

# **A Public Safety Guide for Acquiring Interoperability Communication Systems**

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This guide will assist Public Safety by providing background information and a general technical overview to those responsible for acquiring 1<sup>st</sup> Responder communications networks.

## **FOREWORD**

Advent Ltd. furnishes technical support and project management to State and Local Government agencies throughout North America when acquiring communications technology. We constantly endeavor to stay abreast of the evolving standards by conducting research that will enable us to assist any First Responder Community in the selection and procurement of high quality communications equipment. Our first hand experience with contemporary equipment enables us to maintain a knowledge base spanning the spectrum of communications equipment. This document discusses our methodology which incorporates industry standards and best practices that create a vendor neutral RFP which is based on explicit end user needs which are measurable, achievable and can be documented.

Technical comments and suggestions concerning this guide are invited from all interested parties. Questions and comments may be directed to the Advent Ltd, 4608 Amber Dr, McDonough, Ga. 30252. Phone: 404-274-9930

## **INTRODUCTION**

The primary purpose of this guide is to present First Responders with information that will aid in the development, purchase, and evaluation of a robust wireless infrastructure with an expected life cycle measured in decades.

This topic is inherently technical, however this guide is intended to be more practical than technical in nature and offer information on a range of topics that can be considered when acquiring technical communication equipment. Some of the topics explored include: secure communications compatibility, line of sight (how far transmission can travel), and multiple network topologies of communications compatibility.

We will provide a broad overview of communication systems. Discuss some of the various system technologies, equipment types, accessories and enhancements. We will also focus on various characteristics and performance parameters that are used to evaluate communication equipment. Our ultimate goal is to provide information that will assist you in building a stakeholder selection process that will empower the technology acquisition team by creating a vendor neutral based RFP.



Typically there are three qualifiers during this process (Economic, Technological and Political) depending on the balance among these three will have a direct impact on the success of the technology acquisition.

The most successful technology acquisition will be based on industry standards and best practices that will insure that well-defined user needs are met. Adherence to a process that is objective and balanced which employs a group of stakeholders that is made up of various key individuals from the communications users groups.

## **OVERVIEW OF COMMUNICATION SYSTEMS**

All communication systems are made up of devices that employ both wired and wireless technologies. Wired technology is made up of switches, copper wires, optical lines, coaxial cable, and desk or handsets. Wireless technology employs different types of un-tethered equipment: portable radios, mobile radios, base/fixed station radios, and repeaters.

A wired system is technically known as a hard-line system and can be thought of much the same as a localized, private telephone system that uses wires to operate over a limited area much like the internal telephone system in your office. The Public Switched Telephone Network (PSTN) is the wide area network that the majority of us use on a daily basis. Wireline communication systems operate by transmitting voice and data through a wire, cable (coaxial or fiber optic) that connects to various communications network elements. The major advantage of a wire-line system is the ability to communicate to and from dead spots (underground, in-buildings, shielded enclosures and similar locations) where radio systems are unreliable or unable to be used. They are also capable of transmitting communications over great distances, as far as the wire, cable or coax can travel. An additional advantage of wireline communication systems is that they are very secure. External eavesdropping is generally not possible because the transmissions are contained within the wired system. The disadvantages of a wire-line system are the obvious logistics of distance and mobility constraints imposed by the cable, the time required to set the system up at an incident site, and the limited number of users that can be supported by a system at a given location.

A wireless system uses RF (radio frequencies) to “connect” users and is capable of operating over small or large geographical areas. The major advantages of RF communication systems over wireline communication systems are their ability to provide communications in a mobile environment, through or around many obstacles (depending on the frequency), and to an almost unlimited number of users. The range of the signal is defined to be the distance between the transmitter and the receiver’s ability to communicate with fidelity.

Shared communication systems such as radios, the Internet, and telephone conference calling systems are subject to *over subscription* by users (the maximum system capacity - the point where communications deteriorate and/or degrade as the volume of traffic exceed design limits), a problem that compounds exponentially as the number of users increases. Proper planning for foreseeable critical event and variants of possibilities can facilitate design modifications to mitigate many, if not all over subscription scenarios.



## ***RF spectrum***

Wireless networks broadcast data and voice information using a precise radio frequency tuned to other radios on the identical frequency(s). Common radio messages are transmitted over the RF Spectrum between 0.05 MHz and 900 MHz. Most public safety communications radios (portable, mobile, base station and repeaters) broadcast frequencies between 30 MHz and 900 MHz which are dedicated to public service use. Cell phones and systems, such as global positioning receivers, call boxes, electronic signs, irrigation systems, and mobile command units, that transmit information from remote locations, transmit in the microwave band between 1 GHz and 20 GHz.

There are three frequency ranges that the FCC have allocated spectrum to be used for the Public Safety community, each having applications that are unique to that frequency range. For example, *Low Band* (30 to 40 MHz) was able to cover large distances but had problems with interference from atmospheric conditions. Very High Frequency or *VHF* (152 to 160MHz) is widely used because it has very good propagation characteristics for a network designed for mobile communications and not specifically for in-building coverage. Ultra High Frequency or *UHF* (406 to 512 MHz) is commonly used for in-building communications as well as some mobile applications. The upper UHF range (700 to the high 800 MHz) have been primarily utilized in a trunking network topology which allows for a large number of subscribers to share a group of frequencies in order to achieve a higher degree spectrum efficiency.

Frequency ranges do not dictate what the network topology should be, however when deciding what type of network to deploy, frequency range will be one of the most central factors to consider when acquiring a specific technology that will maximize that resource.

## ***Conventional Radio System***

In conventional Radio systems, each Public Safety group is assigned a discrete radio channel(s) or frequency that is independent of other Public Safety groups' frequencies. The users within the group transmit and receive only on that channel, on a best effort with emphasis on radio etiquette. Transmissions may occur with or without the assistance of a repeater. Communications without a repeater are considered to be simplex communications (transmit and receive on the same frequency) and are typically used when the majority of communications is from the base to mobile or from the mobile to base with limited subscriber-to-subscriber communications are required. Communications with a repeater is a base station that will use two frequencies (one for transmit and the other for receive) that will automatically retransmit what it receives in order to create a mobile/portable communications network.

Disadvantages to conventional radio systems include user accessibility delays when a channel is being utilized by other users, during critical events a conventional radio system can be rendered useless because to many users attempt to talk at the same time. Another issue is security concerns because of the ease of "eavesdropping" on potentially sensitive communications by the public or media equipped with scanner radios. Modulation and encryption system compatibility must also be addressed in planning for interoperable communications.



## ***Trunked Radio Systems***

Trunked radio systems typically allocate up to 30 and at times more frequency pairs (channels) in order to accommodate a very large number of subscribers. This type of radio topology was introduced in the 1980's to create a spectrally efficient network. The core of the trunking technology is the computer/switch. A radio system's computer assigns a subscriber and the talk group to a frequency when the push-to-talk (PTT) button is pressed. A subscriber is an individual assigned to an agency, which has a distinct talk group. Each agency within a jurisdiction can separate its communications by having a separate talk group identity assigned to it. The computer/switch acts like a central office and manages the multiple frequencies, thus maximizing the system capacities. Resulting in channel capacity increases because other subscribers can use the time between transmissions for their communications without the need to wait. Because the computer selects the channel and monitors the repeater(s) before transmitting, the trunked radio system makes critical radio operational functions transpire in fractions of a second. To the subscriber it appears to be simpler and faster to use, it is more efficient and feature rich. Another apparent advantage to a trunked system is the increased difficulty in eavesdropping on any specific conversations that typically switch channels many times during a communications session. However, scanners that can follow talk groups on a trunked radio system are widely available to the general public.

There are a variety of trunking protocols where each adheres a different set of technical specifications all of which may or may not be based on a published industry standard. The Public Safety community has utilized the following trunking protocols: Privacy Plus, Smartnet, Smartzone, Astro 25 that are proprietary technologies provided by Motorola; EADC, OpenSky that are proprietary technologies provided by Ma/Com; LTR provided by EF Johnson; and MPT1327 which is provided by Zetron, TAIT, Kenwood were all the manufactures adheres to the Project 16 Public Safety standards. Moreover the newest standard Project 25 phase 1 and phase 2 is more widely adopted by the Public Safety and First Responder communities and most manufactures are designing radio network technology that adheres to the new standard. The benefit of the new standard is that during the lifecycle of the network additional equipment that will be required to increase capacity will be available from multiple vendors.

Each of the trunking protocols has merits as well as trade-offs. During the due diligence process each network topology should be considered carefully. Each deployment may have an implicit need to employ one specific application that is maximized by a given protocol in order to meet that need.

The disadvantages of the trunked system are those common to most RF radio systems (i.e., atmospheric interference, unreliability in certain environments, such as underground and in-buildings, and unable to be used in explosive environments, etc.). Additional disadvantages of the trunked system include the increased complexity of the infrastructure with regards to an increased number of antenna and repeater sites (especially in the case of 700/800 MHz systems), dependence on the computer/switch system and software that controls the trunked network and reliance on the equipment of one manufacturer for guaranteed operation. When purchasing a trunked radio network you will have to rely on that manufacturer to maintain the switching



network elements during the realistic 20-year plus lifecycle of the infrastructure. If the trunking protocol is an open standard then multiple vendors can provide the subscriber units.

To further complicate the topic, these systems are available in both analog as well as digital signal delivery. While they both have their merits, a good rule of thumb is that additional repeater sites will be required for a digital signal delivery system, which requires a more stable RF environment.

### ***Types of RF Equipment***

The RF communication equipment considered in this guide includes portable radios, mobile radios, base/fixed station radios, repeaters, control stations and vehicular repeaters. Each type of equipment will be discussed in the following sections.

#### ***Portable Radios***

Portable radios are small, relatively lightweight, handheld, wireless communication units that contain a transmitter and a receiver, a self-contained microphone and speaker, an attached power supply (typically a rechargeable battery), and antenna. Portable transceivers (known as a walkie-talkie) have relatively low-powered transmitters no more than 5 watts, need to have their batteries periodically replaced, and may be combined in a wireless radio communication system with other portable, mobile, and base station radios.

#### ***Mobile Radios***

Mobile radios are larger than portable radios and are designed to be mounted in a fixed location inside a vehicle (police cruiser, fire truck, etc.). Like the portable radios, mobile radios contain both a transmitter and a receiver and may contain an internal speaker. However, mobile radios connect to the vehicle's power supply, which enables them to have a higher transmitter output power depending on frequency. The microphone is usually handheld, and the speaker may be externally located to the radio. Because of the higher transmitter power and external antenna, the effective communication range is greater than that of a portable radio. Most first responders rely on the portable radio as their primary communication tool as their activities tend to be away from the vehicle and mobiles are for high speed vehicle use and backup if the portable fails.

#### ***Base/Control Station Radios***

A base (or fixed) station radio also contains a transmitter and a receiver. The radio is powered by an external electrical system (typically wall current) and is connected to an antenna located, typically on top of a building or on a tower. Because the base station radio uses an external electrical system (i.e., commercial power), compared with portable and mobile radios, they have higher-powered transmitters and the most sensitive receivers. This base station can be connected by wire-line control or wirelessly to a control station, which is monitored at a dispatch point. The control station has a microphone, which can either be handheld, or desktop paddle model, and the speaker can either be external or internal to the radio. Dispatcher consoles often



integrate the control station function as a means to reduce the number of devices the dispatcher must interact with in the performance of his/her duties.

### ***Repeaters***

A repeater is a specialized radio that contains both a receiver and a transmitter. Repeaters are used to increase the effective communications coverage area for portable, mobile, or control station radios that otherwise might not be able to communicate with one another. The repeater's receiver is tuned to the frequency used by a portable, mobile, or base station transmitter for incoming signals, and the repeater's transmitter is tuned to the frequency used by a portable, mobile, or base station receiver. The incoming signal is rebroadcast back to the radio network on a different frequency, usually with higher power and from a better location (tall buildings, mountaintops, and/or towers).

### ***Accessories***

Most accessories are for mobile or portable radios and are designed to allow for maximum user flexibility. There are optional accessory boards available for many conventional radio systems, and optional encryption modules available for some radios to allow for secure communications.

### ***Accessories for Portable Radios***

Additional accessories for portable radios include optional batteries for extended operating time, speaker-microphones, carrying cases, battery eliminators, and vehicular adapters. Multiple carrying case options are available: those that allow for optional batteries; those that have specialized operations mounting requirements, such as the strap-on chest case for instances when a radio cannot be worn on or near the waist; or those that are water resistant for operations that may occur in extremely wet environments. Several optional speaker-microphones attach to portable radios through the remote speaker/microphone jack. These include boom microphones (attenuates background noise and works best when the user's voice is not obstructed), ear microphones (worn in the ear and transmits ear canal vibrations into microphone signals), bone microphones (worn on the top of the head or behind the ear and transmits vibration signals), and throat microphones (worn on the throat and transmits vibration signals). Voice operated switch (VOX) activated accessories have the same function as the PTT (push to talk) button but allow hands-free use of the radio. Alternately, full duplex operation of radios (able to transmit and receive on different frequencies simultaneously) provides hands free and simultaneous, bi-directional communications (similar to talking on a telephone). Battery eliminators are specialized accessories that are attached to the radio in place of the battery. They allow portable radios to operate from a power source such as the electrical system of the vehicle rather than the radios own battery, thus extending the useable life of the radio's battery before it needs to be recharged. Battery eliminators are most often used with portable radios that have no external power jack. Battery eliminators can be obtained from radio manufacturers or specialized third party aftermarket vendors. Vehicular adapters are also specialized adapters for portable radios that allow portable radios to operate as a mobile radio. When the portable radio is placed into a vehicular adapter, the radio operates off the electrical system of the vehicle, is connected to an antenna mounted on the vehicle, and in some instances, is connected to an amplifier in order to



increase the output power of the transmitter (for example, 5 W to 50 W for increased range). While the portable radio is in the vehicular adapter, the radio's battery is being recharged.

### ***Accessories for Mobile Radios and Base Station/Repeater Radios***

There are fewer accessories available for mobile and base station radios. They are generally chosen when the radio is initially purchased because they are often dependent upon installation requirements and restrictions. Accessories for mobile and base station radios typically include these devices: transmitter power amplifiers, specialized modules that allow the radio to be connected to computers or other data terminals, remote mounting systems to minimize theft, external speakers that can be mounted for operator convenience, and specialized microphones that may allow for the user to change channels or transmitter output power.

### ***Enhancements***

Enhancements are those items or applications available to the customer for modification of the communication system for a specific purpose. Enhancements discussed in this section include the following items: encryption, digital communications, security measures, and interoperability/networking.

### ***Encryption***

Both conventional and trunked RF radios may allow for the encryption of sensitive communications for security purposes if the system is equipped with the appropriate encryption electronics. Some radios may require the installation of an optional encryption module for secure communications. Voice and data transmissions may be encrypted by simple inversion, rolling code, or by the more sophisticated - digital encryption.

### ***Digital Communications***

Digital communications is a technique whereby voice (sound waves) and data information present in the radio signals are converted into binary code represented using electronic or electromagnetic signals. The binary code is then converted by mathematical algorithms that need to be decoded by the same mathematical algorithms in the receiving radio in order for the user to understand the information. It offers users enhanced signaling and control options, more consistent audio quality, greater radio spectrum efficiency, and a broader range of encryption capabilities. Communications between users is less likely to be interrupted in terms of signals being dropped. At the edges of a coverage area, digital technology improves the signal integrity to maximize communications.

### ***Security Measures***

Communications security is becoming increasingly important. Presently, the general public can purchase any one of several different radio receivers that will allow them to monitor virtually any and all public safety communications. As a result, secure communications may be difficult to achieve unless measures are incorporated into the planning of a communication system. Security



measures that can be incorporated into a communication system include, but are not limited to, digital encryption of radio signals, voice inversion, and use of digital cellular or PCS telephone circuits. Security may also be improved by the use of spread spectrum techniques. No single security measure is appropriate for every situation, nor is it necessarily true that all security technologies will work with, or are appropriate for, all communication systems. Encryption systems may require extensive planning and coordination to ensure compatibility and interoperability. It is best to consult with the radio manufacturer's sales and technical personnel for the most reliable and accurate information regarding current encryption technologies and their uses.

### ***Interoperability/Networking***

Interoperability is the process of connecting different groups using different radio systems and communication technologies (telephones, radios, cellular communications, and satellite communications) so that they can communicate directly with one another without having to go through multiple dispatchers or relay personnel. In the context of communications, interoperability describes the situation where different communication systems that are otherwise disparate, work together without relying on additional manpower. An example of interoperability would be where a police radio system can “directly” exchange information (voice or data) with the National Guard radio system or the State Patrol radio system; or a municipality's public works department using a P25 Simplex or P25 Trunked System can “directly” exchange information (voice or data) with the adjacent jurisdiction's fire department which uses a MPT1327 or LTR Trunked System. Some trunked radio systems may allow for interoperability between different talk groups and may allow the connection of third party dispatch systems. Integration with other communication systems may also be permitted. These systems may include private automatic branch exchange (PABX) systems, data networks, cordless extensions, and paging systems. Examples of data networks that a radio system may be interoperable with are automatic vehicle location (AVL) and Geographic Positioning Satellite (GPS) systems. Another example is telephones interconnect systems where telephone calls are patched through the radio system. Simply stated, a communications interconnect/baseband cross connect system allows any telephone, cell phone, radios on different frequencies, proprietary formats, trunked talk groups, and conventional radio networks to communicate with each other using interface modules. The interconnect/baseband cross connect system can allow for several two-way and conference calls to occur simultaneously. There is no need for a dispatcher to connect one system to another system, as the cross-connection operations are unmanned. This can result in a much greater interoperability between equipment and organizations. A cautionary note is this device can create a continuous environment where conversations become difficult to differentiate resulting in confusion and missed communications.

Types of Interoperability can vary and there are common terms that have been adopted by the Public Safety Community. Typically, interoperability can be defined into six variants.

1. *Swap radios (SR)*, have the agency that is dispatching or responsible for the command and control of the mutual aid event swap radios when other responders arrive on the event.



2. *Talkaround (TKR)*, utilizing the radio to radio functionality which limits the coverage age and could lose the ability to talkback to the dispatch center.
3. *Mutual Aid Channel (MAC)*, are set aside frequencies for interagency communications that normally would operate on a separate networks and have preprogrammed their communication network to utilize these channels.
4. *Gateway Console Patch (GCP)*, this is performed by an dispatch operator and is done via a base band audio crosspatch allowing two or more radio systems to communicate. This can also be accomplished with a field deployed RF gateway using the local radios for the links between networks. There is a more complex gateway that can interface with other RF links, 4 wire audio links, VoIP links which can create a wide area network between multiple networks.
5. *Network Roaming (NR)*, this is done by deploying one infrastructure topology that is based on a single common air interface and can accept multiple manufactures mobile equipment.
6. *Standards Based Shared Networks (SBSN)*, this is an industry agreed upon standard for voice and data transmissions. The standard is commonly known as Project 25 and is managed by the TIA () standards group and the P25 standards are published under the TR08 subgroup. The TIA (Telecommunication Industry Association)

For an evaluation tool use these levels of interoperability to asses your current objectives. Ideally, a network topology will deploy the highest level possible, which realizes a higher echelon of interoperability.

## COMMUNICATION EQUIPMENT SELECTION FACTORS

Successful projects are usually the result of in-depth due diligence by stakeholders. Due diligence assists in creating a disciplined, business-like approach to the project and fosters communication among user groups, often resulting in unmatched agency involvement, system ownership and stewardship of the outcome. A knowledgeable individual that will play a key role in the acquisition of the technology should lead the stakeholders group. Typically there are three qualifiers during this process (Economic, Technological and Political) depending on the balance among these three will have a direct impact on the success of the technology acquisition.

The first step in planning is to *gather information* about agency needs, available assets and resources, existing communications infrastructure, end user requirements, and other related issues. This due diligence is important because it helps to define the project goals, identifies specific challenges or needs, and lists any potential partners and their roles. In addition this work identifies staffing requirements, outlines a marketing strategy, proposes a detailed budget, and helps build an operational plan that addresses how the project will be funded now and into the future.

After the needs assessment has been completed, a comprehensive *gap analysis* should provide an overview of what technologies should be able to meet your organizational requirements. A budgetary “goal” can be calculated for each by performing a generic research by contacting users of that technology and/or manufactures and dealers of the various technologies. Once the



responsible parties who will allocate the funds agree upon a realistic economic goal, the RFP (Request for Proposal) process can begin.

The RFP process best serves the end user by providing the maximum flexibility to focus on the end users requirements. For example, in-building portable talkback delivered audio quality, is far more important the a few ounces that the portable radio may weigh. However, for the fire fighters a portable not only has to talkback but also should be able to withstand the hazards of a wet environment. The RFP process should be one that has proven itself as a vendor neutral methodology that specifies industry standards and best practices based on end user explicit needs. The RFP should be able to provide a detailed needs requirement that the innovators can design to.

The stakeholders should also have agreed upon and signed a document that directly guides them on rules to follow that will insulate them from any legal issues should any arise (confidentiality and conflict of interests).

One of the major issues of a first responder network is interoperable communications between agencies and jurisdiction during mutual aid events. This assessment is a key attribute for maximizing resources and providing the most effective response to any event. In order to identify whom you will need to communicate with and when, is one of the processes in your needs analysis. To assist this process examples are provided in the following tables that can be used to visualize and understand the levels of interoperability needed.



Use this table below for an example of a VHF repeater system

<b>PS agency or jurisdiction</b>	<b>Daily</b>	<b>Common</b>	<b>Rarely</b>
County (intra)		<b>GCP</b>	
County (inter)	<b>NR</b>		
Local Police	<b>NR</b>		
State Police		<b>MAC</b>	
Fire	<b>GCP</b>		
EMS	<b>GCP</b>		
Hospital	<b>GCP</b>		
Public Works			<b>SR</b>
Utilities			<b>SR</b>
State Government		<b>MAC</b>	
Public Carriers			<b>SR</b>
Transportation			<b>SR</b>
Military			<b>SR</b>
Federal Government			<b>SR</b>

- **Swap Radios** (SR)
- **Talkaround** (TKR)
- **Mutual Aid Channel** (MAC)
- **Gateway Console Patch** (GCP)
- **System Roaming** (NR)
- **Standards Based Shared Network** (SBSN)



Use this table for an example for a dedicated trunked radio network

<b>PS agency or jurisdiction</b>	<b>Daily</b>	<b>Common</b>	<b>Rarely</b>
County (intra)		GCP/MAC	
County (inter)	NR		
Local Police	NR		
State Police		MAC/GCP	
Fire	NR		
EMS	NR		
Hospital	GCP		
Public Works			SR
Utilities			SR
State Government		MAC/GCP	
Public Carriers			SR
Transportation			SR
Military			SR
Federal Government			SR



Use this table as an example of a regional network with multiple agencies and jurisdictions sharing one infrastructure.

<b>PS agency or jurisdiction</b>	<b>Daily</b>	<b>Common</b>	<b>Rarely</b>
County (intra)		NR	
County (inter)	NR		
Local Police	NR		
State Police		NR	
Fire	NR		
EMS	NR		
Hospital	NR		
Public Works			MAC
Utilities			MAC
State Government		NR	
Public Carriers			SR
Transportation			SR
Military			SR
Federal Government			SR



A good plan should list all tasks, and may include flowcharts, schedules, and task budgets. A number of software programs, particularly project management software tools, are available that help make creating and maintaining these much easier. If any project is to succeed an adequate amount of time, money, and other resources must be allocated. Therefore, to be successful, resources must be allocated to: Identify, recruit, train, and assign or hire necessary staff. Identify potential project partners and create formal relationships. Identify potential sources of funding and apply for funds (the earlier, the better). Identify and procure appropriate communications technologies. Implement the project.

Before moving forward on a communications project, you will need to answer a number of questions. While collecting the information may seem tedious, there will be an upside when you find that you are asked to provide this same information to potential funding sources, management, and others.

One of the first things you need to identify is your existing business function. In other words, answer the questions:

- What do we do?
- How do we do it?
- What are our core functions?
- How does or will technology support those functions?

Plus, you should try to identify the benefits of such a project, both the tangible, measurable benefits (decreased maintenance costs, improved coverage, etc.) and the intangible benefits (improved morale, better customer service, etc.).

In addition, you should make an inventory of all of your existing communications hardware and software and frequency licenses. The inventory should include as many of the following as possible:

- Quantity
- Manufacturer, make, model (or version number of software)
- Year of installation/purchase
- Year last upgraded
- Frequency of use
- Purpose (what it is used for)
- Location
- Owner (for example, radio towers may be leased rather than owned by the agency, but should still be included in the inventory)
- User (the type of agency and/or personnel, not necessarily the specific individual)
- Original cost
- Estimated remaining useful life (in years)

Identifying what you need is not simply making a list of equipment. You should start at a much higher level and try to determine the kinds of functions/tasks you want to be able to perform. Do you want to add new capabilities to your existing system? What are they? Who will use them, and how often? Will the existing system support those new capabilities? For example, if you want to be able to put mobile data computers into your vehicles, you will need to ask yourself a series of questions, such as what will the computers be used for? Will they need to communicate



with computers in other locations? What locations? What kind of data will be passed over the radio system (dispatch messages, wants and warrants, field reports, a combination)? How much data? How much growth do you expect over the next 5 to 10 years? Just how much bandwidth do you need? What kind of software applications will need interfaces (computer-aided dispatch, records management systems, automatic vehicle location system, geographical information system, etc.)?

Knowing what you hope to accomplish in the long term will also help you to identify the solution that will best fit your needs. Use documents such as your agency's strategic plan to help determine your needs. For example, if your agency is planning to consolidate with another nearby agency within the next 5 years, your communications needs may be dramatically different from those required for just your agency alone. In addition, review the strategic plan(s) for the government entity you are part of (city, county, State) to see if its plans might provide you with some assistance. Review the plans of other government entities that have wireless communications needs (information systems, telecommunications, and various utility departments are often good sources of information). Review your inventory to see how much, if any, of your existing equipment should be or can be retained. What equipment will need to be replaced because it is obsolete or too expensive to maintain?

Now that you know what you have and what you need (at a functional level), you are ready to start reviewing your options. Essentially you will be faced with two options: purchasing a dedicated system or sharing a system with a regional footprint. But you may find a third option of contracting with a commercial service provider, if available.

After arriving at the decisive point of which network technology will meet your agency needs, the matter of selecting a vendor or vendors becomes the next step. The communications industry and the public safety industry have been attempting to develop a standards based approach to assist public safety agencies in the selection of a vendor and not be concerned with being tied to that one vendor due to a proprietary technology. To date Project 25 has not been successful in developing a standard that all vendors can manufacture to, resulting in varying levels of interoperability. Until the Standards Based Shared Network standard is finalized a high level of interoperability cannot be realized through Project 25, alone. Therefore, it is incumbent upon the public safety agency to perform their due diligence before making a vendor selection.

One of the components of the RFP should be a purchasing contract specific to the specialized technology. The contract should have a number of important issues covered that will protect the capital expenditure being invested. Some of these will include the response to the RFP with best and final offer, system acceptance test plan, coverage maps and payment schedule based on successful completion of deployment milestones.

Detailed cost is one of the most difficult items to accurately predict because certain critical items are often left out. The purchase price of the equipment or service alone is not sufficient to understand how much a system will cost you over a 20-year period (the average lifespan of a infrastructure). Looking at the full life cycle cost of the system, including such things as maintenance, personnel, and license costs, is critical. In addition to identifying the costs, try to identify any cost savings that will result from implementing your project. Will there be any



reoccurring charges like tower rental or other contractual service agreements? Any reduction in those charges equates to cost savings, thus reducing your overall life cycle cost. Consider site preparation costs that may fall outside the responsibility of the radio provider. Every agency is different, and vendor prices for equipment and services vary widely.

A recent trend is for agencies to create a joint effort to fund shared communications infrastructure resulting a positive economies of scale. The benefits of increased interoperability and reduced individual agency cost have overcome traditional resistance to combining resources. Agencies have created intergovernmental agreements, joint powers authorities, nonprofit corporations, and other creative mechanisms for allowing the various agencies to contribute funds to a joint project. Most agencies come up with some formula to determine the share of money that each must contribute. Formulas may be based on population, coverage area, number of transactions, number of units/officers, or any combination of these and other factors. In addition to providing a mechanism for funneling local funds, a multi-agency consortium often is able to obtain grant funds that a single agency might not. Many Federal grant programs look favorably on cooperative sharing of resources. If you are considering creating a multi-agency funding authority, contact several agencies that have participated in projects like this for suggestions on how to structure and fund your organization. They can give you valuable information on the time it takes to get all the various local governments to come to agreement, what has worked well for them, and what they would suggest you do differently.

Most commercial vendors or service providers will be happy to provide you with budgetary information to help you plan your project. The information you gathered in your inventory and during your needs analysis should be provided to them to allow them to estimate their costs as accurately as possible.

A competitive procurement usually involves the development of purchasing specifications by the local agency and then issuing of a Request for Quotation (RFQ) and/or a Request for Proposal (RFP). Multiple vendors respond to the RFQ with a bid (or to the RFP with a proposal) to provide what the agency has requested. A competitive procurement is designed to encourage competition among vendors to encourage fair pricing. An RFQ is generally used to purchase commodities, which can be easily described and for which there are several suppliers. Most awards that result from RFQs are based on low bid. An RFP is used for purchasing more complex items, like communications systems, for which a number of variables besides price may influence an award decision. For example, other variables could include maintenance hours, financial stability of the company, references from other clients, and ease of use. Cooperative purchasing refers to the practice of buying from another agency's competitive procurement. The most common type is the ability of a local agency to buy from the State's price agreement list. State governments routinely solicit bids for thousands of commonly used items, like computers and printers, at fixed prices. Vendors promise to supply all of the items the State wants at that fixed price for a fixed period. Local governments can buy from these awards throughout the year at volume discount prices, usually without going through their own bidding process.

As mentioned previously, an RFP is used for purchasing more complex items for which a number of variables besides price are important to the purchasing decision. There are three main sections of an RFP: the instructions to proposers, the terms and conditions of purchase, and the



technical specifications. Your purchasing agent generally provides templates for the first two to you. You may then need to add, delete, or modify portions of these as appropriate to the needs of your project. The development of the technical specifications is usually the responsibility of the project team. The specification must be clear and comprehensive so that both you and the vendor know precisely what is wanted and what is expected of each party. Avoid over specifying, as it can limit the number of vendors that respond and, thus, limit your options. Make sure that your RFP, at minimum, does each of the following:

- Describes the problem being addressed.
- Describes the existing environment (e.g., existing equipment, operational procedures, agency standards, constraints).
- Describes the required project outcomes.
- Describes the scope and standard of service required in ALL areas (i.e., user functionality, system response times, delivery schedule, service levels, training).
- Identifies mandatory features and desirable features.
- Identifies the key contractual terms and conditions (e.g., items that the agency is not willing to negotiate).
- Identifies criteria for acceptance and contract completion.

Once the RFP is written, have your team review it for completeness. Include members of your legal and purchasing departments as part of the review team. Make all necessary modifications before releasing the RFP. It is easier and better to delay issuing the RFP while you make corrections than to have to issue addenda during the procurement process. Issue the RFP.

Once the RFP has been completed and approved by your team, it is usually the responsibility of the purchasing department to issue it. The department has a standard set of procedures to follow that ensures that all of the legal mandates are met.

A period of time is often allowed within which potential vendors may submit questions. You need to be prepared to answer these questions in a timely manner and also to make sure that all potential vendors receive copies of the questions and responses to ensure impartiality. Many agencies host a vendors' conference to allow vendors to ask questions all at once and also to allow the vendors to inspect your site. This may reduce the number of written questions to which you are required to respond.

Allow vendors enough time to prepare a thorough response to your RFP. Depending on the complexity of the project, a period of from 1 to 2 months is common. Proposals must be submitted by the date and time indicated in the RFP. Be sure to request enough copies for all evaluation team members. If a vendor submits a proposal after that time, its proposal should not be opened or included in the evaluation process. Once the proposals are received and verified by purchasing, distribute copies to your evaluation team, which will include your implementation team as well as others with a vested interest in the project. Evaluate responses. When evaluating the responses to the RFP, you must consider a number of items:

- *Compliance.* Does the proposal comply with the required specifications in the RFP? If it does not, eliminate the proposal from further consideration.
- *Value.* Value is more than just price. It may include all or some of the following: purchase price, quality, warranties, maintenance costs, training, service, response time,



reliability, company stability, delivery time, and contract terms and conditions, among others.

- *Total Life Cycle Costs.* How much will the system cost over its expected life. In other words, if you expect the system to last 10 years, the life cycle cost would include the initial purchase price PLUS all operating and maintenance costs incurred over the entire 20 years. A system that has a low initial purchase price may have high maintenance costs that, over time, may cause its total life cycle cost to exceed that of a vendor with a higher initial purchase price.
- *Company References.* Talk to recent clients who have made similar purchases from the vendors for feedback on performance. Talking to several people from each client site will give you a more rounded impression of each vendor's performance.

### ***Evaluate the Proposals***

Evaluate the proposals against evaluation criteria that were defined before the proposals were received. The goal is to select the proposal that best meets the defined needs and to determine whether the vendor has the ability to perform the work. Read each proposal thoroughly. Use a standard evaluation format (e.g., a spreadsheet or written form) to help you compare responses of vendors more easily. Keep copies of the results. Have your agency's purchasing and/or legal staff review the terms and conditions of the proposal to ensure that the vendor has not counter proposed any terms that would be unacceptable to your agency. The entire evaluation process should be clear, fair, and equitable. Treating all vendors the same and keeping good records of the results of the evaluations will help ensure that there is no basis for a protest of your selection.

### ***Select vendor***

If a single best vendor emerges from the above evaluation process, you can move on to the contract negotiation phase of the process. However, it is more likely that there will be two or three vendors who appear comparable on paper (the "short list"). Before a clear winner can be selected, additional in-person demonstrations and/or interviews may be required with each of the short-list of vendors. As a result of the demonstrations and/or interviews, each vendor may be asked to submit a *best and final offer* that allows an "apples to apples" comparison of the proposals and their value. It also forces them to consider their profit margin carefully, one more time. At this time, you should evaluate each company's financial stability as well, through bank references, credit reports, public financial records (if a public company), and other similar checks. Get help from experienced financial experts, either inside your agency or outside it, to ensure that you obtain the right information and that it is correctly interpreted.

Another important consideration is the company's ability to perform the work. In other words, does it have enough staff to do your project as well as the other projects to which it is already committed? Check to see how many concurrent projects the company is working on. Also check to see if it has adequate customer support staff to assist you with maintenance problems after the project has been installed. Ultimately, the final selection should represent the best value for the money, from a financially stable, responsive, and well-respected company. The unsuccessful vendors should be notified in writing once a selection has been made. However, the finalists should not be released from their obligation to perform until a final contract has been signed



between the selected vendor and your agency. In the event that you are unable to successfully negotiate a contract with your selected vendor, you may wish to initiate negotiations with another of the finalists.

### *Negotiate contract*

It is not uncommon for the RFP to include a contract for the vendors to respond to during the evaluation process. This will allow the stakeholders to appraise the tenor of the business relationship prior to the face-to-face discussion to resolve the issues within the contract.

A written contract is mandatory. Both parties will benefit by having a document that clearly identifies each other's obligations. The contract negotiation should begin as soon as possible after selection of the final vendor. The negotiations should be conducted between individuals from each of the parties who have the authority to make commitments on behalf of their agency or company. Otherwise, a great deal of time and effort can be expended during the negotiation process only to find out that the "powers that be" will not approve the resulting contract. Your negotiators should have skills and experience in negotiating complex, high technology contracts. If you do not have such expertise within your agency, seek help from recognized experts within other departments/agencies. Your organization may require you to be represented by legal counsel for this discussion. A copy of your agency's Standard Contract Terms and Conditions should have been included in the RFP and should serve as the basis for negotiating a final contract. (It is usually not in the best interests of the agency to use the vendor's standard contract terms and conditions; however, there may be circumstances when this is the best option available.) In addition to legal terms and conditions, every contract should include a project schedule. This schedule should set clear, identifiable milestones for completion of each phase of the project. A milestone should be easy to measure and/or to determine that it has been completed.

The contract should also include a specific payment schedule, which clearly identifies when and under what circumstances payments will be made. As much as possible, payments should be tied to project milestones, with fixed-price amounts itemized. A certain percentage of the total contract price should be retained until the entire project is completed to ensure that all work has been completed to your agency's satisfaction. The contract should specify how requests for changes in scope of work will be handled and who is authorized to request such changes. The contract should require that all changes to the scope of a contract be in writing (verbal authorization is not sufficient) to be binding. In addition, it is important to specify how any changes in the project cost, which may be associated with scope changes, will be handled. Your agency's purchasing adviser and legal advisor should always be involved in reviewing any contract documents before they are finalized. Otherwise, the modifications made during the negotiation process may not be in compliance with existing governmental laws, rules, and regulations. Ensure that the individuals from each party who are legally authorized to do so sign the final contract. Otherwise, the contract may be ruled invalid.

The specifications should have indicated the system parameters to be tested and accepted. The vendor should submit a thorough test plan. Tests should be run and witnessed by the agency before final system acceptance. Any test should be measurable and achievable based on industry



standards and best practices, which are agreed upon by both parties all deficiencies should be corrected before final acceptance and final payment.

If you decide that you need more dedicated expert help than can be obtained from your agency, you may want to consider hiring a consultant. A consultant can perform a number of the project tasks for you, from conducting the inventory and needs analysis to developing budgetary cost estimates to creating an RFP to assisting you with the project management. You determine the level and extent of services you wish to purchase. Many consultants will perform your work as a fixed-price contract, provided you can clearly identify the scope of work you wish them to perform. Otherwise, you can hire a consultant on a time and materials and if you choose time and materials divide the project up into measurable and attainable incremental segments.

- Identify the project team perform needs analysis
- Develop a desirable technology plan
- Create budget and project goal
- Determine method of procurement develop (RFQ or RFP)
- Evaluate responses negotiate contract and procure
- Install and Test System

One of the first things any agency needs to develop when planning any project is an implementation schedule. The schedule should identify all major tasks and milestones and should allow enough time for the project to be developed, funded, and implemented. If agency is applying for a grant, the agency may also need to add a period after implementation to comply with the grant's evaluation requirements. A clear time line, identifying all of the milestones you expect to reach during the various phases of the project's implementation, is essential. Not only will it help all of your team to understand what has to be done and when, it will help reviewers get a much better perspective on what you are proposing.

Some projects are large enough to require two project teams: a project steering committee and a project implementation team. The steering committee is usually more involved with high-level planning and policy decisions, without getting actively involved in the details of the project. The steering committee often is composed of high-level representatives of the user agencies and/or departments, such as city/county managers, sheriffs, police and fire chiefs, finance directors, and sometimes-elected officials. The purpose of the steering committee is to ensure support for the project at the highest levels of the organization. Full and complete political, financial, and administrative support is required for your project to become a reality. Without complete support, your project may never get started, regardless of the need. The second project team (where needed) is the implementation team. The implementation team is the keystone upon which your project's success depends. This team must have the ability to effectively deal with both the technical complexity of a communications project and the organizational challenges associated with managing the project.

Like any other team, the person selected to lead the implementation team, is critical. The key abilities needed in the project manager are organizational skills and people skills. Knowledge of the technical aspects of the project is helpful, but not critical. The project manager ensures that



the team works smoothly together, makes sure that all tasks are completed on time and correctly, and solves the various problems that arise during the project. Select someone who knows how to get things done. Regardless of the skill of the project manager, that person will not be effective if he or she is not given the following:

- **Responsibility.** The project manager must know that the ultimate success of the project is dependent on him or her and also that he or she will be held accountable for the project's success or failure.
- **Authority.** No manager can succeed if given the responsibility but not the authority to make sure the necessary project tasks are carried out. The project manager must be empowered by the steering committee or other executive sponsor of the project to get and use whatever resources are needed to make the project a success.
- **Time.** One of the most frequent causes for the delay or failure of a large project is not giving the project manager the time needed to do the job. Expecting to take someone who is currently doing one full-time job and assigning the project management tasks to him or her as well is just poor management. Estimate the time needed to effectively manage the project and then adjust the project manager's workload accordingly. Be sure to include time for unseen delays and for fine-tuning once the project is operational.
- **Management support.** If a project manager's manager does not support the project, it is unlikely that the project manager will be successful. Make sure that the person selected has the backing of his or her management team.
- **Physical resources.** It may seem obvious, but an adequate space within which to work is an absolute necessity. The project manager will spend hours on the telephone, in meetings, and reviewing detailed technical documents. Adequate space, privacy, and quiet are mandatory. Administrative support for tasks such as copying, filing, typing, and scheduling make the project manager more productive.

Implementation team members should be selected to provide the project with the best chance for success. Each member should bring a unique perspective to the group. One could be technical. Others might be financial (including finance, budget, and purchasing) and legal. Still more might represent different aspects of the user community. (And don't forget to include your vendor on your team, once a vendor has been selected. Including the vendor on your team will minimize the chance of any last minute, unhappy surprises.) Whatever their qualifications, team members should be willing to take on the assignment of certain tasks from the implementation schedule and have the time to accomplish those tasks.

## **CLOSING**

The project is not a trivial endeavor regardless of the size or scope. The impact of a successful acquisition and deployment of a 1<sup>st</sup> Responder Communication Network is a critical contribution to the infrastructure in the community that will enhance the quality of life to anyone within the community. The network will be an invaluable tool in the day-to-day operation of the 1<sup>st</sup> Responder community that will save lives and preserve property. Anyone involved in the stewardship of the project should consider it a privilege to serve his or her fellow citizens.

