transportation Administrative Service Center. Download from http://itop.dot.gov/itop/.
ITOP Special Project Office
Transportation Administrative Service Center
U.S. Department of Transportation
400 7th St. SW
Washington, DC 20590
202-366-9848
A federal multiple-contractor procurement vehicle available to state and local governments. Second-generation contract is called ITOP II.

51. ***The Government Contracts Reference Book – A Comprehensive Guide to the Language of Procurement***, second edition, by Ralph C. Nash, Jr. The George Washington University Law School Government Contracts Program, 1998. ISBN 0-935165-54-1. *Definitions of terms, phrases, and acronyms, in alphabetical format. Context is Federal contracting.*

52. ***Elements of Contract Administration – Practical Advice on Performing Government Contracts***, by Richard D. Lieberman. The George Washington University Law School Government Contracts Program, 1997. ISBN 0-935165-55-X. *Brief overview of the important elements and issues contractors must address when performing Government contracts. Context is Federal contracting.*

53. ***Project Management – A Systems Approach to Planning, Scheduling, and Controlling***, sixth edition, by Harold Kerzner, Ph.D. John Wiley & Sons, Inc., 1998. ISBN 0-471-28835-7. *A mature handbook, broad in scope, for every aspect of project and organizational management; topics are discussed in depth. See his "16 points to project management maturity" page ii. Includes case studies.*

54. **IT Policy On-Ramp Website,** hosted by the General Services Administration Office of Information Technology at http://www.itpolicy.gsa.gov.

55. ***A Guide to Planning, Acquiring, and Managing Information Technology Systems***, prepared by the General Services Administration, Office of Governmentwide Policy, December 1998. Available at [54] under "Acquisition". *IDIQ contract described on page 5-29.*

56. **American Association of Motor Vehicle Administrators Website**, http://www.aamva.org.

57. ***Setting Your Course: Reaching Your Destination – A Discussion of Successful Project Management Techniques.*** Prepared for AAMVAnet, Inc. by RESI, a research institute of Towson University, Baltimore, MD. Available at [56] under "Publications".

58. ***Successful Project Management***, third edition, by Milton D. Rosenau, Jr. John Wiley & Sons, Inc., 1998. ISBN 0-471-29304-0. *Emphasizes working within the "triple constraint" of cost, schedule, and technical performance.*

59. ***Department of Defense Handbook – Work Breakdown Structure***, MIL-HDBK-881, published by the U.S.D. Department of Defense, January 2, 1998. Available at http://www.acq.osd.mil/pm/newpolicy/wbs/wbs.html. *Everything you ever wanted to know about work breakdown structures. Includes examples from the defense industry.*

60. ***Quality in America – How to Implement a Competitive Quality Program***, by F. Daniel Hunt. Business One Irwin, 1992. ISBN 1-55623-536-4. *Eloquent yet easy-to-grasp thorough overview of the esoteric world of Total Quality Management.*

61. ***Capability Maturity Model for Software***, Version 1.1, February 1993, by the Software Engineering Institute at Carnegie Mellon University. Available free at http://www.sei.cmu.edu/publications/documents/93.reports/93.tr.024.html.

62. ***CVISN Guide to Top-Level Design***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

63. ***CVISN Guide to Credentials Administration***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

64. ***CVISN Guide to Safety Information Exchange***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

65. ***CVISN Guide to Electronic Screening***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

66. ***CVISN Guide to Integration and Test***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

67. ***Introductory Guide to CVISN***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

68. ***IEEE Guide to Software Configuration Management,*** ANSI/IEEE Std 1042-1987***,*** published by The Institute of Electrical and Electronics Engineers, Inc, 1988. Available for a fee at http://standards.ieee.org/catalog.

69. ***ITS/CVO Funding Strategies for States***. Prepared for FMCSA by Cambridge Systematics, Inc., 1998. Available at http://www.avalon-ais.com/itscvo/.

70. ***CVISN Operational and Architectural Compatibility Handbook (COACH).*** Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].
Part 1 - Operational Concept and Top-Level Design Checklists, POR-97-7067
Part 2 - Project Management Checklists, POR-97-7067
Part 3 - Detailed System Checklists, POR-97-7067
Part 4 - Interface Specification, POR-97-7067
Part 5 - Interoperability Test Criteria, POR-98-7126

71. ***CVISN Glossary***. Prepared for FMCSA by the Johns Hopkins University Applied Physics Laboratory. Available at [14].

72. ***Use of a Design / Build / Warranty Contract***. Prepared for FHWA by the Michigan Intelligent Transportation System Center, March 2000. Available through [13] EDL document #13460. *Argues that ITS projects are not "construction". Describes procurement options that are available under Federal-aid regulations for projects that do not meet the definition of construction. See the summary box opposite its Table of Contents.*

73. **COURSE TITLE: Intelligent Transportation Systems (ITS) Procurement.** COURSE NUMBER: 13620. LENGTH: 1 Day (CEU: 0.6 Units). Offered by the National Highway Institute (FHWA). *DESCRIPTION: Deployment of intelligent transportation systems introduces new challenges to State and local transportation agencies that operate under existing procurement policies. Traditional procurement practices were developed to support the design and construction of roads and bridges or to design and construct rail projects. As such, they do not readily accommodate the special needs of ITS procurement which is focused on operations. This seminar is intended to heighten awareness of the challenges in procuring ITS within the traditional construction project environment. It is a companion to, but not a prerequisite for [74].* http://www.nhi.fhwa.dot.gov/13620.html

74. **COURSE TITLE: Intelligent Transportation Systems (ITS) Software Acquisition**. COURSE NUMBER: 13619. LENGTH: 2 Days (CEU: 1.2 Units). Offered by the National Highway Institute (FHWA). *DESCRIPTION: This seminar provides a general understanding of the many issues involved in the ITS software development and acquisition processes. It is a companion to [73]. It is focused specifically on ITS software issues.*
http://www.nhi.fhwa.dot.gov/13619.html.
Course materials available at: http://pcb.volpe.dot.gov/materials.asp.

75. ***IEEE Trial Use Standard for Application and Management of the Systems Engineering Process***. IEEE Std 1220-1998, published by The Institute of Electrical and Electronics Engineers, Inc. Available for a fee at http://standards.ieee.org/catalog. *Defines the hierarchical "pieces" of a system as components, assemblies, subsystems, and products.*

76. ***ITS Program Evaluation and Assessment Guidelines***. Available from [12] at http://www.its.dot.gov/eval/eval.htm.

77. **National Archives and Records Administration.** Federal laws are available in electronic form at http://www.nara.gov/fedreg/nfpubs.html.

78. ***CVISN Scope Workshop Notebook***.
Workshop sponsored by FMCSA and delivered by JHU/APL. Registration and materials available through [14]. *Includes the latest CVISN architecture and standards at the time of the workshop.*

79. ***CVISN and Safety Planning Processes***, 6-hour workshop developed and delivered by FMCSA. *How to integrate CVISN activities with the statewide and metropolitan planning processes. Also covers the Highway Safety Planning Program such as the State and Community Highway Safety Grant Program (Section 402) and Highway Safety Incentive Grants.* Contact your FMCSA Division Office or Service Center to arrange for the workshop for your state.

APPENDIX B. SAMPLE CVISN STATE PROGRAM PLAN OUTLINE

This outline is provided as an indication of the breadth and depth of information that ideally is included in the CVISN State Program Plan. When finished, the plan will provide the overall direction needed by the team to achieve the program's objectives. Additional detailed planning must be accomplished as part of the phased development process.

Sign-Off Page

Not only does the sign-off page make a handsome first page, it also motivates the signatories to actually read the plan. You will want to get the signature of the heads of all appropriate state agencies, plus representatives of major stakeholders – especially anyone who could subvert successful deployment.

The CVISN Pilot States learned that signers often have one or two serious reservations and are therefore reluctant to sign. The states handled it by specifically acknowledging and documenting those concerns in an "Issues" chapter of the Plan. This technique is especially effective if a signer's objection is limited to only one area (say, a budget item) and he or she is comfortable with all other aspects of the plan.

Cover Page

Table of Contents

1. Program Executive Summary

Write this last, and constrain it to just a few pages. Imagine it is for the Governor. You might even want to print it on colored paper so it stands out.

2. Introduction

Help the reader fit CVISN into both historical and system context. For example, ITS/CVO had its roots in the Federal Intermodal Surface Transportation Efficiency Act (Public Law 102-240, 1991) – commonly called ISTEA; it is currently being funded through renewal legislation, the Transportation Equity Act for the 21st Century (Public Law 105-178, 1998) – commonly called TEA-21 [77]. Explain how CVISN fits into your state's existing systems and strategic plans.

3. Program Objectives & Project Descriptions

CVISN itself has the objectives of safety, simplicity, and savings. Your state will have additional objectives such as joining an existing electronic screening program along a major interstate route. This chapter should define high-level, easy-to-understand goals and objectives for your program.

This chapter should also list the initial projects under your CVISN program. Include brief descriptions so that the readers understand what the projects encompass.

4. System Requirements and Design

- Narrative that summarizes the key features of your design.
- Current State System Design.
- Current Physical Design.
- Proposed State System Design.
- Proposed Physical Design.
- Reference your State CVISN System Design Description. (That document should include the filled-in tables from the COACH Parts 1, 3, and 4 [70]; top-level physical system design; system interface summaries; system change summaries; operational scenarios; and technical issues.)

You do not want to bulk up the Project Plan with copies of material that is better packaged elsewhere, such as in the State CVISN System Design Description. Simply cite that document. You will however want to include a few key top-level diagrams and tables so that the Program Plan can stand reasonably well on its own. Be sure the differences between the current and planned diagrams are easy to notice. This can be accomplished by using different line types, fonts, shading, or colors that reproduce clearly in black and white.

5. Program Work Breakdown Structure

- Top-level WBS elements, decomposed enough to give substantive insight. (For example: down to level 3 or 4.)
- Each project should appear at the second or third level of the WBS.
- Also at the second level: program management, system engineering, and other cross-project functions and services.
- Note that there is a special requirement for assessment and evaluation of federally-funded ITS projects [76], hence its inclusion as a separate top-level WBS element.

On diagrams it is usually clearer to show two or three levels of detail on one page, then shift to separate pages for additional decomposition. Sufficient detail should be revealed to substantiate budget needs. Each project leader should develop a more detailed WBS starting from the applicable point of this over-all program WBS.

6. Program Organization Structure

- State Agency Organization Chart.
- State CVISN Program Organization Chart.
- (Optional) Project Organization Charts.

In the State Agency Organization Chart, highlight the entities that are involved in the CVISN program and its projects.

In the State CVISN Program Organization Chart, show the key players for CVISN in the state, and how they relate to each other within the CVISN programmatic structure. Include roles, names, and the individual's home agency/office. If there is a Steering Committee, include it. Also show the configuration management teams.

7. Program Work Assignments

- Map the WBS tasks to the program organization.
- Each task should have a responsible entity (state agency or contractor) and, where possible, be assigned to a specific individual for execution.

The result is a matrix in which each row represents a task, and the columns contain the name of the responsible agency and person.

8. Procurement Strategy

- Narrative and charts explaining the various contracting approaches; which items can be grouped together for procurement actions; procurement lead agency/personnel assignments; and the sources of funding (if known).

The procurement strategy establishes the plan of attack for how the program will go about purchasing various goods and services. The strategy also identifies the stakeholders that should be involved with each procurement.

9. Program Processes

Your program should have defined processes (i.e., descriptions about how you will do business) for the activities you want to be common across all projects. For instance, you may choose to enforce common practices for project planning, procurement, phase planning and tracking, and some aspects of configuration management. Clear and effective coordination and communication result when state agencies and contractors use common processes for activities where information must be shared.

The following are suggested processes to think about:

- Work Planning
- Progress Tracking and Status Reporting
- Budget Planning and Tracking
- Schedule Planning and Tracking
- Procurement
- Contracting and Contract Management
- Sponsor Liaison
- Funding
- Legislative Liaison
- Motor Carrier Liaison
- Inter-Agency Liaison
- Training
- Configuration Management
- System Development
- Information Systems
- Product Documentation
- Testing
- Program Library
- Team Meetings
- Team Communications
- Action Items
- Issue Resolution
- Collecting data for cost-benefit or cost savings analysis per FMCSA guidelines on self-evaluation of ITS projects [76]

Where there are existing process descriptions, simply cite them. Where none already exist, we suggest you create them. Everyone on the program should have the same understanding of how they are going to get the job done.

The state's working copy of the COACH Part 2 Management Checklists [70] should either be included in this chapter or in an appendix. It is used to explain planning and management processes.

10. Program Phases and Critical Milestones

- Major Milestones.
- Program Phase Charts.
- Build Summary Chart for each Project.

At the end of each phase there should be some new or improved capability. Achieving this capability may require synchronized accomplishments in multiple projects. It should be possible to define one or two major measurable milestones for each phase.

11. Funding Resources, Program Budget

- WBS element costs per unit time (probably fiscal year) indicating personnel, subcontract, procurement, and other direct costs.
- Funding: known resources for the program; planned or anticipated funding sources over time.
- Pie chart showing percentages of funding coming from different sources.

12. Program Products

- Table of significant hardware items for the program.
- Table of significant software components for the program. Do you have access to the source code?
- User and maintenance manuals.
- Table of significant deliverable design documents for the program as a whole. Also include major categories of documents for each project.

Products should be inherent in the WBS as tasks so that they appear with assignments, costs, and schedules. Listing them separately in this plan is useful for visibility and as a crosscheck against the details of the project task lists. Be sure to address intellectual property rights, such as the state's ability to modify software source code.

13. Program Issues to be Resolved

There may not yet be any. However, we have found that often enough a signatory to the Program Plan won't sign off without reservations, and this is a place to document those reservations. If there are some high-risk items, note them here, along with your plans for risk mitigation. Keep track as the issues are settled.

Possible Appendixes:

- Definitions of acronyms.
- State's working copy of the COACH Part 2 (Management Checklists) with columns filled in [70].
- State's working copy of the COACH Part 1 (State System Checklists) with columns filled in [70].
- Point-of-contact list with addresses, telephone numbers, e-mail.
- Previous, related plans and reports needed for ready reference.
- Any other information too detailed for the main body of the document, yet necessary in order to communicate fully.

APPENDIX C. SAMPLE CVISN STATE PROJECT PLAN OUTLINE

This outline is provided as guidance for the breadth and depth of information that should be included in a state CVISN Project Plan. In practice, a Project Plan may be published formally at the beginning of each project, and then be maintained as an informal "living" document focused on the phased development of incremental capabilities. As such, a Project Plan often evolves into a collection of historical information, fairly short-term plans, and current status. Additional detailed planning must be accomplished as part of the phased development process.

Please see Appendix B in the CVISN Guide to Phase Planning and Tracking [44] for ideas about maintaining a Project Leader's Notebook. It is convenient to keep the Project Plan in a three-ring binder, or its electronic equivalent. Segregate historical from current information so that you don't keep flipping through material you don't care about at the moment.

Sign-Off Page

At the project level, there are two motivations for getting signatures for the plan: to get the commitment from people who will actually do the work, and to get the endorsement of their commitment from their bosses. This page, together with the budget allocation, staffing plan, and project phase objectives, may be something you turn into a memo that you distribute at the start of each new phase to reconfirm everyone's commitment.

Cover Page

Table of Contents

1. Project Executive Summary

Imagine you are writing it for the person who controls your money, and for the line managers your team members report to. Keep this up to date because you may be asked for a project summary on short notice, for some other venue. Check off the objectives as they are met.

2. Introduction

Help the reader fit this project into a broader context. Explain how this project fits into the overall CVISN program and into your state's existing systems and strategic plans.

3. Project Objectives

The overall CVISN program has objectives stated in the Program Plan. This project's objectives support the program's objectives and can be stated in terms more specific to the functional area the project is related to. Use language that makes sense not only to the project team but also to the ultimate end-users.

4. Project Requirements and Design

- Narrative and illustrations that summarize the key features of the system components in this project.
- Current State System Current Physical Design.
- Proposed State System Design.
- Proposed Physical Design.
- For the preceding 3 items, you might want to show only the components that are involved in this project.
- Reference the relevant parts of your State CVISN System Design Description. Redline or update this companion document as you implement each phase.

On the one hand, this plan should stand on its own; on the other hand, it should not unnecessarily duplicate information better captured elsewhere. This chapter is a place to reference other documents which explain requirements and design. For each phase, expect that more detailed requirements and design need to be fleshed out.

Make use of diagrams and charts – they are powerful tools for communication, and are easier to maintain than extensive prose.

5. Project Work Breakdown Structure

- Graphical representation of up to 5 levels of detail.
- Indented list format for all details.

The top element (level 1) is the project name itself. A graphical view of the WBS is useful for about 5 levels at most; beyond that an indented list is easier to follow. Develop the WBS using a tool that lets you view the information in different formats, sort on different fields, hide classes of information without deleting it, etc. Stay in synch with any programmatic WBS numbering system.

During early project planning, sufficient detail needs to be shown to determine budget and staffing needs for the project. The complete details for later phases can be supplied during phase planning.

6. Project Organization Structure

- Project Organization Chart of team members.
- Include both state and contractor employees, as well as contributing stakeholders.

The entire project team is shown on this chart or series of charts. The Project Leader is shown on both this chart and on the State CVISN Program-level Organization Chart.

7. Project Work Assignments

- Map the WBS tasks to the individuals in the responsible line organizations.
- Map the WBS tasks to contractors and the responsible individuals in those companies.

The result is a matrix in which each row represents a task, and the columns contain the name of the responsible agency and person.

Each task should be assigned to the individual responsible for completing it. If an individual cannot be identified for a task that is far in the future, then show the element of the organization the task is assigned to.

8. Project Processes

- Deviations from program processes.
- Project-specific processes.

Everyone on the project should have the same understanding of how they are going to get the job done. Process descriptions should be as simple and concise as possible. References to existing documents that everyone on the team already has access to may be inserted, instead of copying the process descriptions into this chapter.

9. Project Detailed Schedule and Milestones

- Major Project Milestones.
- Project Phase/Build Charts.
- Reference to location of computer files for latest versions of files, which may change often.

The project's phases may or may not align exactly with the program's phases. During each phase, there are specific objectives for each project, noted on a Project Phase Chart for that phase. Achieving the new or improved capabilities may require synchronized accomplishments in multiple sub-projects corresponding to different products.

It is useful to have one or two milestones each month or so, to indicate how the project's phased objectives will be achieved. Working-level schedules in activity network or Gantt chart format are not part of the document, but do need to be developed, preferably using a desk-top scheduling tool. The CVISN Guide to Phase Planning and Tracking [44] offers advice about the detailed planning and monitoring that occurs during development and deployment.

10. Project Budget Details

- WBS element costs.
- Personnel, subcontract, procurement, and other direct costs phased over time to show staffing requirements and cash flow.
- Summarized costs for each fiscal quarter, as funding may be done by quarter.

11. Project Products

- Table of significant hardware items for this project, including warranty requirements.
- Table of significant software components for this project. Do you have access to the source code?
- User and maintenance manuals.
- Table of significant deliverable design documents.

The product lists should be folded into the WBS as tasks so that they appear in the assignments, costs, and schedules. Listing them separately in this plan is useful as a crosscheck against the details of the project task lists. Be sure to address intellectual property rights, such as the state's ability to modify source code.

12. Project Issues to be Resolved

There may not yet be any. If there are some high-risk items, note them here, along with your plans for risk mitigation. As the issues are settled, it is handy to write a quick note about how they were resolved.

Potential Appendixes:

- Definitions of acronyms.
- Team member list with addresses, telephone numbers, e-mail.
- Previous, related plans and reports needed for ready reference.
- Any other information too detailed for the main body of the document, yet necessary in order to communicate fully.

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APPENDIX D. SAMPLE JOB DESCRIPTIONS

D.1 State CVISN Program Manager

POSITION OBJECTIVE:

This position has specific delegated authority to manage the statewide deployment of separate projects identified to implement CVISN Level 1 Capabilities. This position will be responsible for accomplishing the design and development of these projects. The Program Manager also will be responsible for planning, managing, and directing the work of senior managers and private contractors in multi-disciplined design, plan review, including right-of-way plans, and review of computer system design impacts on construction projects.

The Program Manager also will be responsible for the development of program contracts, Requests for Proposals (RFP), reviewing and making effective recommendation for acceptance of scope of work documentation, and cost estimations. This position also will represent the State at meetings of regional and national ITS/CVO committees.

KNOWLEDGE AND SKILLS REQUIRED:

This position is a high level management position requiring broad experience in managing a multi-disciplined staff, strong managerial skills, and a strong command of federal, state, and local transportation policies and guiding principles. Knowledge of international policies and issues may also be required, especially at border states.

This position requires the ability to negotiate with diverse interest groups to bring about consensus with both the public and private sector partners. A broad knowledge of the transportation agencies' regulatory functions is necessary to ensure that appropriate expertise is available and utilized throughout all phases of the deliverables.

The Program Manager's specific areas of knowledge should include:

- State agency functions in the commercial vehicle arena.
- CVISN architecture and principles.
- State and federal commercial vehicle laws and regulations, industry practices, and other states commercial vehicle operations.
- Contract development and administration involving Federal cooperative agreements.
- Federal grant application/development process.
- Application of project management principles.
- State and Federal budget management, planning, and administration for inter-agency budget proposals.

- State procurement and acquisition policies, procedures, and contract management.
- State and federal legislative processes, including practical experience in working with legislative committees.
- Methods needed to create and communicate strategic and business plans for ITS-related projects.

The Program Manager should have the skills to:

- Coordinate activities of multiple projects to achieve one coordinated outcome.
- Display strategic and creative thinking regarding the deployment methods of multiple projects having long-term impacts on the state's infrastructure.
- Provide effective oversight to projects, identifying problems and constructing plans of actions to mitigate risks.
- Communicate effectively and interface with customers, private sector business executives, high level regulatory agency managers, legislators, executive management and technical staff.
- Work without direct supervision.

NATURE AND SCOPE:

The scope, authority, and impact of this position will have significant impact from within and outside of state government. The incumbent will be expected to develop policy regarding CVISN, which will have a visible impact on a substantial portion of the state's economy and which will be critical to the central business purpose of the state.

Because of the high visibility of CVISN, the Program Manager will retain full oversight for all business, administrative and technical aspects of the projects. This position will be expected to practice the full utilization of management principles in carrying out the duties of this job. This position will direct supervisors and managers from the other transportation agencies while fulfilling the goals and objectives of the CVISN program. The implementation of this program demands that this position have the ability to define the work breakdown structure and execute the work. The position will be responsible for making decisions in all matters of the design process, advising senior management of decisions, and soliciting input and alternatives on decisions of major impact to the CVISN program.

PRINCIPAL RESPONSIBILITIES:

- Develop, execute, and maintain the CVISN Program Plan.
- Identify, secure, and maintain program funding.
- Staff program leadership positions.
- Administer the CVISN Program, assisted by the Program Facilitator/Administrator.
- Provide technical, schedule, and financial/funding oversight and guidance during the design process for all state CVISN projects to ensure conformance with state and national standards.
- Ensure that the proper management and technical documentation is developed and appropriately reviewed.
- Work with the public and private sectors to develop and ensure consensus about program definition. Receive and resolve complaints or concerns from the public about program definition.
- Interface with executive level management, administrators, managers, and both program and non-program staff.
- Liaison to the CVISN Steering Committee.
- Assist with the development of strategic ITS/CVO regional business plans to ensure compatibility with adjoining states.
- Assist with testimony to the appropriate legislative committees regarding the deployment of CVISN.
- Work with industry in the deployment of CVISN.

D.2 State CVISN System Architect

POSITION OBJECTIVE:

The position has delegated authority from the CVISN Program Manager to direct the technical engineering, development, and deployment of CVISN compliant systems and networks for safety information exchange, credentials administration, and electronic screening. The engineering will involve planning for interfaces and modifications to existing statewide legacy systems, and ensuring that the State systems are compatible with the national CVISN architecture, standards, and operational concepts.

The System Architect, in addition to providing technical engineering services, will manage professional, technical personnel responsible for a variety of tasks. The technical tasks managed by the architect will include: information system design and documentation; implementation and installation of CVISN software and hardware; and communication systems development and design. The System Architect also will provide technical expertise to all CVISN partners (both state and industry) and will be responsible for monitoring the design deliverables from private sector vendors. The System Architect will represent the State at the national and international level in discussions about CVISN standards and protocols.

KNOWLEDGE AND SKILLS REQUIRED:

The System Architect's specific areas of knowledge should include:

- Information system design and documentation principles.
- CVISN system architecture.
- CVISN interface standards.
- Current and emerging Commercial Vehicle Operations practices.
- Operational and technical principles of analog and digital microwave carrier systems.
- Operational and technical principles of mobile data communication systems;.
- Operational and technical principles of wide area networks (WAN), local area networks (LAN), and their associated protocols.
- Strategic planning and organizational development.
- Identifying and managing conflict within the work environment.
- Quality management techniques.
- Problem solving using quality principles to effectively facilitate change.
- Project management principles and tools.

The System Architect should have the skills to:

- Design, develop and manage multiple technical projects simultaneously.
- Make sound technical decisions.
- Lead technical people effectively, including successful team building, coaching, mentoring, and persuasive and influential leadership.
- Work with staff at all levels within the organization including the executive level.
- Communicate effectively technical and non-technical information (written, oral, and presentations).
- Work with multiple state and federal agencies on highly technical issues and projects.
- Work without direct supervision.

NATURE AND SCOPE:

The System Architect position will:

- Report to the CVISN Program Manager.
- Provide appropriate and desirable guidance to technical and project leaders in such a manner as to strategically cause a unified approach to the program.
- Work with the CVISN Project Leaders in developing the designs for the state CVISN components.
- Assist the CVISN team in identifying, developing, implementing, and managing information system policies regarding the deployment and maintenance of the CVISN program.
- Advise managers and leaders at all levels within the state transportation agencies and private sector partners on issues of an architectural nature that might affect them.
- Identify, develop, and implement policies regarding the design, installation, maintenance and coordination of data systems supporting local, state, and federal customers.
- Consult with other state agencies, other states with their respective agencies, and federal agencies on the potential policy impacts regarding the implementation of new technologies, their associated standards, and communication system designs.
- The System Architect will have technical leadership responsibilities for the program.

Employees who may be indirectly managed by this position have responsibility for duties such as: designing and managing the implementation of statewide communication systems; providing consultation to local, state and federal agencies; and developing and implementing standards and practices for the CVISN information systems within the State.

Decision-making responsibilities brought to this position for action include:

- Information system and communication system design, implementation and maintenance decisions.
- Evaluating technical alternatives.
- Assessing the impact of problems.
- Development of Requests for Proposals (RFP) for technical projects and evaluation of responses.

PRINCIPAL RESPONSIBILITIES:

- Develop and maintain the State CVISN Top-Level Design Description.
- Monitor the design, implementation, test, and integration activities within and across projects, to ensure that the top-level design is satisfied, and that program objectives are met.
- Assist the Program Manager in establishing objectives and top-level phase plans.
- Oversee the Independent Validation and Verification process of the state's CVISN program to ensure nationwide compatibility.
- Identify, develop, and implement policies and processes having multi-agency application regarding the design, installation, maintenance, and coordination of CVISN related information systems.
- Identify, assess, and communicate to state and federal CVISN partners and private industry the impacts of current and developing technologies.

D.3 State CVISN Program Facilitator/Administrator

POSITION OBJECTIVE:

This position provides administrative assistance to the State Program Manager in managing the State CVISN Program. The Program Facilitator/Administrator implements a consistent, unified approach to project management by applying and promoting basic project management and system engineering principles to the State CVISN Program, including:

- Planning - beginning with a shared view of the objectives and agreement on priorities (prepare and maintain program plan).
- Organizing - developing clear statements of work and responsibility.
- Development - maintaining program awareness and documentation as program elements change (organize and facilitate status meetings; define templates for reports).
- Visibility - identifying what is going well, what is behind, who needs help, and what can be deferred (schedule and track milestones).
- Control - ensuring key goals and objectives are being met.

The Program Facilitator/Administrator can be a representative of a participating State agency, or a consultant working with the State.

KNOWLEDGE AND SKILLS REQUIRED:

The Program Facilitator/Administrator's specific areas of knowledge should include:

- Program organization, planning, and administration; principles and tools; application of program/project management principles, including WBS and scheduling techniques.
- Team building and facilitation for meetings, workshops, and other conferences.
- State information technology system planning and status reporting requirements.
- State procurement and acquisition policies, procedures, and contract management.
- Methods needed to create and communicate strategic and business plans for ITS-related projects.
- Basic information system design and system documentation principles.
- Awareness of CVISN system architecture and principles; awareness of State agency functions in the commercial vehicle arena.

The Program Facilitator/Administrator should have the skills to:

- Lead the preparation of program-level planning documentation.
- Organize program level status meetings and State status presentations at external conferences.
- Identify and report on activities of multiple projects to present a single coordinated status.
- Work with employees at all levels within the organization including the executive level.
- Facilitate technical and planning meetings.
- Effectively communicate both technical and non-technical information (written, oral, and presentations).
- Work without direct supervision.

PRINCIPAL RESPONSIBILITIES:

- Assist the Program Manager in developing and maintaining the State CVISN Program Plan.
- Develop, with the Program Manager, System Architect, and Project Leaders, the procurement strategy.
- Assist the Program Manager in administering the CVISN Program.
- Assist the procurement team(s) with accomplishing the procurements.
- Define and develop program status reports; prepare milestones and status summaries.
- Schedule and lead program status meetings; prepare agenda, coordinate logistics, coordinate and review presentations for accuracy, completeness, and applicability.
- Facilitate discussions at technical group meetings.

APPENDIX E. PROCUREMENT PRINCIPLES & STRATEGY

E.1 Three Excellent References

The challenges of CVISN system acquisition are not unique to CVISN but rather are common to every area of Intelligent Transportation Systems. Fortunately in the last several years much has been documented, and pioneering procedures and lessons learned are readily available. Three of the references cited in this guide stand out as being profoundly useful in the area of procurement.

The **first is *The Road to Successful ITS Software Acquisition*** [18-20]. If you only have time to read one other document, read its executive summary [18]. The full report [19, 20] is enriched with anecdotes and lessons learned.

The **second is *Innovative Contracting Practices for ITS*** [23, 24]. This is for your team's contracting professional; not warm and fuzzy lessons learned but rather hard cold legal procedures and citations. It is thoroughly researched and footnoted relative to federal/state legislation and case law; comprehensive and detailed; yet readily absorbed. Everything you always wanted to know about ITS contracting. Section II is a primer on federal highway funding. Section III covers types of contracts and methods of award, and barriers and solutions for contracting on ITS programs.

The **third reference is *FHWA Federal-Aid ITS Procurement Regulations and Contracting Options*** [22]. If you have ever had the thought "I want this software developed on a fixed price contract, with a product warranty" then you should read this reference.

Much of this chapter is adapted directly from these three references.

These references are available as a packaged set from FHWA: *ITS Procurement Resource Guide* [9].

E.2 "Software is Different"

Deploying CVISN means deploying multiple software products, and "software is different" [18]. Acquisitions that involve a significant amount of software development are notorious for their problems. Experienced project managers find that proven managerial techniques – which worked so well for them on other types of projects – fail for software. They complain about their lack of insight into what the final system will be like, and their lack of visibility into progress by the contractor.

Representatives from the public and private sectors who have been involved on ITS software acquisitions have very different perceptions as to what goes wrong. Each feels that the other takes advantage of the situation. They perceive that the other party "wins" while they "lose".

This leads to mistrust. Both sides then resort to acquisition practices that further exacerbate the situation.

Compared to traditional state DOT acquisitions, software is different in that it requires a greater customer role than many are used to, from requirements to risk management to system acceptance. As a major consequence, flexibility is needed in the contract to accommodate change and take advantage of the opportunities presented by collaboration and open communication.

E.3 Why do Software Acquisitions So Often Fail?

Reasons given are [19]:

1. Software systems are more complex. They have temporal characteristics, such as sensor data inputs or operator interactions, with real-time interactions. System integration, the most difficult aspect, is primarily a software concern.

2. Human interfaces (including printed reports) are implemented in software. Often the users don't know what they want or don't want until they experience it.

3. On software projects, *production costs* are relatively inexpensive (example: producing a CD-ROM) as compared to *design costs*. This gives the illusion that changes are easy to make. Compare this to highway construction projects, where the fabrication costs serve as a natural impediment to making unrestricted changes to the finished product.

4. Monitoring progress on software projects is difficult. It's not like seeing asphalt being laid down.

5. It is difficult to get a sense of the look and feel for the eventual system from paper documents.

E.4 CVISN Development Contracts Need Flexibility

Some of the decisions you will make are easily reversed. A requirement can be altered with the stroke of a pen. Staffing can be altered with a graceful change in assignments. But by its very nature a contract has permanence through its period of performance. So you want to make sure you are using the right contract vehicle, and with a viable vendor.

No one acquisition practice or contracting mechanism is a panacea that can be relied upon to rescue a project. No acquisition vehicles are ideal for software, **and the familiar highway-oriented engineer/contractor (design-bid-build) approach is particularly inappropriate**. Any type of contract with firm deliverables and fixed ceilings for price does not provide the needed flexibility for building software or modifying existing products.

As compared with other construction projects, software projects need more give-and-take. Flexibility is needed throughout the acquisition lifecycle: in the requirements, in the applied technologies, in the working relationships, and in the contracting mechanism.

Requirements will evolve over time. Reference [18] cites an internal reference that states that two percent of the requirements will change per month. Over just a two-year acquisition this is half of the requirements! Meeting only 80-90% of the perceived needs may be the most realistic and cost-effective solution.

Practical technologies also evolve over time. For example, within the course of recent deployment projects, the World Wide Web evolved from a risky emerging technology to a taken-for-granted feature of the networking infrastructure.

With respect to software development cost, it is impossible to provide precise, reliable cost estimates at the beginning of a project; only a range is possible. When difficulties arise, there must be the flexibility to trade off costs with schedule and functionality as the acquisition unfolds. Here is where the phase-planning approach pays off; it allows the project to be re-scoped. This means you need the flexibility of loosely-defined contract options that are more precisely defined as the project proceeds.

By using incremental phased development, users are more willing to defer capabilities into the next release of the software. On the other hand, if they see a long development cycle, they will try to cram as much capability as possible into the initial release, which further exacerbates the problem. Phased development is discussed fully in *the CVISN Guide to Phase Planning and Tracking* [44].

E.5 Utilize Existing Commercial Software

Purchasing pre-existing ("COTS" for commercial off-the-shelf) products alleviates many of the risks associated with building custom software. Unique requirements can preclude their use, but any such requirements should be examined to determine whether they really are important or whether the system is over-specified. This is an opportunity for your state to partner with neighboring states to develop common CVO business practices and therefore have common requirements.

E.6 Software Acquisition Process

Traditional contracting vehicles used on construction, consulting, and other types of transportation projects are not appropriate for software. Reference [18] makes these key recommendations in the following critical areas:

E.6.1 Acquisition Team

Take a team approach. Skills that must be included on the acquisition team include:

- Software technical experts (system architect; legacy databases; networking).
- Domain experts (IRP, IFTA, safety, inspection, enforcement).
- Contracting officials to select and implement the most appropriate contracting vehicles.
- Legal staff to anticipate and resolve intellectual property rights issues, which are commonplace with software.
- End-users (both within-agency and at carrier's offices).

E.6.2 Requirements Management

The first key activity is to develop a sound set of functional and performance requirements. Unlike other transportation projects, software acquisitions should not develop design specifications or technical requirements at this stage. **Specify "what" not "how".**

An on-going requirements management process will be needed, carried out collaboratively by customer and contractor **with give-and-take on both sides**. There is a compromise line to be walked between freezing the requirements versus never-ending scope creep. It is necessary to allow for extensive iteration between the customer and the designer as part of the system definition. Start off on the right foot with a requirements walk-through with the software contractor, where every requirement is thoroughly examined until the customer and contractor achieve a common understanding of it.

Changes to requirements must be carefully controlled. This does not mean "frozen". There should be sufficient teamwork and contractual flexibility to clarify ambiguities, flesh out lower-level requirements not initially addressed, and reconsider requirements that pose unexpected risk or difficulty.

Human interface requirements are best developed by rapid prototyping and user feedback. It is often impossible to visualize the implication of written requirements. Real-world interaction with the system reveals flaws inherent in the requirements. Users know what they like or don't like when they see it, but often cannot articulate it beforehand.

E.6.3 Intellectual Property Rights

Intellectual property rights come up because of the customer's wish to own and/or retain "the code". Resolving the intellectual property rights must be done before a contract is signed. Chapter 13 of reference [20] provides a checklist to assist with this thorny issue.

E.6.4 Software Scheduling

There are two common flaws with software project scheduling [18]:

- Milestones may be established independent of requirements (for example, to meet political goals).
- Schedules are squeezed so tightly that they are impossible even if everything goes perfectly.

More often "realistic" equates to "pessimistic".

Citing one of its own references, [18] asserts that **one of the most effective ways of lowering the cost and total effort on a software development project is simply to stretch out the schedule**.

E.6.5 The After-Thought of Acceptance Testing

Even though system testing does not take place until much later in the lifecycle, you should plan a formal system acceptance testing strategy early. Pursue acceptance test preparations (preparing test cases, setting up a test environment) in parallel with software development. This will avoid the common problem of treating acceptance testing as an after-thought. In your RFP, ask the vendor to propose their test methodology.

E.6.6 On-Going Management Activities

Conduct monthly and quarterly project reviews; use quantitative measurement data to gain visibility into contractor progress. Have team meetings; the closer the participants are to the day-to-day work, the more often they should meet. Individual development teams typically meet weekly; project teams monthly; oversight committees quarterly. Monitor schedule and inter-project dependencies. Reference [18] emphasized that **if schedule slips occur, do not try to play "catch up"**. Either stretch the remaining schedule in accordance with the slip or reduce functionality in the same proportion.

E.6.7 Risk Management

Engineers define "risk" as probability-of-occurrence times consequences. For risk management to work, there must be an atmosphere that fosters project personnel to come forward. **Continually foster open communications. Each side needs to be able to bring bad news to the other without fear of being "shot down" or of facing recrimination.** This is most effectively done as a teaming activity between customer and contractor since their different perspectives on the system lead them to identify different risks.

E.6.8 Keeping the Customer-Contractor Relationship Win-Win

Open communications allows contractors to better understand customer needs (not "requirements"), while at the same time customers can better understand the implications of their requirements and changes on the level-of-effort required.

Formal *acceptance test plans* clarify what criteria are used to accept a system. This allows contracts to reach closure, and it assures the customer that the system meets requirements and provides sufficient reliability.

Attention to *maintenance and training* clarifies expected roles during these phases. Provisions for contractor maintenance allow bugs to be fixed. Documentation addressing system administration functions alleviate customer dependence on the contractor.

E.7 Software Acquisition Best Practices

The list below of best practices for software acquisition is adapted from [20].

- **Use existing products to the maximum extent practicable.**
- **Build a cross-functional team and collaborate with them.**
- **Maintain on-going, open communications with the contractors and other members of your team.**
- **Document requirements and have them serve as the basis of other activities.**
- **Develop a support strategy for the system.**
- **Trade off requirements to decrease cost and schedule. Keep all three in synch.**
- **Identify problems, record them, and track their status.**
- **Track expenditures and progress.**
- **Conduct risk management, as a team, as an integral part of the acquisition process.**
- **Develop an acceptance test plan and carry it out.**
- **Develop training materials and carry out a training program for use and support of the system.**
- **Have explicit contract language documenting licensing and ownership rights.**
- **Ensure software meets Federal requirements for architecture and standards consistency.**

E.8 Utilize Indefinite Delivery / Indefinite Quantity (ID/IQ) Task Order Contract Vehicles for Information Systems

An ID/IQ contract is one that provides for an indefinite quantity, within stated maximum or minimum limits, of specific supplies or services to be furnished during a fixed period of time, with deliveries to be scheduled by placing task orders with the contractor. See the definitions in Reference [51]. The theory behind ID/IQ contracts is to compete them beforehand based upon qualifications, in response to a broad statement of work. Their flexibility makes them well-suited for phased development and deployment, and amid the rapidly-changing technology underlying transportation information systems.

E.9 Omnibus Contracting Vehicles

A Federal contracting vehicle may become available for State use.

The U.S. DOT Transportation Administrative Service Center manages the Information Technology Omnibus Procurement (ITOP) contracting vehicle. It is a multiple contractor procurement vehicle that is designed to provide a broad range of support resources related to Information Technology. The intention is to extend its availability to state and local government agencies. The second-generation Information Technology Omnibus Procurement (ITOP II) program consists of 26 contractors (and their associated subcontractors) who have formed 35 ITOP II teams:

- Information Systems Engineering (14 contractors).
- Systems Operations and Management (13 contractors).
- Information Systems Security Support Services (8 contractors).

ITOP has these characteristics:

- Indefinite Delivery, Indefinite Quantity (ID/IQ) task order contracts which could total $10 billion over an estimated 7 year life
- Multiple contract types available
  - Firm Fixed Price
  - Cost Plus Fixed Fee
  - Cost Plus Award Fee
  - Time and Materials
  - Fixed Price Award Fee
- Multiple year task orders permissible
- $300 million task order limitation
- Primarily competitive, with some limited directed (sole source) orders allowed
- While primarily services, hardware/software may be acquired and leasing may be included to support full solution based IT contracting

The ITOP Special Project Office (SPO) is responsible for overall contractor performance management. There is a small fee.

E.10Innovative Contracting Practices – Major Findings

In *Innovative Contracting Practices for ITS* [23], several findings cut across all issues as being critical to the success of ITS procurements. These four major findings are:

E.10.1 "How a Procurement is Characterized is Critical."

How one classifies an ITS project is important. For example, procurement rules and regulations may provide much more flexibility to procure financial administration systems than to procure ITS design services. It is important to be flexible in the classification of ITS projects early in the procurement planning process in order to preserve a maximum range of procurement options and implementation strategies.

E.10.2 "Flexible Procurement Practices Work Best if Initiated Early."

Innovative contracting practices can be applied to all phases of an ITS project, but work best if applied at the outset to incorporate strategic objectives into the procurement planning process and the terms of the resulting contracts. Institutional or legal barriers that were identified in advance by participants were eliminated or mitigated by innovative contracting practices.

E.10.3 "ITS Solutions Can Be Implemented at Various Institutional Levels and Project Phases."

State and local transportation agencies implementing federally funded ITS projects have a variety of tools available to overcome contracting barriers to ITS. Not all barriers require legislative or regulatory changes; many can be implemented by flexibly restructuring organizational or managerial aspects of a project. The report identifies a variety of procurement tools to build in flexibility at various institutional levels:

- Partnering with other public and private sector entities.
- Enacting new or revised legislation.
- Selecting funding sources which allow flexibility.
- Leveraging intellectual property rights.
- Utilizing private sector cost sharing with reasonable compliance requirements.
- Carefully segregating, bundling and drafting contract scopes of work.
- Promoting competition among pre-qualified offerors.
- Utilizing evaluation and award criteria that are fair and flexible.
- Incorporating expedited dispute resolution practices.

E.10.4 "ITS Procurements Present Opportunities for Experienced Procurement Professionals to Innovate Within Existing Legal Framework."

Procurement professionals experienced in utilizing innovative contracting practices can assist in removing institutional barriers to ITS deployment. There is however, **a shortage of experienced professionals who are knowledgeable in nontraditional public or private procurement models**. As a result, innovative procurement solutions allowable under current rules, regulations and practices go unidentified, unused, or underutilized. ITS procurements represent opportunities for experienced, creative procurement professionals to develop creative solutions.

Involving experienced procurement professionals early in the planning process enhances a project's chance of success. In addition to in-house professionals, **agencies deploying ITS should consider contracting for external resources to provide innovative procurement expertise**. Having experienced contract professionals involved in a procurement enhances its chances for a successful outcome. The organization from which a contract professional comes is less important than ensuring that a project has access to at least one person who knows the procurement rules, regulations, and practices, and knows how to proactively apply them.

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APPENDIX F. PROCESS MATURITY

F.1 What is a Process?

Teamwork and processes get projects accomplished. A short definition of "process" is [11]:

> *A set of activities performed for a given purpose.*

A more insightful definition is [60]:

> *The logical organization of people, materials, energy, equipment, and procedures into work activities designed to produce a specified end result. A system in operation to produce an output of higher value than that of the sum of its parts.*

A small number of key processes must be in place for CVISN development and deployment. Key technical processes are described in the CVISN technical guides. Key project management processes are described in the guide you are holding and in the *CVISN Guide to Phase Planning and Tracking* [44]. Since software is such a significant element of any ITS project, your state might be interested in assessing the maturity of its own software acquisition process [11].

F.2 What is Process Maturity?

Process maturity is what gives you confidence when you visit the ophthalmologist's office for laser vision correction, or when you take out-of-town guests to your favorite restaurant. The success of those organizations isn't by luck on a good day. Rather, it is built upon **repeatable robust processes that work in spite of fallible human beings**.

Process maturity has been modeled as stages though which organizations evolve as they define, implement, measure, control, and improve their processes. In an effort to permanently transform software development from esoteric wizardry into predictable engineering, the Software Engineering Institute at Carnegie-Mellon University in 1988 first published the seminal concept of a process maturity framework, best known as the software development process capability maturity model [61]. See Figure F-1.

This framework has proven to be so profoundly useful that it has been applied to several other areas such as system engineering, and most recently the *Software Acquisition Capability Maturity Model* [11]. As a project manager you have the power to exert firm control over many of your project's processes. Awareness of process maturity helps you envision what is possible; smooth-running processes (even for "simple" tasks like status reporting) are more efficient, effective, and satisfying.

F.3 Process Maturity Framework

The Software Engineering Institute's landmark process maturity model framework has five levels:

Level 1. Initial

Often better described by what it lacks rather than by what it has. There are no formalized procedures, no cost estimates, no project plans, no change controls. It is marked by a lot of crisis behavior. "Initial" may be a polite word for "chaotic".

Level 2. Repeatable

Key process areas are recognized. There is requirements management, project planning, project tracking and oversight, subcontract management, quality assurance, and configuration management. Can't do better than this, right?

Level 3. Defined

Whereas the key process areas in Level 2 are recognized, they may vary greatly in implementation from project to project or with personality style. In Level 3 they are institutionalized; there is an organizational process focus; and as a result processes are defined and written down. For example, there will be an organizational Cost Estimating Manual, and a Software Quality Assurance Plan. There will be training programs. There will be inter-group coordination, and peer-level reviews. All projects use an approved, tailored version of the organizations' standard processes.

Level 4. Managed

At this level not only is product development managed in a projectized environment, but the processes themselves are also managed, and in a quantitative manner. For example, the Cost Estimating Manual would be updated periodically with feedback on actual costs such that parametric estimates could be made based on experience. The rate of a product's problem failure reports (presumably declining) would be measured and projected into the future as a measure of product quality. Processes are quantitatively understood and controlled.

Level 5. Optimizing *(note the "ing" implying continual improvement)*

Continual process improvement is enabled by quantitative feedback from each process and by piloting innovative ideas and technologies. For example there is a defect prevention process, not just a defect cure process. There is a process in place to inject new technology into development, such as new computer-aided design tools or computer-aided software engineering tools. There is a process in place for changing processes.

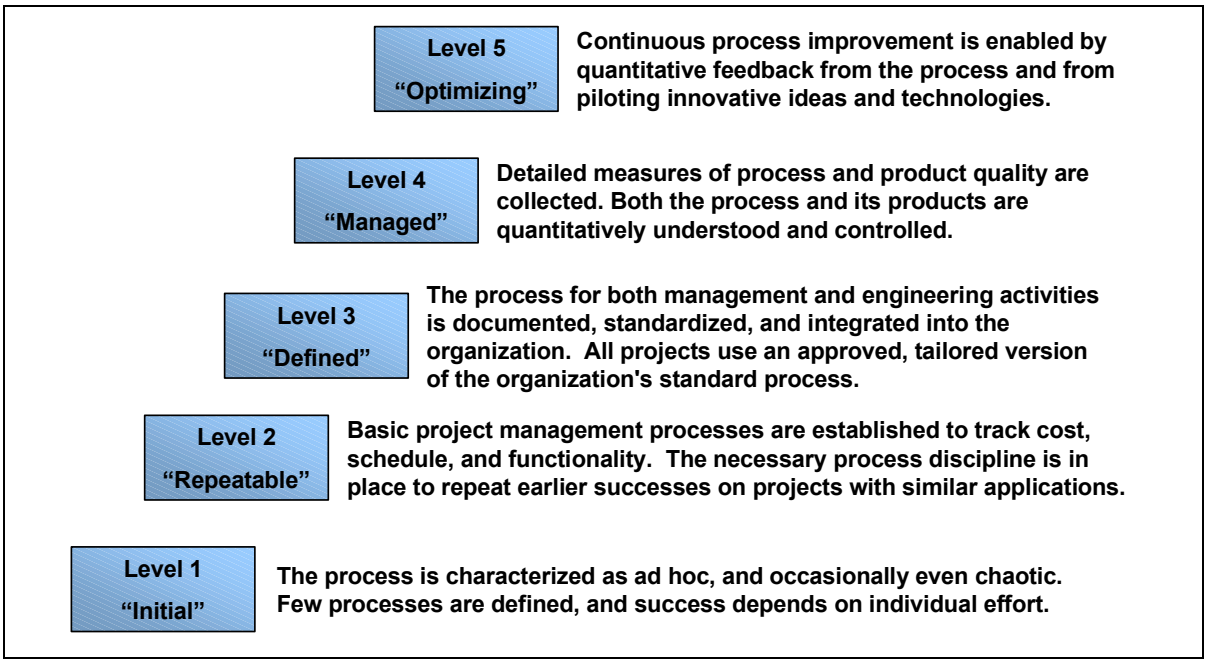

Figure F-1. Process Capability Maturity Model

Even after all this description you still might wonder what these levels would feel like in ordinary experience. Figure F-2 is an analogy.

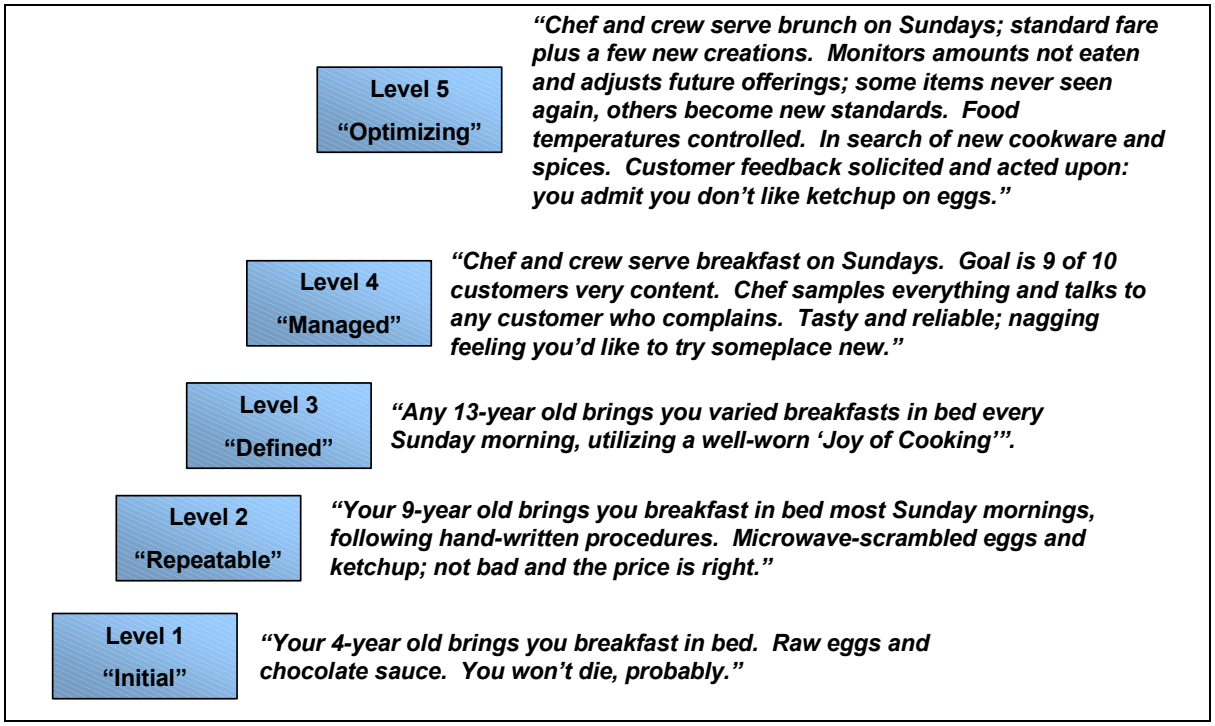

Figure F-2. Analogy of Process Capability Maturity Levels

Of particular interest to the states will be the *Software Acquisition Capability Maturity Model* [11], whose major activities are shown in Figure F-3.

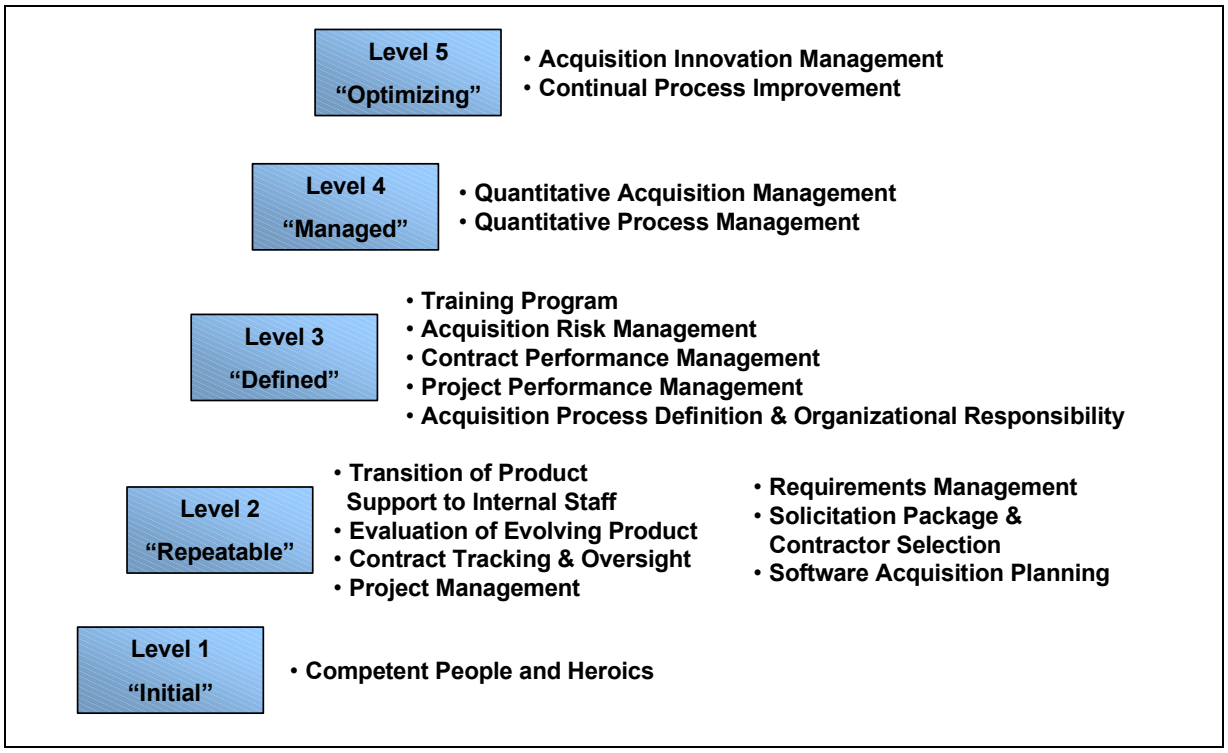

Figure F-3. Software Acquisition Capability Maturity Levels

APPENDIX G. CVISN SURVEY LESSONS LEARNED

Specifically for this Guide, in April 1999 several of the CVISN States responded to these questions:

» What did you do right that you'd recommend to other states?
» What didn't you do that you wish you had?
» What issues do you wish you could have settled earlier?
» In general, what lessons learned would you like to share about project planning, phase planning, contracting, organization, and teaming?

The next several sections are the answers provided by the states.

G.1 Lessons Learned – California

What did you do right that you'd recommend to other states?

- Agreed to the concept that CVISN required a multi-agency and industry effort.
- Approved over 100 carriers who volunteered to participate in this demonstration project either directly, through agents, or through leasing companies.

What went right:

- Agreed to the concept that CVISN required a multi-agency and industry effort.
- Established an executive steering committee and a working level task force early in the project.
- Conducted an Industry Day to give the motor carriers a brief overview of CVISN to solicit their participation.
- Approved over 100 carriers who volunteered to participate in this demonstration project either directly, through agents, or through leasing companies.
- Established an industry advisory council early in the project.
- Developed the CVISN project plan with staff from the participating agencies.
- Assigned project management and state architect responsibilities to state staff.
- Utilized federal funds for only new hardware/software development and evaluation.
- Contracted for an independent project oversight and quality assurance early in the project.

What didn't you do that you wish you had?

- Seek federal funding through earmarks for funds committed.
- Evaluate, in detail, the availability and functionality of core infrastructure systems.
- State teams attending the workshops should demand significant break out sessions for open state interaction.
- Be concerned about lack of qualified vendors to support CVISN development.
- Be proactive in discussing multi-state development contracts to minimize cost.
- Conduct concurrent development of the documentation required for state and federal approval (state-FSR; federal-project plan).
- Recognize the impact that Y2K requirements have on technical resource availability.

What issues do you wish you could have settled earlier?

- Finalize and encumber all federal funds early in the project, rather than on a year-by-year basis.
- Reduce the gap time between planning workshops.

G.2 Lessons Learned – Colorado

- It always takes more time, money, staff and effort to do these projects than is economically feasible. At least if you're one of the pilot or prototype states.
- It is our hope that over time vendors will have gained the necessary experience and knowledge that will allow them to give reasonable estimates and to rely less on state staffing in order to insure project success.
- With few vendors willing to take the risk and provide these services to the states, there isn't the competitive marketplace that the states need to insure reasonable pricing.
- Get industry involved and keep them there. Besides our monthly meetings, which are well attended by both state and industry representatives, we have hired an industry representative to act as a “go between” to insure that the concerns and needs of both sides are being communicated.

G.3 Lessons Learned – Kentucky

- Uniformity/compatibility among numerous states is necessary before the full benefits of CVISN can be realized
- Coordination efforts are directly proportional to the number of organizational units involved. The fewer the number of organizational units (departments) containing the credentialing, safety, and electronic screening processes, the easier it is to administer the CVISN activities.

G.4 Lessons Learned – Maryland

- Involve operations staff from day one: describe the business process first, then identify the functions of the system. Improve the process if you can, rather than just automating it, but don't stake the project on your ability to change the business process.
- Learn what the most-responsible agency's engineering staff needs, and what they like and hate. They, too, will have to live with the system after it's built.
- Make sure supervisors (and THEIR supervisors) know that it will take staff-hours for requirements and again for testing, and some in between, too.
- Use CVISN as a catalyst: stick your neck out to make "the right thing" happen for the state staff in areas broader than CVISN. You make friends and build momentum that way. (Examples: promote use of TCP/IP network access and make it available to other projects; eliminate dumb terminals in favor of client/server systems- let others get onto the CVISN workstations; deploy capabilities where they belong, not just where they are now.)
- Set small milestones very early; make them larger and farther apart only when confident in the capabilities and commitment of the vendors.

G.5 Lessons Learned – Michigan

- In summary, Michigan has found that proper staffing and a strong commitment at the very beginning can avoid many pitfalls and lead to a much smoother project.
- The #1 issue that our committee has faced from the very start of this project has been the lack of a full time person to “run” this project. States coming on board should realize the major time commitment required and the need for a full time project manager.
- Michigan found that a person who is a full time state employee and project manager for CVISN just does not have enough time to do both jobs. Most states have at least one person full time assigned to CVISN.
- Further, turnover has been a problem. Michigan has had a number of different project managers, who were state employees but left due to promotions, reassignments, etc. This created a void while the new project manager comes up to speed.
- Hiring a consultant at the start to assist the project manager brings consistency and a dedicated person who works on CVISN only.
- It is important to insure that the agency designated as the lead agency and administrator of the contract is willing to put forth the needed resources and staff time.

- Michigan has had a group of motor carrier representatives from each of the departments that deal with motor carriers working together for over 12 years. This group formed the backbone of the CVISN Committee and allowed us to bypass much of the steep learning curve that individuals go through as they learn not only about what each department does but also about each other.
- Make sure everyone on the CVISN Committee is up to speed on activities of the state agencies. The CVISN Committee spent a lot of time, up front, to bring everyone up to speed learning in great detail about what each department did, what they had in current technology, and also what other types of technology was available or coming in the future. This was made easy by the long working relationship many of us had over the past 12+ years.
- Insure that the committee has a clear and agreed upon overall vision of what CVISN should be.
- Insure that the industry representatives on the committee are given an opportunity to give input and, most importantly, listen to what they say.
- More lead-time from the contractors for information requests would assist all parties involved. It would allow more time to research the questions raised and produce a better product.

G.6 Lessons Learned – Virginia

What went right:

- Developed a formal project plan that divided the project into phases and milestones.
- Documented and monitored action items, decisions, and issues.
- Established regularly scheduled project and core team meeting to resolve issues and to drive project.
- Devoted full time CVISN system architect and project manager support.

What we didn't do but should have:

- Driven the project from a business perspective rather than a technical perspective.
- Assigned a full-time business person to lead the project.
- Assigned DMV technical resources to the project full time, including a managerial level technical resource.
- Established CVISN as a high-level agency objective having executive commitment.
- Developed integrated, realistic schedules having agreement from all vendors and stakeholders.
- Planned hardware and software expenditures in concert with projected use.
- Ensured that all project vendors were contracted by the state and were under the state's control.

What issues should have been settled earlier:

- Establish formal vendor contracts specifying terms and conditions of delivery.
- Resolve EDI mapping requirements with all development vendors.
- Adopt CVISN architecture into state network infrastructure.
- Involve motor carriers early and obtain their acceptance.
- Determine full staffing and skill requirements.
- Have agreement between all parties regarding what specific functionality would be required to support grant obligations.
- Resolve funding issues early.
- Alert users of vendor schedule slippage to better manage expectations and dependencies

G.7 Lessons Learned – Washington

- It takes longer than you think for mapping to legacy systems.
- For leverage, partner with other states that use the same vendor. *For example, our state is no different than other VISTA states. We should have partnered with them in dealings with Lockheed.*
- All partners (Enforcement Officers, Trucking Association members, and state agencies) were involved at the start. *Example: Early in the project we partnered with the Washington Trucking Associations without any clue as to the importance of that decision. Our intent was noble, in that we thought we wanted them on board so they could "see what we were going to do for (to) them"! In actuality, they become our biggest asset in terms of "insider information" (finding out what really will and will not work) and lobbying for funding. They were the folks that eventually sold CVISN to our state legislators*.
- Established weekly meetings for information exchange and open agenda. *Example: We conducted team meetings once a week (every Thursday morning) that lasted from 1 to 3 hours long. Rule number one…an open agenda with everybody speaking their minds. These meetings proved to be most productive in terms of good communications, sharing ideas and workloads, and sharing lessons learned. Management representatives from various state agencies dropped into these meetings to find out what was going on. They quite often raved about the process and results. We would also conference the vendors/consultants into these meetings.*
- Subcontracting creates communication/schedule/specification problems. *Example: The more* subs *involved, the harder it was to control the deliverables/time frames. It was frustrating to have one vendor hold up the others. This is a real life hurdle!*

G.8 Lessons Learned – Miscellaneous Sources

- Have some wiggle room in the project plan for the signatories, in the form of an "open issues" list. Otherwise, they will be reluctant to sign a document that seems deadly definitive.
- Good overall project planning facilitates phase planning and monitoring.
- Planning and generating a plan should be formally recognized as a responsibility of a least one team member.
- Use a planning process, format, and tools compatible with tools for monitoring project in your organization.
- Overemphasis on documentation can detract from developing useful planning document.
- If planning document is too long and takes too many resources, it will not be kept current.