dear colleagues:

We are pleased to bring to you the Public Safety Wireless Network (PSWN) Program's *How2 Guide for System Planning, Design, Procurement, Implementation, and Operations and Maintenance.* We developed the guide in response to inquiries from public safety agencies that needed and wanted to plan and operate regional or statewide radio communications systems—but did not know where to begin.

The guide makes it easy to assess the information you need. It covers issues essential to successful planning, design, procurement, implementation, operation, and maintenance of a regional or statewide radio communications system. It addresses central questions, such as "How do I establish project objectives?," "What are the system's technical and operational requirements?," "How do I decide what design best meets my mission requirements?," "How will I fund the new system?," "How do I build a new system to fit my needs?," and "How do I best use and maintain this system?" In addition, it offers many resources, lessons learned, and success stories from the field to assist you. This valuable tool helps you ensure that user needs, not technology, remain the focus of your new radio communications system. We have also developed a document that provides a quick and straightforward overview of each of the system development concepts presented in the reference guide. That document, known as the *Public Safety LMR: A Road Map to Systems Development,* can be found on the PSWN Program's Web site or by calling our toll-free number.

The PSWN Program can help you successfully integrate experience and best practices into your radio communications system planning and operations. The program has a solid record of cooperating effectively with local, state, and federal public safety organizations to plan and achieve interoperability among wireless networks. We work daily to enhance cooperation and partnerships among public safety officials at all government levels. We owe a great deal of success to you, the public safety community, for reaching out beyond jurisdictional lines and organizational constraints to improve public service. We salute your accomplishments in establishing relationships and communicating with partner agencies to increase the Nation's safety.

We solicit your feedback on this reference guide. We also welcome opportunities to provide you with additional resource material and assist you in other ways. Further detail regarding the PSWN Program and its products and services can be found at **http://www.pswn.gov.** Please call the program toll free at **1.800.565.PSWN** or contact us via e-mail at **Information@pswn.gov.** We look forward to hearing from you.

Sincerely,

Robert E. Lee, Jr.
PSWN Program Manager
Department of Justice

Julio R. Murphy
PSWN Program Manager
Department of the Treasury

thank you

The Public Safety Wireless Network (PSWN) Program thanks the public safety communications representatives who generously shared their time, knowledge, and resources to help us develop this guide. We salute their contributions and their sustained championing of interoperability.

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preface

The PSWN Program is jointly sponsored by the Department of Justice and the Department of the Treasury. The program encourages interoperable communications among wireless networks to address local, state, federal, and tribal public safety requirements. It strives to achieve the vision it shares with the public safety community—seamless, coordinated, integrated public safety communications for the safe, effective, efficient protection of life and property.

A Shared Vision...

Seamless, coordinated, and integrated public safety communications for the safe, effective, and efficient protection of life and property.

The vision of improved communications is shared with public safety organizations. These organizations include local, state, federal, and tribal agencies whose missions encompass the protection of life and property.

A Compelling Mission...

To plan for and foster interoperability among wireless networks that meets the requirements of local, state, federal, and tribal public safety organizations.

The challenges are to make public safety communications more effective, efficient, and cost effective.

...To Achieve Interoperability

Communications links that permit persons from two or more public safety agencies to interact with one another and to exchange information according to a prescribed method in order to achieve predictable results.

partner ships

Success through Cooperation and Partnerships

In its initial 4 years, the PSWN Program has:

- Promoted partnerships among public safety agencies
- Conducted case studies in several regions nationwide
- Implemented pilot projects to test and define interoperability solutions
- Addressed spectrum policy and funding issues critical to public safety communications
- Investigated security issues associated with public safety wireless communications
- Supported standards and technology development.

The program recognizes that its accomplishments are due in large part to all the public safety personnel who have dedicated time and resources to working with their colleagues to strengthen relationships and improve radio communications.

What to Expect

This guide was developed to provide system planners with a user-friendly introduction to the key steps involved in planning, designing, procuring, implementing, operating, and maintaining a complex radio communications system. Using the life-cycle system development process as a set of guidelines, the PSWN Program conducted thorough research and numerous interviews with local and state agencies to uncover success stories, lessons learned, and useful resources. The guide integrates these components into the life-cycle system development discussion to assist system planners as they embark on new initiatives by sharing what others have learned about the process.

This reference guide does not itemize specific, detailed instructions for every possible activity that could occur during the life cycle of a communications system. Such detail would require significantly more information to address the variations encountered in each state and local jurisdiction. Instead, this guide provides information assembled from the benefits of our experience and the experience of system planners in the field in performing some of the more difficult or often overlooked steps, for example, conducting risk assessments, getting political support, and acquiring funding.

The guide is divided into six sections—System Planning, Requirements Analysis, Design and Engineering, Procurement, Implementation, and Operations and Maintenance—prefaced by a brief introduction to public safety communication issues and the system life-cycle development concept:

- System Planning, the first phase detailed in this guide, introduces the key steps involved in the initial planning and strategy development for a radio communications system. Steps include defining project objectives, assessing internal capabilities and external technical trends, and projecting financial resources.
- The Requirements Analysis section explains the process of assessing and defining technical and operational requirements.
- The Design and Engineering section discusses matching a potential design to the technical and operational requirements.
- The Procurement section examines the financial options available to fund a radio communications system.
- The Implementation section discusses the various methods that can lead to successful system realization.
- The final section, Operations and Maintenance, describes strategies that can be used to effectively manage a system.

Feedback cards are provided at the back of this publication for comments and suggestions. Alternatively, to provide feedback or to obtain information about how the PSWN Program can help public safety agencies, call **1.800.565.PSWN** or send an e-mail to **Information@pswn.gov.** Further detail regarding the PSWN Program and its products or services can be found at **http://www.pswn.gov.**

introduction

Public safety personnel need immediate access to communications and information for routine and emergency operations. Most of these individuals use land mobile radio (LMR) communications as their primary link to information and resources. According to recent surveys, however, most local and state public safety agencies experience serious problems with their communications systems. These difficulties impair the effectiveness of their communications and, ultimately, endanger the lives of their field personnel and the public they are entrusted to protect.

Most public safety agencies identify the following as the primary issues with which they have to contend:

- Lack of interoperability
  Public safety personnel cannot communicate effectively with each other and with other local, state, federal, and tribal public safety agencies because of disparate frequency bands and radios.
- Changing nature of public safety response
  The changing mission requirements of public safety have placed greater emphasis on joint operations and joint task forces, thus increasing the need for interoperability.
- Deterioration of existing systems
  Many existing radio and microwave systems are becoming obsolete, and high maintenance costs are making them difficult to sustain.
- Lack of available funding
  Rising costs of wireless technologies and the significant investment required to maintain and operate a sophisticated communications system often exceed agency resources.
- Competition for spectrum resources
  Public safety agencies face significant communication delays because of channel congestion and must compete with commercial users for spectrum while also complying with new regulations governing refarming and other federal initiatives.

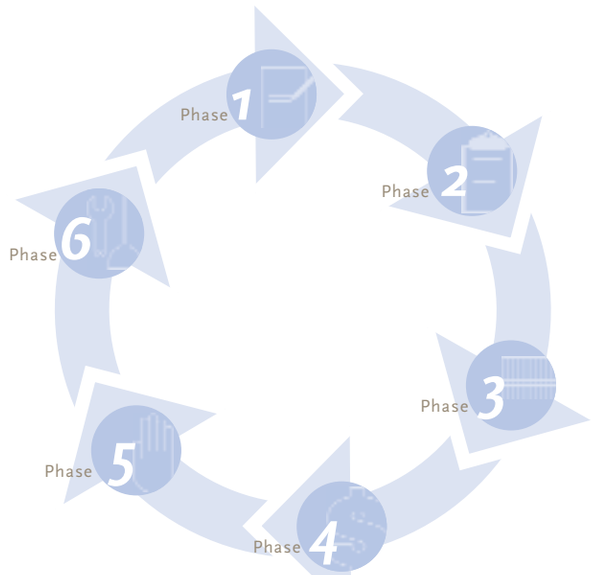
Planning is a major key and system planners are required to perform a difficult balancing act as they plan a new LMR system

These issues are leading local and state agencies to upgrade or replace their communications systems. However, planning for new or upgraded systems itself presents challenges. System planners must provide their agencies with the necessary communications capabilities while balancing often slim operating budgets and answering to public and political challenges. They must be aware of the key steps to successfully managing this delicate juggling act and to implementing a communications system that meets their agency's specific needs. In addition, when state and local public safety agencies were asked to rate various obstacles to radio systems replacement and interoperability, approximately one-third (32 percent) identified inadequate planning as a serious obstacle. If system planners are to make the best decisions in developing systems that align with their agencies' strategic objectives, effective, cautious planning and knowledge of potential pitfalls are critical. Likewise, implementing, operating, and maintaining a new system can be an extremely complicated process. The system planners must not only be aware of the technologies, but must also understand the various political and operational issues involved. Only by considering all the strategies available can the system planners make informed decisions that best serve the communication needs of their agencies.

This reference guide is intended to help system planners plan, design, procure, implement, operate, and maintain an LMR voice communications system. It is based on extensive research and on interviews with local and state communications representatives by the PSWN Program. Using the results of this research, the program has identified the key steps in each phase of LMR systemlife-cycle development. More importantly, it has uncovered many lessons learned and success stories from public safety agencies that may help others plan and operate their communications systems.

The PSWN Program's mission is to plan for and foster interoperability among wireless networks that meets the requirements of local, state, federal, and tribal public safety organizations. Interoperability is defined as communications links that permit persons from two or more public safety agencies to interact with one another and to exchange information according to a prescribed method in order to achieve predictable results. Seamless, coordinated, and integrated public safety communications for the safe, effective, and efficient protection of life and property is the goal of the PSWN Program and the guiding vision for all of its efforts.

Figure 1-1: *System Life-Cycle Development*



System Life-Cycle Development

The system life-cycle development concept depicted in Figure 1–1 is a step-by-step process to help system planners and managers plan, design, procure, implement, operate, and maintain an LMR voice communications system. The process addresses both technical and operational considerations from the conception of a system to the end of its useful life. The six-step process includes tasks such as assessing agency and user communications requirements, identifying infrastructure changes or enhancements, establishing technical performance standards, developing policies and management systems, designing technical specifications, validating and verifying systems through testing, and using procedures to optimize system performance.

The structure of this guide follows the system life cycle, with Section 1 addressing system planning, Section 2 addressing requirements analysis, Section 3 describing the design and engineering phase, Section 4 explaining the procurement process, Section 5 reporting on the system implementation process, and Section 6 describing the operations and maintenance phase.

phase one
system planning

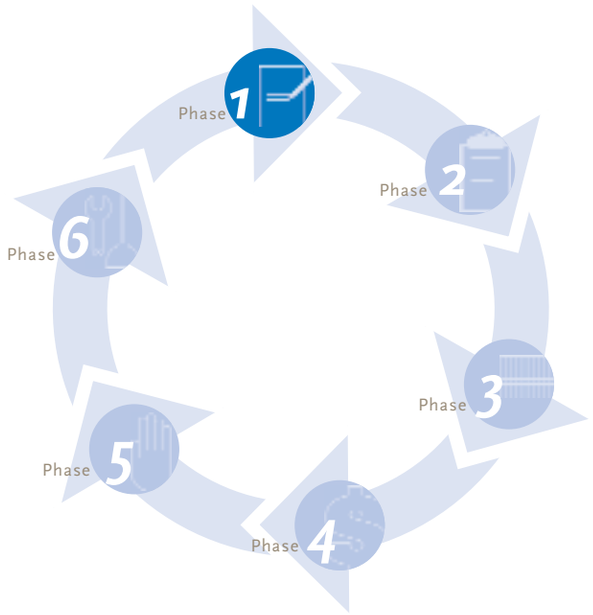
Purpose

This section introduces the key steps in initial system planning, the first phase of the system life-cycle process. The section also presents some success stories and lessons learned from radio system managers who have completed this phase.

Objectives

By the end of this section, readers will understand how to:

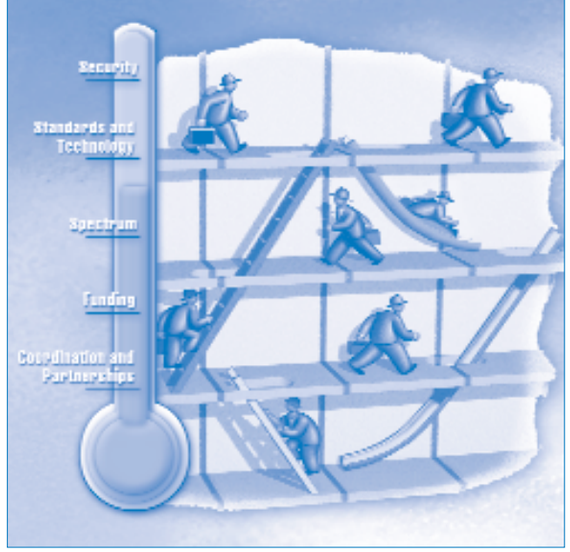
- Define project objectives
- Assess existing radio infrastructure to provide a baseline
- Identify desired system capabilities
- Determine resource allocation and make financial projections
- Establish a strategic plan and set goals
- Assemble a multidisciplinary team and establish operational roles
- Build awareness of the need for change.



Key Steps

Define project objectives

To build public and political support for the proposed transition, system planners must show the necessity of replacing the existing communications system. To achieve this goal, planners must define project objectives, both operational and technical. Operational objectives affect the day-to-day operations of a specific agency. They include mission requirements, operating procedures, and staffing obligations. Technical objectives concern the equipment, tools, and technologies used by an organization. They can be as simple as replacing one disabled radio or as complex as developing a statewide radio system. Operational and technical objectives should relate directly to the overall objectives and goals of the agency the communications system is designed to serve.



Achieving your agency's goals requires defining clear project objectives

Operational objectives for a communications system require a system planner to:

- Clarify the agency's missions
- Define the communications system's operational objectives
- Define potential operational deficiencies
- Identify and analyze stakeholders.

Clarifying an agency's specific mission can help a system planner identify all organizations with which communications will be necessary. For instance, highway patrol officers responsible for responding to highway traffic accidents may need to communicate with a number of state and local agencies—fire and rescue, transportation, emergency management, other law enforcement, corrections, environmental protection, and public utilities. System planners must consider all potential emergency situations, including those incidents where public safety agencies operate in a supporting role—like assisting public utilities with a water main break—to determine accurately the need to interoperate with other agencies. They can gather this information through informal conversations with user groups and from incident reports and other historical data.

System planners must also define the operational objectives for building a new radio communications system. These objectives should align directly with the overriding mission of the organization. For instance, an agency with a mission of, "to serve and protect," may define one operational objective as "to communicate with other public safety personnel or agencies as needed, at all levels of government and across jurisdiction boundaries."

System planners identify the ideal operating environment by clarifying their agency's mission and defining the new system's operational objectives. Highlighting operational deficiencies with the current radio communications system is equally important. For instance, if local police officers cannot perform required job functions—for example, notifying dispatch via radio communications when they sign in and out of service—this problem could hinder their agency's ability to perform its mission. Again, system planners can determine operational deficiencies through informal conversations with user groups and from incident reports and other historical data. By clearly detailing all the operational deficiencies of the current radio communications system and specifying their actual and potential impact on public safety personnel and community residents, planners can shape powerful arguments for winning the public and political support necessary to support a new system.

Effective communication is essential throughout the planning process

It is not enough, however, simply to identify agency missions, project objectives, and current deficiencies. Any major change initiative needs stakeholders who champion project objectives. System planners must perform a stakeholder evaluation—also called a stakeholder analysis—early in the planning of a new radio communications system. Key stakeholders are usually individuals who have investment in the project and can "make or break" the initiative because they have strong political influence. Primary stakeholders are those ultimately affected, either positively or negatively, by the project. For instance, radio communications system users are primary stakeholders because their work performance and environment are directly affected by the decision to build a new system.

Performing a stakeholder analysis helps system planners assess their project's environment. More specifically, a stakeholder analysis can:

- Elicit stakeholders' interests as they relate to the purpose of the project or the problems it is seeking to address
- Identify conflicts of interests among stakeholders, which can undermine appreciation of the project's importance even before funding discussions occur
- Build relations with stakeholders and foster coalitions that cooperate to sponsor and take ownership of the project
- Assess the appropriate type of participation by different stakeholders at successive stages of the life cycle.

A stakeholder analysis includes several steps:

- Creating a stakeholder table
- Assessing each stakeholder's importance to project success and his or her relative power and influence
- Identifying risks and assumptions that may affect project design and success.

A stakeholder table (see Table 1–1) allows system planners to list each key and primary stakeholder, identify each person's interests in relation to the project, classify his or her impact as positive and/or negative, and rank the importance of the project to the individual, given his or her priorities. Stakeholders' interests may be difficult to define, especially if they are hidden or run counter to the openly stated aims of the project or the groups involved.

System planners can elicit stakeholder interests by asking:

- What does each person expect of the project?
- What are the potential benefits for each stakeholder?
- What resources will the stakeholder commit to, or withhold from, the project?
- What other interests does the stakeholder have that may conflict with the project?
- How does the stakeholder regard the other stakeholders?

Table 1-1: *Example of Stakeholder Table*

Key Stakeholders	Interests	Potential Project Impact	Relative Priorities of Interest
City Manager	• Public safety and welfare • Public perception • Election in the fall	+/- +/- +	3
Fire Chief*	• Safety of uniformed personnel • Public image • Project control	+ +/- -	1
County Procurement Officer	• Achievement of budget targets • Cost savings • Control over funds and activities	+/- + +/-	3
State Chief Information Officer	• Sustainable statewide communication system • Ability to coordinate all public safety agencies in the event of emergencies that require more than one agency response • Public recognition for success of the project	+ + -	2
State Telecommunications Director	• Achievement of statewide communications among all public safety agencies • Interoperability among all agencies responsible for public safety • Development of sustainable, reliable, flexible system	+ + +	3

**Note: Police and fire chiefs, emergency medical services director, and other influential public leaders may all be important stakeholders to consider.*

Technical and operational objectives must align with one another for best results

Most system planners interviewed by the PSWN Program recommended defining specific operational objectives that were linked directly to their agency's mission because this relationship created a solid foundation for the rest of the project. Many said they preferred using help from outside professionals to define operational objectives, rather than handling this task alone. If operational issues were not addressed properly at the beginning of the project, planners found that they were haunted by the oversight.

Defining technical objectives during the initial planning of a radio communications system is just as important as defining operational objectives. Technical objectives require a system planner to:

- Identify technical importance of LMR communications to the agency
- Assess the radio communications technical market and its status
- Understand current regulations and requirements
- Define potential technical deficiencies.

Like operational objectives, technical objectives must be aligned with the agency's mission. An example is "to have reliable, effective communications systems with sufficient coverage for public safety personnel to effectively communicate." This technical objective provides the necessary communication capabilities for an agency to meet its mission of "to serve and protect."

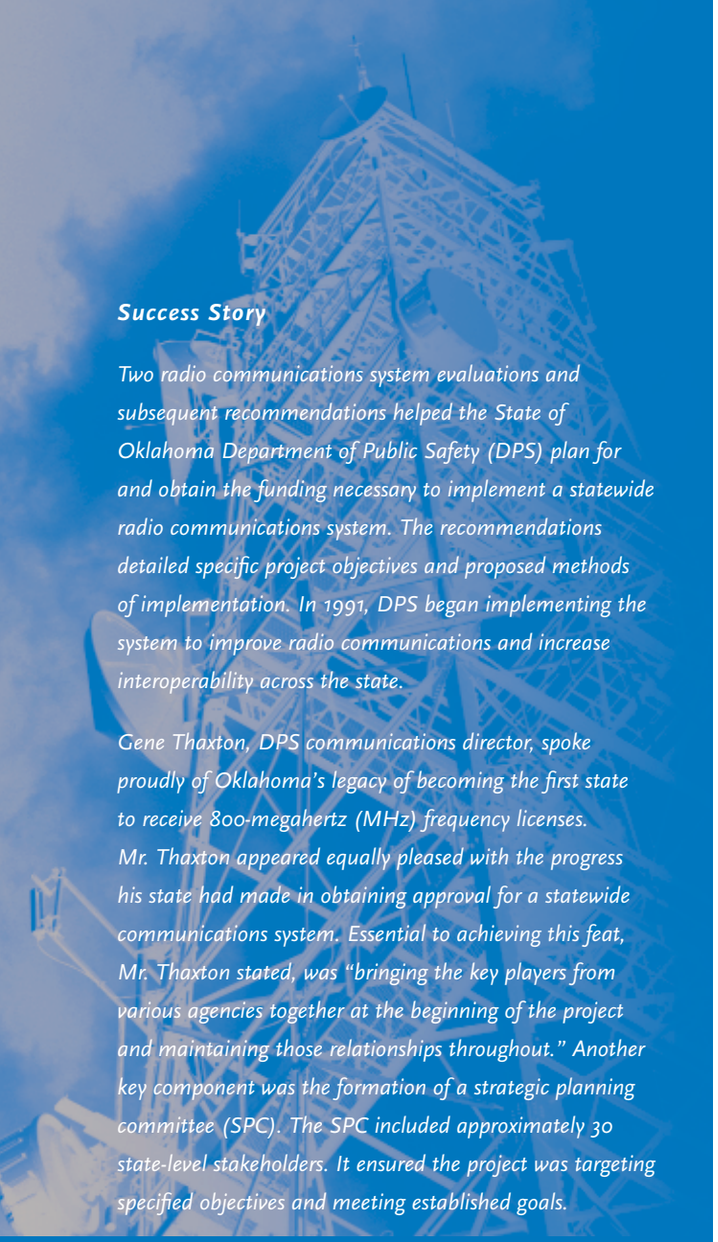
Other technical objectives identified by public safety agencies include the following:

- To possess equipment that is practical to install, interactive with other radio and data systems, and compatible with both current and future technologies
- To have enough channels to handle emergency communications at an incident site
- To have secure communications to prevent monitoring by criminal elements.

To provide technical solutions that support operational objectives, system planners must constantly expand their knowledge of the evolving technical market and the status of radio communications. Ways to stay abreast of developments include participating in professional organizations, establishing relationships and communicating with other system planners (radio user groups), subscribing to trade magazines and journals, and surfing the World Wide Web. Staying current with the market equips system planners to identify potential solutions that meet short-term requirements and prepare for future enhancements.

System planners must also be familiar with current federal, state, and local regulations and requirements and with policy changes, all of which may influence the design and engineering of a proposed system. For instance, the Omnibus Budget Reconciliation Act of 1993 and the National Telecommunications and Information Administration (NTIA) 93-300 narrow-banding mandate for federal agencies may impact the design considerations of local and state system planners. Especially when planners convey information about radio communications legislation to others, they must be sure they understand and communicate its provisions accurately. Failure to keep abreast of current laws about radio communications increases the likelihood of misguided decision making and costly errors. To protect against these hazards, planners can initiate and maintain relationships with their colleagues in local and state system planning, and they can also contact organizations like the PSWN Program specifically created to assist system planners at the local, state, and federal level.

Deteriorating infrastructure, damaged equipment, and limited spectrum availability all can affect the technical functioning of a radio communications system and impair the daily operations of public safety personnel. To define the specific technical deficiencies of their current system, system planners must perform a high-level technical evaluation of the system. They can hold informal conversations with user groups and radio technicians and inspect maintenance records and financial reports. These techniques enable system planners to assess current equipment reliability and functionality and understand the financial burden of maintaining the existing system.



Success Story

Two radio communications system evaluations and subsequent recommendations helped the State of Oklahoma Department of Public Safety (DPS) plan for and obtain the funding necessary to implement a statewide radio communications system. The recommendations detailed specific project objectives and proposed methods of implementation. In 1991, DPS began implementing the system to improve radio communications and increase interoperability across the state.

Gene Thaxton, DPS communications director, spoke proudly of Oklahoma's legacy of becoming the first state to receive 800-megahertz (MHz) frequency licenses. Mr. Thaxton appeared equally pleased with the progress his state had made in obtaining approval for a statewide communications system. Essential to achieving this feat, Mr. Thaxton stated, was "bringing the key players from various agencies together at the beginning of the project and maintaining those relationships throughout." Another key component was the formation of a strategic planning committee (SPC). The SPC included approximately 30 state-level stakeholders. It ensured the project was targeting specified objectives and meeting established goals.

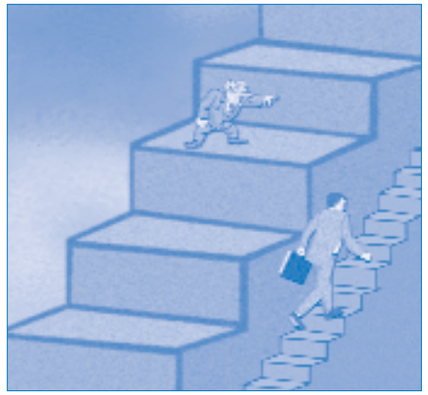
Mr. Thaxton suggested system planners consider involving a public information officer to convey key project information and successes to citizens. Although he noted that funding was always a significant issue in the state, he emphasized that turf battles limited interoperability and resource sharing. He was keen to point out that "if you leave out any party, it won't work. Especially if you leave out the user."

Assess existing radio infrastructure to provide a baseline

System planners must assess the existing communications system to understand its current functionality and establish a baseline. A comprehensive baseline assessment evaluates operational processes and technical operations. By examining both components, system planners increase their accuracy in identifying deficiencies in the existing system. While the bulk of the work to assess existing infrastructure is done through formal user interviews and other data collection techniques in the requirements analysis phase, it is important for a system planner to have a high-level understanding of the current system capabilities.

An operational systems analysis helps system planners assess how their current communications system is operating from a user's perspective. The analysis identifies operational procedures, organizational structure, and personnel issues that may hinder successful accomplishment of an agency's mission. The goals of an operational systems analysis are to:

- Understand the "as is" relationship between current operational and technical systems
- Determine current operational procedures and requirements
- Delineate an ideal operational environment from a user's perspective
- Define existing obstacles to achieving the ideal
- Identify organizations with which users need to communicate.



System planners must identify their individual starting point to gauge how much effort is required to reach their end goal

A technical systems analysis helps system planners assess the functionality of their current communications system from an engineering perspective. This analysis identifies critical information about the technical infrastructure, equipment operations, and site locations. A baseline assessment of the existing system enables system planners to evaluate whether the current system successfully meets the mission needs of an agency. The goals of a technical systems analysis are to:

- Develop high-level assessment of existing technical infrastructure
- Evaluate system performance based on established procedures
- Identify trends in local and statewide radio communications
- Determine availability of spectrum resources
- Develop site survey criteria
- Assess system-level design needs for security.

Methods for gathering information and understanding the current status of an existing communications system include:

- Radio manager and technician interviews
- User interviews
- Maintenance records inspection
- Review of architecture and technical plans
- Examination of financial reports.

The requirements analysis section of this guide details each data-gathering method. In the initial system planning phase, it is important simply to be aware that methods are available to collect operational and technical performance data. System planners may decide to use outside experts to analyze and make recommendations on certain technical aspects of the baseline assessment like spectrum and site availability. Also, developing interview guides and conducting effective focus groups require considerable effort and some expertise. Many system planners recommend working with professionals who specialize in using these methods to gather information because their involvement often produces superior results.

Each organization and agency differs in the resources—both funding and internal expertise—available to perform a baseline assessment. System planners must determine whether the task is too cumbersome to tackle with only in-house personnel. Whatever the decision, its importance should not be underestimated. The more information planners have about the operational and technical functions of the current system, the better they will be able to identify and plan for future needs.

A system planner needs to understand his/her agency's current capabilities while keeping in mind future requirements

Identify desired system capabilities

By identifying capabilities and creating a vision for the ideal communications system, system planners develop a model that targets their efforts and strives to accomplish specific goals. In concert with making the baseline assessment, system planners must examine the operational and technical capabilities desired in a new radio communications system. Defining the new system's operational and technical capabilities contributes to a comprehensive plan that is technically sufficient and operationally sound.

The majority of the work to define desired system capabilities is completed through formal user interviews and other data collection techniques in the requirements analysis phase. At this point, system planners should have a basic idea of what is needed and required to meet their agency's mission.

To develop an operational vision, system planners must define the "to be" operational model. This model should detail the desired operational functions of the new communications system. System planners need to examine how operational and technical enhancements would enable the agency's personnel to improve their job performance. System users might be asked, for example, "Who do you need to talk to but cannot with the current communications system?" The operational and functional requirements must drive the technical requirements for the new radio communications system. During this phase, system planners should also—

- Identify optimal technical and operational performance levels
- Determine capabilities and resources required to realize the vision
- Estimate risks that may challenge achieving the vision.

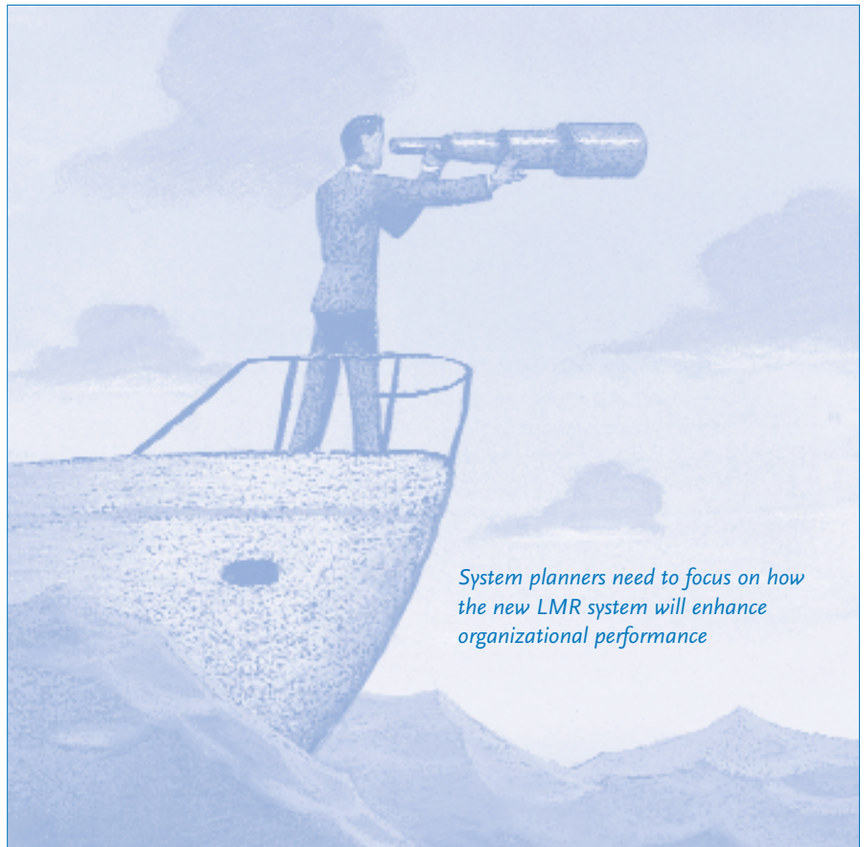
To identify technical considerations for the new radio communications system, system planners must define infrastructure requirements, technical and regulatory issues, opportunities for developing shared systems with surrounding or related jurisdictions, and the benefits of doing so. They also need to assess the potential impact of new technologies on the job performance of their agency's personnel. System users might be asked, "What does your agency do now that it could do better tomorrow if radio communications provided the necessary support?" Technical considerations also include determining whether the agency would benefit from—

- Trunking or conventional radio operation
- Digital or analog radio operation
- Hybrid digital or analog radio system
- Voice and/or data network.

For a more technical discussion, system planners may wish to refer to the *Understanding Wireless Communications in Public Safety—A Guidebook to Technology, Issues, Planning, and Management* which has been prepared by the National Law Enforcement and Corrections Technology Center. To determine the ideal radio communications system, planners should also answer the following technical questions:

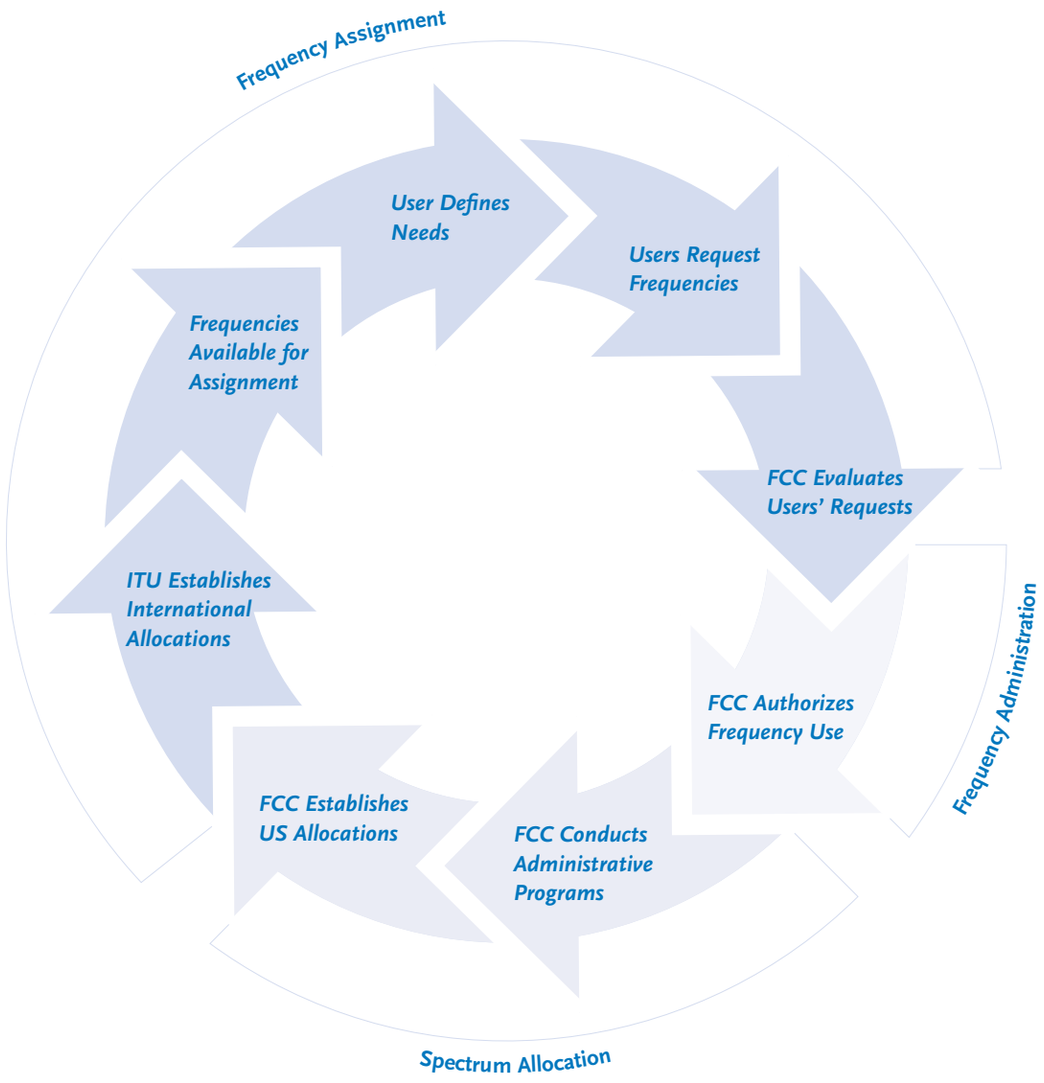
- Frequency band options—What band does the agency currently use—very high frequency (VHF), ultrahigh frequency (UHF), 700 MHz, or 800 MHz? Would another band help optimize interoperability?
- Subscriber equipment—Who needs to use the agency's system? What type of portable and mobile radios (or other equipment) is required?
- Telecommunications connectivity—How is the infrastructure connected? Might other types of connections be more advantageous in optimizing performance?
- Coverage—Area and in-building considerations dictate infrastructure size and requirements.

In planning for future communications capabilities, it is critical to determine the LMR frequency band that best meets an organization's needs. Once a frequency band is selected, all local and state agencies must follow established Federal Communications Commission (FCC) processes. Figure 1–2 illustrates the cyclical nature of the assignment, administration, and allocation processes. Table 1–2 highlights each phase of the processes for applying for and obtaining frequency for new radio communications systems.



System planners need to focus on how the new LMR system will enhance organizational performance

Figure 1-2: *Frequency and Spectrum Processes*



**Note: ITU, International Telecommunications Union*

Table 1-2: *Steps in Obtaining Frequency*

Process Phase	Key Steps to Complete
Frequency Assignment*	One of the first steps in the process of developing an LMR system is to acquire radio frequencies. To obtain frequencies, planners must follow the frequency assignment process developed by the FCC. The process consists of activities undertaken by users, a specified frequency coordinator, and the FCC. The five key steps are as follows: • Users—Define the communications requirements of the public safety entity seeking the frequency • Users—Prepare the necessary FCC application forms • Frequency coordinator—Completes the selection of available frequencies • Frequency coordinator—Forwards application for FCC review for compliance with FCC rules ensuring that the public interest is upheld • FCC—Authorizes frequency use by granting a frequency assignment to the applicant. System planners should note that this process could take weeks or months to complete. This process often requires several iterations.
Frequency Administration	After assignments are granted and licenses are issued, both the FCC and the licensed local or state public safety entity have responsibility for managing the use of assigned frequencies. The licensee is responsible for keeping the FCC informed of any changes or modifications to the licensed system, such as an address change, that affect the conditions of the original license. In addition, the FCC requires licensees to renew their license every 5 years regardless of system modifications. Additionally, Regional Planning Committees monitor local and state use of National Public Safety Planning Advisory Committee (NPSPAC) 800 MHz spectrum. The U.S. Department of State will intervene on behalf of domestic licensees in cases of international interference.
Spectrum Allocation	The remaining parts of the cycle shown in Figure 1–2 represent spectrum allocation, which is the designation of a particular frequency range for a specified service. The FCC and the National Telecommunications and Information Administration work with federal executive branch agencies to allocate portions of the spectrum to specified services. Although international allocations strongly influence decisions about spectrum allocations in the United States, the interests of domestic spectrum users generally take precedence. U.S. and international spectrum allocations, therefore, do not always coincide. The U.S. Congress can also influence spectrum allocations through legislation. Once spectrum is allocated, the frequencies become available for assignment to local and state users, and the frequency assignment process begins again. Although system planners usually are not directly involved in this stage of the process, the political decisions and legislative considerations that affect this phase—for instance, the Spectrum Allocation Act of 1993 and the NTIA 93-300 narrowbanding mandate for federal agencies—may ultimately affect the requirements of an impending local and state project. Therefore, system planners always need to be cognizant of federal legislation that relates to radio communications as it may impact local and state efforts.

**Note: For more detailed information, see PSWN's* State and Local Spectrum Management Processes Report *(November 1998).*

Planning for the ideal radio communications system is desirable, but many system planners find that the most viable option is to develop new radio communications systems to meet basic requirements and accommodate projections of future capabilities. Planners who cannot obtain full support for the optimum system must create a system that is at a minimum:

- Reliable and dependable
- Able to satisfy main mission requirements successfully
- Flexible in response to changing requirements
- Adaptable to future enhancements.

To support these basic requirements, radio communications systems need technology that provides the capabilities listed below:

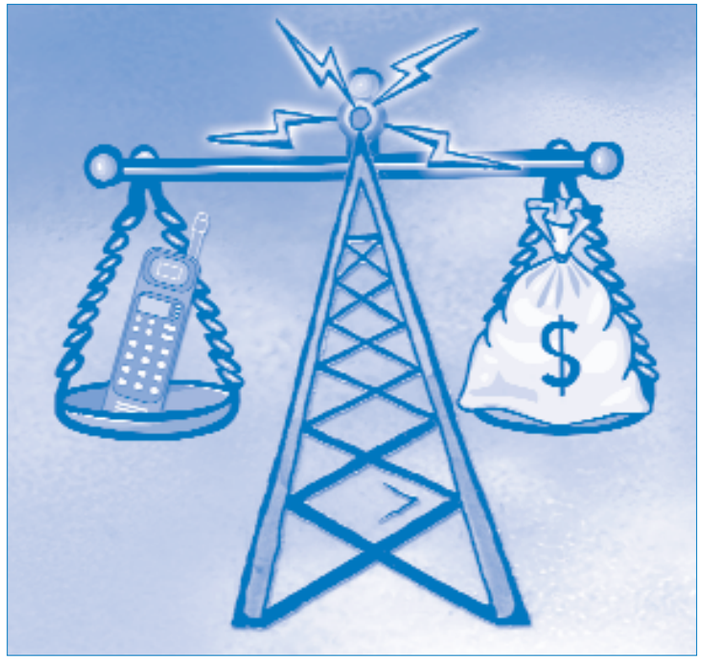
- Reliable communications when roaming over appropriate distances
- Transmission of high-quality voice signals
- Support for end-user equipment that includes handheld portable radios and vehicle-mounted mobile radios
- In-building radio communications, if required by agency mission
- Ability to accommodate peak usage needs
- Backward compatibility with existing technology.

Like the baseline assessment of the existing system, defining the capabilities of the new radio communications system requires intensive data collection. System planners need to set priorities among users' needs, while considering enhancements to improve operational performance. The most efficient methods for eliciting information about the functionality desired in the new system appear to be radio technician and user interviews and focus groups. Once interviews are completed, system planners can then match the desired functions identified with the capabilities offered by various types of radio communications systems.

Determine resource allocation and make financial projections

At this phase it is essential to survey the financial landscape and gain a basic understanding of the options available to fund the communications system proposed. Some of these options are presented in this section.

The rising cost of technologies and the monies necessary for most agencies to maintain existing systems have made it challenging to acquire the necessary funding for capital improvements. System planners must be sensitive to financial constraints and must offer creative solutions to fund the communications system needed to satisfy mission requirements. To meet this challenge, system planners must assess their current financial situation and analyze potential system affordability. They should also have a firm understanding of the personnel resources required to plan, design, and implement a new communications system. Related questions are whether outsourcing is necessary and what costs are associated with each option.



Financial forecasting helps system planners weigh the costs associated with the technologies desired

To determine resource allocation and make financial projections, system planners must:

- Review financial reports
- Forecast revenue and expenditures
- Analyze costs and benefits of in-house and outsourcing options
- Involve procurement and budget analysts early in the process.

If system planners can secure funding mechanisms that endure throughout the system's life cycle, they will build continuous support for their initiative. To achieve adequate, sustained funding, planners need to evaluate the numerous resources available. Potential resources include:

- Local bonds
- State bonds
- User fees
- Partnership agreements.

Table 1–3 illustrates how various jurisdictions have used different funding mechanisms to build radio communications systems. System planners with a strong strategy for establishing a project cost baseline and determining the benefits of funding alternatives place themselves in a solid position to:

- Develop and document a sound business case for the project
- Formulate and defend its budget
- Evaluate available contract mechanisms to determine the most cost-effective alternative
- Determine criteria for most cost effective own or lease option.

Table 1-3: *Use of Various Funding Mechanisms*

Funding Option	Example
Local Bonds	The City of Mesa, Arizona, funded three-quarters of its system with local bond financing. Equipment with a life expectancy beyond that of the bond, like mobile and portable radio equipment, is funded through other mechanisms. Bonds allow a jurisdiction to make a large expenditure up front and pay for it over the life of the system.
State Bonds	The State of Michigan funded its system by issuing a tax-exempt state bond and using general fund money allocated to supporting the communications needs of the Michigan State Police. The tax-exempt bond allowed the state to provide the up-front funding needed for system build-out, and subscriber fees were used to recover the cost from other participating agencies.
User Fees	The State of Florida secured funding through a state law that levied a $1 surcharge on every automobile and boat registration in the state. This law has generated much of the funding necessary to implement the state public safety communications system. Because the legislation has a sunset provision and expires in 2003, the state is seeking either to extend the law or to secure other sources of funding. Possibilities include common user fees or taxes levied at the local level, such as monthly surcharges on telephone lines or a percent of gross payments from telecommunications companies. Either of these could be earmarked for public safety system upgrades.
Partnership Agreements*	Costs for building tower sites can be partially defrayed through partnering arrangements with private entities, such as power companies. This option includes leasing tower space to private cellular and personal communications services (PCS). For instance, the State of Delaware partnered with a private company and leased space on a state-owned tower for PCS use. The revenue generated through this arrangement supports system operation and maintenance. The State of Florida also used this option. It issued a request for proposal to hire private companies to manage the state's tower sites. The site managers are responsible for marketing the site and obtaining the appropriate permits. The state will retain a certain percentage of the tower lease revenue.

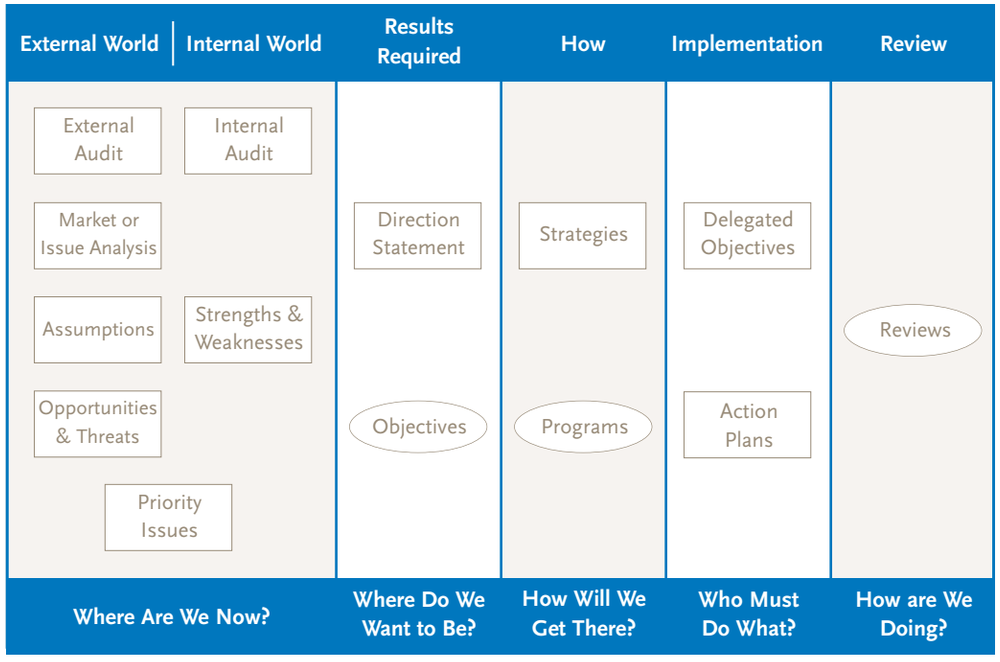
**Note: Although partnering with private companies is a viable option, some states are prohibited from doing so. Michigan's use of a tax-exempt bond, for example, limits nongovernment use of the funded infrastructure to 5 percent.*

As part of their financial responsibilities, system planners need to educate legislators, budget officers, and the public about the importance of funding in maintaining and improving radio communications systems and the potential impact of failing to provide public safety agencies with proper communications systems. Table 1–4 lists some key strategic steps system planners should consider as they begin to develop funding requests.

Table 1-4: *Key Steps in Developing Funding Requests*

Strategic Steps	Impact
Elevate Importance of Public Safety Radio Communications	The public safety community needs to raise the priority placed on the critical need for radio communications infrastructure and the funding required to modernize and maintain these systems. Education and public relation efforts can help policy makers understand LMR technology and the impact lack of funding has on public safety's operational readiness and capabilities.
Avoid Technical Jargon	Explanations to political officials need to be clear and succinct. Public safety radio communications and related requirements must be communicated to local, state, and federal governing bodies to justify requisite funding. To accomplish this objective, highly technical issues must be made understandable to policy makers. "Layperson's guides" written by nontechnical personnel are one way to explain the issues in nonthreatening, easy-to-understand terms. Besides avoiding technical jargon, the text should use plain, direct language and empirical data to help streamline the message to legislative and budgetary bodies.
Develop Well-defined Goal Statement	Budget officers and government decision-makers are more apt to understand the need for a system if its urgency is clearly communicated. Examples of compelling goals include meeting federal government or FCC requirements, enhancing personnel safety or operational capabilities, improving efficiency, and saving taxpayer dollars.
Promote LMR Systems	The education campaign must endorse the need for radio communications systems and articulate the importance of radio communications to policy makers at all government levels.
Speak One Message	Planners must coordinate those who carry the message to ensure consistency. It is important to avoid division between the community and public safety agencies when discussing requirements specific to some elements of the public safety community. Communicators must approach policy makers with a concerted, coordinated effort.
Build Relationships	The campaign must communicate to citizens the compelling need for a community or statewide commitment to public safety communications infrastructure. Equally important, it must highlight possible consequences in the absence of much-needed funding. Education targeted to specific citizen groups (e.g., citizen advisory committees) may be necessary to get a specific project into a bond election or to overcome resistance to new taxes or user fees.

Additional information on managing the funding process may be obtained by reviewing the *Guidebook to Technology, Issues, Planning, and Management* prepared by the National Law Enforcement and Corrections Technology Center.



Strategic planning allows system planners to establish a tactical plan for rolling out project development

Table 1-5: *SWOT Analysis (Partial)*

Potential Strengths	Potential Weaknesses	Potential Opportunities	Potential Threats
Improved coordination among all agencies during emergency operations	Confusion of roles and responsibilities	Reduction in financial obligation of individual agencies because system is shared	Communications hindered by increased radio traffic

Establish a strategic plan and set goals

To win support for a new communications system, system planners need to create a strategic plan and set goals for the project. Strategic planning builds on two previous steps, the operational and technical assessment of the existing communications system and the identification of desired system capabilities. Once these steps have been completed, system planners will see a gap between the existing system functionality and the desired system capabilities. The goal of the strategic plan is to outline specific action items that the agency will take to transition from the "as is" or existing communications system to the "to be" or ideal communications system.

Many system planners find that assessing their agency's proposed system's strengths, weaknesses, opportunities, and threats—also called a SWOT analysis—helps them develop a solid strategic plan. To make this analysis, system planners must:

- Clearly define the need for change
- Create a vision for the future and identify strengths of the new communications system
- Communicate impending weaknesses and develop a high-level risk management plan
- Present potential partnerships with other jurisdictions and highlight increased interoperability opportunities
- Detail possible threats and other security considerations.

Table 1–5 shows a partial SWOT analysis to help system planners in analyzing their agency's proposed system.

System planners can perform a SWOT analysis using personal knowledge, focus groups, confidential interviews, diagnostic questionnaires, and examining core work processes. Once the analysis is complete, the next step is to define the organization's strategic direction. The following questions can help:

- What is the organization's fundamental purpose? Why does it exist?
- What is its vision for the future? What does the organization want to become?
- What values will guide the organization's actions to satisfy internal and external stakeholders?

After the strategic direction has been defined, system planners should consider developing an operational transition support plan. This plan details the impact of transition to the new system on the current operational system. It also defines a clear strategy for communicating changes in the functional and operational paradigms throughout the agency.

The strategy should include the introduction of new performance measurements. Although performance measurements are often overlooked, they must be established and reinforced for a successful transition to occur. The chances of success increase if the performance goals are also SMART—specific, measurable, action-oriented, realistic, and timed. Table 1–6 describes each SMART goal and provides a real-world example. This example may assist system planners in formulating specific goals for their respective agencies.

Table 1-6: SMART Goals and Examples

Goal	Description	Example
Specific	Each goal should be a detailed statement of your desired result. Exactly what is it you wish to accomplish? It is difficult to determine action steps for vague goals and even harder to recognize when they have been achieved.	Reduce LMR costs by 20 percent.
Measurable	Identify the means by which you will achieve each goal. How will you know when you have reached it? There are two types of goals—performance goals and outcome goals. Keep in mind that you will always have more control over performance than you will outcome so set performance goals whenever possible.	Twenty percent of LMR costs will be reduced.
Action-oriented	Describe your goals using action verbs. What will you do (step by step) to reach your goal?	Perform analysis to determine the cost of maintaining current system versus cost of acquiring new system.
Realistic	Choose goals that are possible and achievable. Who do you know who has achieved goals similar to yours? Goals set too high will discourage you, while goals set too low won't challenge and motivate you.	Operational mission will remain the same and require technical enhancements to maintain optimal performance.
Timed	Determine deadlines for each of your goals. Deadlines can be flexible and adjusted as needed, but deadlines that specify time limits help keep you focused and moving.	Final draft by next fiscal year. In the interim, plan weekly status meeting with team members to track progress.

The transition strategy should also provide a training development plan, including a timeline for completing needs analyses and for designing and creating training resource materials and a schedule for training implementation. Many system planners suggested that early involvement of education and training personnel improved instructional design and sped up implementation. Ideally, education and training sessions are scheduled to follow promptly on the implementation of the new radio communications system.

Diversity of skill sets on a team strengthens project output

Several state agencies make their strategic plans publicly available through state Web sites on the Internet. These examples allow system planners to take advantage of previously developed resources to map out their strategic objectives.

- State of Alaska Telecommunications and Information Technology Plan
- State of California Strategic Plan for Public Safety Radio Communications
- Nebraska State Radio Communications Task Force Recommendations for a State and Local Government Public Safety Statewide Wireless Communications Infrastructure

Other strategic planning resources include:

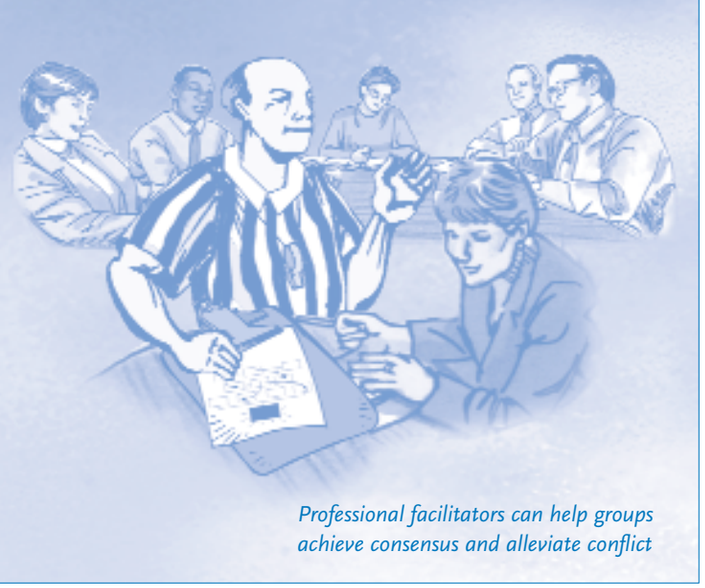
- Mary Simon Leuci, Jack McCall, and Jerry Wade. *The Action Planning Process.* Columbia, Missouri: University of Missouri, 1993.
- Douglas Schuler. *New Community Networks: Wired for Change.* New York, New York: Addison Wesley, 1996.
- Perry Pascarella and Mark A. Frohman. *The Purpose-Driven Organization: Unleashing the Power of Direction and Commitment.* San Francisco, California: Jossey-Bass, 1990.
- Frances Moore Lappe and Paul Martin DuBois. *The Quickening of America: Rebuilding Our Nation, Remaking Our Lives*. San Francisco, California: Jossey-Bass, 1994.

Assemble a multidisciplinary team and establish operational roles

Planning a new communications system is a tremendous amount of work. Many system planners use an integrated team, rather than tackle the initiative alone. Even with a team, however, system planners must still assess the project level of effort, identify the skills and abilities necessary to accomplish the tasks at hand, define operational roles, and develop a set of work process strategies to ensure that team efforts support the system concept.

System planners who have successfully obtained the essential public and political support and funding to build new radio communications systems recommend assembling a range of different skills and abilities on the planning team. A team composed of individuals who specialize in certain functional areas and are dedicated full-time to the initiative can help planners make experience-based decisions and effectively move the project toward achieving the necessary support. Many system planners have benefited from having the following kinds of experts on their teams:

- Procurement and budget analysts
- Contract attorneys and legislative experts
- System engineers and technical support personnel
- Political points-of-contact and advisors
- Operational and organizational specialists
- Public and media relations specialists.



Professional facilitators can help groups achieve consensus and alleviate conflict

A diverse team provides many advantages, but it also presents some challenges. Organizing, guiding, and building consensus among team members with different specialties and personalities can appear next to impossible. Several system planners found that using a trained facilitator to coordinate and guide discussion was useful throughout the transformation process. Group facilitation is a unique skill and powerful tool that can assist system planners in tapping into the distinctive knowledge of each team member and exploiting it to meet project objectives.

When a team with the appropriate mix of skills and knowledge has been assembled, it becomes important to establish and reinforce operational roles. Typically, trained facilitators instruct groups to institute "ground rules." Some examples of ground rules include listening to each other, refraining from criticism during brainstorming, approaching the task with the mindset of learning from each other, and everyone has an opportunity to engage in the dialogues and actions of planning. These are the group's operating procedures. Individual members are then responsible for abiding by the procedures they have helped to define. Failure to adhere to the ground rules should have consequences, like asking a group member to leave the meeting and privately discussing any issues.

In addition, teams benefit from adopting specific roles and responsibilities for group participation. Misunderstanding of roles and ambiguous characterization of responsibilities often result in conflict and resentment. To avoid these problems and promote effective group functioning, many system planners describe roles and responsibilities in writing and verbally communicate them, along with the group's purpose and objectives, to individual members.

One format for communicating roles and responsibilities to the entire team is the work breakdown structure. It is valuable because it provides the necessary framework for task completion. To develop the work breakdown structure, system planners must:

- Identify each task and the costs and other resources allocated to it
- Estimate task duration
- Develop a working schedule
- Establish task performance tracking methods
- Assign task responsibilities.

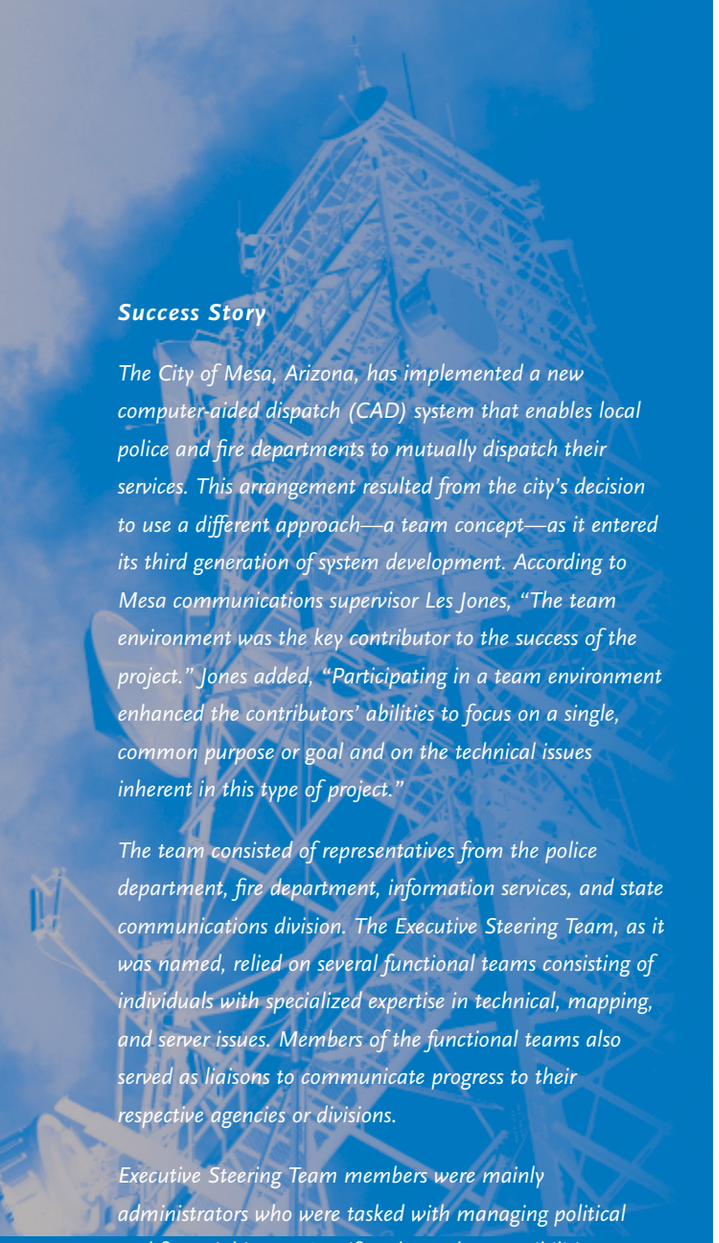
Once the work breakdown structure is developed, system planners may wish to create a linear responsibility chart that lists all task activities, identifies the approximate time frame for each, and names the person responsible for each task. Planners can then track performance against projected tasks, costs, schedules, and resource allocations. It is worth taking the time to map out project logistics and display each important element so that team members can move forward with a clear understanding of their contribution to achieving the larger goal.

Table 1–7 illustrates one example of a work breakdown structure. The table details the number of hours per individual task.

Table 1-7: *Example of Work Breakdown Structure*

Step Number	Work Breakdown Structure Element Description	Total Hours
1.1A	[Work Step]	[Hours]
1.1B	[Samples provided below]	[#]
1.2A	Inspect facility for needed repairs based on wear-and-tear	24.0
1.2B	Develop recommendations regarding needed repairs	16.0
1.2C	Meet with the Government to discuss needed repairs	4.0
1.3A	Develop white paper to describe needed improvements and repairs	8.0
1.3B	Develop drawings and diagrams to show reconfiguration improvements	24.0
1.4A	Refine white paper based on Government direction	2.0
1.4B	Refine drawings and diagrams based on Government direction	8.0
	Step Total	**86.0**
2.1A	Hold discussions with the contractor to describe facility improvements	12.0
2.1B	Hold discussions with the contractor to describe facility repairs	12.0
2.1C	Answer contractor questions during facility improvements and repairs	8.0
2.2A	Evaluate quality of the contracted work	12.0
2.2B	Evaluate completeness of the contracted work	8.0
2.3A	Develop punch list of needed rework	8.0
2.3B	Review punch list of needed rework with the contractor	8.0
	Step Total	**68.0**
3.1A	Prepare summary for PMO facilities support performed	16.0
3.1B	Compile white papers, drawings and diagrams for inclusion in the report	2.0
3.2A	Distribute draft report for review and comment	4.0
3.2B	Editor review of the report	2.0
3.3A	Incorporate comments and changes	4.0
3.4A	Finalize and deliver final report	4.0
	Step Total	**32.0**
	Total for All Steps	**186.0**

A work breakdown structure visually displays responsibilities and time frame for completion



Success Story

The City of Mesa, Arizona, has implemented a new computer-aided dispatch (CAD) system that enables local police and fire departments to mutually dispatch their services. This arrangement resulted from the city's decision to use a different approach—a team concept—as it entered its third generation of system development. According to Mesa communications supervisor Les Jones, "The team environment was the key contributor to the success of the project." Jones added, "Participating in a team environment enhanced the contributors' abilities to focus on a single, common purpose or goal and on the technical issues inherent in this type of project."

The team consisted of representatives from the police department, fire department, information services, and state communications division. The Executive Steering Team, as it was named, relied on several functional teams consisting of individuals with specialized expertise in technical, mapping, and server issues. Members of the functional teams also served as liaisons to communicate progress to their respective agencies or divisions.

Executive Steering Team members were mainly administrators who were tasked with managing political and financial issues. Specific roles and responsibilities were identified at the outset, and each member determined individual decision-making authority. The team jointly developed a request for proposal, which defined technical aspects of the project, and delivered it to the city manager for approval before it was presented to the city council.

Interestingly, now that the system is fully implemented, all agencies have decided to continue having representatives on the functional teams but shift their purpose to maintaining communications among the agencies. The facilitator hired to guide discussion and build group consensus for the project has also become a full-time employee with the state communications division.

Build awareness of the need for change

Often the most challenging aspect of developing a new communications system is building awareness of the need for change. This awareness is prerequisite to winning support from essential decision-makers. Successfully gaining the necessary public and political backing appears to depend on two factors—skillful tactical planning and effective communication of the overriding benefits of a new communications system.

In a 1995 literature review entitled "Measure by Measure: Benchmarking and Performance Measurement in the South," *The Public Sector Accountability Literature Review* concluded that the following factors were critical to the success of performance-based governance:

- A framework that included a widely shared vision, measurable goals, and performance-based budgets
- Extensive educational, organizational, behavioral, and cultural changes
- Broad involvement by citizens, legislators, and their staffs, which in turn led to broad support
- An incremental approach to implementation, beginning with those who were most supportive of the concept
- Integration of performance measurement with the budget formulation, review, and decision-making process
- A communications strategy to convey the benefits of the approach to employees and others
- Strong gubernatorial leadership and support.

Similar findings from *The Public Sector Accountability Literature Review* identified the critical success factors to implementing change in an organization as:

- Obtaining and maintaining visible commitment from top management
- Gaining support from the managers and employees who must implement and cooperate with the change by providing incentives and benefits
- Providing adequate training, recognition, and support
- Adopting an organizational structure and management style that supported creativity and entrepreneurial behavior in exchange for accountability.

Many public safety agencies have found that they can significantly increase the likelihood of successful implementation by creating governing boards, steering committees, or management councils with sufficient authority to advance the development of a system. Ideally, a steering committee or similar body consists of 10 to 12 highly influential people. Small groups tend to operate more effectively than large groups, and they more accurately represent the needs of the parties involved in proposing the development of a new radio communications system. More important, a small group improves the productivity of communications and increases shared decision making. Prominent individuals who can focus on resolving issues and moving swiftly toward the common goal appear to function more effectively in small groups, rather than large ones.

In recruiting members of the steering committee, system planners should seek to:

- Accurately represent the community and the proposed initiative
- Identify recognized community leaders, influential public figures, and community activists
- Involve emerging leaders or others who effectively bring people together
- Include public and media relations persons to communicate benefits to the public
- Delicately engage citizen participation to foster collaboration, partnership, and meaningful involvement and to assess the economic, social, political, environmental, and psychological impact on those associated with the impending change.

Communicating the need for change and preparing the public are critical to successfully obtaining the political and financial support necessary for the new radio communications system. Mishandled, the public can be system planners' greatest obstacle. On the other hand, the public can serve as their most powerful ally. To promote public support and effective public participation in community issues or projects, system planners must understand that people need:

- To be aware of issues and their impact on themselves
  People need to understand that ineffective public safety communications impair the ability of law enforcement, fire and rescue, and other state and local agency personnel to adequately serve the public.
- To realize and believe that they have a reasonable opportunity to make a difference
  Empowering the public to positively affect the common good of their own community is a potent resource.
- To have a basic understanding of the importance of the change initiative
  Change, in and of itself, increases anxiety. However, communicating with the public and educating people about project objectives and their overriding benefits to the community can alleviate undue trepidation.
- To have access to information they can trust
  The more information available and the more accurate the messages, the less misunderstanding and distortion of factual information are likely to occur.

Building community support and participation is crucial. System planners must pay careful attention to obtaining political support. Their ability to achieve this objective, however, depends partly on having a well-qualified multidisciplinary team. Planners need dedicated full-time team members who include system engineers, procurement and budget analysts, and operational specialists to perform design reviews, address funding requirements, and generate sound information that wins stakeholders' confidence. If system planners understand their internal and external environments and assemble a multidisciplinary team equipped to answer challenging questions, they lay a solid foundation for building a new communications system.

The following list suggests resources that deal with building broad support and participation by individuals and organizations:

- Center for Urban Affairs and Policy Research, Neighborhood Innovations Network. *Building Communities From the Inside Out: A Path Toward Finding and Mobilizing a Community's Assets.* Evanston, Illinois: Northwestern University, 1993.
- Donald Littrell, Doris Littrell, Lee Cary, Murray Hardesty, Susan Maze, and Jack Timmons. *Community Development Handbook: A Guide for Facilitators, Community Leaders and Catalysts.* New Orleans, Louisiana: The Entergy Corporation, 1992.
- *Community Information Service Management Guidelines.* Pittsburgh, PA: infoWorks Publishing, 1996.
- David Mathews and Noelle McAfee. *Community Politics. 2nd edition.* Dayton, Ohio: The Kettering Foundation, 1993.
- Marvin Weisbord, ed. *Discovering Common Ground: How Future Search Conferences Bring People Together to Achieve Breakthrough Innovation, Shared Vision & Collaborative Action.* San Francisco, California: Berrett-Koehler Publishers, 1993.
- Aspen Systems Corporation and The Harrison Institute. *Neighborhood Networks: A Resource Guide.* Washington, DC: U.S. Department of Housing and Urban Development, 1996.
- Douglas Schuler. *New Community Networks: Wired for Change.* New York, New York: Addison-Wesley, 1996.
- Kathe Schaaf and Teresa Hogue. *Preparing Your Community: A Guide to Community Action Planning in Oregon.* Oregon: Positive Youth of Oregon (530 Center Street N.E., Suite 300, Salem, OR 97310), 1990.
- *Understanding Wireless Communications in Public Safety: A Guidebook to Technology, Issues, Planning, and Management.* March 2000. The National Law Enforcement and Corrections Technology Center (Rocky Mountain Region).

phase two

requirements analysis

Purpose

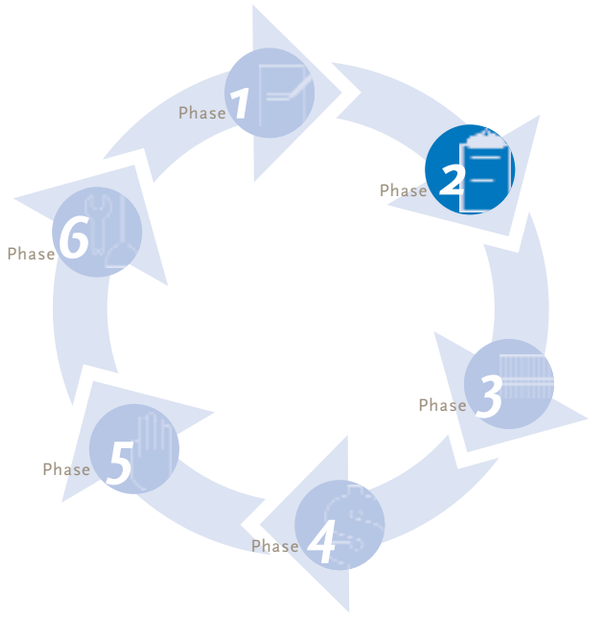
Requirements are the foundation of the system life-cycle development process. They form the basis for system design, test, and operations. System planners must ensure that a complete, but minimum, set of requirements be established early in the development of the new system. By ensuring that requirements are accurate and necessary, they protect their agency from having to make costly revisions later in the design and engineering phase.

This section introduces the key steps involved in conducting a requirements analysis. Due to the time and resources that are required to perform these key steps, requirements analysis is a function that is often outsourced.

Objectives

By the end of this section, system planners will understand how to:

- Define user needs
- Assess current system operational, functional, and technical capabilities and limitations
- Establish operational, functional, and technical performance standards
- Ascertain future operational, functional, and technical requirements
- Establish a requirements baseline and validate requirements.



Key Steps

Define user needs

The requirements analysis phase centers on carefully defining the operational and functional requirements of the user community. System planners can identify operational and functional requirements through a user needs assessment. The most important function of the user needs assessment is to obtain solid operational and functional requirements through a thorough data-gathering process. Definition of these requirements ensures that the network is built to meet measurable and testable performance standards, and this approach leads, in turn, to cost effective solutions. The full set of operational and functional requirements form a baseline to assess current capabilities, and the operational and functional requirements are also used later in this phase to derive technical requirements. Table 2–1 illustrates specific examples of operational, functional, and technical requirements.

Table 2-1: *Examples of Operational, Functional, and Technical Requirements*

Requirement	Description	Specific Examples
Operational	Specific needs users require to perform mission-critical functions	• Equipment use and functionality • Type and occurrence of voice and data communications • Identifying groups with whom interoperability is necessary • Education and training needs • Maintenance procedures • Necessary applications from user perspective
Functional	Specific communications capabilities necessary to fulfill unique operational requirements	• Radio signal coverage • Voice clarity • Mobile data applications • Automatic vehicle location
Technical	Specific technical capabilities necessary to fulfill operational and functional requirements	• Coordinating talkgroups • Automatic reply to calls • Broadcast communications to specific groups • Broadcast alert notification • Encryption

An example of a situation where operational requirements demonstrate what users require to perform mission critical functions is when a law enforcement officer uses his/her portable radio to communicate the assessment of a crime scene to dispatch. This situation reflects the need of the law enforcement officer to utilize portable equipment to communicate with a specific group or individual.

Functional requirements are the overall communication capabilities necessary to ensure the fulfillment of operational requirements. Expanding on the previous example, the functional requirement is the law enforcement officer at the crime scene needing radio signal coverage at that geographic area to communicate with dispatch. Voice clarity is another communications capability necessary for dispatch to be able to understand the message the officer is sending across the network.

A thorough user needs assessment includes the following steps:

- Identifying the information to be collected
- Establishing a data collection team
- Determining user segmentation based on agency mission and environment
- Determining the data collection methodology and tool(s)
- Collecting the data and analyzing it to derive user operational and functional needs.

The approach to identifying the information to be collected is to set objectives that will determine the operational and functional requirements of the users. For example, to identify operational requirements the system planner can ask the users what type of equipment is currently used in the field and which critical groups they must communicate with. Once the information to be collected has been identified, system planners can select a data collection team. The team should include one or more experienced radio communications engineers and experienced representatives of relevant engineering, test, and operations disciplines. Before data collection begins, the system planner must give the team members the authority to carry out the data collection effort.

The next step is to segment users by identifying each division in the organization that may have a unique mission because mission differences result in varied operational and functional requirements. Segmentation is important in helping the data collection team recognize the different user needs that stem from different mission requirements. The team must not overlook the value of gathering mission specific data from multiple sources.

Archival research is the best way to begin data collection. Through this process, team members become familiar with the users' operational environment. Examples of documentation available for archival research include the following:

- Baseline assessment (completed in the system planning phase)
- Requirements from contractually cited documents (technical and cost studies) for the system and its configuration items
- System plans
- Standard operating procedures (SOP)
- Concept of operations (CONOPS)
- Memorandums of understanding (MOU) with local, state, or federal agencies that address implementation of an interoperable or shared system.

After completing archival research, the data collection team can continue its task by using various techniques to define user needs. In fact, along with archival research, the following techniques also continue to be useful throughout the requirements analysis phase:

- Formal user interviews
- Formal radio system manager interviews
- Performance/satisfaction surveys
- Focus groups
- Sequences and scenarios
- Performance analyses
- Evaluations of limitations

Several factors can determine the data collection methodology chosen. For example, the sensitivity of the data being collected may require face-to-face interviews. If users are geographically dispersed, a mail survey may be the best method. If time is limited, phone interviews may be the most effective approach. Focus groups may be appropriate to obtain a consensus on a specific issue. Sequences and scenarios may be helpful if the system planner is trying to pinpoint strengths and weaknesses of equipment or types of voice communications.

Once the data collection methodology has been determined, the data collection team must develop an appropriate tool to capture information. An interview guide can be used for this purpose. Questions to define user needs could include, for example:

- How much coverage is needed for agencies to perform mission-critical functions?
- What types of communications (data or voice) do users need?
- With whom do users need to communicate?
- What types of subscriber devices and functionality do users need?
- What service features do they require?
- How do future changes in operations, communication needs, user population, and other areas affect communication needs?

System planners gain a better understanding of their agency's current operating environment by carefully analyzing the collected data

Sorting and analyzing the data to derive user operational and functional requirements is as important as data collection. For instance, some system planners catalog participant responses in a data book, whereas others use a computer database to enter all the information and calculate statistical results. Whatever method is used, it is critical to track all data collected to make the design decisions that meet the users' operational and functional needs.

In concert with collecting and analyzing the data, system planners must also begin to consider potential educational and training programs. While they collect information about current operational and functional needs, system planners also have an opportunity to assess users' current knowledge of equipment, system functions, and operating procedures. This baseline offers a foundation for system planners to initiate an education and training program that will roll out during implementation. The process of identifying education and training needs will be discussed in further detail in the design and engineering phase.

Assess current system operational, functional, and technical capabilities and limitations

System planners need to identify operational, functional, and technical capabilities and limitations of the current system for several reasons. For example, they need to determine whether the existing technical system can support the current operational environment, define what the current system should be capable of performing, and identify and define the current system design characteristics. It is important to identify this information before beginning a detailed design of the new system. Achieving this objective early in the requirements phase provides system planners with historical data that highlights best practices and lessons learned so that they can be incorporated into the proposed system.

The methods used to assess operational, functional, and technical capabilities depend on the nature of the information being collected. Some of the methods previously used to identify and define user needs can also be applied in this step. In most cases, user or radio system manager interviews are the best way to make certain that the data is complete and accurate. First, however, system planners must establish objectives to guide the process. The following are some examples of objectives that have been used in a focus group discussion for a radio system analysis: describe how the present communications system is used, clarify current system capabilities and limitations, identify groups or individuals that should be able to communicate with the agency, and assess short- and long-term needs. System planners should also use the information obtained from the data collection to begin evaluating the current system's capabilities and limitations.

One method to accomplish this step is to perform categorical assessments of system capabilities. The first category is an operational assessment. In this category, system planners evaluate how well and under what conditions the system products are used. The objectives of the operational assessment are:

- To design an "as is" assessment to understand the relationship between current operational and technical systems
- To determine current operational procedures and requirements
- To assess the ideal operational environment from a user perspective
- To define existing obstacles to optimizing operations
- To identify organizations with which users need to communicate.

The second category is a functional assessment. In this category, system planners review and evaluate the functional performance of equipment and processes. The objectives of the functional assessment are:

- To define technical performance measures (TPM) that are key system performance indicators. TPMs should pertain to critical and non-critical modes of operation. Examples of TPMs include bit error rate, message error rate, quality of service, speed of service, and capacity (number of channels for various classes of communication such as data, voice, and video).
- To assess functional interface requirements as they relate to external, higher level, or interacting systems, platforms, humans, and/or products.

The third category is a technical assessment. In this category, system planners assess the technical design of the current system from an engineering perspective. The assessment identifies critical information about the technical infrastructure, equipment operations, and site locations. The objectives of the technical assessment are to identify:

- Previously approved specifications and baselines (best obtained through archival research)
- Interfaces with other communication systems
- The characterization of information displays and dispatch controls
- System characteristics such as design limitations (e.g., capacity, power, size) and technology limitations (e.g., precision, data rates, frequency)
- Design constraints.

While assessing system capabilities, system planners should also assess system limitations. Many limitations may have surfaced in the operational assessment, when the users were asked to identify the ideal operational environment, but the following steps are key to identifying fully the current system's limitations:

- Identifying design constraints placed on the system
- Identifying groups that frequently encounter operational, functional, and technical limitations and interviewing them for their input
- Analyzing standards imposed on the system that may hinder optimum performance
- Identifying current system interfaces and any limitations they impose
- Identifying any commercial off-the-shelf (COTS) equipment used and the limitations it imposes
- Reviewing all related documents (operating procedures, concept of operations, etc.) to note previously identified system limitations.

Establish operational, functional, and technical performance standards

Many benefits result from establishing solid operational, functional, and technical performance standards. Performance standards increase the probability that multiple vendors will be able to provide the specified systems. It is beneficial to involve multiple vendors to obtain a competitive package of services and pricing. Standards also provide a quantifiable way to measure vendors' performance in meeting user communication needs.

To guide system concept development, the requirements analysis focuses on identifying and expressing requirements that state user needs in measurable, testable parameters. For example, audio distortion shall not exceed 3 percent with a test tone of 1000 Hz in accordance with the Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA) 603 standard. Parameters may already be documented in existing standards that can be used to develop system requirements. To take advantage of existing standards, system planners should:

- Identify existing standards that include parameters relevant to the operational, technical, and functional requirements identified
- Refer to industry-adopted standards, available technology, and existing vendor data on technologies
- Compare proposed performance standards with each system requirement
- Select all or part of the performance standards for use in requirements definition.

__Table 2-2:__ Examples of U.S. Operational, Functional, and Technical Standards

Standard	Description
ANSI/TIA/EIA-102 (Project 25)	The suite of TIA/EIA-102 (Project 25) standards is evolving into the digital interoperability standard for public safety land mobile radio equipment operating in all public safety bands. Approximately 30 documents make up the Project 25 suite of standards defining open architecture interfaces (Common Air Interface (CAI), Data Port Interface, Inter-System Interface, Telephone Interconnect Interface, Network Management Interface, Host and Network Data Interfaces).
ANSI/TIA/EIA-603-93	The Land Mobile FM or PM Communications Equipment Measurement and Performance Standards regulate the test conditions and methods of measurement used to ascertain the performance of radio equipment, and are commonly used with Project 25 compliant equipment.
MIL-STD-810F	The Department of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests is used to tailor equipment environmental design and test limits to the conditions that the specific equipment will experience throughout its service life. It also establishes laboratory test methods that replicate the environmental effects on the equipment rather than trying to reproduce the actual environments.

Notes: ANSI, American National Standards Institute; FM, Frequency Modulation; PM, Pulse Modulation; MIL-STD, Military Standard.

Examples of commonly used industry standards are provided in Table 2–2.

Measurable, testable parameters are the primary criterion for determining the soundness of performance standards. Additional criteria for validating performance standards include:

- Their use of appropriate quantitative measures (e.g., how much?, measures of capacity)
- Their use of appropriate qualitative measures (how well the function is performed)
- The presence of clearly defined parameters and testing methods for each parameter
- The traceability of each requirement (operational, functional, or technical) to a single system function
- The absence of contradictions with or duplication of any other known requirement.

Forecasting requires system planners to think about how their agency will operate in the future

Ascertain future operational, functional, and technical requirements

It is very important to create a system that accommodates future needs. System planners should recognize this priority and take action to ascertain future operational, functional, and technical requirements. Thus, they put themselves in a position to design a system that can meet these requirements. As a foundation for determining future requirements, they can use data obtained from the user needs assessment and the capabilities and limitations assessment. To estimate future requirements, they need to:

- Assess historical data such as traffic patterns and system usage
- Assess projected demographics
- Assess future data applications and requirements
- Forecast operational, functional, and technical requirements.

For example, a similar forecast conducted in the past stemmed from a requirements analysis. To estimate future requirements, an assessment of historical trends and projected demographics was performed, providing several scenarios for evaluation. The first was that the transition from single agency/single system to consolidated operations would improve the level of direct LMR-to-LMR communications among agencies, which would likely change traffic patterns from the past. Secondly, the expansion in coverage for some agencies would increase traffic in formerly unserved areas. Lastly, the increase in the amount of users over the course of 5–10 years would affect the channel capacity needed for each agency. The next step of assessing future data applications showed that the emergence of data, and the uncertainty about the rate of adoption would also increase traffic. The outcome of the requirements forecast was a 10–year forecast of requirements that included subscriber devices, capacity requirements, and security requirements.

Forecasting is usually limited to a 5–10 year outlook; forecasting further out is difficult because the telecommunications industry is extremely dynamic. In forecasting, the goal is to annualize results to allow enough detail for system planners to stay ahead of requirements. For example, a system planner may have determined that the system in place requires the ability to accommodate data traffic within the next 5 years. The system planner will then work with vendors to make enhancements to the system to ensure that the network will be able to manage the additional traffic. These enhancements will then be annualized over the course of the next 5 years. The key thing to remember is that system planners must remain proactive to meet changing requirements from both users and the environment.

Establish requirements baseline and validate requirements

The requirements baseline guides the remaining activities of the requirements analysis and represents the definition of the problem to be solved. By establishing a requirements baseline and validating requirements, system planners ensure that data collected during the analysis is consistent and representative of agency needs. The results are requirements that are likely to remain stable throughout their application in the design and engineering phase.

System planners build the requirements baseline based on the assessments already conducted in this phase. They:

- Analyze the requirements obtained from the user needs assessment
- Analyze the data gathered from the assessment of current system operational, functional, and technical capabilities and limitations
- Incorporate future requirements
- Allocate requirements to functional, operational, and technical areas
- Set priorities among requirements
- Document the complete requirements baseline.

Next, system planners validate requirements to ensure that the requirements baseline responds to the user needs identified and addresses operational, functional, and technical limitations. Validation determines whether the baseline adequately addresses the full spectrum of possible system operations and system life-cycle support.

System planners should take the following steps to validate requirements:

- Compare requirements with user needs
- Compare requirements with operational, functional, and technical limitations
- Compare requirements with external constraints such as spectrum availability and legislation
- Identify the variances and conflicts highlighted and resolve them, if possible
- Establish a validated requirements baseline.

Resources

San Francisco Bay Area Chapter, International Council on Systems Engineering. *Systems Engineering Handbook: A "How To" Guide for All Engineers*, 1998.

Institute of Electrical and Electronic Engineers, Inc. (IEEE) IEEE Standard for Application and Management of the Systems Engineering Process. New York, New York, 1999.

phase three

design and engineering

Purpose

Once a baseline assessment of the current infrastructure has been completed and user requirements have been identified, the project enters the design phase.

The system design and engineering phase resembles the other life-cycle phases in that system planners must consider their organization's operational and technical infrastructures while making decisions from a system planning perspective.

Planners should ensure that system design and engineering always begin with the end-user in mind and result in a system designed so that operations can be performed as simply and efficiently as possible.

System planners must also consider industry or regulatory standards and mandates applicable to the public safety community. Clearly defined performance criteria—derived from the requirements analysis—help them evaluate alternative architectures and standards. The performance criteria also provide a solid rationale for making decisions in the highly dynamic procurement environment.

This section defines the steps system planners need to take to succeed in the design and engineering phase of the system life-cycle process. It also includes lessons learned from system planners who have completed this phase in developing a new radio communications system.

Objectives

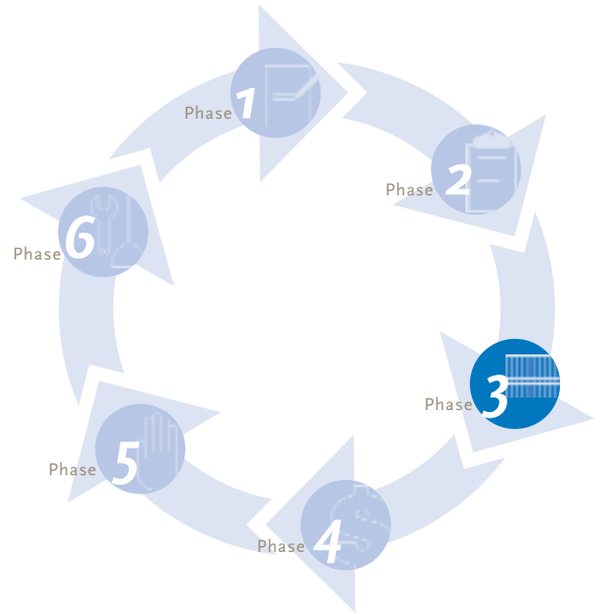
After reading this section, system planners will understand how to complete the following steps:

- Research governing procedures, laws, standards, and regulations
- Establish and communicate a technical plan
- Prepare and distribute requests for information (RFI)
- Design and evaluate primary and alternative system architectures
- Ensure that system design meets technical and operational needs
- Develop scenarios for performance and acceptance testing
- Analyze costs and benefits
- Develop an education and training plan.

Key Steps

Research governing procedures, laws, standards, and regulations

System planners need to become familiar with procedures, laws, and regulations that may bear on the design and engineering phase and on the subsequent procurement of a public safety radio communications system. They may need to research, for example, the legally acceptable placement of public safety tower sites.



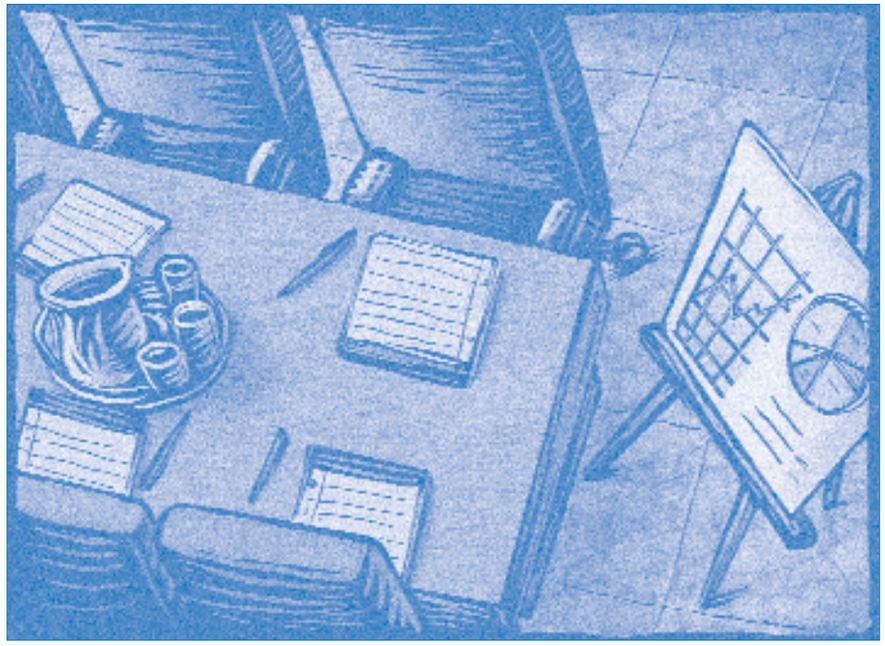
A number of resources can help system planners collect this type of information. They may want to begin their research internally, by starting with the procurement division or administrative services department in their agency, county, or state. Second, public libraries, particularly those located in capital cities, can often supply them with information on many regulatory issues. A third resource is the Internet; agencies such as the FCC maintain quite thorough, current Web sites. Fourth, planners can turn to industry and trade journals affiliated with professional organizations that specialize in government regulatory issues.

In addition to these resources, the Public Safety Wireless Network (PSWN) Program regularly tracks changes in regulations and policies that affect radio communications and maintains a library of numerous documents that cover the areas of procedures, laws, and regulations. Several of these documents are available on the PSWN web site, http://www.pswn.gov. Under its Interoperability Assistance Program, the PSWN Program can also provide assistance targeted to the specific needs of local, state, or federal entities. The PSWN Program Office can be reached at **1.800.565.PSWN** or via e-mail at **Information@pswn.gov.**

System planners should be careful not to rely on interpretations of the applicable procedures, laws, and regulations by other jurisdictions (or vendors) because nuances and details of the procedures, laws, and regulations can be lost in the interpretation.

Once the data has been collected, system planners should evaluate the information and compare it against the operational, functional, and technical requirements of the project at hand for relevance and applicability. For example, a system planner may discover an FCC mandate intended for public safety agencies operating within particular parameters. Upon further investigation, the system planner may find that the mandate does not apply to his or her own agency. This analysis will help planners assess the potential impact of any regulatory issues and enable them to refine the project plan accordingly.

> *Involving legal counsel from the Nevada Government Relations office was key to learning about the legislative issues that might affect development of this type of system. Understanding policy and standards applicable to your efforts can smooth the process and reduce the headaches.*
>
> *Richard Sheldrew,*
> *Nevada Department of Transportation*



Establishing a technical plan gives all team members a clear approach to overall system design

Establish and communicate a technical plan

The technical plan is the primary planning document for all technical tasks. It details basic design considerations. System planners should develop the overall technical plan with input from various functional experts, such as procurement and budget analysts, system engineers and technical support personnel, and operational and organizational specialists. Using a team to define the steps necessary to achieve project objectives is an effective method of ensuring that the technical plan deals adequately with the complexity of the issues it is intended to address. Another method is to align the technical plan with the work breakdown structure developed in the planning phase and identify parallel and related tasks.

The technical plan should lay out a clear approach to establishing, documenting, and implementing the overall system design. It should also set up a process for defining, reporting, measuring, and controlling the status of essential operational and technical milestones and other significant project events. Having this process in place will make team members aware of each other's progress, an awareness that is particularly valuable when tasks are linked to multiple areas of responsibility. System planners should track not only milestone events but also the performance parameters derived from the requirements analysis because the data becomes useful in analyzing the tradeoffs of various design alternatives later in this phase.

When developing the technical plan, system planners should begin by detailing the function and operation of each current system component and predicting the function and operation of each new system component. Much of the current system information can be obtained from the baseline assessment already performed in the planning phase. Additional information can be gathered by developing several questions. Table 3–1 provides examples of questions and answers related to specific technical aspects of the project. Table 3–2 lists questions on both technical and operational aspects of the project, together with objectives that address each question.

System planners should use the information from the responses to these questions as well as data obtained from the requirements analysis to set priorities for system replacements or modifications and identify alternative solutions. In making these decisions, planners should consider key technology market drivers, such as standards or competitiveness and compatibility of different vendor products, because these factors can strongly influence the development of the new system. System planners should also establish a process in the technical plan for monitoring financial expenditures and use of other resource allocations. Planners can then compare the resource data with project milestone achievements to ensure the project stays within budget and on schedule. Although unplanned and uncontrollable incidents can throw almost any project off track, system planners should try to define their design and engineering steps so they allow reserve funds and extra time to work around unexpected problems.

Table 3-1: *Sample Technical Questions and Answers*

Sample Questions	Sample Answers
• What type of system is currently used?	• Conventional analog
• What frequency bands are now used?	• VHF
• What are the system's technical capabilities and limitations?	• Voice, coverage gaps, redundancies
• What sites are available?	• Reuse of existing facilities and potential shared facilities
• What type of security is in place? How extensive is the security?	• Encryption and other authentication measures, very extensive
• What type of system is desired?	• Trunked digital simulcast system
• What frequency band will fulfill mission requirements?	• UHF and VHF
• What technical capabilities will the system include?	• Over-the-air rekeying (OTAR)
• Where will the sites be located?	• Additional sites will need to be developed
• What coverage will the new system provide?	• 95% coverage outside buildings, 85% coverage in buildings

Table 3-2: *Sample Technical and Operational Questions and Corresponding Objectives*

Sample Questions	Objective
• How long will each roll-out phase last? • What are the steps in each phase? • What are the project milestones?	• A comprehensive schedule detailing the transition from the legacy system to the new design
• How will the new system be measured to ensure it meets specified requirements? • What are the criteria for success?	• Test plan and system evaluation criteria
• How will the new system change the way work is done? • What should be done to prepare the organization for the change? • How will processes, functions, and responsibilities change? • How will the organization transition to the new system?	• Identification of all components and procedures affected by the change
• How will site plans be measured to ensure they meet specified requirements?	• Site acceptance test plans
• What should be done to prepare for emergency situations such as natural disasters, power outages, or other unplanned mutual aid circumstances? • How will interference or other intrusions into sensitive communications be prevented?	• System security and disaster recovery plans
• What should be done to determine whether the system meets coverage requirements?	• System coverage requirements and test plans
• How will system reliability be measured? • Under what conditions must the system operate?	• System reliability requirements and acceptance test plan

System planners should construct ways to effectively communicate the technical plan to all members involved in the process

System planners have several options in determining how financial expenditures will be monitored. They can schedule regular financial reporting meetings with team members who have purchasing authority, for example, or require that all purchases be documented in a centralized electronic spreadsheet. Regardless of the method, planners need a way to stay aware of whether the project expenditures are tracking well with the overall timeline estimations. This information allows them to assess where increased or decreased allocations may be necessary or beneficial.

Resource monitoring is an integral part of risk management, a process that focuses on identifying and controlling events that have the potential to cause unwanted changes and impacts. Risk management helps system planners ensure that the project is finished on time, within budget, and in compliance with all specified objectives and standards.

Accordingly, risk management techniques should be part of the technical plan. The plan should include a complete strategy for identifying, analyzing, and reducing risks associated with system development. System planners should monitor many types of risk—planning, technical, schedule, support, and cost. They should identify and document any known risk areas early in developing the technical plan. In addition, their objective is to determine areas where risks could unexpectedly, but nonetheless predictably, arise.

The work breakdown structure developed in Phase 1 is a sound resource for beginning to identify potential risks. It provides the framework for the project and is relevant to the development of project specifications, which are the source of technical performance definitions. By reviewing the specifications, system planners can identify technical risks, and by evaluating the relationship between the work breakdown structure and the specifications, they can detect inconsistencies between the project plan and project accomplishments. The SWOT Analysis performed in Phase 1 is an additional resource for identifying potential risk areas. Other techniques to identify risks include interviewing subject-matter experts, performing independent technical assessments, and reviewing the overall project plan for inconsistencies.

Once risks have been recognized, system planners need to devise methods to reduce them, track them, monitor their impact, and document how they were controlled for future reference and potential training opportunities. Planners can analyze and quantify risks using various methods, but the method used should identify the risk's potential impact on the project (e.g., high, medium, or low). For example, a risk that could delay the project by a week would be characterized as low, whereas a risk that would probably delay it for a year would be classified as high.

Table 3-3: *Initial Risk Management Matrix*

Risk Area	Risk Probability	Possible Impact	Anticipated Timing	Estimated Occurrence	Risk Probability
Planning Joint partnership agreements have yet to be signed among four key agencies.	4	Unconfirmed partner agreements could significantly delay project.	Current	Once	Approach in phases, e.g., obtain agreements with two agencies at a time.
Technical Eventual site implementation and testing could be delayed at high altitude locations because of poor weather.	1	Schedule is delayed.	Annually	Twice	Develop primary and contingency implementation plans per site.
Schedule Multiple functional elements of the project increase potential slippage in the schedule.	2	Slippage could disrupt project schedule and increase costs.	Monthly	Twelve	Hold biweekly meetings with functional area managers to check status.
Support No deputy project manager has yet been hired; project responsibilities are too great to be managed by one person.	3	Project management tasks are overlooked or too little supported, and overall project suffers.	Current	Once	Continue resumé reviews and hire an external recruiting service firm to help with the search.
Cost This 5-year project is funded through annual fiscal agreements	4	Project is delayed or abandoned.	Annually	Four times	Continue to communicate successes to public.

Table 3-4: *Risk Management Matrix for Project in Progress*

Risk	Planning	Technical	Schedule	Support	Cost	Description	Risk Reduction
Design and engineering	•		•		•	Design and engineering changes have been necessary on two occasions, delaying site implementation and adding an unanticipated cost of $5,000 to the project total.	Identify areas in which costs can be lessened without detrimental impact.
Objectives and strategy	•	•	•	•	•	Agency ABC has unexpectedly requested to be added to the new system. We have negotiated use of four of their tower sites in our system design. Although this appears to be a "win-win" situation, it will significantly impact the project plan and development.	Adjust plans and schedule to incorporate changes.
Staffing additions	•			•	•	The project is expanding quickly, and necessary stakeholder communications have increased so much that a public relations specialist is needed to manage the situation.	Determine cost implications and begin process to create this position.

System planners can track all aspects of the risk by conducting a cost/benefit analysis (explained in detail in Phase 4) or a critical-path analysis. A critical-path analysis graphically depicts the sometimes sequential and sometimes parallel relationships among activities, identifying activities whose completion is prerequisite to other activities and highlighting the sequence of activities that require the greatest amount of time to complete (the critical path). The visual display helps system planners identify activities whose disruption would put much of the project at risk and those whose accomplishment significantly facilitates progress in subsequent activities.

Another method for controlling risk is to develop a risk management matrix. Tables 3–3 and 3–4 illustrate two basic approaches. The first table illustrates a matrix prepared at the outset of a project. The second reflects risks encountered after the project is under way.

System planners should ensure the technical plan is communicated to appropriate personnel once it has been established.

Prepare and distribute RFI documentation

System planners prepare a request for information (RFI) and distribute it to the vendor community as a way to gather information about capabilities and limitations of available technology and about current issues that may affect the project. Planners also use the information to help develop specification requirements and a statement of work (SOW) when they issue requests for proposals (RFP).

A standard RFI describes the purpose of the request and outlines the scope of the project or work to be performed. System planners should ensure the RFI clearly identifies any prerequisites for responding, point-of-contact information, deadlines for responding and any specific requirements pertaining to the impending procurement such as reliability, accountability, maintainability, and survivability expectations. Additionally, system planners may wish to address most or all of the following issues:

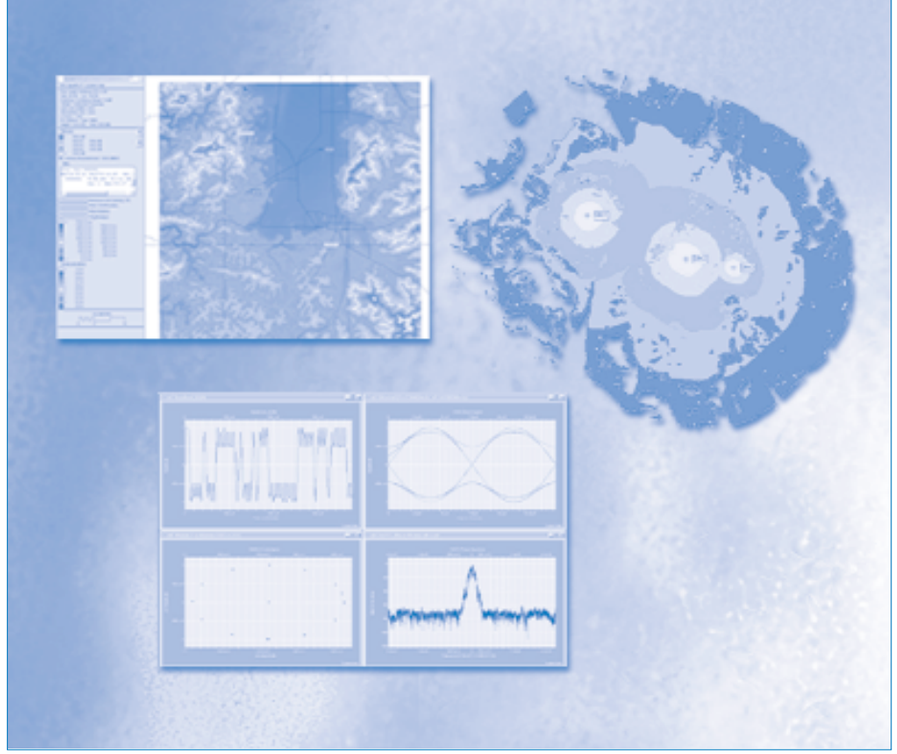
- Agency mission and needs, including affiliations with other agencies
- Site location and facility status
- Legacy system architecture and backbone
- Operational, functional, and technical requirements (an overview)
- Desired vendor qualifications and experience
- Recommended vendor approach and methods for meeting requirements
- A statement indicating that the RFI does not commit the agency to procure a system.

Posting RFI and RFP information on Web sites well known to the public safety community is an effective avenue for distributing the RFI and RFP documents, particularly for those agencies wanting to improve their procurement process. This practice enlarges the audience awareness of the opportunity and increases competition, often resulting in decreased cost.

Design and evaluate primary and alternative system architectures

Primary and alternative system architectures should be designed to meet performance standards, with provisions to ensure compliance with regulations (Federal Aviation Administration [FAA], NTIA, FCC, etc.) and within the resource constraints of the agency to be served. An effective system design meets most, if not all, system and user requirements.

System designers and engineers should consider long-term internal and external environmental changes and plans such as population growth patterns in the area, frequency regulation and licensing issues, and advances in technologies used by public safety agencies. System planners should strive to incorporate legacy assets into the design of the new system to prevent waste of valuable resources such as funding.



System planners should test performance against established requirements using appropriate engineering assessment tools

Design alternatives should be modeled and simulated, testing expected performance against established requirements to assess design theory and gain early warning of potential problem areas. Propagation analysis techniques, for example, can predict coverage for various kinds of terrain, help system designers estimate the number of sites needed, and identify potential site locations. Additional types of models, simulations, and tests include:

- Collecting and analyzing continuous data on radio traffic and system usage
- Performing thorough site surveys and documenting findings
- Determining individual radio site configuration
- Conducting "what if" scenarios and applying successful results to the design.

Architecture design and evaluation should also address the following issues:

- Security and privacy
- Potential radio frequency (RF) interference with adjacent channels
- Frequency and channel plans
- Opportunities to share sites and equipment with other agencies.

"Teams should design innovative pilot or test projects to determine whether the proposed system changes or enhancements meet their needs and match their cost estimates."

Richard L. Tannehill, P.E.,
Senior Telecommunications Engineer
Arizona Department of Public Safety

Essential to any design is ensuring that it meets user needs. This objective requires validation of the design plan. It also means that system planners should look at how the new technologies affect day-to-day user operations. The goal of implementing a new system is to improve the way work gets done. In an emergency, you cannot afford technical or logistic mistakes.

Bud Whitehead
Arizona Division of Emergency Management

Ensure that system design meets technical and operational needs

System planners must ensure that projected solutions truly meet the technical and operational needs defined by the requirements analysis. First, they should make certain the design and engineering team is familiar with the requirements analysis. This information will help team members determine the most effective approach in developing the new system. The team can refer to the requirements analysis, for example, to determine what architecture is most appropriate and whether applications such as mobile data should be integrated into the system or, alternatively, whether outsourcing is the best solution for those needs.

Previously established performance measurements can also help the design and engineering team develop a system that meets technical and operational needs. Performance measurements evaluate each system function and interface. For system planners, these tests confirm that projected system specifications and designs properly address capability, security, operational, functional, and technical requirements.

To be effective, the performance measurements themselves must clearly define what they are to measure and how the tests will be performed, documented, and analyzed. The measurements should also be focused on specific results, designed to evaluate both the quantitative and qualitative elements of the function or interface, and be realistic in terms of available resources. Performance measurements should follow the SMART goals described in Phase 1 and illustrated in Table 1-6.

Develop scenarios for performance and acceptance testing

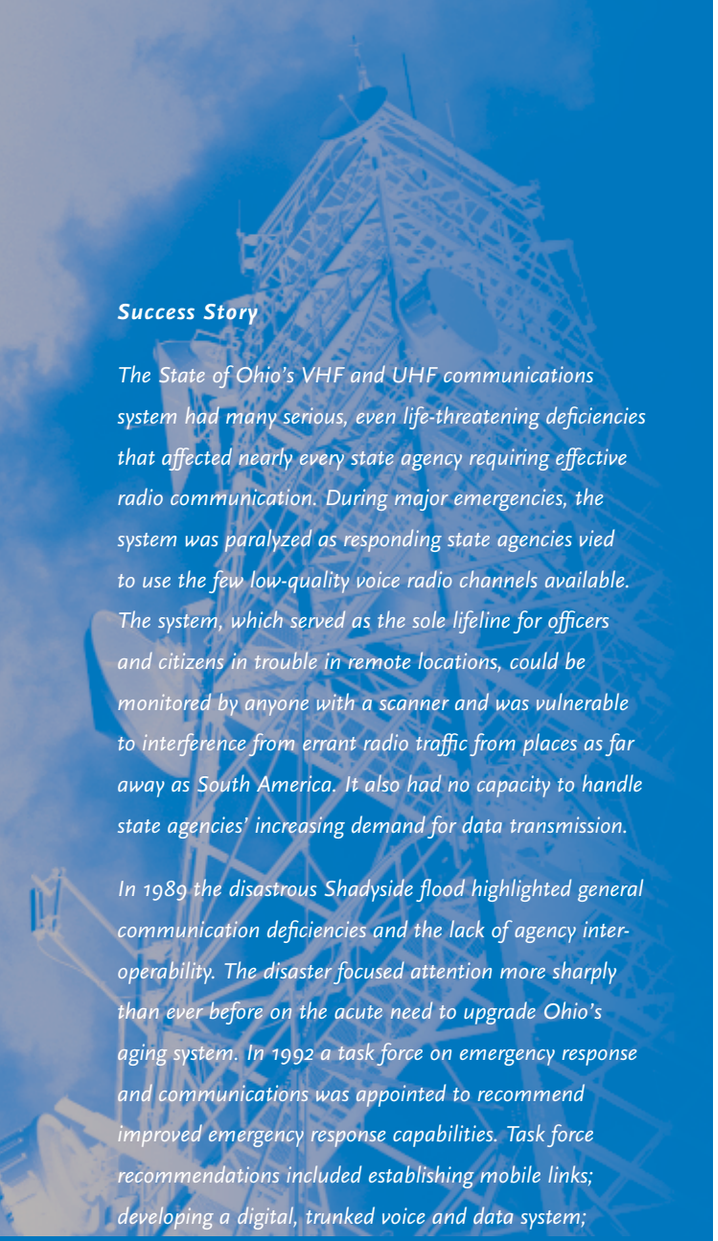
To evaluate new system performance and identify any deficiencies, system planners must ensure that the tests developed are as close as possible to the real world. The scenarios created should test both technical and operational system performance. All test participants should receive an overview of the scenarios and descriptions of their individual roles and responsibilities. Procedures for collecting and analyzing the test data should also be established and clearly communicated to all test participants.

The design and engineering team determines the effectiveness of the technical system by evaluating quantitative data derived from system performance parameters. System planners and other team members determine the effectiveness of the operational system by evaluating qualitative data derived from inter- and intra-agency operational interfaces, education and training sessions and materials, analysis of organizational procedures, and documentation development.

Scenarios help system planners assess the new system under real-world operating conditions

Analyze costs and benefits

Before the new system's architecture is selected, system planners must ensure that a cost/benefit analysis is conducted. In fact, this analysis should be performed before initiating any large system modifications. In addition to the costs of various components, the analysis must estimate the costs of the whole system life cycle. It should give system planners a quantitative understanding of the life-cycle costs and the benefits of alternative architectures. A cost/benefit analysis is also helpful during the planning phase to determine the return on investment and support a formal business case demonstrating the project's advantages to senior management and steering committees. The objective of the analysis is to define system modifications whose benefits outweigh their costs over the system life cycle. System planners should realize that the analysis may have to be revised in different phases of the project as technology changes or the results of concept test pilots lead to alterations in development and implementation plans.



Success Story

The State of Ohio's VHF and UHF communications system had many serious, even life-threatening deficiencies that affected nearly every state agency requiring effective radio communication. During major emergencies, the system was paralyzed as responding state agencies vied to use the few low-quality voice radio channels available. The system, which served as the sole lifeline for officers and citizens in trouble in remote locations, could be monitored by anyone with a scanner and was vulnerable to interference from errant radio traffic from places as far away as South America. It also had no capacity to handle state agencies' increasing demand for data transmission.

In 1989 the disastrous Shadyside flood highlighted general communication deficiencies and the lack of agency interoperability. The disaster focused attention more sharply than ever before on the acute need to upgrade Ohio's aging system. In 1992 a task force on emergency response and communications was appointed to recommend improved emergency response capabilities. Task force recommendations included establishing mobile links; developing a digital, trunked voice and data system; and constructing a new state emergency operations center. A new system, known as the Multi-Agency Radio Communications System (MARCS), is being developed and is expected to be complete in the year 2003.

The analysis should be conducted by an individual or a team of people familiar with technology systems development, procurement procedures, statistical evaluations, and the operational processes supported by the system. To provide a solid foundation for the architecture decision, the analysis should consider at least two options, one of which is the status quo. As a baseline, the analysis begins by determining the costs and benefits of continuing to use the current system without changes. For each alternative considered, the cost/benefit tradeoff analysis must include the following steps:

- Estimating costs and benefits of each alternative
- Documenting assumptions
- Converting costs to a common unit of measurement to permit comparisons
- Evaluating costs and benefits of each alternative
- Determining the most appropriate option.

System planners should always be attentive to financial considerations

Develop an education and training plan

The education and training plan is the primary document for all tasks related to education and training. System planners should develop the plan in concert with education and training specialists to ensure the instructional strategy is devised in such a way that the individual learner's needs are satisfied. Education and training in the context of developing a new communications system generally refers to educating and training system operators, maintainers, and end users. The education and training plan should address the following items:

- Clearly defined purpose and objectives
- Participant identification and current level of knowledge
- Method of instruction, instructional guides, and materials required for different audiences
- Program duration and estimated cost per participant
- Roll-out schedule and estimated time of completion
- Assessment methodology, baseline for success, and process for continuous refinement of instructional materials.

Design and engineering Best Practices

Interviews with experienced system developers suggest the following best practices and lessons learned for planners to observe during the design and engineering phase:

- Although communications system planning is a more reactive environment than most, planners need to remain as proactive as possible in their decision-making and planning.
- Planners can guide their efforts by establishing a vision for the new system that identifies long-term objectives and desired communication capabilities. To keep projects focused, planners can ask their teams, "What should we or could we be doing?"
- Upward migration to new communications technologies presents an extremely complex set of issues. System planners need to keep the magnitude of what they are attempting in mind so as not to become overwhelmed with the scope of their efforts.
- Planners need to define system requirements clearly to vendors and guard against letting them become bogged down in minute details.

- In addition to conveying requirements clearly, system planners should ensure performance of regular tests to verify that vendors' work matches system needs and delivers what they are being paid for.
- It is also a good practice to let vendors know up front the resources available for a project and the infrastructure currently in place.
- Vendors should be required to build on and around the current system.
- If system costs increase, planners may wish to have a consultant review and recommend the proposals. Legislatures are often more likely to approve budget requests when a consultant or a system integrator has verified the proposed costs than when verification comes from internal departments.
- By establishing mutual aid agreements with other agencies, system planners can ensure that the public's needs are addressed first, regardless of which agency responds. ("It doesn't matter what color the fire truck is; the closest truck responds.")

Resources

- Public Safety Wireless Network. *Radio Spectrum Policy and Legislative Issues.* November 1997 [www.pswn.gov]
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- IEEE Standard for Application and Management of the Systems Engineering Process, *IEEE Std 1220-1998 (Revision of the IEEE Std 1220-1994)*. January 1999.
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phase four
procurement

Purpose

During the procurement phase, system planners must balance system needs and requirements against allocated resources. They must obtain necessary resources for conducting the procurement process, develop a request for proposal (RFP) that accurately identifies all system requirements, and identify the best vendor(s) for the project—all while maintaining stakeholders' cooperation.

The primary role of system planners during the procurement phase is to develop and implement a strategy that ensures achievement of project goals while obtaining the best overall purchase value. Additionally, program management and tracking procedures and the evaluation of procurement documentation are necessary components of this phase. To make good procurement decisions, system planners must be able to evaluate proposals and subsequent vendor responses to assess system design options. These evaluations include:

- Identifying proposed changes to technical and functional specifications
- Ensuring functional specifications support technical and operational needs
- Examining cost/benefit analyses
- Creating technical procurement documentation.

System planners who thoroughly understand and can answer questions regarding these activities will be in a strong position to maintain high-level management support for the implementation plan.

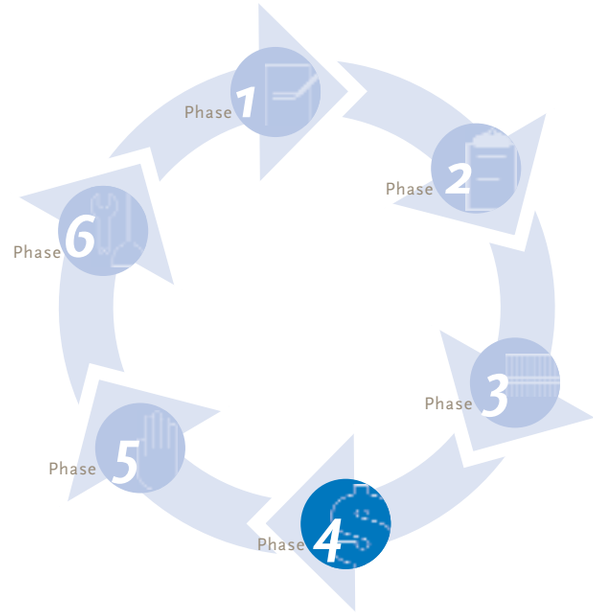
System planners must ensure that the procurement processes are efficient and effective. Delays during this phase can increase costs and decrease service to the public. Streamlining the process for procuring equipment and services is a key objective during this phase.

This section defines the steps system planners need to take to succeed in the procurement phase of the system life-cycle process. It also includes some success stories and lessons learned from others who have completed this phase.

Objectives

By the end of this section, system planners will understand how to complete the following steps:

- Prepare and distribute an RFP
- Analyze vendor responses to RFIs (issued during the Design and Engineering phase) and RFPs
- Use program management and tracking methods
- Ensure procurement planning complies with all prevailing rules, policies, and procedures
- Prepare a new equipment procurement and legacy equipment removal plan
- Maintain high-level management and financial support
- Develop education and training materials.



Key Steps

Prepare and distribute an RFP

Preparing and distributing the RFP begins the procurement process and lays the groundwork necessary for handling legal and contractual issues that may arise. The RFP is a tool to clearly characterize the property or services desired, conditions and schedule for the work to be performed, legal ramifications, vendor evaluation factors, and any other procurement expectations.

RFPs become particularly necessary when system planners conclude that key project activities would be best accomplished by resources external to the agency. External resources could include equipment vendors, system integrators, or consultants. At times, it may even be appropriate to hire an external resource to manage some procurement functions (e.g., developing the RFP, negotiating contracts, or handling legal issues).

This becomes especially important if special expertise or independent judgment is needed. A standard outline for an RFP includes the following items:

- Introduction
- Background and scope
- Vendor information
- Proposal procedures and instructions
- Proposal evaluation procedures and criteria
- Technical approach
- Deliverable requirements
- General terms and conditions
- Schedule
- Travel and other direct costs
- Labor distribution
- General provisions
- Technical specifications
- General installment stipulations
- Acceptance testing
- SOW.

We recommend including a procurement specialist in the process from the beginning of the project. In our initiative, we avoided many obstacles and barriers because we had the expertise on our team to advise us on the best direction to obtain funding for our new communications system.

Les Jones, Communications Supervisor
City of Mesa, Arizona

The introduction and background and scope sections should include the procuring agency's point-of-contact information, the description and purpose of the procurement, an overall project history, and information about future expectations. The RFP is also an opportunity to request applicable vendor information. For example, system planners may want to know specific vendor information such as years in business, similar work experience, the project manager's name and qualifications, any subcontractor(s), and a list of references. This section of the RFP should also state whether single or multiple contracts will be awarded and which departments or agencies the contractor(s) will be accountable to.

The proposal procedures and instructions section includes information about the response preparation process, such as submission instructions, response deadline, and a statement of all vendor evaluation factors. If the evaluation factors are weighted, it is beneficial to state their values in the RFP. For example, system planners may have determined that the vendor's ability to present the system design is very important. In this case the RFP might request the vendor to prepare both a preliminary design of the new system and a follow-on conceptual design. These two elements might be weighted at 20 points each out of a total of 100, whereas other elements would be worth only 10. As a result, satisfying this particular condition would give the vendor a stronger rating than satisfying a condition deemed less critical.

The RFP technical approach section should be structured to elicit the methodology the vendor intends to use to fulfill the project requirements. In this section the vendor could be required to identify key steps for developing the data collection strategy, determine appropriate technologies to meet acceptable specifications and performance measurement requirements, and define the approach to be used to select and integrate the final system concept.

The deliverable requirements section of the RFP should define all work products to be completed during the project period of performance. In addition, this section should define when each item is due, how long the agency has to review each deliverable and respond to the vendor, how long the vendor has to make changes to each deliverable, and what the final acceptance guidelines are.

The general terms and conditions section discusses elements such as contract duration (period of performance), inclusive of renewal options; travel and other direct costs; labor distribution; and general provisions. Often an RPF provides travel and other direct costs estimates. The RFP should specify whether the vendor or the procuring agency would assume these types of costs. Labor distribution summarizes the labor hours and compensation structures required for each category of work to be accomplished. The pricing should be sufficiently detailed and itemized to allow system planners to easily evaluate associated costs. Additionally, invoice and payment procedures should be included in the RFP. General provisions could address such subjects as nondisclosure, risk of loss and damage issues, termination conditions, indemnity, insurance and claims issues, and organizational conflict of interest and future contracting restrictions.

Technical specifications identify the system characteristics and objectives required by the user. Technical specifications include issues such as system, subsystem, and component functionality definition; operational, functional, and technical performance requirements; hardware or software specifications for major subsystems; applicable electrical and mechanical attributes; and specific interfaces required with other systems.

The general installment stipulations section addresses installation plans, procedures, and approval processes. This section of the RFP also details any specific equipment installation requirements such as grounding, bonding, and lighting protection requirements or antenna and transmission line installation.

The acceptance testing section addresses the stages necessary to integrate and accept the new system. Acceptance testing requires performing multiple evaluations. Some of those evaluations include the following types of testing:

- Equipment (prior to installation)
- Staging area acceptance
- Field acceptance
- Functional
- Performance
- Radio frequency (RF) coverage
- Operational.

The acceptance testing section of the RFP should identify whether the vendor or agency will perform all tests necessary to evaluate the completeness of the system integration.

The SOW should provide a coherent, methodical, thorough description of all aspects of the services, equipment, facility construction, and subsystems to be provided by the vendor. The SOW is instrumental in enabling successful achievement of project objectives by the vendor and effective management of the contract by system planners. A well-written SOW can widen the field of potential vendors that choose to compete for the contract, and it serves as a standard for determining whether a vendor meets the specified performance requirements. Specific items detailed in the SOW include:

- Project scope
- Applicable documentation
- Operational, functional, and technical performance requirements
- Description of work to be performed
- Project schedule
- Acceptance testing.

For tracking purposes, the SOW should also include a cover page that shows the SOW title, date of preparation, procurement request or contract number, revision number, and name of the preparing agency.

The Ohio Department of Administrative Service utilized a tactical process to analyze and evaluate the RFI and RFP responses. This process was critical to selecting the best candidate for implementing the type of communications system our public safety community requires.

Raymond R. Smith, Project Manager, MARCS, State of Ohio

Analyze vendor responses to RFI and RFP

To make solid procurement decisions, system planners should evaluate proposal responses using tracking methods and program management tools. System planners can reduce the time and support costs required to process RFI and RFP submissions by requiring submission in a standard electronic format.

In evaluating proposal responses, system planners must ensure all system requirements and evaluation criteria are adequately met. Selecting vendors and negotiating work contracts, legal issues, and schedules is time consuming. To decrease the time required to search a vendor's response for specific evaluation criteria, system planners can require that the vendor address key requirements separately.

System planners can also reduce the time required to analyze RFI and RFP submissions by benchmarking other agencies to determine whether commercial or government equipment is most effective and by using both commercial and government specifications and standards as requirements.

Receiving and replying to vendor responses can take a great deal of time because the vendors may highlight areas where specifications need to be rewritten or where other issues need to be clarified. Therefore, system planners should allocate adequate time for this multifaceted process. For additional guidance on preparing RFP document and evaluating vendor responses refer to the *Guidebook to Technology, Issues, Planning, and Management* prepared by the National Law Enforcement and Corrections Technology Center.

Use program management and tracking methods

Program management and tracking methods are vital aids for system planners during the procurement phase because they provide a basis for continuous planning and cost estimation. These methods include implementing formal, automated procedures and tools for tracking work orders, planned and actual project costs, and project milestones and objectives.

Two common visualization tools used in program management and tracking are the Gantt and Program Evaluation and Review Technique (PERT) charts. Both of these tools can be found in commercially available software packages. A Gantt chart, illustrated in Figure 4–1, is a bar chart that focuses on the sequence of the project tasks. A Gantt chart portrays the interdependency between resources and time and most often details the tasks to be accomplished on the left and a corresponding estimated time scale to the right. A PERT chart, illustrated in Figure 4–2, shows the relationship between interdependent tasks and becomes particularly useful in demonstrating critical paths—a series of tasks that must be completed on time for a project to finish on schedule. Regardless of which type of chart is used, the system planner should modify the chart during the project as schedules are revised.

Table 4-1: *Gantt Chart Example*

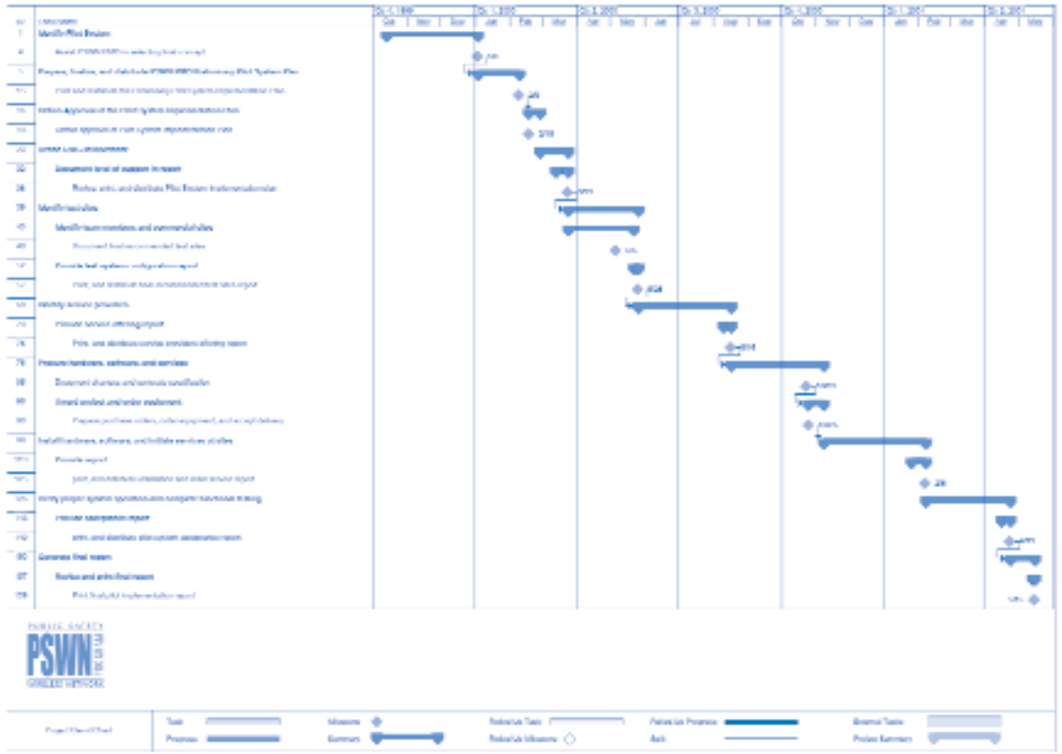
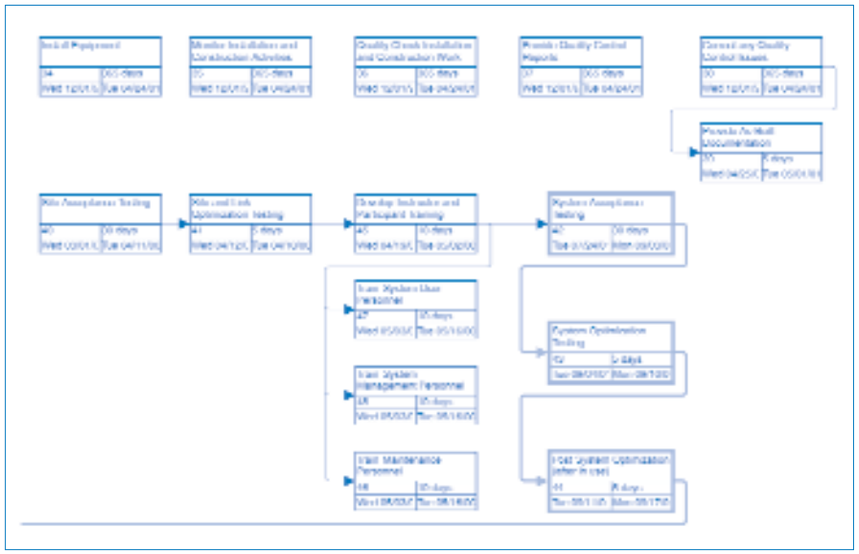


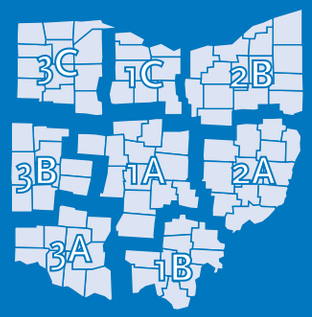
Table 4-2: *PERT Chart Example*



Success Story

In 1994 the Ohio Department of Administrative Services (DAS) in conjunction with participating agencies and the independent consultant began development of a Request for Proposal for the Multi-Agency Radio Communications System—known as MARCS. Later that year, the 120th General Assembly created the MARCS Steering Committee from directors in the DAS, Public Safety, Natural Resources, Transportation, Budget and Management and the Adjutant General to expedite the construction of MARCS as well as develop policies for its ongoing operation.

Under the guidance of the Steering Committee, the MARCS was refined and pushed forward over the next several years. From $15 million in funds appropriated from the 1993–1994 capital budget, the new Emergency Operations Center and Joint Dispatch Facility was constructed at the Beightler Armory in Columbus. In 1995, the state secured a quality assurance contractor to provide evaluation services and project engineering consulting for MARCS. By October 1998 the first $24.9 million phase of an estimated $271.9 million 5-year project was awarded by DAS and put under construction. The first 10-month phase includes the design of the central Ohio portion of MARCS with certain portions of the first phase project scheduled to be operational as early as spring 1999.



In addition, system planners must devise a process for tracking and comparing the budgeted and actual costs of the project to ensure the acquisition is within budget. In tracking actual costs, it may be necessary for system planners to establish formal analysis criteria and develop a cost-variance report. A cost-variance report assesses any financial deviation from the project plan. This report will become particularly useful if the need arises to implement any price-reduction acquisition strategies or request additional funds.

Ensure procurement planning complies with all prevailing rules, policies, and procedures

To develop an effective communications system, system planners need to actively involve individuals with varied functional expertise throughout project development. Specialists who are knowledgeable about procurement procedures can be particularly helpful in the procurement phase, to ensure acquisition planning complies with all county, state, and federal acquisition rules, policies, and procedures. Many states have a purchasing division with this functional expertise. System planners should seek guidance from these experts by having them attend key meetings and participate in RFP, policy, and contract development.

Also, because procurement personnel eventually must answer all questions regarding the system purchase, it is wise to include the project procurement representative early in the system development process. System planners should empower the procurement representative to serve as the spokesperson for the project so he or she can respond to questions from, for example, the city council.

> *The State of Ohio created a new communications system roll-out plan that detailed the steps in each phase of the implementation process. The roll-out plan included timetables for completion of installation as well as the specific costs associated with each section of the state. We also made certain that our education and training program followed the identical roll-out pattern to ensure our users were receiving immediate training to operate the new system. This pattern to ensure our users were receiving immediate training to operate the new system. This plan was communicated throughout the state by an intensive public relations campaign.*
>
> *Todd Barnhouse, Public Relations Manager, MARCS, State of Ohio*

Additionally, a city or state contract attorney should review all potential contractual agreements between the procuring organization and the vendor. This review could include evaluating the legality of RFI, RFP, contracts, and procurement paperwork. Legal representation should also be present during final contract negotiations.

Prepare a new equipment procurement and legacy equipment removal plan

The equipment procurement and acquisition plan should address new equipment procurement and installation as well as removal of legacy equipment. Equipment procurement and implementation often take years. It may be most effective to structure the procurement plan in discrete phases that take internal and external environmental influences into account and that can be realized with some degree of certainty.

It is important for system planners to develop an equipment procurement plan consistent with the vendor's ability to design and implement the system, the stability of funding resources, the time required to process procurements internally, and the status of spectrum allocations. System planners should begin scheduling actual procurements as early as possible in this phase.

> *The State of Nevada requested assistance from the Nevada Government Relations legal counsel to ensure we were aware of the federal, state, and local policies and regulations associated with building a statewide communications system. We cannot imagine moving forward without this type of legal assistance.*
>
> *Rich Sheldrew, Nevada Department of Transportation*

Schedule: Phases 1A ➤ 1C ➤ 2B ➤ 3C ➤ 3B ➤ 3A ➤ 1B ➤ 2A

Phase	Sites			Population (As of 1996)	Square Miles	Estimated Completion Date (Year)
	State	Lease	Purchase			
1A	13	11	2	1,785,395	6,472	2001
1C	7	2	1	500,270	3,267	2001
2B	12	19	3	4,083,132	7,155	2001
3C	5	6	2	1,013,927	5,330	2002
3B	4	7	1	1,080,313	3,996	2002
3A	7	15	3	1,799,471	4,588	2003
1B	10	19	11	363,072	4,172	2003
2A	15	16	10	546,202	5,971	2003
Totals	**75**	**95**	**33**	**11,172,782**	**40,951**	**2003**

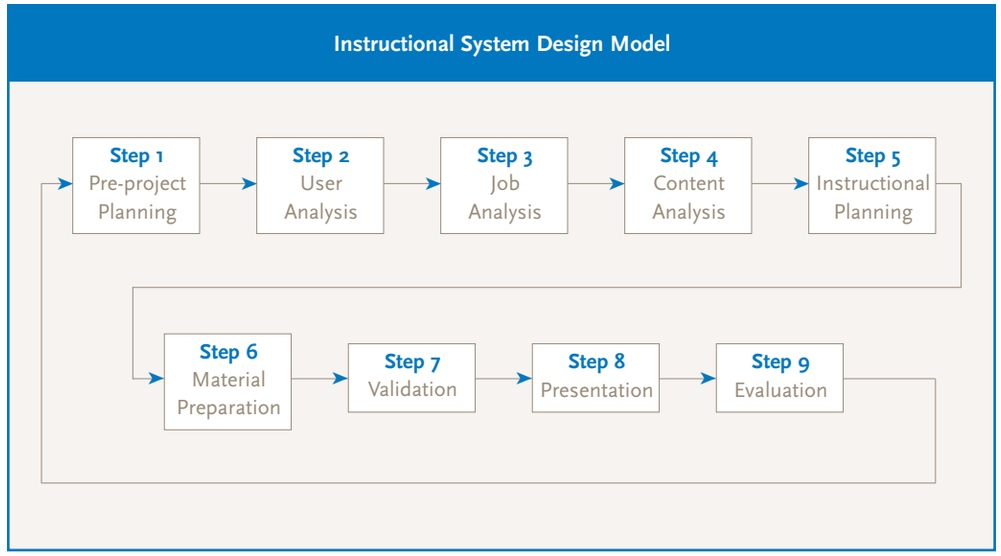
Maintain high-level management and financial support

Maintaining high-level management and financial support may sound like a relatively easy task. On the contrary, this highly visible and challenging assignment may demand significant effort from system planners. In this step, system planners must approach key stakeholders proactively, communicating with them effectively and often. This effort may entail scheduling weekly, biweekly, or monthly meetings to brief stakeholders on project accomplishments and overall successes. An important link to stakeholders, too often overlooked, is the local media. The media should be recognized for their keen ability to link the public safety community with the larger community.

Develop education and training materials

Similar to the life-cycle system development, the Instructional System Design method—ISD—is a systematic process to design instruction. This process provides system planners with a step-by-step approach to plan and develop instruction to meet an agency's educational and training needs. Like the life-cycle system development, designing instruction takes time and careful planning. Figure 4–3 illustrates the ISD process. Table 4–3 lists the instructional system design steps that will crystallize as the life-cycle system development unfolds.

Figure 4-3: Instructional System Design



"Key to building our statewide communications system was the strong administration support we received directly from the governor and lieutenant governor. We also established a cabinet-level executive sponsor to communicate the need for a new system. Equally, if not more important, was the solid support from the user community. Specifically, the Pennsylvania State Police and the Fraternal Order of Police were instrumental in pushing our goal of interoperability."

Donald Appleby,
Radio Project Officer,
Governor's Office of Administration,
State of Pennsylvania

Table 4-3: Instructional System Design Steps

Step	Objective
Determine Instructional Goal	• Determine what the participants should be able to do at the completion of instruction
Analyze the Instructional Goal	• Determine step-by-step what participants are doing when they perform the goal and the skills and knowledge that are required of participants to be able to begin the instruction
Analyze Learners and Contexts	• Identify participants, the context in which they will learn the skills, and the context in which they will use them
Write Performance Objectives	• Write specific statements of what it is the learners will be able to do when they complete the instruction
Develop Assessment Instruments	• Develop assessments that are parallel to and measure the learners' ability to perform what was described in the objectives
Develop Instructional Strategy	• Identify the strategy that will be used in the instruction to achieve the terminal objective
Develop and Select Instruction	• Design and develop instructional materials
Design and Conduct the Formative Evaluation of Instruction	• Evaluate instruction and instructional materials
Revise Instruction	• Identify difficulties in instruction and revise as necessary
Conduct Summative Evaluation	• Evaluate instruction and revise as necessary

Procurement Best Practices

Interviews with experienced system planners suggest the following best practices and lessons learned for planners to observe during the procurement phase.

System planners should develop, maintain, and distribute a "preferred vendors" list based on previous performance and satisfaction of acceptable standards relevant to the public safety community. The list should detail which vendors were used in the past, why they have been designated preferred, what types of services they offer, and a point-of-contact in the government agency endorsing the vendor. This list can be used for reference to assist system planners in evaluating potential vendors.

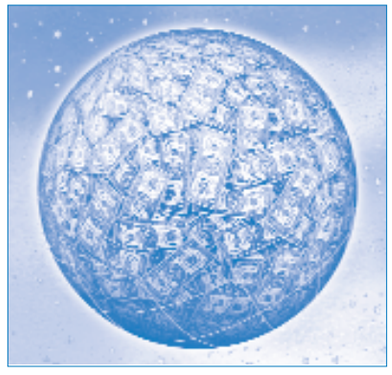
Harnessing the collective knowledge, skills, and abilities of all team members increases the likelihood of success

"Best value" techniques offer a constructive and proven approach to procuring a communication system. The National Association of State Purchasing Officials describes this approach as "a process for selecting the most advantageous offer by evaluating and comparing all relevant factors in addition to cost or price so that the overall combination that best serves the interest of the state is selected." A best-value procurement considers:

- Total cost of ownership
- Performance history of vendor
- Quality of goods or services
- Delivery
- Proposed technical performance
- Financial stability of vendor
- Timeliness
- Cost of necessary training
- Qualifications of individuals proposed for a project
- Realistic risk assessment of the proposed solution
- Availability and cost of technical support
- Testing and quality assurance program.

Performance-based contracts help ensure technology solutions meet operational requirements. Elements in the process of developing and managing a performance-based contract include:

- Developing internal proposal and request for funding
- Establishing measurable specifications
- Developing vendor relationship and dedication
- Requiring vendor to verify system operation
- Holding vendor accountable for system reliability.



Financial support from key players is essential for project completion

Resources

Procurement

- The Commonwealth of Massachusetts. *Procurement Policies and Procedures Handbook.*
- *Understanding Wireless Communications in Public Safety: A Guidebook to Technology, Issues, Planning, and Management.* March 2000. The National Law Enforcement and Corrections Technology Center (Rocky Mountain Region).

Funding

- *Buying Smart: Blueprint for Action.* May 1998. [www.naspo.org/reform/reform.html]
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Outsourcing

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- Christopher J. Dorobek. "GSA: Contract Out IT Work If It Makes Sense." *Government Computer News.* March 16, 1998. [www.gcn.com/archives/gcn]

phase five
implementation

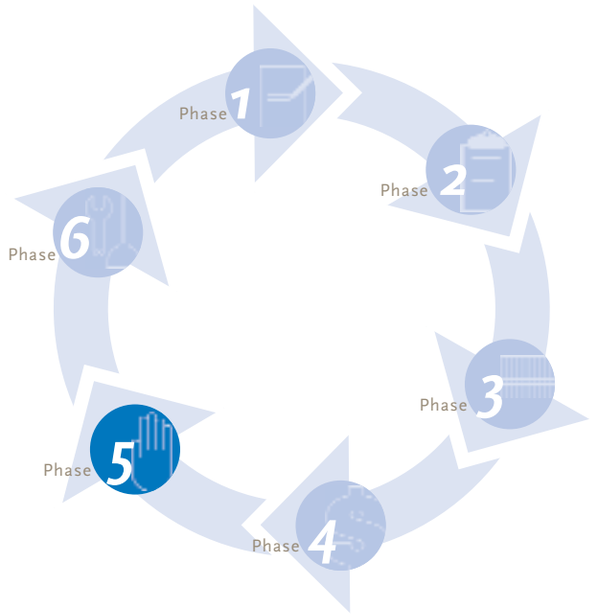
Purpose

This section provides guidance for the system planner who must move the system design and other preparatory work performed during the first four phases of the life-cycle process to an on-the-air, fully functional wireless communications system. By now, the system planner should have a clear picture of what the finished product will be when site construction and system implementation are complete. This section discusses several of the many paths the system planner can follow to achieve the desired objective.

System planners are likely to have numerous alternatives for building the system infrastructure, installing equipment, and preparing the users to receive the new services. Some of the more common methods for developing the infrastructure are:

- Using agency personnel and resources exclusively
- Using the services of a private company to provide a turnkey solution
- Partnering with other agencies or private companies
- Turning the entire project over to another agency or private company to development the system and then leasing back the services.

This section defines the key steps to ensure success in constructing a wireless system and migrating users to the new system. It also presents some success stories and lessons learned by others who have completed this phase of the process.



Objectives

By the end of this section, system planners will understand how to:

- Select from the various options available for system implementation
- Make an informed decision about which implementation method to use
- Develop a task breakdown structure
- Identify skills and services needed to ensure success
- Perform acceptance testing and performance evaluation
- Resolve performance issues
- Obtain or prepare needed documentation
- Develop, schedule, and perform training
- Migrate users to new systems
- Decommission and remove old equipment from service
- Optimize system performance.

Key Steps

In-House Implementation

When implementing a system using in-house resources, the planner assumes all risk, technical and otherwise, and in particular, all risk associated with achieving specified system performance. The planner must have acquired, or plan to acquire, all of the skills, tools, supplies, facilities, experience, and personnel necessary to implement the system. The technical risk is very high, and the financial risk is moderate.

This alternative may be the least expensive if the planner already possesses all of the skills, tools, supplies, facilities, experience, and personnel necessary to implement the system because the planner can implement the system at a net cost that is lower than that incurred when a turnkey integrator is used. These cost savings occur because the planner can potentially implement the system at cost—without having to pay for the integrator's profit margin.

Be certain to identify all the skills and resources needed before undertaking system construction

Develop a System Implementation Plan

System planners should approach an in-house implementation as though they were contracting with an integrator, with the exception that they themselves would fulfill the role of the integrator, with work being performed by staff and contractors. Therefore, planners should not only be aware of the issues associated with a turnkey implementation, as outlined in this guide, but also plan to deal with additional issues.

The planners should develop a program plan addressing all issues associated with project implementation. These issues include, but are not limited to, developing a work breakdown structure; defining roles and responsibilities, skills required, and staffing and resources; preparing schedules and timelines; addressing spectrum needs; dealing with site acquisition, shipping, payment milestones, and inventory control; creating a project administration plan, project controls, and a quality assurance plan; and coordinating contractors and client staff.

Because thorough planning is critical to implementation success, the planners should not hesitate to seek outside help with any of the planning elements that they do not understand. These vital elements are discussed in detail in the following paragraphs.

Work breakdown structure

It is critical that the planner identify and understand every step that must be executed to implement the system. The work breakdown structure should be organized by task, subtask, and work element. The work breakdown structure should also specify the duration of each work element for implementation as well as the resources and cost associated with each work element.

Roles and responsibilities

The program plan must define the roles and responsibilities of each person involved in managing the implementation, including the project manager, his or her assistants, and all administrative assistance.

Technical skills required

The program plan should identify all technical skills required to implement the system and the staff and resources required. Analysis should be performed to identify areas where expertise needs to be developed or performed by contractors.

Scheduling and timelines

The program plan should include a project implementation timeline for installing the system, including ordering materials, supplies, and labor; and define installation steps for each major system element (such as site equipment, antennas, radio equipment), including testing, burn-in, cutover, and acceptance. The schedule should clearly define each project milestone.

Spectrum management

The program plan should address the need for radio frequencies and take into account the time and skills needed to identify the spectrum needed, obtain the licenses required, and coordinate their usage. The process of acquiring frequency licenses or authorizations can be very long and complex, so the planner should begin early and expect delay.

Site acquisition

The program plan should identify all potential risks associated with acquiring sites for system facilities and how they will be dealt with. This can include lease negotiation, real estate purchasing, zoning and land use concerns, as well as community concerns.

Shipping, payment, and inventory control

The program plan should define mechanisms for handling shipping, vendor payments, and inventory of items as they are received and moved from storage to final installation sites.

Project administration including sub-contract administration

The program plan should include a project administrative plan that defines administrative guidelines and processes, such as protocols for correspondence, interface points, and periodic reports.

Quality assurance

The program plan must include a well thought out quality assurance plan to ensure adherence to standards and specifications as work progresses.

Prepare for Installation

The planners must develop the skills and capabilities identified in the program plan as outlined above. These skills and capabilities may be addressed using existing staff, through recruiting and training of new staff, or through contractors.

Before installation commences, all radio sites must be identified and acquisition issues addressed as described later in this document for turnkey installations, including available space, capacity of existing structures to handle additional antennas (structural analysis), acquisition, local opposition based on visual appearance, FAA restrictions, permits and licensing, interference, frequency coordination, and suitability for meeting system design criteria. The Motorola R56 Issue A, *Standards and Guidelines for Communications Sites,* includes a flow chart that details the steps involved in site acquisition.

When all resources are accounted for and site issues are settled, the planner must procure the needed contract work and materials. The planner must develop specifications for all materials and whatever contract work is required, and solicit bids for these items. At this point, the implementation schedule may need to be updated because lead times for equipment procurements may result in changes to the overall schedule.

Training and documentation are major issues with in-house implementations. In a turnkey integration, integrators provide training and documentation. However, in self-implemented systems, the planner must coordinate the training and documentation elements among in-house staff, vendors, and contractors. It is recommended that the planner develop a plan to identify training elements required and include these training elements in procurements for equipment and services to the extent possible.

System documentation must be developed by the planner or a design contractor. As with training, system installation and as-built documentation is critical to successful implementation. It is recommended that the planner develop a complete list of documentation required for inclusion in the implementation plan and prepare to develop the documentation using in-house or contracted resources.

The in-house planner must also deal with testing and verification of the system to ensure system performance and adherence to specifications. The same guidelines described for turnkey installations should be followed by the in-house planner. Guidelines for system testing can be found in EIA/TIA TSB88-A.

turnkey procurements present the least technical risk, but there are still **pitf lls**

Turnkey System

Employing an integrator to provide a turnkey solution presents the highest potential up-front cost because the contractor is responsible for design, implementation, and acceptance. Contractors incorporate design margins and corresponding added expense to cover their performance risk—this is not necessarily a risk because the contractor is responsible for making the system work.

Using a turnkey integrator also presents the least technical risk to the planner because the contractor must design the system, make it perform as specified, and then turn it over to the planner upon acceptance. Although the planner may not be responsible for making the system work, he or she should use great care to ensure that the system's performance meets or exceeds the users' requirements.

Although using a turnkey integrator involves the least technical risk for the planner, many opportunities remain for problems to arise; and the planner must be prepared to deal with these possibilities. The following sections describe the key steps and discuss problem areas common in turnkey installations.

Establish Communications and Coordination Guidelines with the Contractor

Effective coordination and communication with contractors are perhaps the most important factors in ensuring an effective implementation. The system planner should require the turnkey contractor to develop a project implementation plan. A good project implementation plan should include, at a minimum:

- Guidelines for communications and reporting
- Identification of key personnel and their roles
- Identification of interface points between planner and integrator
- Contract administration plan (including invoicing, payment, etc.) and payment triggers and schedule
- Project implementation schedule
- Consequences for not meeting scheduled milestones
- Quality assurance plan addressing compliance with specifications, policies, and procedures for changes and deviations
- Guidelines for required documentation
- Procedures and forms for inventory of shipped items
- Procedures for contract change control.

Planner review and approval of the plan should be required before any work begins.

Resolve Antenna Site Issues as Early as Possible

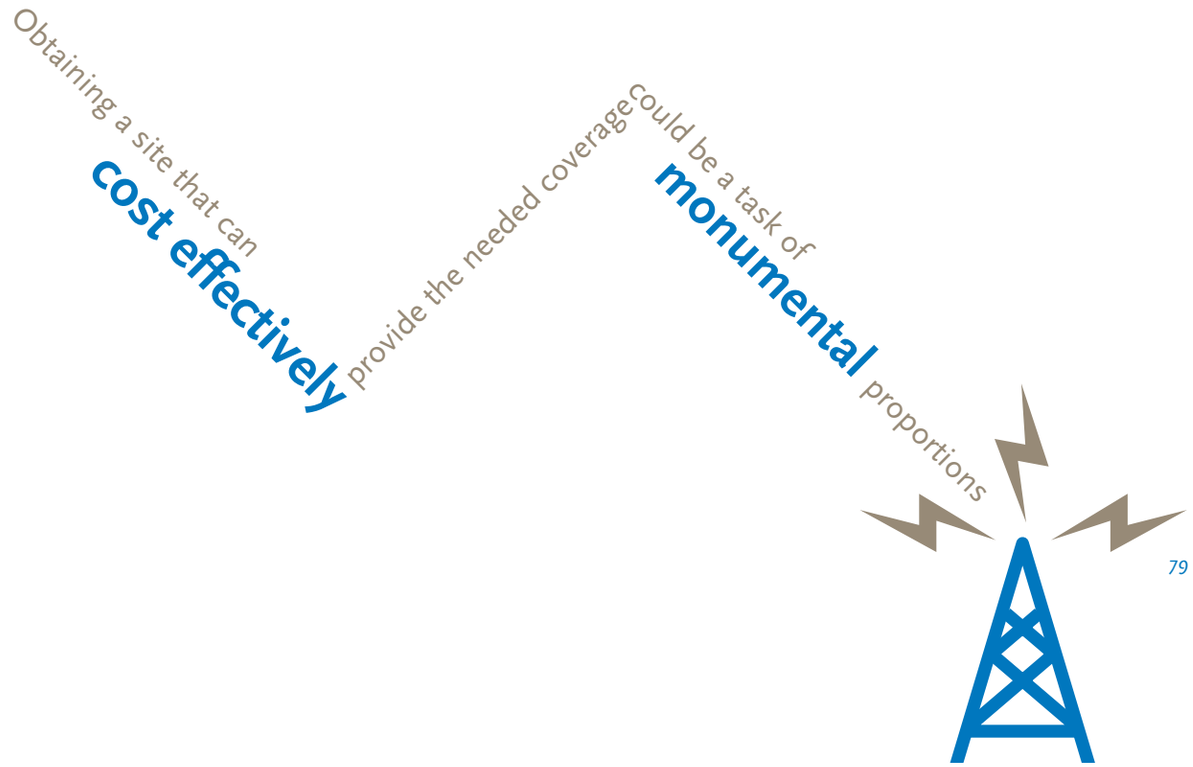
Site acquisition is a major issue in any system implementation. Although engineering designs may indicate that a site is the best choice in terms of system performance, other issues may dictate selection of a different site. It is in the interest of system planners to investigate these issues before finalizing a design and contracting for equipment shipments. It is critical that the planners work closely with the contractor during this phase.

Many questions must be answered during site acquisition. First, does the site provide the necessary space for the structures required by the system design? A guyed tower requires much more space than a self-supporting tower; however, the guyed tower itself costs much less. Also, is there space for an appropriate equipment room, fencing, and parking area at the proposed location?

When the system planner concludes that a site is potentially suitable, site availability must be determined. If the planner does not own the site, can the planner get the space at a reasonable cost? It cannot be assumed that owners of commercial sites will make exceptions or special accommodations for public safety agencies. When considering commercial sites, planners must keep in mind that existing commercial site owners may have already leased their most desirable space. System designs should never be based on obtaining the most desirable space at a commercial site—unless, of course, a written agreement with the site owner has been obtained.

If the planner wants to acquire the desired site, can the planner acquire ownership or a lease to use of the site? The answer to this question is critical. If the planner does not already own the site, steps must be taken to acquire it. Must existing structures be removed? What will be the cost of acquiring the site? Will there be a political impact if the site must be taken by right of eminent domain or in defiance of the will of the public? These factors must be identified and assessed as early as possible in the process.

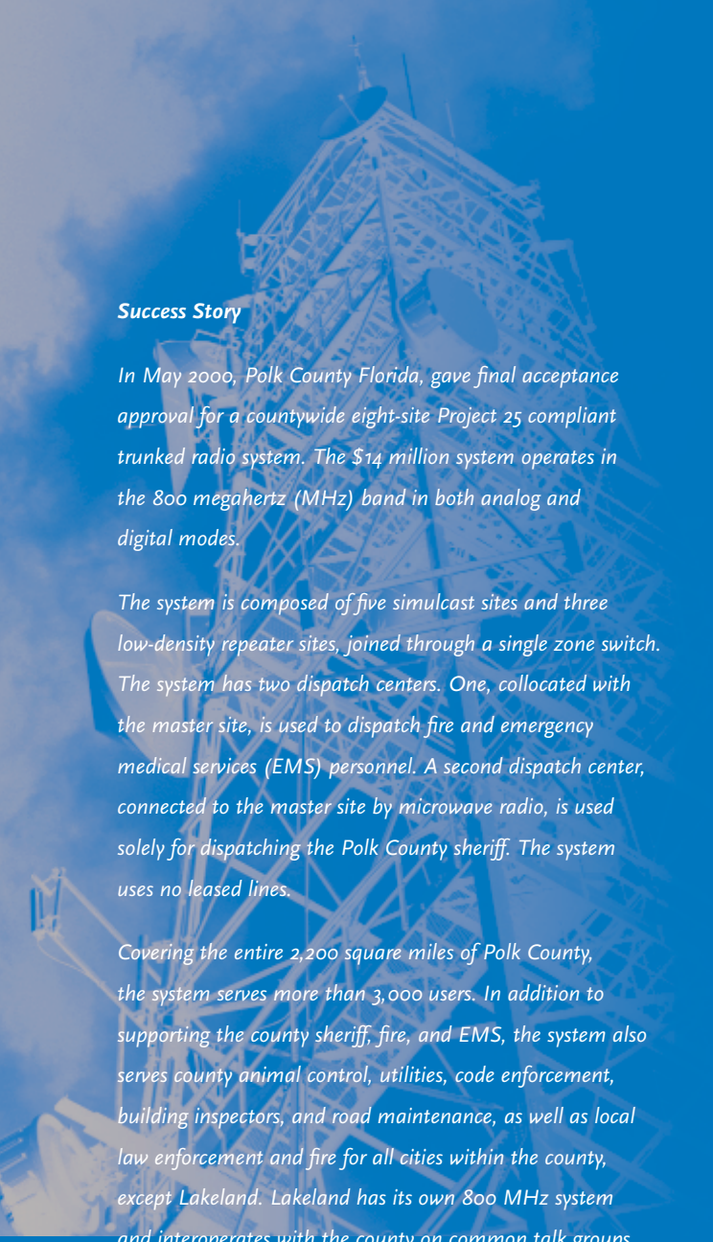
Unforeseen consequences may emerge during and after the site is acquired and development begins—will citizens object to the construction of a tower or other structure? Are there zoning or land use issues that must be addressed? Some sites may require an environmental impact statement or other special studies before development may begin. The community might be concerned about site aesthetics or perceived radio emission hazards. What can be done to manage these concerns, and how much would it cost? Finally, structures to be constructed on the site must be approved by governing authorities. For buildings, local permits must be obtained. Application must be made to the FAA for review of any potential impacts the structure may have on aviation. FAA approval must be obtained before construction can begin. This approval may include requirements for tower lighting and painting. Local approval of towers is also required in most locations.



The use of existing towers, whether controlled by the planner or a commercial concern, must be scrutinized carefully. Several factors must be addressed: Will the structure support additional antennas? If old antennas are to be replaced with new ones, how will the new antennas and feed lines affect the structural integrity of the tower? If modifications are needed to a commercial tower, who will be responsible for the costs? Will proposed antenna changes trigger any land use and zoning issues? Will the tower safely handle the load imposed by the system design? Is the tower already overloaded?

The best way to approach the use of existing structures is to hire a qualified professional engineer licensed in the subject state to conduct a structural analysis of the tower and the foundation. The analysis should consider current and proposed loading of the tower. It is important to note that any changes to the antenna design will also change the loading. Therefore, it is critical that structural analysis of the tower be performed as soon as possible after designing the antenna system. If a tower is found unsuitable for the load imposed by the system design, early identification of the problem provides time, before equipment is ordered, to explore options, such as changes to the system design or structural modifications to the tower.

Electromagnetic interference must also be assessed, especially when considering the use of an existing antenna site. As with the loading of an existing tower, the present electromagnetic interference at the site must be considered, along with the impact of the new transmitters at the site.



Success Story

In May 2000, Polk County Florida, gave final acceptance approval for a countywide eight-site Project 25 compliant trunked radio system. The $14 million system operates in the 800 megahertz (MHz) band in both analog and digital modes.

The system is composed of five simulcast sites and three low-density repeater sites, joined through a single zone switch. The system has two dispatch centers. One, collocated with the master site, is used to dispatch fire and emergency medical services (EMS) personnel. A second dispatch center, connected to the master site by microwave radio, is used solely for dispatching the Polk County sheriff. The system uses no leased lines.

Covering the entire 2,200 square miles of Polk County, the system serves more than 3,000 users. In addition to supporting the county sheriff, fire, and EMS, the system also serves county animal control, utilities, code enforcement, building inspectors, and road maintenance, as well as local law enforcement and fire for all cities within the county, except Lakeland. Lakeland has its own 800 MHz system and interoperates with the county on common talk groups.

According to the county's radio manager, the turnkey implementation of the infrastructure was contracted as a sole source to Motorola. During the planning stages of the new system, a needs assessment and technology review were conducted that indicated that the best way to facilitate migration, future system changes, and avoid obsolescence was to specify standardized components and modular construction.

The county's selection considerations included serviceability and the integrator's experience with systems. An innovative requirement used to evaluate proposed integrator teams was that the integrator had to demonstrate established working relationships with proposed vendors and subcontractors.

Establish Testing, Verification, and Payment Milestones Up Front

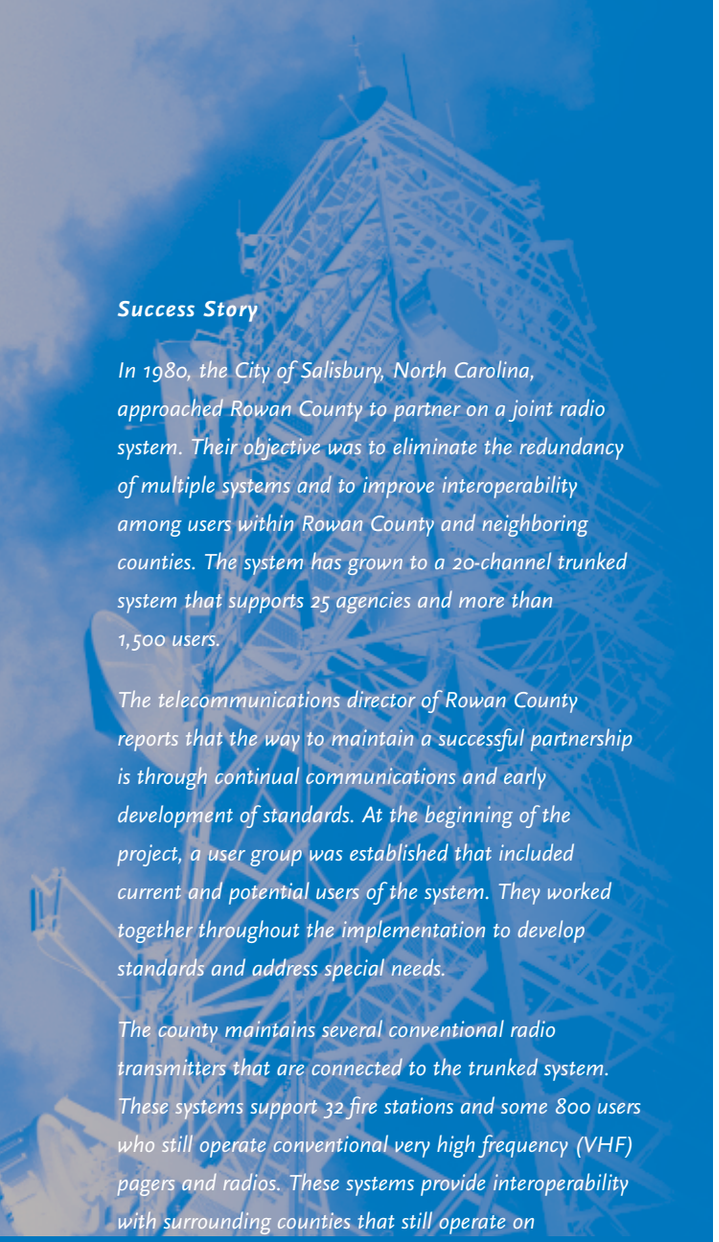
Milestone payments should be linked to discrete, performance-based milestones, rather than payment at regular monthly intervals. In cases where tight adherence to the schedule is critical to the project, the planner may want to impose a financial penalty for late performance on a milestone or final completion basis. In addition, final payment should be held back until after final system acceptance. A final payment of 10 percent of the value of the contract is customary.

Acceptance testing is the mechanism by which the contractor proves to the user agency that the system meets the performance specifications, triggering final payment and transfer of the system to the user agency. Therefore, it is in the interest of the user agency to specify acceptance testing requirements that mirror the system performance specifications as closely as possible. Some contractors may try to use a cursory system test that does not prove that the system meets the specifications. When this acceptance testing is initiated late in the system implementation, the user agency is often left in the position of accepting what the contractor provides or must delay system acceptance while an acceptable test is developed. Therefore, the user agency should require the contractor to submit proposed acceptance test plans early in the system design process, preferably as part of the final design documentation. This approach provides the user agency an opportunity to insist that the test mirror the design.

Two types of acceptance testing should be required: system functional testing and coverage performance testing. System functional testing is designed to demonstrate that the system performs in accordance with the system performance specifications. This testing may be achieved through demonstration of each of the system functions required in the specification.

Based on the Polk County system and other implementations, planners are advised of the following lessons learned:

- Government agencies tend to consider only the initial costs when evaluating system costs; there is a critical need to look at life-cycle costs before deciding to select the lowest bid.
- Good management practice and financial analysis appropriate to the situation are mandatory for large system procurements. The system planners need to look at new system implementation from a business perspective.
- The responsible technology manager must stay up to date on the state of the art, vendors, and products through participation in professional associations, trade shows, seminars, publications, and visits to successful systems—travel, professional activity, R&D, and other expenses are to be expected. The Polk County planners felt that building current and comprehensive knowledge of vendor offerings made selecting a vendor much easier.
- The radio manager must develop an understanding of system capabilities and talk group planning, develop a talk group plan, and understand how that plan would work in the system. The radio manager must understand the technology well enough to perform fleet mapping.
- Planners must have a clear understanding of what is required and must articulate it clearly in the specification. It is strongly advised that if the planners do not understand what is required or how to express it, professional help be obtained to ensure clear and complete specifications.
- Involving end users in the process of requirements definition can help the radio manager understand operational needs.
- A process for resolving disputes between the buyers and the integrator should be clearly outlined in the contract.
- Although it is a basic principle of business, the Polk County planners felt it was important to reiterate the idea that all agreements between the planners and integrators must be explicit and in writing.



Success Story

In 1980, the City of Salisbury, North Carolina, approached Rowan County to partner on a joint radio system. Their objective was to eliminate the redundancy of multiple systems and to improve interoperability among users within Rowan County and neighboring counties. The system has grown to a 20-channel trunked system that supports 25 agencies and more than 1,500 users.

The telecommunications director of Rowan County reports that the way to maintain a successful partnership is through continual communications and early development of standards. At the beginning of the project, a user group was established that included current and potential users of the system. They worked together throughout the implementation to develop standards and address special needs.

The county maintains several conventional radio transmitters that are connected to the trunked system. These systems support 32 fire stations and some 800 users who still operate conventional very high frequency (VHF) pagers and radios. These systems provide interoperability with surrounding counties that still operate on VHF systems.

The city and county worked out agreements to share the operations and maintenance responsibilities of the system. The city maintains the maintenance contract established when the system was installed in 1980. The county supports operations and maintenance through annual users' fees negotiated in advance between the city and the county. The partners periodically review maintenance records and evaluate future needs for replacement and upgrades. When the time comes for upgrading the system, the funding has already been established.

Coverage performance testing demonstrates that the system provides the specified coverage. Although system functionality can be proven objectively through demonstration, human perception of coverage performance may vary greatly from person to person. Therefore, human subjectivity must be avoided when performing coverage testing by using measuring equipment. Disagreement and misunderstanding between the contractor and user agency often occurs regarding the specification of the testing methodology and pass/fail criteria. To reiterate, the coverage performance test should reflect the coverage specification, which should be concise and specific enough to describe the mean signal threshold for the performance desired, the reliability required over the coverage area, and the area to be covered at the specified reliability. The user agency should ask the contractor to test the coverage performance by sampling the mean signal level in a defined number of "tiles or grids" covering the required area, such that the number of tiles or grids yields a 99 percent certain result. The percentage of tiles or grids that measure mean signal level at or above threshold should be equal to or greater than the required reliability. A coverage performance test specified in this way ensures that the coverage performance test reflects the coverage specification.

System planners may choose to partner with another organization to implement a shared system

Partnerships

Partnerships offer a distinct financial advantage when implementing independent systems. The costs of design, implementation, and acceptance testing are shared among multiple parties. Entities with limited radio resources benefit by gaining a more capable system than they could have implemented alone. Entities with more radio resources benefit by sharing some of the financial burdens.

Partnerships may help reduce duplication and improve interoperability between organizations. In many cases, multiple agencies operate separate LMR systems in the same geographic area. Upgrading or replacing multiple systems is usually more costly and labor intensive than partnering to replace multiple systems with a single shared system. Implementing multiple systems, especially in different frequency bands or by different vendors, creates a lack of interoperability. In a partnership, all users share the same system, so communicating between groups is easier.

There are, however, some disadvantages to consider when evaluating partnerships. By partnering with another organization, the system planner loses some control over the implementation. The other organizations must be relied upon to adhere to implementation schedules and plans. Once again, good communications between the organizations is a must.

Determine Best Method for System Implementation

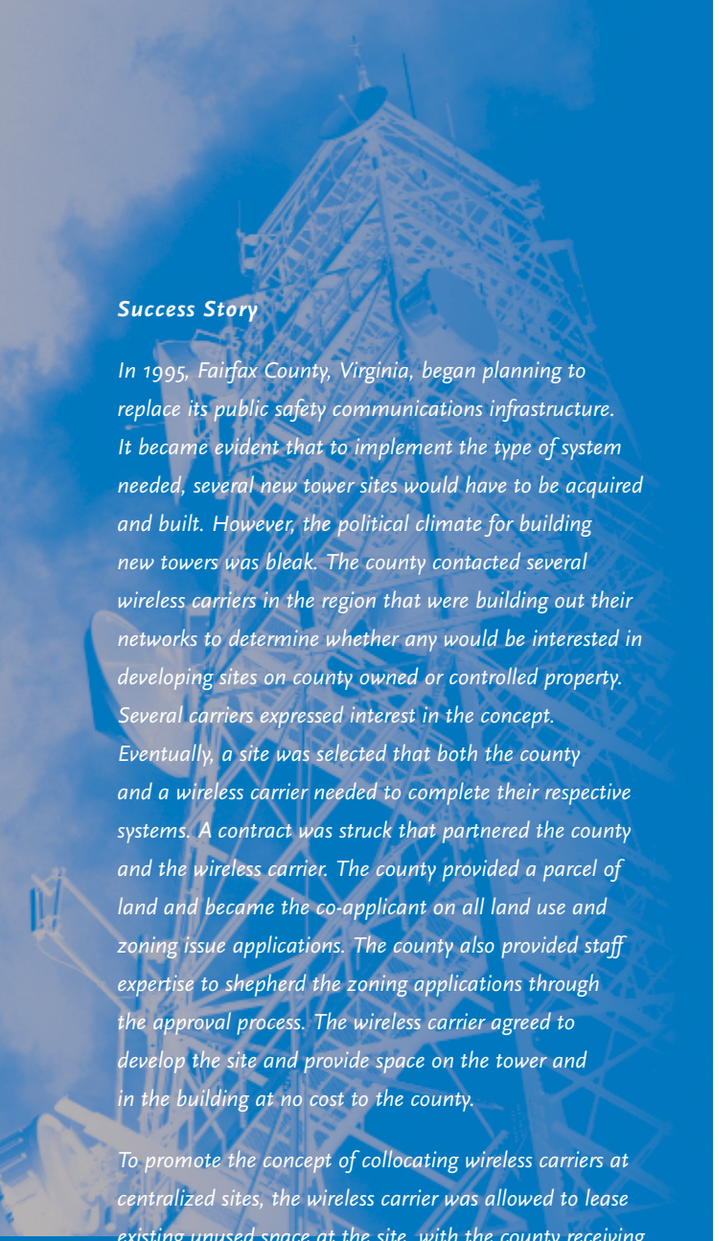
In response to the cost and effort of implementing an LMR system, more system planners are forming partnerships to share the burden of system implementation. Where multiple entities share common radio requirements, partnerships decrease costs, reduce duplication, and improve interoperability. Partnerships come in two forms:

- Partnering with one or more government agencies
- Partnering with a commercial enterprise.

The remainder of this section discusses issues associated with each form and the key steps that should be taken to help ensure a successful partnership.

Partnering with Another Government Unit

Separate government units typically partner to implement radio systems when they have a need for radio communications in common areas. Often the units require the interoperability that a shared system offers. Partnerships exist between units such as county and city entities, federal and local organizations, and statewide systems for all state and local users.



Success Story

In 1995, Fairfax County, Virginia, began planning to replace its public safety communications infrastructure. It became evident that to implement the type of system needed, several new tower sites would have to be acquired and built. However, the political climate for building new towers was bleak. The county contacted several wireless carriers in the region that were building out their networks to determine whether any would be interested in developing sites on county owned or controlled property. Several carriers expressed interest in the concept. Eventually, a site was selected that both the county and a wireless carrier needed to complete their respective systems. A contract was struck that partnered the county and the wireless carrier. The county provided a parcel of land and became the co-applicant on all land use and zoning issue applications. The county also provided staff expertise to shepherd the zoning applications through the approval process. The wireless carrier agreed to develop the site and provide space on the tower and in the building at no cost to the county.

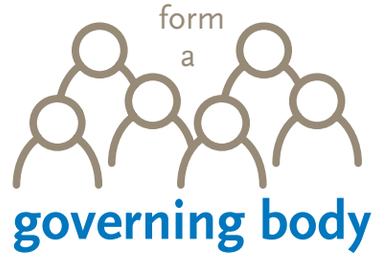
To promote the concept of collocating wireless carriers at centralized sites, the wireless carrier was allowed to lease existing unused space at the site, with the county receiving a percentage of any associated revenues. This spirit of cooperation became a win-win-win situation for the county, the community, and the wireless carrier. The county gained use of a communications site at no cost, along with a potential source of revenue. The community was spared the potential of multiple towers being built in the same area while gaining the intrinsic benefits of an improved public safety communications system. Finally, the wireless carrier was able to expedite the permit process by partnering with the county and obtain additional revenue by leasing unused space at the site.

Partnering with a Commercial Enterprise

In the past few years, there has been a push for government agencies to identify services that could be provided more effectively through outsourcing to private industry. Government agencies have also begun working closely with commercial enterprises to successfully implement projects when there is a potential mutual advantage. Commercial enterprises assist government agencies in all stages of the system life cycle. To maintain a successful partnership with a commercial enterprise, standards and expectations must be established at the outset. The entities must agree on their roles in the implementation, and communication between the entities must remain strong throughout the process.

Although commercial services, such as cellular and paging, cannot completely replace government-run LMR systems, they often augment them. These services provide added flexibility and cost-effective solutions for secondary communications requirements. Commercial services are often selected for handling administrative traffic, freeing radio channels for more critical use. Cellular phones are usually more cost effective than offering telephone interconnect or “private call” features in a radio system.

Regardless of the type of partnership that is formed, the following steps are essential to the successful implementation of a partnered system.



Select and Outline a Method for System Implementation

Implementing an LMR system to serve multiple user groups requires input from all the organizations represented. Some form of governing body should be assembled during the system planning phase. The governing body should be made up of representatives from all partnering entities. This group is often called an executive council or users group. This group should guide the entire process from system planning to operations and maintenance. During the implementation phase, the group oversees the process of implementing the LMR system. It also acts to maintain communication between all user groups.

Develop a Task Breakdown Structure

System planners should establish buy-in by all partnering organizations before implementing the LMR system. Allowing their input in the planning and design phases helps ensure their buy-in. In this phase, the partnering entities should work together to develop a set of standards for the system implementation. These standards should meet the needs of all partnering organizations. By this point, each organization knows what to expect of the new system and concerns should have been addressed. Implementation standards should cover items such as site and facilities, installation, and performance.

System implementers will frequently choose to partner with private enterprises to perform certain specialized tasks. Tasks, such as site construction, legal negotiations, and frequency planning and licensing, are often contracted to commercial enterprises.

Identify Skills and Services Needed to Ensure Success

Implementing an LMR system requires resources from each partnering organization as well as outside help. The partnering organizations should identify what resources are needed to implement the system. Then they must examine what skills and resources each entity can offer for this stage. In many cases, the agencies do not have the ability to perform some of the implementation tasks; outsourcing would then be more effective.

Once the system planners have identified what resources are needed to complete the implementation, they must come to an understanding of what their agency’s individual responsibilities are in implementing the system. The responsibilities should be assigned based on the resources of the different agencies. Because the partnering units have varying resource levels to perform the implementation, the responsibilities can be divided many ways. In some cases, a single agency has much greater radio resources and acts as the lead agency for implementing the system. In other cases, the responsibilities are divided more evenly among the partnering units. The executive council is responsible for making sure that the units are performing their duties.

Assign Ownership

Assigning ownership of the various parts of the system, including who acquires and holds the frequency licenses and tower permits, is important when moving forward into the operations and maintenance phase. This issue centers on who takes over control of the system elements when the implementation is complete. To avoid conflict later, ownership must be defined in the implementation plan.

Perform Acceptance Testing and Performance Evaluation

Testing the performance of the new system is an integral part of the implementation process. The partnering organizations should work together to develop acceptance tests and scenarios to ensure the system meets their requirements and build these tests and scenarios into systems design.

The system planners are responsible for planning and executing testing of the new system. The system must meet the functional and coverage specifications set by the user group. Each user group must ensure that the system is tested and meets the needs of its group.

Develop, Schedule, and Perform Training

User training is sometimes more difficult on a shared system because users from multiple organizations must be trained to use the new system. All end users must be trained to use their radios on the new system. This training includes not only how to use the different functions on the radio unit but also radio etiquette that may be required on a shared system.

In addition, to operate and maintain the new system, the technical staff should be provided adequate training. The staff must be trained on the technical aspects of maintaining the system as well as how to work with operations and maintenance staff from the other participating organizations.

Migrate Users to New Systems

In a shared system, migrating users to the new services can be complicated by the differences in organizations, such as how they conduct business and where they place their priorities. The partnering organizations must work together to coordinate the transition of users to the new services. Communication among organizations is key to success in this process, and a well distributed and detailed transition plan is highly recommended.

system planners have two commercial service implementation options

Commercial Services

After considering the extensive set of requirements developed in Phase 2, system planners may conclude that a commercial service provider is the best source for obtaining LMR services. These services can be obtained in one of two forms:

- Leasing service on an existing commercial network
- Working with a commercial entity willing to construct and take ownership of a commercially managed LMR network.

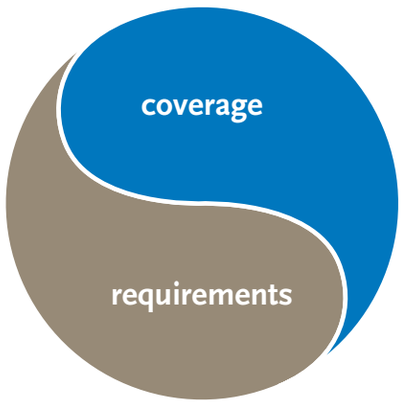
The methods for evaluating each of these options are similar; however, where they diverge the salient points are addressed in the following key steps. In either scenario, the commercial entity could be replaced with a government agency willing to provide service on a fee-for-service basis.

Determine Best Method for System Implementation

Commercial services offer system planners a distinct financial advantage. With no infrastructure to purchase, the only capital cost would be for subscriber units and, depending on the service agreement negotiated with the vendor, even those costs may be waived. Because government communications budgets are continually strained, system planners may find avoiding a sizable up-front cost highly desirable.

Use of commercial services also lifts the technical burden from system planners. Agreements can and should be negotiated, guaranteeing specific levels of service. To ensure all the agency's communications requirements are satisfied, the specified level of service would naturally reflect the technical baseline established in the requirements phase. Use of commercial services also relieves system planners of the responsibility for site acquisition. With the extensive time, costs, and effort typically required to perform these activities, the planners' ability to distance themselves from these duties is a definite advantage of using commercial services.

Spectrum management complications are also tempered with the use of commercial services. If service is leased on an existing commercial network, system planners face no spectrum issues because the commercial networks are responsible for all the requisite licensing and frequency coordination. If a commercially managed LMR network is used, the government agency may need to bring its own spectrum to the table. With the increasing scarcity of available spectrum, the agency may need to provide its own to be able to have its mission priorities (e.g., priority access, availability) addressed by the vendor. In that case, the spectrum management responsibilities would remain with the system planners.



Matching commercial service coverage to requirements is mandatory

The areas where coverage is available and the extent to which this coverage matches the system planner's established coverage requirements may vary depending on which of the two commercial services strategies is adopted. For system planners who choose to lease service on an existing commercial network, a service provider whose coverage footprint encompasses the requirements should be selected. If significant coverage enhancements by the commercial provider are required to satisfy requirements, then system planners must ensure those enhancements are part of whatever service-level agreements are negotiated with the service provider. In such circumstances, the governmental agency may have to fund the enhancements. In the case of a newly designed commercially managed network, the system planners' coverage requirements should be easier to institute because planners can simply verify that the proposed system design satisfies their requirements.

When a commercially owned system is implemented for government communications, there are inherent risks. The command and control of the system is not in the hands of the government entity, making it difficult to ensure that the needs of that entity are taken into consideration in management decisions. Requirements must be integrated into the service-level agreements that prevent situations in which the commercial entity could compromise the provided service through implementation decisions made without the consent of the government agency. The potential for this situation magnifies the importance of system and acceptance testing and a strong service level contract.

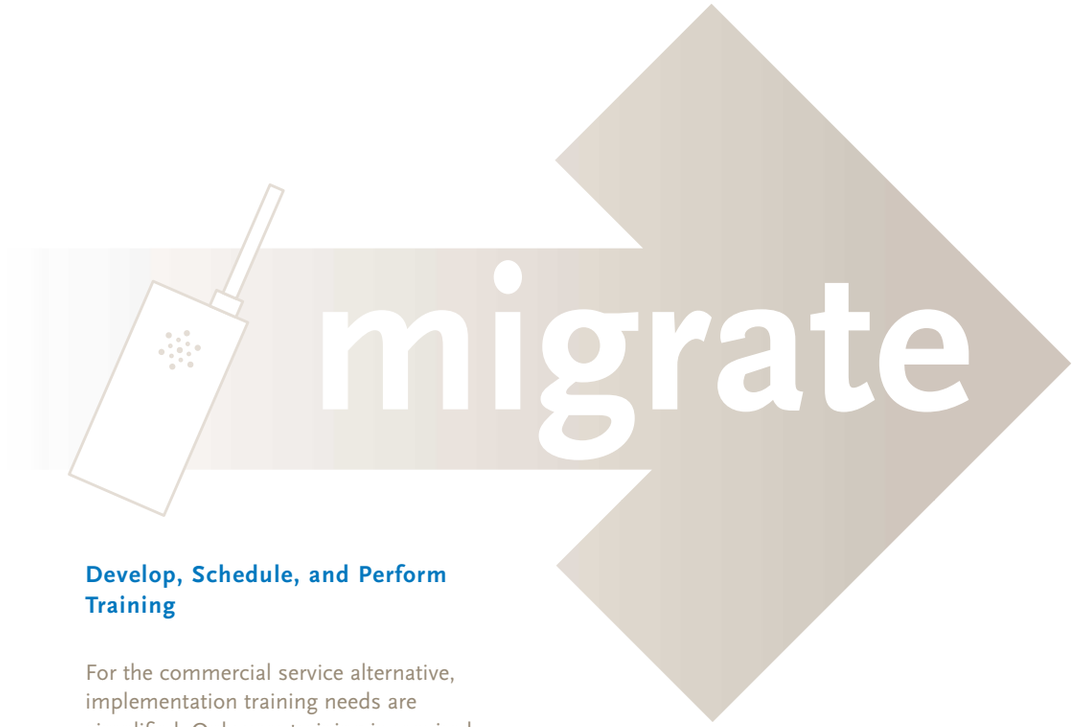
Develop a Task Breakdown Structure

Implementation planning and implementation are substantial undertakings when transitioning to commercial services. Although some of the added complications of installing a second system over an existing system (e.g., equipment shelter space, tower loading) are alleviated, significant effort is still required. All the planning documentation developed in Phase 3 must be expanded into task breakdown structures specific to the type of commercial service implementation selected.

The test plan and system evaluation criteria should be modified to reflect parameters relevant to the type of commercial services being employed. Site acceptance test plans are no longer necessary because overall network performance is the key under this scenario, and individual site performance is not as important. System coverage plan procedures need to be modified based on the mutually agreed upon coverage requirements and guarantees. System reliability verification procedures also need to be updated to reflect the commercial solution selected. The procedure for verification may need to be customized based on the information available from the commercial service provider.

Perform Acceptance Testing and Performance Evaluation

System planners need to be sure that implementation plans intricately detail the timing of distribution and testing. The planners need to execute the test and system evaluation plans efficiently to sufficiently validate that the commercial system performs all the system requirements as expected, while minimizing the time that the commercial and legacy systems are operating in parallel. If the test and system evaluation plans are successful, the previously documented acceptance test procedures will be executed. The testing procedures are used to verify that the system performance and coverage satisfy the requirements as indicated in the service-level agreement between the system planner and the commercial service provider.



users to new systems

LMR

Develop, Schedule, and Perform Training

For the commercial service alternative, implementation training needs are simplified. Only user training is required. System planners should divide their user base into different types of users (e.g., normal user, power user, dispatcher, administrator). The planners need to work with the vendors to decide what level of training each type of user requires. Once training models are developed for each type, training should be scheduled for all subscribers and console operators on a rotating basis to minimize the operational impact of the training. The level of vendor participation in the design, scheduling, and performance of training is variable and based on the preference of the government agency.

Migrate Users to New Systems

The compatibility of the commercial system and the legacy system determines the planner's transition options. All of the users who may need to intercommunicate must be switched over at the same time. If the two systems are incompatible and all users need to communicate with one another, the planners must orchestrate a full concurrent systemwide switchover. If the systems are compatible, a more extended, staged transition would be possible.

In the case of a full concurrent switchover, all end-user equipment needs to be distributed throughout the network before any users switch to the new system. Both the legacy system and the commercial system will have to be operational simultaneously for an extended period of time to conduct all the performance and load testing required. In the case where the two systems are compatible, the system planner has the luxury of selecting how many users to transition in what order, on what schedule. Possible divisions for transition include office location, user group, or tactical component.

Decommission and Remove Old Equipment from Service

When all the testing procedures have been performed and the system functionality is verified, the decommissioning process can occur. Legacy equipment should be decommissioned and removed from service in accordance with the transition plan developed in Phase 3. Depending on legacy system compatibility and the user agency's acceptable level of risk, this decommissioning process can be performed in a staged manner paralleling the staged transition.

Optimize System Performance

As with any implementation, system performance must be optimized. When the system is in full use, tactical and operational issues may come up that require modifications to system settings or user groups. The commercial service provider contract must include provision for these modifications.

Resources

- EIA/TIA TSB88-A
- Motorola R56 Issue A, *Standards and Guidelines for Communications Sites*
- Public Safety Wireless Network, *Public Safety Land Mobile Radio—A Road Map For Systems Development*. [www.pswn.gov]

phase six
operations and maintenance

successful operations depend on quality maintenance

Purpose

This section discusses the actions needed to manage the operations and maintenance of a modern LMR system—the sixth phase of the system life-cycle process.

Without proper user training, system maintenance, and system management, the finest system will quickly become little more than an expensive embarrassment. It is critical to the success of any wireless system that a well-planned and appropriately funded maintenance and operation program is in place.

This section includes several success stories and lessons learned from radio system managers who have been successful in this phase of the life-cycle process.

Objectives

By the end of this section, the system planner will understand how to:

- Prepare and maintain operations and maintenance plans
- Include radio system needs in operational and budgetary planning
- Develop and maintain software, equipment, and other system infrastructure inventory
- Monitor regulatory environment for changes that affect system
- Track and maintain tower and site permits and FAA, NTIA, and FCC authorizations and licenses where appropriate
- Staff and manage a service organization
- Coordinate with vendors and commercial shops for system support
- Monitor system operation and track changes in performance
- Project and manage maintenance and equipment replacement budgets
- Provide ongoing training
- Develop and maintain sharing agreements where appropriate.

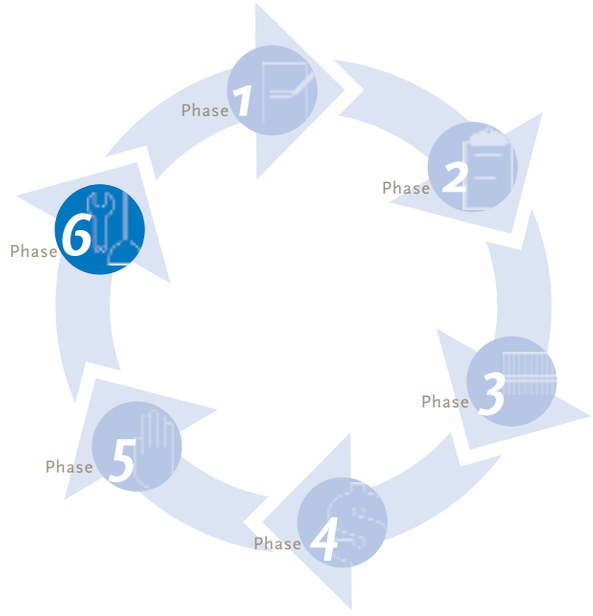
The main advantage of in-house operations management is that the planner maintains control of all operations and does not depend on any outside or commercial party for system operations. The major disadvantage of in-house operations is that the planner must identify, develop, and train staff to operate the system. Many public safety agencies choose to develop their own operational capabilities in order to maintain control over operations and eliminate dependence on outside parties, providing a level of flexibility that may be critical in emergencies.

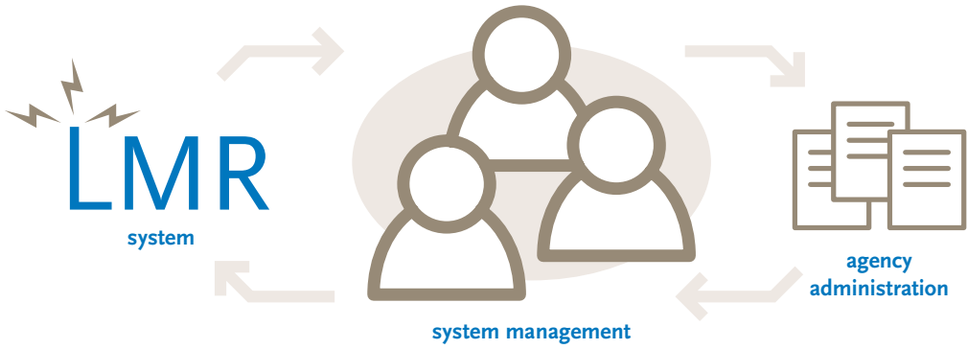
Key Steps

Develop a System Management Plan

To manage the system on a day-to-day basis, the planner must develop a management plan. Management of the system includes assigning equipment to individuals, ordering programming changes to radios and system equipment, developing and maintaining the talk group structure or fleet map, managing dispatch operations, monitoring and reporting on system usage, allocating billing in multiagency systems, archiving system audio logs, and other routine administrative requirements. The management plan should include procedures for all these activities.

The planner must administer costs associated with operating the system. These costs will take the form of capital costs for equipment and supplies, and recurring costs of data links, site rental, maintenance contracts (unless self-maintained), and other recurring cost items. The planner needs to identify all of these costs up front and include procedures for administering these items in the management plan.





Automation is key in the effective management of modern wireless services

Include Radio System Needs in Operational and Budgetary Planning

In public safety, radio systems are integral to an agency's operations; therefore, radio system needs should be included in the user agency's regular periodic operational and budgetary planning process. As described in the next step, information regarding system utilization and trends can be automatically collected from the radio system. Other information about future system requirements can be developed from the organization's operational planning, and maintenance records can provide information about system availability and downtime. When inserted into the planning process, this information can be used to plan for system expansion, system enhancements, operational approaches, system management requirements, spare parts, and even system replacement.

Use Automated Systems to Enhance Operations

Successfully managed implementations, such as the system in Polk County, Florida, rely heavily on information systems to support operations at all levels, from planning to management and administration. Implementation of an advanced radio system, especially trunked systems, demands that certain aspects of operations be automated. The planner should give strong consideration to automating processes wherever possible.

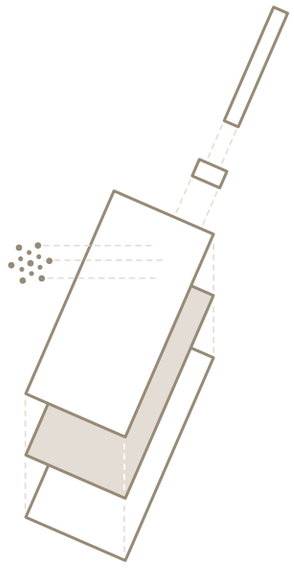
Many advanced LMR systems have the capability to collect and process information about system usage, including details of individual unit activity. This capability is valuable when the information is transferred to operational systems used for system management, administrative, and planning purposes. Most vendors and integrators of advanced LMR systems will be able to design and implement applications for integrating radio system management with operational systems, as well as the operational end systems themselves.

In-House Maintenance

The major advantage of in-house maintenance for a planner is control over response time in emergency situations. The disadvantage of in-house maintenance is that the agency must deal with a new set of issues associated with self-maintenance.

Issues that must be addressed by agencies with self-maintained systems include:

- Minimizing downtime for system and individuals
- Controlling the costs of system maintenance.

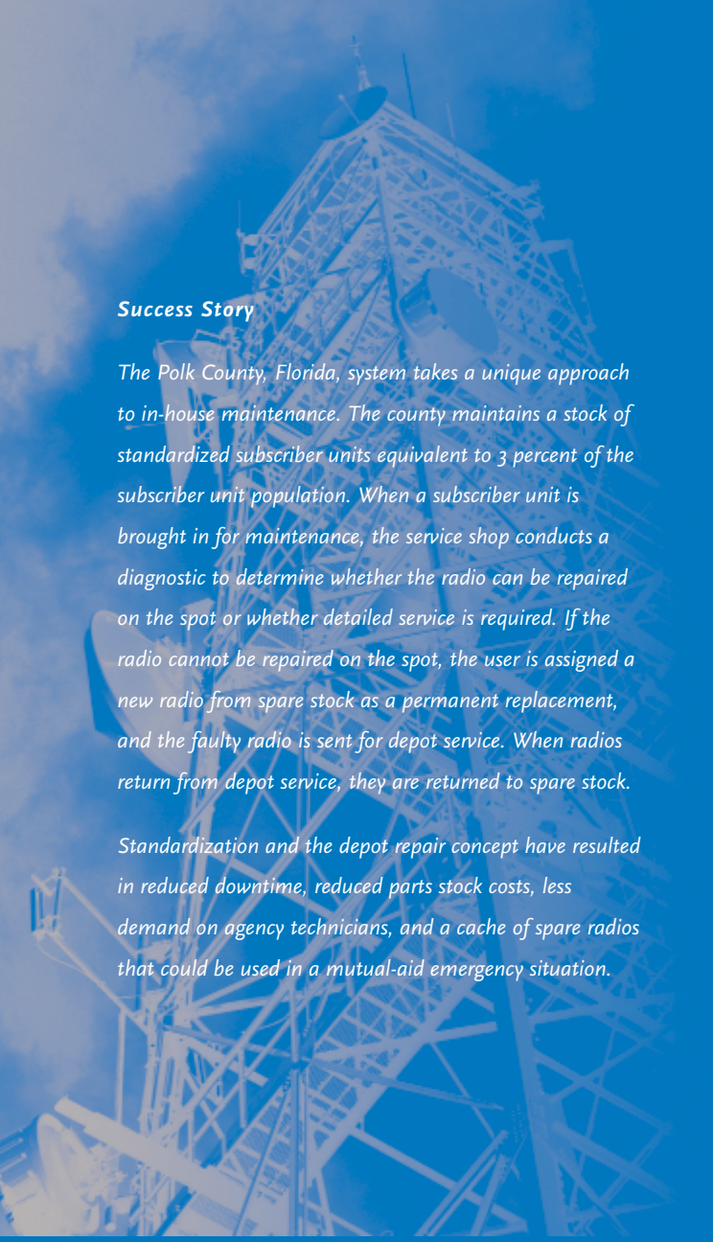


Identify Level of Support That Balances Response with Cost

The planner should first identify the level of support required by the agency. The level of support is defined by several factors, most importantly the time required to respond to and correct system and unit failures. System failures have the potential to affect more users; therefore it is usually preferred that failures affecting major levels of system functionality be corrected very quickly and with the highest priority. However, although failures of individual subscriber units usually affect only one user at a time, public safety and other high-priority users usually cannot wait weeks, days, or even hours for repair of their radios. Often, maintaining an inventory of field-replaceable spares is the best solution for minimizing system and unit downtime. Depending on the system type and the specific equipment included in the system, component-level maintenance can be minimized by maintaining a moderate level of field-replaceable spares and using depot service for low-level repairs.

versatility

buying uniformly more capable and versatile radio units can make sense when economies of scale and simplification of maintenance are considered



Success Story

The Polk County, Florida, system takes a unique approach to in-house maintenance. The county maintains a stock of standardized subscriber units equivalent to 3 percent of the subscriber unit population. When a subscriber unit is brought in for maintenance, the service shop conducts a diagnostic to determine whether the radio can be repaired on the spot or whether detailed service is required. If the radio cannot be repaired on the spot, the user is assigned a new radio from spare stock as a permanent replacement, and the faulty radio is sent for depot service. When radios return from depot service, they are returned to spare stock.

Standardization and the depot repair concept have resulted in reduced downtime, reduced parts stock costs, less demand on agency technicians, and a cache of spare radios that could be used in a mutual-aid emergency situation.

Based on the level of support required and the system complexity, the system planner must estimate the cost of setting up and maintaining the repair shop, including the cost of space, tools, test equipment, spare parts, service vehicles if required, and recruiting and training of service personnel. In addition to the initial costs of establishing a maintenance capability, the planner must identify ongoing costs associated with continuous training of maintenance personnel, upgrading of tools and equipment, vehicle maintenance, and other recurring costs.

During this process, the planner should also consider which maintenance elements can be performed by contractors and should carefully consider the cost differential between contracted service and in-house service, including the oversight required to manage contracted elements.

Develop a Preventive Maintenance Plan and Monitor System Performance to Identify Failures and Issues

The task of properly maintaining an advanced LMR system can be formidable. However, a key to success in this area is to anticipate and mitigate common failures where possible, and to detect failures that cannot be prevented. Many common failures, such as backup batteries and tower lighting failures, can be mitigated through periodic checks and replacement—for these situations, a preventive maintenance plan is invaluable. Other failures, or indications of impending failures, can be detected by monitoring sites using a combination of built-in systems reporting and alarm and control systems. System problems can also be detected by analyzing system performance indicators such as access time when tracked over time.

Contract Management and Maintenance

For systems owned by government agencies, vendors offer an ever-increasing array of management and maintenance contract options. Vendors have realized that the government market is fiscally constrained in the number of large capital outlays it can make for systemwide replacement. As a way to generate additional revenue, vendors are putting their advanced system knowledge to good use as system managers and maintenance providers.

Prepare and Maintain Operations and Maintenance Plans

Operations and configuration management plans must be developed in the same manner as in the commercial operations scenario. Using these plans as a guide, the amount of service provided by a contractor can range from complete system management and maintenance (similar to that provided on their own networks by most commercial service providers) to a "pick from the following" menu-type plan. Contractor services can include:

- Standard warranty service
- Dispatch services
- Troubleshooting support by phone
- Remote monitoring and diagnostics
- Spare part supply
- Emergency repair and maintenance.

Develop and Maintain Software, Equipment, and Other System Infrastructure Inventory

An inventory management system must be developed to track the different infrastructure and subscriber equipment owned by the government agency as well as all its software licenses. Automating this process ensures increased adherence. Maintenance of the system can be performed by government personnel or can be contracted out.

Monitor Regulatory Environment for Changes That Affect the System

It is critically important to monitor the regulatory environment for changes that might affect the system, including congressional actions, FCC rulemakings, and NTIA spectrum activities. This research and tracking could be performed in house or could be contracted out to a telecommunications consultant, law firm, or other contractor.

Track and Maintain Tower and Site Permits and FAA, NTIA, and FCC Authorizations and Licenses Where Appropriate

Contracting out site development removes the responsibility from the government agency to track and maintain tower and site permits. Based on heights and proximity to airports, different filings with the FCC and FAA are required for each site. The administrative requirements to track FCC tower registrations and FAA authorizations, and to process all zoning application requirements can be offloaded to a contractor to release government personnel for other duties.

Staff and Manage a Service Organization

Depending on the existing technical expertise of the agency's personnel, a balance can be struck between what is economical to do in house and what should be contracted out. An agency with extensive operational experience, but no technical expertise, may opt to do all network operations themselves but issue a blanket contract for maintenance. An agency with some technical knowledge may maintain a small maintenance staff and contract out large jobs or ones that lie outside the staff's area of expertise.

Monitor System Operation and Track Changes in Performance

Performance monitoring and operations tracking can also be outsourced. Contractors can provide an on-site manager who scrutinizes and verifies the satisfaction of performance criteria, or can monitor performance remotely for government entities without expertise in this area.

Project and Manage Maintenance and Equipment Replacement Budgets

System planners must also make financial decisions regarding contracting. For each of the operations and maintenance responsibilities, analysis must be performed to compare the cost of contract services with the cost to develop similar capabilities in house. A number of requests for proposals (RFP) will probably need to be issued to gather the information necessary to make these decisions. The results of this analysis must be weighed against the control risks of having the individual tasks performed outside of agency management.

Provide Ongoing Training

Similarly to the commercial scenario, contracting out maintenance reduces the internal training requirements. The only required training would be on subscriber unit and console use, with provisions for new hires and new equipment. If some maintenance responsibilities were kept in house, training requirements would parallel those for the in-house scenario.

Partnerships

Partnering with other organizations for the operations and maintenance of a system is a good way to reduce the cost of radio communications. Ideally, the partnering organizations are involved in the design and implementation of the system and develop agreements to share the operations and maintenance of the system.

Prepare and Maintain Operations and Maintenance Plans

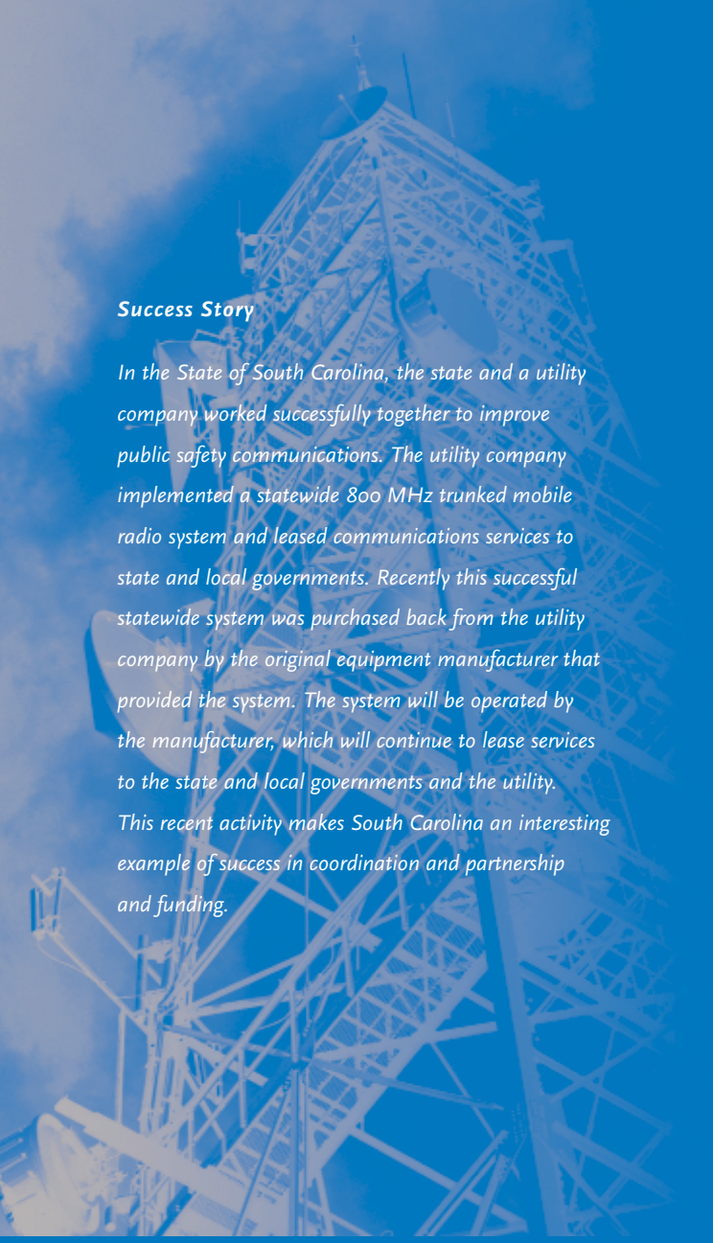
Partnering can range from sharing resources to leasing access. Partners sharing a common system may choose to divide the operations and maintenance of the system between them. In other cases, a single agency maintains the system and leases access to the system to other organizations.

Lead Agency

In this approach, a lead agency manages all operations and maintenance, and the other partners provide financial support. The partner units would lease use of the system based on number of users, airtime, or channels. For this approach to be successful, the partner units and the lead agency must maintain good communications. Memorandums of Agreement should be established to set billing rates for service and maintenance as well as system standards.

Shared Maintenance

In this approach, operation and maintenance is spread among the partners. In this case, quality standards must be set and monitored for each part of the system. Methods must be established for dealing with situations where the system does not comply with the established standards. The partnering units must also agree upon ownership of the system before delegating the operations and maintenance of the system.



Success Story

In the State of South Carolina, the state and a utility company worked successfully together to improve public safety communications. The utility company implemented a statewide 800 MHz trunked mobile radio system and leased communications services to state and local governments. Recently this successful statewide system was purchased back from the utility company by the original equipment manufacturer that provided the system. The system will be operated by the manufacturer, which will continue to lease services to the state and local governments and the utility. This recent activity makes South Carolina an interesting example of success in coordination and partnership and funding.

Develop Agreements for Sharing Radio Resources

A common means of partnering with commercial enterprises for radio systems is by sharing radio towers. In many cases, the agency leases access on its radio tower to commercial enterprises for fees. These fees help cover the cost of operating and maintaining the system. In other cases, the agency leases access to commercial sites. Sometimes the best locations for radio transmit and receive equipment are on existing communication towers or rooftops. Agreements or leases are worked out between government agencies and the commercial owners for site use.

Commercial Operations and Maintenance

Agencies that use commercial service providers to provide communications systems services for their operations have extensive preparation and planning responsibilities. Enlisting a commercial services provider to perform the actual duties does not diminish the thought process involved in developing the systems operations and maintenance plans.

Commercial operations and maintenance release agency personnel from non-mission-related duties. In non-commercial systems, the people performing operations and maintenance on the communications equipment are typically agency personnel. By eliminating these additional duties, use of commercial operations personnel also reduces additional training time and costs. The only agency staffing requirement is someone to manage the interaction with the service provider and ensure satisfactory performance of required duties.

Commercial operations and maintenance places the responsibility for failure and outages outside the agency. Although this shift in responsibility can be beneficial in a problem situation because the commercial entity has a deeper knowledge base from which to draw, it also puts the agency at the mercy of the service provider. The agency will not have complete control or flexibility in an emergency situation and will be dependent on the response of the commercial entity.

Prepare and Maintain Operations and Maintenance Plans

As with any government communications system, an operations plan must be developed describing a number of details about the network. These details include:

- Number of expected users
- Predicted traffic patterns
- Number of channels and talk groups
- Equipment distribution procedures
- Procedures for radio use and programming
- Required logging of system activity.

The agency must establish how the commercial service provider is expected to handle each of these issues. Most of the programming and activity-logging functions can be performed by the service provider and integrated into the service level agreement. Depending on the dispatch requirements and security sensitivities, the network owner could also perform this function.

Expected traffic dictates the development of a configuration management plan. This plan defines the segregation of the different groups requiring communications with one another on the radio system. The predicted volume of communications for each group should be examined to determine whether any modifications to the plan are needed. Be sure to evaluate all likely scenarios. The configuration management plan should then be presented to the commercial service provider and a mutually acceptable agreement reached on the best way to implement operations to maximize the fit for the operational needs. Procedures can then be added to the plan to account for configuration modification and additional provisioning.

Include Radio System Needs in Operational and Budgetary Planning

When using commercial service providers, the task of budgeting for the service can be and often is delegated to the user. While this may relieve the system planner of a great deal of responsibility, there remains a need to keep the user apprised of market trends and possible change in contract offerings and pricing. One approach to keeping the user informed is to establish committees made up of users and administrative personnel with whom contract information is shared and from whom feedback about the service offerings is requested.

Develop and Maintain Software, Equipment, and Other System Infrastructure Inventory

A mutually acceptable inventory management system should be implemented to track the acquisition and distribution of equipment. This system can be used to track equipment types, current users, and software versions. Ideally the agency and vendor systems would be integrated; however, independent systems with a negotiated method to exchange information would be acceptable.

Monitor Regulatory Environment for Changes That Affect System

A government representative may want to monitor the regulatory environment to remain aware of potential future change agents. Because the commercial entity should already be doing this research as well, the contract could include a task requiring the contractor to provide the government agency periodic reports of regulatory activities.

Track and Maintain Tower and Site Permits and FAA, NTIA, and FCC Authorizations and Licenses Where Appropriate

The burden of submitting regulatory filings, requesting tower and site permits, and obtaining government authorizations is removed from the government agency in the commercial services environment. Procedures should be established for the agency to perform periodic audits to verify regulatory compliance of the commercial system.

Staff and Manage a Service Organization

Staffing and managing a service organization is not typically required in a commercial services environment. Unless there is some incumbent technical knowledge that the government agency wants to make use of in a service capacity, the commercial entity should provide service, or a means of obtaining service, as a part of its contract. The only staffing requirements for the government agency would be a contracting officer to monitor contract performance. This officer should have a combined technical and business background. He or she should understand the components of the network and their expected performance, as well as approximate cost for various operations and maintenance activities. This contracting officer would be responsible for coordinating with vendors and/or commercial shops for system support, based on the terms of the contract.

Coordinate with Vendors and Commercial Shops for System Support

Another critical inclusion in the service-level agreement is documentation of the escalation procedure when failures occur. Guaranteed response times for different types of support and guaranteed maximum downtimes are key indicators of the maintenance capabilities of the commercial service provider. As guaranteed response times decrease, costs can escalate drastically. Therefore, it is important to weigh the agency's downtime tolerance versus budgetary restraints.

Monitor System Operation and Track Changes in Performance

The service-level agreement should be negotiated to include standard procedures for the agency to receive information and logs of system performance sufficient to determine that the required service levels are being maintained. Measured signal levels and diagnostic test results should be sufficient to determine the ongoing acceptable performance of the system. The frequency and detail of this reporting depend on the nature of the agency's requirements.

Provide Ongoing Training

A training plan should also be prepared for ongoing training. Whether performed in house or by the commercial entity, refresher training courses must be held periodically. Procedures must be in place for training new hires, as well as providing training for new equipment releases. If the commercial entity is to provide the training, provisions for the different types of training and their associated processes and costs must be laid out in the contract.

Resources

- *Understanding Wireless Communications in Public Safety,* National Law Enforcement and Corrections Technology Center.
- Public Safety Wireless Network. *Public Safety Land Mobile Radio—A Road Map For Systems Development.* [www.pswn.gov]

thank you
and best wishes

We hope the information in this guide saves you time and unnecessary expense as you plan and operate your new land mobile radio communications system. It draws on best practices, lessons learned, and success stories gleaned from interviews with many state, regional, and local public safety agencies already planning and implementing new communication systems. We appreciate our continued partnership with the public safety community and other local, state, federal, and tribal agencies that support interoperability.

Special considerations are associated with long-term planning and implementation of new communications systems. To address those needs, the PSWN Program is available to assist you and provide you with more information. Please call the program office toll free at **1.800.565.PSWN** or contact us via e-mail at **Information@pswn.gov** with any questions, concerns, or comments about public safety communications. Further detail regarding the PSWN Program and its products and services can be found at **http://www.pswn.gov**.

The PSWN Program, your resource for public safety wireless communications, wishes you success as you apply the techniques and methods highlighted in this guide.

Acronym List

ANSI	American National Standards Institute
APCO	Association of Public-Safety Communications Officials – International, Inc.
CAD	Computer-Aided Dispatch
CONOPS	Concept of Operations
COTS	Commercial Off-the-Shelf
DAS	Department of Administrative Services (Ohio)
DPS	Department of Public Safety (Oklahoma)
EIA	Electronic Industries Alliance
EMS	Emergency Medical Services
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FM	Frequency Modulation
GSA	General Services Administration
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
ISD	Instructional System Design
ITU	International Telecommunication Union
LMR	Land Mobile Radio
MHz	Megahertz
MIL-STD	Military Standard
MARCS	Multi-Agency Radio Communications System
MOU	Memorandum of Understanding
NASPO	National Association of State Purchasing Officials
NPSPAC	National Public Safety Planning Advisory Committee
NPRG	National Partnership for Reinventing Government
NTIA	National Telecommunications and Information Administration
OMB	Office of Management and Budget
OTAR	Over-the-Air Rekeying
PCS	Personal Communications Services
PERT	Program Evaluation and Review Technique
PM	Pulse Modulation
PSWN	Public Safety Wireless Network
RF	Radio Frequency
RFI	Request for Information
RFP	Request for Proposals
SMART	Specific, Measurable, Action-oriented, Realistic, and Timed
SOP	Standard Operating Procedure
SOW	Statement of Work
SPC	Strategic Planning Committee
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TIA	Telecommunications Industry Association
TPM	Technical Performance Measure
UHF	Ultra High Frequency
VHF	Very High Frequency

feedback

Please take the time to let the PSWN Program know how to improve the second edition of this guide to better meet system planners' needs. Send this form by **fax** to **703.279.2035.** Thank you for your feedback.

Check the appropriate box to indicate your agency's level.

☐ Local ☐ State ☐ Federal ☐ Tribal ☐ Other

Check the appropriate box to indicate your agency's mission.

☐ LE ☐ Fire ☐ EMS ☐ Multi-Mission ☐ Other

Circle the appropriate response based on your impression of the information provided in the guide. Additional comments may be written in the space below or on an additional sheet.

	Poor				Excellent
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Requirements Analysis	1	2	3	4	5
Design & Engineering	1	2	3	4	5
Procurement	1	2	3	4	5
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