RADIO COMMUNICATIONS FOR THE FIRE SERVICE:

A Planning Guide for Obtaining the Communications System You Need for Enhanced Safety and Emergency Preparedness

ABOUT THIS GUIDE

First responders know exactly how their communications are supposed to work. Fire departments need a communications system that's reliable in the dense downtown area, in high-rise buildings with a lot of concrete and steel and that operates well in the rural areas with varying terrains. The police department needs a system that functions reliably from portable radios in moving vehicles. A first responder system must accommodate both extremes.

Radio is a lifeline, and for people who put their lives on the line every day, reliable communication is vital everywhere, every time.

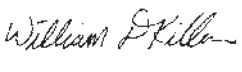
Today, in the interest of interoperability and cost justification, first responders are being asked to participate in countywide, statewide, countrywide or citywide shared communications systems. Although fire departments are being asked to be a part of these multi-agency systems, they are often not part of the process of defining the specifications. This can result in a system that does not meet the unique needs of the fire service.

The range of technologies and alternative solutions available is staggering. Choosing and implementing a new wireless communications system can seem a formidable task.

To ensure successful outcomes for new communications systems, it is necessary to become involved early on in the planning process. You'll discover that some commonly overlooked factors can have a surprisingly important impact on how well your personnel can communicate. The critical areas covered in this guide include appropriate levels of funding for system development, project staffing, training, acceptance testing and problem solving.

Our primary responsibility is that everyone goes home safe at the end of each shift. As fire professionals, we are proud of our profession and strive to give citizens our best effort to save lives and property. One of the most important elements of life safety equipment is reliable, effective radio communication.

With the help of this guide, you will be able to take the first steps in creating informed, thoughtful decisions to facilitate the development of an effective emergency communications system.



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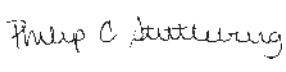

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CHAPTER 1: INTRODUCTION

The voices of fire fighters need to be heard. Before your department's personnel can talk on the radio, they must first speak up during the planning process that determines the kind of wireless communications support that will be available to the fire service in your area.

This guide is for all fire service professionals including front-line personnel, supervisors, management, and union officials. Whether you are assigned to a committee, answering questions, or simply attempting to follow developments and voice your opinions, this guide will help you to:

- Make sure the needs of the fire service are fully addressed within your community's overall communications planning process
- Determine your department's requirements for radio capabilities during routine operations, disaster preparedness, and future growth
- Understand the basic technology choices and trade-offs when selecting a communications system
- Participate in a smooth transition to the new system
- Locate sources of funding, write effective grant proposals, issue RFPs and evaluate vendor responses

This resource guide will give you enough information to get started immediately as an active participant in your local government's communications system decision-making process.

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CHAPTER 2: THE FIRE SERVICE PERSPECTIVE

There are many reasons why fire departments are now taking a more active role in the selection and implementation of public safety radio systems:

Utility: Fire personnel are making more and better use of radio communications to promote safety and enhance their ability to work together more effectively.

Feasibility: New technologies are making it more practical and cost-effective to develop equipment that meets the special needs of firefighting, such as lightweight portable radios that are able to withstand extreme temperatures and work reliably inside buildings.

Mutual assistance: Fire departments are setting up more mutual aid/automatic aid agreements with nearby communities and with local, state and Federal agencies – which places critical importance on networks that can interoperate with other departments and jurisdictions.

Shared investment: Communities are recognizing the benefits of sharing one system across multiple departments in order to share costs and ensure reliable and available communication when events require a joint response.

Capabilities: New capabilities such as wireless data, global positioning, personnel tracking and video monitoring have vast potential as tools for firefighting and especially for fire fighter safety and accountability.

Funding: With homeland security a top priority, more funding is available for fire departments and other first responders to upgrade their communications.

These factors are bringing a new sense of urgency to the communication needs of the fire service. Instead of allowing other agencies to take the lead, fire professionals must be encouraged to take their place at the planning table to ensure that their own needs are met.

Every public safety agency requires communications *that are rapid, rugged, responsive, and reliable.*

THE FIRE SERVICE HAS DIFFERENT NEEDS

Every public safety agency requires communications that are rapid, rugged, responsive, and reliable. However, the fire service has unique concerns that are not always recognized or understood by other agencies:

- Service requires radios that are portable, hands-free, easy to use, and mounted inside masks. In other words, radios that are designed to be operated by users who are actively fighting a fire.
- Radios must be exceptionally rugged and able to operate in severe environments with extreme heat, cold, water, and sudden movement.
- The network must provide reliable coverage indoors – including stairwells, basements, near the floor, and other locations where it is often difficult to receive a clear signal.
- Conversations must be audible in very noisy environments.
- Because of mutual aid agreements/automatic aid, networks must be able to support joint communications with personnel from other towns.
- Fire incident command systems often use multiple channels (or talk groups*) at a single event. The network must make enough channels/ talkgroups available in an organized, multi-level manner to allow for fast deployment of communications at the scene.
- Fire fighters operate in a dispatch environment and need a network that can provide up-to-date incident status, access to hazardous materials information, and other critical data about an incident while en route.

Apart from the primary communications system, which you might share with the police and other agencies, there are unique sub-systems used only by the fire service. Therefore, make sure that the primary system is compatible with your fire-specific sub-systems.

* Channels and talkgroups are pathways for communication. Think of them as lanes on a highway. The more lanes you have, the more cars (or separate conversations) you can have traveling at the same time. Conventional radio systems use channels, which correspond to radio frequencies. Trunking radio systems assign each call to its own talkgroup and can carry more than one talkgroup on the same channel although not simultaneously. You'll learn more about this in Chapter 8.

Fire Service Applications and Sub-Systems

ALERTING SYSTEMS *Fire Station Alerting Systems* *Personnel Alerting Systems*	The first step in fire/EMS response is to alert personnel when a call is received. Various systems can be used to alert career employees based at firehouses; volunteers responding from home, work, or station; and EMS personnel responding from ambulances or chase cars. Fire Station Alerting Systems are used to alert personnel who are based at a fixed facility. Personnel Alerting Systems are used to alert personnel who are away from their stations.
RESPONSE SYSTEMS *Status/Message Systems* *Mobile Data Systems* *Vehicle Location Systems* *Apparatus Intercom Systems* *Key Management Systems*	Response systems provide information to personnel while they are traveling to an incident scene. These systems also provide dispatch personnel with information regarding the status of responding units.
FIREGROUND COMMUNICATIONS SYSTEMS *Vehicular Repeater Systems* *Ruggedized Equipment* *Dual Control Head equipment* *Self Contained Breathing Apparatus (SCBA) Communications* *Personnel Accountability* *Dispatching solutions*	Fireground systems support communication at the scene: incident command, engine company operations, truck company operations, supporting EMS, and all other ancillary activities. Most networks are designed so that dedicated channels (or talkgroups) are available for fireground and tactical communications. This ensures that the incident commander will have channels available. Meanwhile, the dispatch channel is left free for dispatching other units and responding to other incidents.
EMS COMMUNICATIONS SYSTEMS *Medical Consultation Systems* *MEDEVAC Communications*	Most fire departments today are involved with Emergency Medical Services (EMS) at either the Basic Life Support (BLS) or Advanced Life Support (ALS) level. EMS providers may be dedicated EMT and paramedics, or they may be dual-certified fire fighters. In either case, specialized communications systems have evolved to support the EMS providers.

LOOKING AHEAD

The planning timeline for a new communications system can range from a few months to several years. Once installed, the system could have a life of 10 years or more. Therefore you'll want to keep the future in mind as you evaluate choices.

Community needs: Anticipate population growth, density changes, geographic expansion, alliances with other communities, and evolving issues in homeland security. Any investment you make today should have the potential to grow tomorrow.

Organizational changes: Consider potential staffing changes, departmental realignments, task forces, and greater collaboration with state and federal agencies. Will you be hiring more fire fighters? Opening or closing station houses? Fielding specialized crews for hazardous materials or biological weapons?

New technologies: While you can't predict every future capability, you can read news reports and technology journals for emerging systems, pilot programs, and development projects. Look for military spin-offs that will be adapted to the fire service, such as thermal imaging cameras for locating fire victims and missing personnel, GPS location systems, and radios that can operate using different frequency bands and protocols as needed.

In the next few years, radio networks will be able to support a range of new features. Even if you don't have the funding to activate these features today, you'll want to invest in a system that will be capable of supporting them later. That's especially true for the many firefighter-safety features that are newly available or will become available soon:

- Voice activated intercom systems that allow multiple interior attack fire fighters to freely communicate while keeping their hands free.
- Large accessible buttons provided on gear to enable immediate distress signaling.
- Radio-linked PASS devices that alert a safety officer if a fire fighter remains motionless for too long.
- Turnout gear equipped with temperature, location, SCBA pressure and atmospheric sensors to relay information about danger levels to the incident commander.
- Telemetry of fire fighter pulse, blood pressure, and respiration rates are transmitted to medical units to assess danger levels.
- Compact video transmission systems that relay thermal images of the fire to command post vehicles.

While this near-future technology promises vast improvements in operations and safety, fire officers need to choose the best and most cost-effective technology within their financial limitations. Whenever possible, you'll want investments that won't limit your future ability to deploy safety improvements.

THE COMMUNICATIONS PROCESS AND YOUR ROLE IN IT

Representatives of the fire service should participate in every step of the communications planning and implementation process. Some of the things you need to consider include how to:

- Organize the planning team
- Gather data: Where are you now?
- Define requirements: Where do you need to be?
- Obtain funding
- Prepare and distribute a Request for Proposals (RFP)
- Evaluate proposals and choose a solution
- Oversee design, implementation, and changes to operations
- Train all personnel and incorporate radio usage into ongoing training and simulations
- Test and confirm system performance prior to acceptance
- Continue to monitor performance and seek improvements
- Perform annual system testing, evaluation, and fire fighter refresher training.

You may be collaborating with other departments to build a shared multi-agency network… or you may go it alone on an interoperable network for the fire service only. Either way, the more you learn about your department's needs and the communication technologies available today, the more effectively you can represent the perspective of the fire service in your community.

CHAPTER 3: THE COMMUNICATIONS PLANNING TEAM

WHO SHOULD BE INVOLVED?

The rule is simple: everyone affected by the fire communications system should have a hand in its selection. This includes:

- Front-line fire fighters and the teams who support them in the field
- Dispatchers and others who provide support away from the scene
- Supervisors and managers at all levels
- Fire Department leadership
- Union representatives
- Elected officials
- Personnel from other agencies that collaborate with the fire service

This doesn't mean everyone participates at every step. It does mean stakeholders must be consulted and their needs given serious consideration. If any constituency is left out of the planning process, critical needs may get overlooked… and the result could be a system that fails to meet the requirements and expectations of the entire community.

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WHAT ABOUT OTHER AGENCIES?

In today's world, interoperability - the ability of public safety agencies to communicate with each other when events require them to coordinate a joint response - is a major concern. Many localities are answering the need for interoperability by designing large networks that will be shared by multiple departments… and sometimes by multiple cities and counties.

If your community is planning a network that will be shared by other agencies in addition to the fire service, you must collaborate with representatives of those organizations, giving each agency's needs appropriate weight. While it's common for the Information Technology Department to drive the overall direction of the project, it's essential for each stakeholder to claim its fair share of the resources.

As an advocate for the fire service, you can use these tips to help ensure that your concerns will not be lost in the shuffle:

- Be prepared with statistics that reinforce your department's importance to the community: how many incidents handled each year, how many citizens involved, how many lives saved (these can be hard to quantify but some research should produce numbers you can use).

- Be familiar with your department's planning initiatives and be prepared to talk about anticipated growth, potential incidents, and disaster scenarios to demonstrate the importance of fire service preparedness.
- Focus on the critical need. It's not a question of how many antenna towers you have… it's whether fire fighters can communicate to coordinate tasks, strategies or hear emergency traffic of a mayday call when they're working inside a building. Emphasize how each decision impacts the safety of your personnel and citizens.
- Look for financial paybacks. Consider the impact of a new system on future equipment purchases, system maintenance and expansion costs, deployment of resources. Over the long term, can you show the system paying for itself?
- Find sources of funding that are earmarked for the fire service. See Chapter 6 for a list of sources.

HOW ARE THE ROLES ASSIGNED?

Each community has a different approach to organizing the planning effort. Typically you'll have:

- A Steering Committee with top leadership setting the overall policy agenda
- Working Groups that are assigned to complete specific tasks and report back to the Steering Committee

If you are appointed to one of these groups, it can sometimes be difficult to determine exactly what your role is supposed to be – both as a group and as individuals. Insist that you be given a clear indication of the goal and expectations. Of course, it is up to you to make your best effort to exceed those expectations.

SHOULD WE GET A CONSULTANT?

Time, staffing, and know-how are factors in deciding whether to hire a consultant.

- Do you have people with the necessary technical capabilities and an understanding of complex modern communications systems?
- Does your organization have time to do the job alone?
- Can you obtain the necessary staff internally?
- Do your people know how to perform the assigned tasks?

If the answer is "no" to any of these questions, consider getting a consultant's assistance.

Even if you have some degree of technical capability in-house, the use of an outside consultant brings the benefit of experience. The consultant has (or should have) more experience than you in dealing with communications challenges and providing communications project oversight. The consultant also provides a fresh outsider's viewpoint, which can be valuable.

A consultant can be hired to perform a single, clearly-defined task, or to take on a more comprehensive role. Often, it's wise to hire a new consultant for a small-scale project and see how it works out before turning over a large-scale responsibility.

If you decide to use a consultant, ask these questions before you hire:

- Have you worked with public safety?
- Have you worked with fire departments?
- Have you worked with any fire-specific sub-systems such as alert systems and accountability systems?
- Have you worked with fire departments of our size?
- Are you able to provide assistance to overcome budget issues, such as grant writing, understanding the bond process, and creative financing solutions?
- What types of systems have resulted from your work?
- What are some of your successes? What were some challenges? How did you overcome those challenges?
- Who are your references, and how can we contact them? (Be sure to follow up on those references!)

WHERE ELSE CAN WE GET ADVICE?

Whether or not you use a consultant, investigate these alternative sources of assistance:

Other communities: Chances are, another town near you has already been through this process. Schedule a site visit so you can talk with fire fighters and operations officers for advice.

Conferences: Attend fire and public safety conferences with an eye for communications sources. Programs, panels, vendor displays, demo projects… these are all good places to get information and hook up with others who have experience they're willing to share.

Associations: Industry and government groups offer a wealth of information at the local, state, regional, federal, and international level.

Vendors: Manufacturers and system integrators can often provide brochures, white papers, and similar resources. This is a good place to find information about technical issues. An established vendor understands that well-informed customers are the best customers, and providing accurate information is one way to build a strong lasting relationship and ensure the customer's long-term satisfaction.

Several national organizations act as clearing houses for information about public safety communications. These organizations are also grant and funding conduits for testing pilot programs.

- SAFECOM'S mission is to help local, tribal, state and federal public safety agencies improve response though more effective and efficient interoperable communications. Visit www.safecomprogram.gov or call their toll free number 1-866-969-SAFE.
- National Public Safety Telecommunications Council (NPSTC) is a federation of federal, state, and local associations and agencies. It serves as a liaison among the FCC, Congress, and appointed officials involved in public safety communications. More information is available online at www.npstc.org or by calling their toll free number 866-807-4755.

Also see Chapter 6 for a list of organizations that provide funding for fire communications. Many of them can also offer information and guidance to assist you.

CHAPTER 4: GATHERING DATA

TAKE A SNAPSHOT OF YOUR COMMUNICATIONS AS THEY ARE TODAY

What is the current state of your fire communications? This is not an easy question to answer. It's not uncommon for a department to use more than one communications system and even with the same equipment procedures can vary markedly. Every station house is likely to have a different perspective. Incident commanders, line personnel, dispatchers, inspectors, fire safety officers… they'll all have their own ways of doing "business as usual."

Collecting this information and pulling it all together in one place is a necessary step and one that requires the commitment of time and resources. Few departments keep statistics about radio usage and performance, so you'll have to generate much of this information from scratch. Many departments bring in a consultant at this phase, especially to help with the more technical aspects of the job such as charting call traffic and measuring grade of service. A consultant can also be helpful in collecting "softer" data. Often it's easier for an outsider to interview users and get their honest opinions.

CREATE A USER GROUP

This can determine the what, why, where, when and how. Ask what is good about the current communications system and what changes would help them perform efficiently or effectively. Use this information as part of the overall plan.

You need to compile a complete and accurate picture of how the fire service communicates today before you can get on with the process of making it better tomorrow.

Collecting this information and pulling it all together in one place is a necessary step… and one that requires the commitment of time and resources.

Gathering Data

ABOUT THE DEPARTMENT	Number of members? Number of radio users? Number of fire stations? Organizational structure? Type of department, career, volunteer, combination, on call? Expected growth? Collaboration with other departments? Mutual aid agreements with other jurisdictions? What is your current budget for fire communications? Number of fire/EMS, command vehicles? Number of personnel on duty or who typically respond to alarms?
YOUR CURRENT CORE NETWORK SYSTEM(S)	Manufacturer/make/model? When was it first installed? How recently has it been upgraded? Analog/digital* Conventional/trunked?* Is it running at or near capacity in terms of traffic volume? Service agreement or are you supporting it internally? Is there a backup power supply? Is there a backup system at another location in case this one is damaged or rendered inoperable?
NETWORK ARCHITECTURE	Single or multi-site?* If multi-site, is it multicast or simulcast?* Remote site equipment (repeaters, towers, remote receivers etc.)? What is the current level of coverage over the service area within structures?
FIRE SUB-SYSTEMS	How does your alerting system work? Response system? Fireground? EMS? Are these systems integrated with the core network or do they operate separately using different equipment?

*You'll learn more about these in Chapter 8.

Gathering Data

DISPATCH	Number and location(s) of dispatch center(s) Number of dispatchers on each shift during normal operation 24X7 Communications Supervisor Maximum number of dispatchers during an emergency **Automated systems used by dispatchers:** Caller location Mapping Automatic vehicle location (AVL) Automated hospital availability monitoring systems Mobile data systems/premise hazards Event mapping/routing systems Mapped premise hazards/hydrant locations **Records management/fire and EMS records interfaces:** Audio recording Hazardous materials databases Station alerting systems Emergency medical dispatch (EMD) systems How does the public safety telecommunicator/dispatcher alert a station? Via radio system toning? Public telephone switched system? Via computer alerting via inter/intranet? Wired system? Commercial paging system or private paging system? Does the main dispatch center have backup power? Do you have a backup facility in case the main dispatch center is rendered inoperable or uninhabitable?
STATION EQUIPMENT	What is installed in each fire station? How is it used? Is it integrated with other systems?

Gathering Data

USERS	Which types of personnel are issued radios? When do they receive their radios and training: at the academy, first day on the job, or as needed? Who is not issued a radio? Why don't they have radios? How do they communicate now (phone, etc.)? How would radios help them communicate more effectively?
USER EQUIPMENT	Type of radios used by field personnel? Vehicle-mounted? Handheld or clothing-mounted? Analog/digital? Are these different types of radios mutually compatible (if users have different radios, can they still talk to each other directly?) Number of radios in use on average day? Maximum radios that can be deployed in an emergency within 1 hour… 12 hours… 24 hours? Number of spare radios and batteries kept in stock? What accessories are used? What deployable systems such as a suitcase repeater, trailer mounted equipment, command vehicles, mobile data in apparatus? Do SCBA's have a radio integrated into it? Are portable radios equipped with remote speaker microphones?
NETWORK MANAGEMENT	Does the current system have performance monitoring capabilities? Who monitors and troubleshoots network performance? Can the entire network be administered from a single site? How are network reconfigurations handled? Who sees the system alarms? When there's a problem in the network, how long does it take to diagnose and isolate the problem? If your network administration site is damaged, how will the network be administered?

Gathering Data

PROCEDURES AND OPERATIONS	Who maintains the equipment? **What are the standard operating procedures when:** Radio needs repair? Radio fails in the field? Incident in a location with poor radio coverage? Joint response with other agencies?
TRAINING	**What training is required for:** New recruits? New equipment? Refreshers/advanced training for experienced personnel? **What is the standard training for:** Fire fighters in the field? Command Officers? Dispatchers? Others?

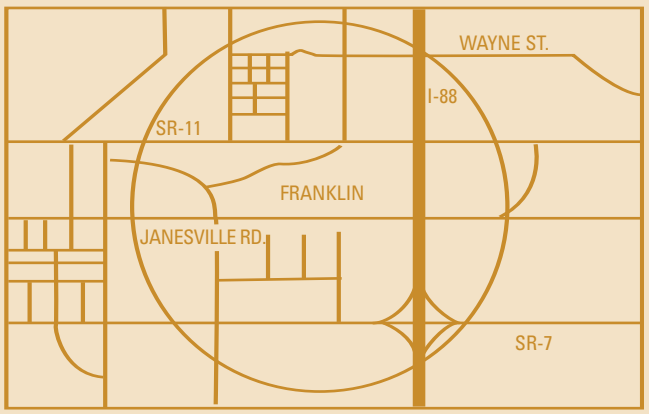
COVERAGE AND GRADE OF SERVICE MAPS

Network designers wrestle with two interrelated concepts that affect whether a user can rely on his or her radio in a given location:

Coverage: Where do fire fighters need to talk? Are radio signals able to reach this location with enough strength to activate the equipment and keep the conversation audible? Signals fade with distance, obstacles such as hills and buildings can block the signals, and electrical equipment can create interference that prevents calls from getting through. Coverage can also change as users move even a few feet in either direction, and even the weather can have an impact.

Grade of service (GOS): How often do they need to talk? Does the network have enough capacity to handle this call right away, or will the user get a busy signal? The network must have enough channels available in this location (or talkpaths if the network can carry more than one conversation on the same channel). Grade of service can become a problem at certain times of the day, or during special events and emergency incidents – any situation that creates more than the usual amount of radio usage at a given location. In most communities there are places where either coverage, GOS, or both are inadequate. Users cannot depend on their radios when they venture into these locations. As a planner, you must also consider emergency preparedness – locations that have adequate coverage and GOS for routine operations may not be able to handle the increased radio traffic during a disaster response in that area.

It's essential to take a map of your community and note every location where coverage and/or GOS is less than adequate. Talk to field personnel and supervisors who can often tell you exactly where the problem areas are. Discuss both outdoor and indoor coverage – although you'll focus more on indoor coverage during the requirements phase.



Coverage area: If you think of range as the radius of a circle, the circle itself will be the coverage area. In a radio system, a circle drawn on a map indicates the usable area of the radio system.

CHAPTER 5: DEFINING REQUIREMENTS

HOW TO IDENTIFY AND PRIORITIZE YOUR ORGANIZATION'S COMMUNICATION NEEDS

You can't design a network that meets your community's fire safety requirements until you determine exactly what those requirements are. It sounds obvious, but experience shows defining your requirements is the single most critical phase in the planning process. Planning efforts in many communities fail because they lose sight of this simple fact:

To clearly define your needs, you must obtain extensive feedback from users – the people on the front lines who use radios every day to save lives, and the people behind the lines who support their work. You need input from every type of user including teams that are less numerous, less obvious, and less vocal. Include volunteers, probies and trainees, union members, and non-union personnel. Also include citizens and elected leaders, since your decisions will have a major impact on public safety.

Seek input from employees and functional areas that do not currently use the network but might be expected to use it in the future. Maybe your fire investigation crews have not been carrying radios but could work more efficiently if they did.

Map the geographic area where your agency requires dependable radio coverage and availability. Consider future growth and annexations. In many communities, today's cornfield is tomorrow's shopping center.

Identify neighborhoods where coverage is especially critical due to occupancy loads, occupancy design, economic importance, and/or perceived risk. The network can be designed to give these areas extra coverage and channel capacity to ensure that signals are not blocked by obstacles or busy signals… and to provide a measure of redundancy so that even if one transmission site fails, another can provide backup and coverage to that location.

You can't design a network that meets your community's fire safety requirements until you determine exactly what those requirements are.

The new radio network must support...

NUMBER OF FIRE SERVICE USERS TODAY	Projected % of annual staffing increase Number of simultaneous calls In each location… During normal operations During full-staffing emergency operations Identify locations that require the capacity to handle higher traffic volumes
NUMBER OF DEDICATED FIRE CHANNELS	For fire dispatch For fireground communications
EXISTING EQUIPMENT *(Often it's possible for a new network to continue supporting some of the equipment you've already invested in)*	Portable and mobile radios (unless you're prepared to pay for an immediate change-out of all user equipment) Remote site equipment such as repeaters and towers (you can specify that these facilities are available and should be used if feasible, but engineers will ultimately determine whether they can be re-used effectively) Dispatch facilities and systems Network administration and management systems
INTERFACE TO OTHER COMMUNICATIONS AND INFORMATION SYSTEMS	Fire-specific sub-systems Dispatch databases Computer Aided Dispatch (CAD) systems Records management Audio recording Geographic Information Systems (GIS)/Mapping Asset Management
INTEROPERABILITY WITH OTHER NETWORKS/DEPARTMENTS AND JURISDICTIONS	Other municipal departments Mutual aid with fire departments in other municipalities State, regional, and federal agencies Regional interoperability networks
COVERAGE AREA	Percentage of coverage needed inside buildings, tunnels, elevators, basements, stairwells, etc. Coverage maps of entire service area

DEFINE MINIMUM EXPECTATIONS

What are the minimum basic requirements that the fire service will demand from the new system?

IDENTIFY CRITICAL BUILDINGS FOR INDOOR COVERAGE

Coverage is especially problematic indoors. Most existing public safety networks were designed to support vehicle-mounted radios… which have a tendency to stay outside on the street. Now that portable equipment is being carried into buildings, fire fighters have discovered that radio signals may not reliably penetrate indoors. This is one of the most critical problems facing fire communications. Your new network must be able to support radios inside the buildings where fire fighters are working.

Building materials affect signals in ways that are difficult to predict and hard to overcome. Today's networks can provide indoor coverage, but often at the cost of installing additional equipment. Municipal governments can work with building owners and tenants to share some of these costs.

Radio users, management, policy leaders, and the public should all have a say in identifying and prioritizing buildings that require dependable indoor coverage.

All fire service radio communications systems must specify a fallback communications method. This kind of redundancy is required so there is always alternate communications during emergency situations. For example, a trunked network can offer a "talkaround" mode that allows direct radio-to-radio communication inside a building even if network coverage does not reach inside, so fire fighters can still talk to each other at the scene. You may identify buildings at several priority levels with different degrees of coverage requirements, or different timetables for deploying the coverage you'll ultimately demand.

Critical Building Coverage

Your list of "must cover" buildings might include any or all of the following, plus locations unique to you community.

- ☐ Convention centers and hotels
- ☐ Shopping malls
- ☐ Courthouses and government offices
- ☐ Airports, train stations, and other transportation hubs
- ☐ Public safety headquarters and stations
- ☐ High schools, elementary schools, child care centers
- ☐ Universities and trade schools
- ☐ Office complexes
- ☐ High-rise buildings
- ☐ Sports and entertainment venues
- ☐ Museums and other public attractions
- ☐ Other buildings you identify as important

THE P25 STANDARD FOR INTEROPERABILITY

Project 25 is the national standard for achieving interoperability. Equipment that demonstrates compliance with Project 25 meets a set of requirements so that users are assured of compatible equipment and the ability to communicate via direct radio contact.

The International Association of Fire Chiefs has endorsed the P25 standard to achieve interoperability for fire communications.

A system that complies with the P25 standard offers several advantages. It can allow you to:

- Coordinate communications with other agencies and jurisdictions using the P25 standard
- Purchase radios and other equipment from more than one vendor
- Upgrade or migrate systems without replacing all of your equipment
- Share resources with other organizations to control costs

If you invest in a P25 compliant network, you retain complete control over your separate network, and yet it can seamlessly interoperate with other P25 networks whenever joint communications are required.

For more information on Project 25 visit www.project25.org

MAKE A "WISH LIST" OF FEATURES AND CAPABILITIES

Today's sophisticated communications systems provide a level of functionality never imagined even a few years ago and have become valuable tools that support your department's mission. Some of the new features include:

- Emergency button – allows the user to quickly call the dispatcher for help by pressing a single easy-to-reach button on the radio set.
- Unit ID – allows the network or display equipped radio to determine exactly which unit is making or receiving a call.
- Hands-free accessories – help users communicate even when their hands are busy.
- Color casings – make it easier to see the radio in dark and smoky conditions.
- Ruggedized and water-resistant models – perform even under wet or challenging conditions.

DISASTER PLANNING AND INTEROPERABILITY

Communications are never more important than when disaster strikes. Advance planning can prepare your networks to handle emergency operations. The following table shows just a few examples…

RISK FACTORS	PREPAREDNESS STRATEGIES
Man-made or natural disasters can cause damage to the network facilities or Emergency Communications Center	Redundant equipment and backup sites can take over for damaged parts of the network, ensuring uninterrupted communications.
Response to a large-scale incident results in extra personnel making heavy use of their radios, overwhelming the network's capacity	Extra capacity can be designed into the network, perhaps with overlapping transmission sites. Networks that can be reconfigured quickly to assign more channels to the affected area enable the right level of network capacity.
A joint response with state agencies, FEMA, and nearby communities requires coordinated communications	Networks that comply with the P25 interoperability standard enable seamless communications. Otherwise, you can stockpile enough extra radios to distribute to cooperating personnel.
Events occur in remote locations that have limited coverage	Upgrade your network coverage, or use mobile repeaters for temporary support.
Despite advance preparations, the network is destroyed or overwhelmed	Train your personnel on a procedure to follow when they are out of radio contact and teach them how to shift into "talkaround" mode for direct radio-to-radio communication if the network infrastructure is unavailable.

CHAPTER 6: OBTAINING FUNDING

DON'T TAKE "NO" FOR AN ANSWER

Funding is a critical issue but it should not be your first consideration when assessing your communications requirements. The first priority is to understand if your network is meeting your needs today and is scalable to meet your needs tomorrow. If not, what will it take to get there? Only then will you be ready to confront the challenge of obtaining the funding that will close that gap.

With the renewed focus on public safety and first-response capabilities, more funding options and funding sources are becoming available. A creative and active effort will turn up numerous funding options including:

FUNDING OPTIONS

- Charitable and corporate donations, especially for high-visibility items such as thermal imagers or automated defibrillators
- Federal, state, and regional government grants
- Joint investments with other agencies or nearby communities (network facilities such as core systems, repeater systems, fire alerting systems, towers, etc. can be shared, spreading the cost among several different organizations)
- Alternatives to up-front capital investment, such as leasing agreements and other financing options
- Phased implementation plans and adaptable networks that start small and add more capabilities over time as the funding becomes available

Do not allow cost to become a barrier that prevents your community from building the fire communications system its citizens and your colleagues deserve.

SOURCES OF FUNDING

New sources of funding are becoming more readily available. Keep an eye on state and Federal legislation related to homeland security and first response. Examples include:

- State Homeland Security Grant Program (SHSGP), administered by the U.S. Department of Homeland Security (DHS) through the Office for Domestic Preparedness (ODP).
- Assistance to Fire Fighters Grant Program, administered by the Office for Domestic Preparedness and U.S. Fire Administration.

Do not allow cost to become a barrier that prevents your community from building the fire communications system its citizens and your colleagues deserve.

RESOURCES

The Office of Domestic Preparedness has a web site for funding opportunities at
www.ojp.usdoj.gov/fundopps.htm

The DOJ also has a Grants Management System with tutorials at:
https://grants.ojp.usdoj.gov/index.html

Also see the web sites of the SAFECOM, the National Public Safety Telecommunications Council (NPSTC), and the Federal Emergency Management Agency (FEMA):
www.safecomprogram.gov www.npstc.org www.usfa.fema.gov/grants

Other groups that provide useful information include:

- Association of Public Safety Communications Officials: www.apcointl.org
- Congressional Fire Services Institute: www.cfsi.org
- International Association of Fire Chiefs: www.iafc.org
- International Fire Service Training Association: www.ifsta.org
- International Municipal Signal Association: www.imsasafety.org
- National Fire Protection Association: www.nfpa.org
- National Volunteer Fire Council: www.nvfc.org

APPLYING FOR GRANTS

A successful grant proposal is well-prepared, thoughtfully planned, and concisely packaged. Before you start writing:

- Become intimately familiar with the grant criteria and eligibility requirements of each funding source. You must be able and willing to meet these requirements. You might find that eligibility would require you to provide services otherwise unintended, such as working with particular client groups or involving specific institutions. You may need to modify your concept to fit.
- Talk to the information contact person to obtain updated information as to whether funding is still available, the applicable deadlines, and the agency's process for accepting applications.
- Determine whether any similar proposals have already been considered in your locality or state. Check with legislators and area government agencies and related public and private agencies which may currently have grant awards or contracts to do similar work. If a similar program already exists, you may need to reconsider submitting the proposed project, particularly if duplication of effort may be perceived.
- Enlist the support of community leaders. Once you have developed your proposal summary, look for individuals or groups representing academic, political, professional and lay organizations who may be willing to support the proposal in writing. The type and caliber of community support is critical to your proposal's ability to survive the initial and subsequent review phases.

You can probably develop the proposal without hiring a grant writer. Most fire grant programs are designed so that an astute member of any fire department can write a successful application. Fire departments having questions regarding the program can reach the Department of Homeland Security/Office for Domestic Preparedness AFG Program staff at 1-866-274-0960, or via email at firegrants@dhs.gov

You can write a successful fire grant application. Thousands of fire departments already have.

CHAPTER 7: ISSUING RFP's AND EVALUATING RESPONSES

PREPARING THE REQUEST FOR PROPOSALS

The more relevant information you pack into request for proposals (RFP), the better. Responding vendors need to clearly understand your requirements and current systems so they can propose appropriate solutions. If it's not called out in the RFP, you can't expect to have it addressed properly in the proposals.

As a representative of the fire service, make sure your department's concerns are included in the RFP. Make sure the RFP covers:

- Fire-capable end user equipment (water resistant, intrinsically safe, hands-free operation, environmental hardiness, etc.) – these radios are more costly than the radios commonly recommended for the police department, so be sure the RFP includes the right equipment
- Required interfaces to all of your existing fire-specific sub-systems (alert systems, etc.) – be sure to identify each and every system that will need to be integrated, complete with system specs, so the vendor can incorporate these systems from the beginning
- Interface to computer-aided dispatch (CAD) systems and any database systems used by your dispatchers or management
- Interoperability with communications networks used by the departments with whom you have a mutual-aid agreement
- Indoor coverage for critical buildings
- Fallback solutions for on-site communications where the network doesn't provide 100% coverage. Ask the vendor: what will users do if they are outside the range of your network system or indoors where signals don't penetrate?
- Training, testing, maintenance, pilot program, project review and quality assurance evaluation

The first thing to look for is a proposal that was written specifically to address your unique concerns as set forth in the RFP. Ascertain that you're not reading a generic boilerplate response that could have been written for any community.

EVALUATING RESPONSES

The first thing to look for when evaluating RFP responses are those that were written specifically to address your unique concerns as set forth in your RFP. If it reads like a generic boilerplate response that could have been written for any community, the vendor probably didn't take the time to understand your specific needs.

Next, check that the response shows awareness of fire service requirements and is not aimed solely for other functions.

Finally, make sure the vendor has expressed a clear understanding that deploying a new network is not just a technical challenge, but also a major organizational change that requires a full support structure. The vendor's response should include:

- Clear identification of how your existing internal procedures might be affected by the new system
- Phased rollout plan for gradual transition from your current system to the new one
- Upgrade/migration plan for making further changes in the future
- User training before, during and after implementation
- System testing and acceptance
- Practice sessions
- Life cycle maintenance, network performance monitoring, and repairs
- Software upgrades for radios and the system infrastructure

To adequately evaluate the solutions proposed by each vendor, you'll need to understand the relative advantages of the technological choices they are recommending. Chapter 8 provides a basic overview of radio communications technology.

CHAPTER 8: TECHNOLOGY CHOICES

SELECTING THE BEST ALTERNATIVE

Today's complex radio networks utilize many different technologies. The best choice for your community usually boils down to this: Striking the right balance between initial cost and long-term capabilities that help your users perform better and more safely on the job. You need a system that fits your needs and available resources today…with the potential to grow and add more capabilities tomorrow.

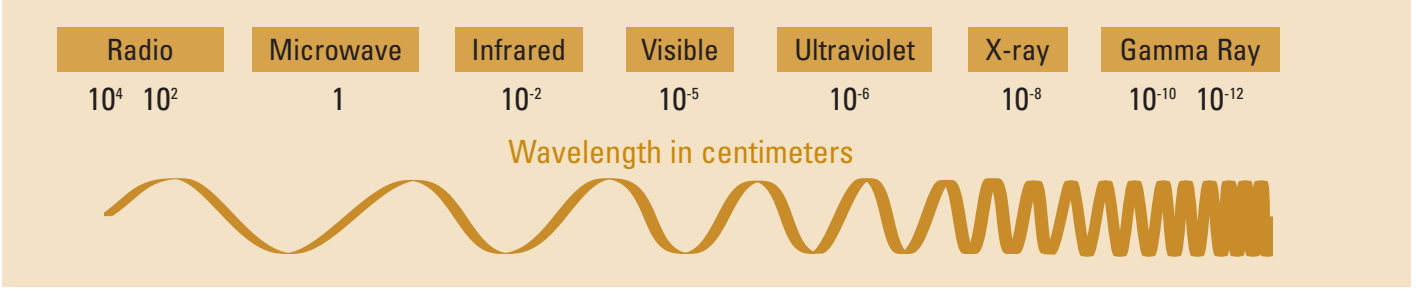
The best choice for your community usually boils down to this: Striking the right balance between initial cost and long-term capabilities.

The vendor responses to your RFP should not only detail the type of system they're proposing, but also explain why they're recommending it over the alternatives. The vendor should be ready to answer any questions you have about why their recommended system design meets your specific needs and not simply because they recommend the same system to everybody.

It helps to understand a few basic principles of radio network design, and to know something about the trade offs between different technologies. This chapter provides the basics and will point you in the right direction to learn more from other sources as you find the time if necessary.

RADIO WAVES

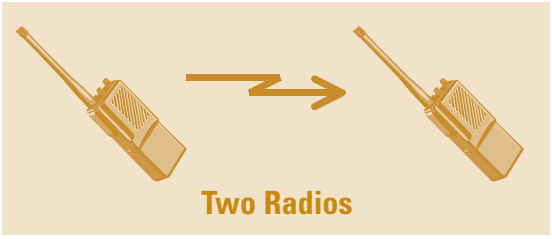
A radio is a device that transmits and receives radio waves. These waves are part of the electromagnetic spectrum along with light, radiant heat, TV and commercial radio broadcasts, microwaves, and other forms of radiation.



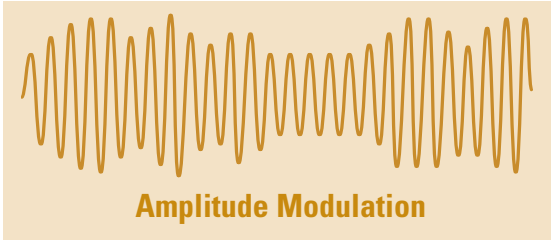
Radio waves can travel through air, water, or empty space. The distance between two peaks of the wave is the "wavelength" and the entire pattern of the wave is called the "cycle". Engineers measure the wave's "frequency" by counting the number of cycles that occur each second. The frequency is measured in Hertz (a thousand Hertz is a kilohertz or KHz and a million Hertz is a megahertz or MHz). So when engineers talk about an "800-MHz system" they're talking about a system that transmits signals in the frequency band around 800 million cycles per second.

TRANSLATING CONVERSATIONS INTO WAVES…AND BACK AGAIN

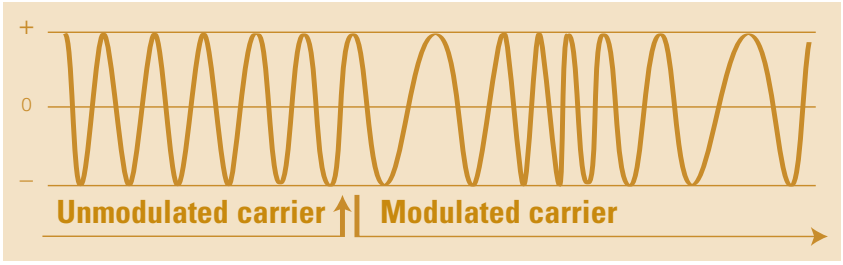
When a user speaks, the radio translates the audible sound into electromagnetic signals. The radio then sends those signals to another radio, with a carrier wave – a uniform wave that contains no information. By making changes to the carrier wave, it encodes the speech so that another radio can receive it. The receiving radio translates the signal back into audible sound for the user to hear.



There are three commonly-used ways to encode information onto the carrier wave. The first is amplitude modulation (AM). The height of the wave changes.



Another method, frequency modulation (FM), changes the frequency but not the amplitude of the wave.



Both AM and FM are "analog" methods that code information as gradual changes to the signal. Analog radio systems were the first systems available on the market and are still used by many public safety organizations today.

An alternative to analog is digital. "Digital" systems convert information into a simple series of on/off signals (computers do the same thing with data, converting it into a series of 0s and 1s). Most of today's digital radios use an encoding method called "phase modulation," which changes the angle of the carrier wave.

Digital signals are less sensitive to the normal degradation that occurs as signals fade over distance. Why? Think of a digital signal as a simple black-and-white drawing done with a wide marker. Compare it to a detailed picture that has many subtle gradations of color. From a distance, the black-and-white picture is easier to see, while the small details of the color picture can be lost if you don't have a good view. The subtle variations in an analog signal are comparable to the colored picture: from a distance, the analog signal may come through with less audio quality, making the sound less distinct and the conversation harder to hear.

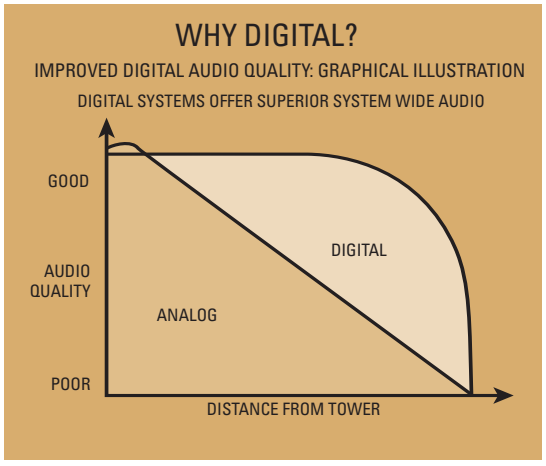
ANALOG OR DIGITAL?

One of your first technology decisions is whether to invest in an analog or digital system. The newer digital networks have many advantages and less potential to become obsolete. However, cost and issues of compatibility still lead some communities to stick with analog. If you're considering staying with analog, unless your resources are extremely limited, consider a dual analog/digital system instead of analog-only, since this will give you more flexibility in the future.

Analog or Digital Transmission?

ANALOG ADVANTAGES	*DIGITAL ADVANTAGES*
Your old networks are probably analog, which means you already own compatible radios and other equipment	More consistent signal strength (and audio quality) provides better coverage across your entire coverage area
Lower initial cost	More features are supported, now and in the future
Familiarity and comfort level, not going to something new	

A dual analog/digital system can support your old analog radios, while simultaneously supporting new digital radios with added features. This allows a gradual migration from analog to digital without having to immediately replace all of your old equipment.



Signal strength is a key advantage of digital systems. If you have an analog radio system, signal strength weakens gradually as users travel further from the transmitter. Users will notice that audio quality gets worse as they move farther away. Digital systems do not fade gradually. Instead, their signals maintain strength for a longer distance before dropping off rather suddenly. Users of digital systems enjoy better audio quality in the "gray area" at the edge of the signal range…but they'll still lose the signal entirely if they travel outside the range.

CONVENTIONAL OR TRUNKED?

"Conventional" operating systems, are basic analog systems that provide talk and listen capability. Radio channels are permanently assigned to certain user groups. For example, if your town has an FCC license to operate 12 public safety radio channels, a conventional system might assign:

- 2 channels for emergency dispatch
- 5 channels for police
- 5 channels for fire

If a single emergency requires a massive fire response and you need more tactical channels for the tactical radio traffic, reassigning those channels is a system administration job that takes time. Meanwhile, fire fighters are left waiting for their channel to clear.

"Trunked" operation makes better use of available frequencies. All users have access to all frequencies in the form of predefined groups. The system automatically assigns and reassigns frequencies to these different groups as needed, moment by moment. In our example, fire personnel could have access to all 12 frequencies if that's what it takes to handle the increased radio traffic.

In fact, each push-to-talk is likely to occur on a different frequency while remaining seamless to the users. This concept works because statistically, not all radio users need to communicate at precisely the same time. Therefore, resources (frequencies) are more efficiently used.

On a trunked network, pre-defined groups of users are called "talkgroups." You might have fire talkgroups, police talkgroups, and other talkgroups forthose who need to communicate on a regular basis. Many more talkgroups than frequencies can be made available because not all users attempt to access the system at the same time. Thus, the same number of frequencies can support more users – although your disaster planning should ensure that enough total frequencies are available to support the additional talk groups and the extra traffic required in emergencies and not just for normal operation.

A fire service agency operating on a trunked system should set aside a minimum of one or two frequencies for firefighter safety and conventional system use. Others in the fire service call these channels, fireground channels, guard channels, tactical channels or talkaround channels. These can work side by side with the trunked channels on the same portable and mobile radios.

Trunked systems offer features that may not be available on conventional systems. These include multiple access priorities, busy signaling, queuing, callback, central system management, and a whole range of advanced features made possible through computer signaling and access control. The system administrator can plan ahead for different talkgroups to be implemented in emergencies and activate those changes quickly when required, making a trunked system more flexible in an emergency.

Conventional or Trunked?

CONVENTIONAL ADVANTAGES	TRUNKED ADVANTAGES
Simpler design and administration	All channels can be accessed by all users; no channel sits idle when it's needed by a different user group
Lower initial cost	More users can be supported on the same number of channels
Familiarity and comfort level	Advanced features such as emergency signaling, callback, etc.
If no repeater is in range, radios can talk to each other directly without any change in operations	Flexibility: you can prepare alternate plans for different groups to talk to each another and implement those changes quickly as events require

If you're not sure whether it's time to migrate to a trunked network design, consider investing in a dual-mode system. You can initially configure it to operate in conventional mode, and reconfigure it later to support trunking when you're ready.

Trunked systems employ very sophisticated technology (and they all require the use of repeater systems as described below), but actual user operation is simple. Users need only select the channel talkgroup they wish to use and hit the push-to-talk button to communicate. The system performs automatic frequency assignment, verification, and regrouping of users in a fraction of a second and is virtually unknown to system users. In contrast, on a conventional system, a user must manually select from a limited number of channels, check for channel activity, and hope that all users are within range.

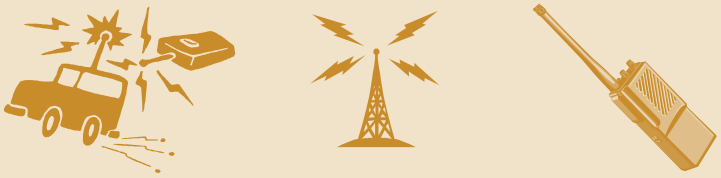
Despite the many advantages, fire departments are wary of moving to a trunked system because it takes time for users to adapt to radios that operate differently. During fire or rescue operations, momentary confusion about how to operate a radio can become a life-threatening problem. As with any new technology or process that is introduced to users, it is vital to provide proper training and ample opportunity to get used to the new radios prior to emergency use.

WHAT ABOUT REPEATER SYSTEMS?

Portable radios carried by users in the field have a limited range – their signals don't travel very far. Vehicle-mounted radios – which are larger, more powerful, and use the vehicle's antenna, – have a greater range. Still, unless your coverage area is very small, your network will need repeater systems to further extend the range of your communications.

A "repeater" does exactly that: it listens to radio traffic and repeats it. When it rebroadcasts a message, using its stronger antenna, the signal can travel farther… to another user's radio or to another repeater that can keep sending the call on its way until it reaches its destination. Today's repeaters receive signals on one frequency and simultaneously retransmit on a second frequency. This is called "half-duplex operation" and it's standard for all current networks.

Half-Duplex Operation



How many repeaters you need, and where you put them will depend on many factors and you should ask the following questions:

- How large is the geographic area you need to cover with your radio network?
- Is your network analog or digital (remembering that digital signals have more consistent strength up to the limits of the transmission range)?
- How do obstacles in your coverage area (terrain, buildings, etc.) affect the radio signals and their ability to reach every location?
- How many buildings require indoor coverage, and will they require their own separate in-building repeater systems?
- How much priority do you put on uninterrupted coverage, balanced against the cost of building the network?

The vendor's proposal should explain why they are recommending the given number and placement of repeater systems. Look for a phased implementation, rather than installing every repeater at once, since this will give you the opportunity to perform coverage tests and determine for certain how many extra repeaters are needed and where they should be installed.

Too often, agencies try to reduce costs by deviating from the design. They might construct only two repeater sites when the design specified seven. The network winds up with serious coverage gaps, and users blame the network when in reality it is due to a misguided attempt to save money.

If you're not prepared to build the network as designed, don't go forward until you obtain more funding, or identify a new design that fits within your budget. A network that doesn't adequately cover your community is no bargain.

WHAT IF A LOCATION IS NOT SERVED BY ANY REPEATERS?

If an incident takes place in a location that is not within the range of a network repeater, there are options for coverage:

- **Mobile and portable repeaters** are now available. These are small, complete, and comparatively lightweight repeater systems. Often, they are mounted inside a vehicle. In an emergency, crews can move these repeaters to the scene of an incident. The incident commander can deploy mobile repeaters to support communications at the site, and to link up with the rest of the network. Mobile repeaters are valuable resources for emergency preparedness, since they give agencies the potential to improve radio coverage in any location on short notice.
- **Direct radio-to-radio communication** is possible where no repeaters are available. Users at the scene can talk to each other, but may not be able to reach dispatchers, supervisors, or anyone else beyond the limited range of their portable radios. On a conventional network, this is the normal mode of operation. On a trunked network, users would need to switch to a talkaround channel. Even though the range is limited, and system-level features such as emergency button signaling are not available, direct radio-to-radio communication is a vital fallback capability when nothing else is available. Users, especially on a trunked system, must receive training to know when and how to operate in this mode.

Your vendor's proposal should include one or both of these options. They are necessary even if your main network has no coverage gaps – because unexpected events can damage the network. If a disaster destroys a repeater site or renders its equipment inoperable, these backup communication capabilities will be crucial to the safety of the public and your personnel.

SINGLE-SITE OR MULTI-SITE?

If you have a fairly small geographic area to cover, your network could be designed with a single repeater site. However, hills, buildings, or other obstacles could easily block signals between a user and that one site. If there is a second site within range of the user's location, the likelihood of getting a clear signal is much higher. Also, if something happens to that one site on a single-site network, there's no backup.

Multi-site networks can cover a larger area beyond the range of a single site's antenna. They can also provide better coverage in neighborhoods where radio availability is critical. When engineers design a multi-site network, they can arrange for more than one site to have overlapping coverage in critical locations. The overlapping sites provide backup for each other in case a user's signal is blocked or one of the sites has an equipment failure or sustains damage in an emergency.

Single or Multi-Site?

SINGLE-SITE ADVANTAGES	MULTI-SITE ADVANTAGES
Simpler design and administration	Covers wider area
Lower initial cost	Overlapping coverage improves signal strength (but only if the network uses a simulcast architecture: see "Multicast/Simulcast Comparison Chart" on next page)
Lower costs associated with remote sites: site acquisition, equipment, maintenance	If users can't get a clear signal from one site, they may be able to reach an overlapping site
	Redundancy in case one site is damaged by a disaster

Any system capable of supporting multiple sites is also able to work with a single site. You can start with a single site and add more sites as the need arises and as funding becomes available.

FOR MULTI-SITE NETWORKS: SIMULCAST OR MULTICAST?

Today's sophisticated radio systems use two ways to manage transmissions on a multi-site network. Your network could use either approach or a combination of the two:

- **Simulcast** carries the same message on the same channel at every site (**simul**taneous broad**cast**). Every site has access to every channel. If an emergency generates a lot of radio traffic, the site(s) serving that location can use as many channels as necessary (within the confines of the system).
- **Multicast** assigns different channels to different sites. If the same message is broadcast from different sites, each site must use a different channel. This ties up more channels. In an emergency, the site serving that location is able to use only the limited number of channels assigned to it.

Cell phone companies and other commercial interests usually choose a multicast network design, but their needs are different from public safety. For mission-critical applications, simulcast is often the better approach because it can provide more reliable coverage, a higher grade of service, and some measure of redundancy in an emergency.

Multicast / Simulcast Comparison Chart

MULTICAST	***SIMULCAST***
Different sites use different channels. A site can only access the channels that have been assigned to it.	Channels are in a pool that is shared by all of the sites. Every site can access every channel.
When an emergency creates heavy call traffic, the serving site can only access its assigned number of channels.	When heavy call traffic occurs, the serving site can access all available channels on the network.
In a location where more than one site provides overlapping coverage, the signals do not reinforce each other because they're operating on separate channels.	Where sites overlap, their combined signals reinforce the signal strength and allow for better coverage.
Users in locations that have coverage overlap can receive a call from more than one site – but on different channels. If the radio can't get a signal from one site, the user must manually switch to a different channel to get service from the other site.	Users don't have to switch channels to get service from another overlapping site, because sites use the same channel for the same call. Service is not interrupted if one site has to take over for another in the middle of a call
When you add sites, you have to take channels away from old sites so you can reassign them to the new sites. Adding new sites does not require taking channels away from existing sites.	Adding new sites does not require taking channels away from existing sites.

An important consideration for future growth: When you add a site to a multicast network, you reduce the grade of service at your old sites if the number of frequencies you have available remains constant. Why? When you reassign channels to the new site, you'll have to take away channels from old sites. It's a zero-sum game unless you can obtain FCC licenses for more spectrum. For example:

A network has 12 total channels, divided equally between two sites (six channels per site). If you add a third site, you'll have to reassign channels; perhaps making it four channels per site. In a neighborhood where site coverage does not overlap, there are now only four channels where once there were six. Users in that neighborhood are now more likely to hear a busy signal.

If your community is growing, a simulcast network will be easier to expand without reducing grade of service.

WHICH FREQUENCY BAND(S)?

Radio spectrum availability is a critical factor for improved fire communications. In many parts of the country, the airwaves are getting crowded. There are only so many frequencies available and numerous interests are competing for them, including: broadcast radio and TV stations, commercial wireless providers, individual and corporate users of two-way radio… and public safety agencies.

The Federal Communications Commission (FCC) currently reserves these spectrum bands for the use of public safety:

NARROWBAND	Current bands: VHF, UHF, 800, 900 MHz New 700 MHz band
WIDEBAND	New 700 MHz band
BROADBAND	New 4.9 GHz band

Narrowband has the advantage of carrying more conversations. Wideband and broadband have the advantage of greater bandwidth, which is important for data-intensive applications such as mapping, video, and the ability to view building blueprints and other graphic images on portable screens in the field.

Choosing the best frequency (or frequencies) to use for your system usually boils down to a few practical considerations:

- Which frequencies are available in your area?
- Will you require new radios to utilize these frequencies?
- Do you need to be compatible with certain channels used for interoperable communications with nearby departments and jurisdictions?
- Are you supporting other applications (such as video or data) in addition to voice?

Your vendor should offer a clear explanation of how the proposed system will use the spectrum available in your area. A full-service vendor will be able to help you obtain and manage the necessary FCC licenses.

As a representative of the fire service, you can become an advocate for allocating more radio spectrum to public safety. This will become a political and economic issue of growing importance as new wireless technologies, such as mobile Internet access, join the competition for this scarce resource. This is an opportunity to speak up and make a difference by getting involved in the activities of Safecom and NPSTC, for example.

CHAPTER 9: IMPLEMENTATION AND TRAINING

Inadequate training is an especially critical problem and could endanger the lives of fire fighters and the citizens they protect.

A SMOOTH TRANSITION… OR A HORROR STORY?

Implementation is the longest and in many ways most delicate phase of the acquisition process. It begins as soon as you have signed a contract with a vendor. It ends with a working system that's comfortably integrated into your normal operations. Some of the steps along the way include delivery, installation, testing, optimization, training, and user acceptance. How long will it take? For a small system, it might take a year. For larger networks a two to five year phased implementation is a reasonable timeline.

While fire service representatives must be actively engaged throughout this phase to prepare a smooth transition, technology installation should be the least of your worries. That's for the vendor to manage. Your challenge is to prepare the organization and the people in it. The following three steps are absolutely critical to a successful transition:

- **Set users' expectations** so they have a realistic understanding of what will happen during this phase, and what the new radio system will be capable of doing once it has been deployed successfully.
- **Monitor any decisions and changes** made during this phase, and carefully observe system acceptance tests to ensure that the new network fully conforms to your requirements as stipulated in the contract.
- **See that all users are properly trained** on the new system since, without training, people will not be able to use the new system to its full potential.

Most of the "horror stories" you hear about new systems can be traced to a failure to attend to these three steps. Inadequate training is an especially critical problem and could endanger the lives of fire fighters and the citizens they protect.

EXPECTATIONS: KEEP EVERYONE IN THE LOOP

Know what the implementation steps are and how they will impact your organization. Then let people know about it as soon as possible. Open, two-way communication is vital for earning trust. Use existing lines of communication – meetings, newsletters, web sites, video networks, training sessions, etc. – to tell people about the new system. What will it do? When will it happen? How will it change the way people do their work?

Encourage everyone to ask questions and make comments. You want to handle concerns and objections now, before they have the chance to evolve into rumors and long-standing gripes.

Before the contract is signed, ask the vendor or consultant to go over the following, critical information and then begin to share that information with the rest of your department:

- What are the operational differences our users will notice between our current system and the new one? How will their procedures change? What new features will be available? Which, if any, of the old features will change or become unavailable? What are the advantages to the users moving to the new system?
- What's different for the dispatchers? For field supervisors? For personnel back at the station house? For personnel using the in-vehicle radios? For administrators and network managers?
- Will users still be able to use their old equipment, or will they be required to learn new equipment?
- Describe some of the successes and pitfalls experienced by other fire departments implementing this type of system. What have you learned from previous deployments?

Working with you and your team, the vendor should develop appropriate plans at the beginning of the implementation phase, including:

Cutover: Users will need time to adjust to the characteristics and operation of the new system before they begin using it in actual operations. Therefore, the old and new networks should be operated in parallel for a time until everyone – users, supervisors, dispatchers, network operators – is trained and comfortable with the new system. The cutover plan should include a schedule for weaning away from the old network, but it is best to be flexible and give the process more time if needed.

Fleetmapping: The fleetmapping process establishes the number of desired talkgroups/channels and the number, type, and priority of features assigned to each channel (or talkgroup in a trunked system). Too many results in unnecessary complexity, while too few would deny you the full benefit of the system. The vendor's engineers will create the fleetmap in response to your requirements and feedback or assist you in building one.

Integration: A prime concern is how to integrate the new network into all of your related systems: dispatch, fire station alerting, databases, records management, legacy networks, etc. Successful integration requires careful attention from the beginning to design compatible links and then test, test, and test again. The vendor's engineers must have a detailed plan that identifies all of the systems to be integrated and defines which capabilities will be made to work together and when. The plan should also include schedules and priorities and whether the new network will be made operational before all of the integration is completed.

Training: The vendor will participate in the development of your training program, but this is a far bigger issue than simply knowing how to turn on the radio and which buttons to press. The new system will have implications for your entire human resources development effort, from recruit training to the officer's academy. Training must not become a one-time experience: fire fighters need refresher courses and opportunities to incorporate radio usage into other training and simulation exercises.

The integration plan may also cover interoperability with systems in other departments or jurisdictions. Interoperable communications must be tested with the joint cooperation of these other agencies, and perhaps their system vendors as well. Keep everyone in the loop about scheduling and what to expect.

DECISIONS: FOCUS ON LONG-TERM RESULTS, NOT SHORT-TERM SAVINGS

During the proposal process, there are many pressures to economize and it's tempting to cut corners. Doing so could jeopardize the system's performance and the readiness of your firefighters. For example, installing fewer repeater sites will save a few dollars… but will likely result in coverage gaps and dead spots that endanger fire fighters who are working in those locations. Stay on top of every decision, being careful to balance short-term and long-term goals. Otherwise, your hard work in defining requirements and evaluating proposals could be lost in a single ill-informed decision that undermines the network's ability to deliver the promised results.

One money-saving idea that has been successful in many communities is to take a "wait and see" attitude – although you have to be careful using this approach. The vendor first installs the core network and the main repeater sites. Then extensive coverage tests are performed to identify gaps (for example, some buildings may need their own small repeater systems for indoor coverage). Then more repeaters are added, and tested again until the entire area has coverage that meets your requirements.

The risk of taking this approach is that someone may lose sight of the end goal. Only attempt this "wait and see" approach if the funding for those additional repeaters is already set aside and everyone is fully committed to installing them when and if they are proven necessary. Fire fighters must be informed of this attempt and trained on a potentially incomplete system.

Timing is another decision that can go awry if not managed carefully. Everyone is eager to get the system up and running so they can enjoy the results of their investment. However, turning the system up too soon, before the entire network is ready, can be disappointing. If the network doesn't work flawlessly on day one, it will lose the trust of many users and can take months or even years to win it back. It's also dangerous to switch over before all of your mutual aid partners and other interoperability links are ready. When in doubt, wait.

With careful management, it should be possible to live within the budget, make changes as required by external pressures, adjust the schedule as needed, and still have a network that meets your original objectives. If trade offs are necessary, be sure everyone understands their impact before the decision is made.

DOES THE IMPLEMENTATION PHASE EVER END?

Arguably, the implementation phase never ends. After the system is up and running, it still needs careful management. Throughout the life of the new network, fire service representatives will need a way to handle such ongoing responsibilities as:

- Answering users' questions and helping them solve problems
- Incorporating radio usage into new training programs and exercises, and presenting refresher courses
- Monitoring the performance of the system and collecting reports of problems, such as buildings that lack coverage, or situations in which there were not enough channels or talkgroups available
- Implementing network interoperability links to support new mutual aid agreements with other communities
- Decisions about purchasing system upgrades and new features or implementing new applications such as wireless data and video.

Communications is an integral part of the fire service's mission. Like any other vital safety issue, it requires attention, every day, from personnel at every level in the organization. The voices of fire fighters can indeed be heard, as long as your department makes the commitment to listen.

CHAPTER 10: GLOSSARY OF TERMS

Analog — voice and signals are sent over the air in an unaltered form. Voice communications are heard in the same timeframe over which they are communicated. No compression or digitizing of voice occurs.

Bandwidth — frequencies which are allocated for a specific purpose. In the land mobile spectrum, radios operate in low band, high band, UHF, VHF, 700 and 800 'bands of frequencies.

Broadband — telecommunication in which a wideband of frequencies is available to transmit information. Information can be multiplexed and sent on many different frequencies or channels within the band concurrently, allowing more information to be transmitted in a give amount of time.

Channel — a narrowband of frequencies within which a radio system must operate in order to prevent interference with stations on adjacent channels.

Conventional — refers to use of base/tower/repeater/antenna and compatible equipment. User must monitor the frequency for availability before initiating a call.

Digital — voice is converted to a digital format before being sent over the air. When the digital signal reaches the receiving radio, it is converted back to analog so that it is intelligible to the human ear.

Electromagnetic spectrum — the total range of frequencies of electromagnetic radiation extending from the longest radio wave to the shortest known cosmic wave.

FCC — Federal Communications Commission. A board of commissioners appointed by the President having the power to regulate domestic communication systems other than Federal Government agency systems.

Fleetmapping — A system feature allowing an organization to define its communication patterns into talkgroups.

High band a section of the frequency spectrum from 132-174 MHz.

Kilohertz KHz. A unit of frequency equal to one thousand hertz.

Low band a section of the frequency spectrum from 30-50 MHz.

Megahertz MHz. A unit of frequency equal to one million hertz.

Mobile two way radio equipment designed for vehicular installation.

Multi-Site a multi-site system usually contains multiple receiver and transmit sites that extend radio coverage beyond that of a single-site system.

Narrowband telecommunication that carries voice information in a narrowband of frequencies.

NFPA 1221 guiding standard on communications.

Portable a radio unit capable of being easily carried: a hand held radio.

Project 25 the interoperability standard for digital two-way wireless communications products and systems. The P25 standard was created by and for public safety and federal communications professionals to provide detailed standards for the design of communications systems so that all purchasers of P25 compatible equipment can communicate with each other.

Push-to-talk a control operation which activates the transmitter so that a message can be sent.

Queing orderly access to a system, generally first in, first out prioritization.

Radio receiver a device which amplifies radio frequency signals, separates the audio signal from the RF carrier, amplifies it, and converts it back to the original sound waves.

Radio spectrum the entire range of useful radio waves as classified into seven bands by the FCC.

Radio wave a combination of electric and magnetic fields varying at a radio frequency and capable of traveling through space at the speed of light. It is produced by feeding the output of a radio transmitter to a transmitting antenna.

Range the extent of coverage or effectiveness. The measure of distance.

Request for Proposals Request by a procuring entity for detailed proposals for the delivery of a given product or service.

Repeater extends the range of a radio system. When the repeater receives a signal from a mobile or portable unit, its transmitter is turned on and the message is repeated.

Redundancy a system design that duplicates components to provide alternatives in case one component fails.

RF radio frequency often used generically as the transmitted or received frequency of a two way radio.

Signal an electronically transmitted electromagnetic wave.

Simulcast a product that provides improved outbound coverage of base station equipment to mobiles and portables.

Single-Site a single site system contains either one base or repeater station and operates over the distance that the transmitter covers. Within the range of the station, mobiles and portables are able to communicate to dispatch or to other mobile/portable users.

Talkaround optional feature on receivers used with radio systems. When the repeaters are down, this feature permits users to talkaround the system thereby enabling close range communications.

Transmitter the equipment that generates and amplifies an RF carrier signal modulate this carrier signal with intelligence and then radiates the modulated signal to space.

Trunked a two way system which has up to twenty frequency channels.

UHF term used to designate system operation in the 406-420 MHZ, 450-470 MHz and 470-512 MHz range.

Unit-to-unit the most basic talk and listen two way radio communication system. Field personnel can converse with one another without having to go through a repeater or a dispatcher at the base. Users are equipped with two-way radios, either mobile or portable.

VHF the portion of the radio spectrum extending from 132-174 MHz (often called high band) and 30-50 MHz (often called low band).

Wideband a transmission medium or channel that has a wider bandwidth than one voice channel.

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