

Public Safety Interoperability 101 and its Implications for Santa Clara County Public Safety Agencies

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In the context of public safety radio and data communications, interoperability is generally described as the ability of field resources to communicate with each other via voice and/or to exchange data whenever the need exists to do so. The ideal interoperability environment is one where field staffs from different disciplines and jurisdictions can easily and seamlessly communicate with each other verbally and/or exchange data information in real time, when needed and as authorized to successfully respond to day-to-day incidents and large-scale emergencies.

Communications, or the exchange of information, seems like a simple concept. In reality several factors have made public safety interoperability quite challenging. Some of the key issues that will be covered in this paper include radio frequency and equipment incompatibility, radio system coverage area differences, data format differences and proprietary protocols.

Radio Frequencies

75 years ago few public safety agencies had radio systems. They would rely on call box systems or signal lights placed in strategic places that would alert a field officer to call into dispatch, or field officers were instructed to call in via telephone every 30 or 60 minutes at which time they would receive their next assignment.

The early radio systems were very basic; typically a vehicle-mounted radio on a single frequency. Later, portable hand-held radios were introduced but they were bulky and had limited range and battery life. As both government and commercial users embraced radio communications technology there was a need to provide more and more frequencies for users to communicate on. This process of issuing new frequency use licenses was rather convoluted with the end result being the use of a wide variety of different frequency bands. Until recently, all two-way radios were only capable of working on one of four major frequency bands. A similar example would be an AM radio user could not listen to an FM broadcast. In order to listen to an FM station you needed an FM radio or a dual band AM/FM radio.

Today, public safety users in Santa Clara County operate radio systems on a variety of frequencies that include Low Band, VHF, UHF R1, UHF R2 and 800 Mhz. There are over 100 different public safety radio systems in use each with its own distinct frequency set and coverage profile.

Methods of overcoming frequency differences

A recent development has been the availability of dual band or multiband radios that can work on more than one frequency band. At this time only a few of these

multiband radios have been available for field testing in Santa Clara County, however we do not believe any have been purchased for use in the field. The newest versions are software-defined radios, which can be reprogrammed to work on different frequency bands and using multiple communications protocols. Earlier versions of multiband radios use hardware defined technologies that are less flexible.

Another method of connecting users in different frequency bands is through a temporary or permanent patch, sometimes called a bridge or gateway. Either method cross connects two or more different frequencies so that the field users seem to be on a single channel. Most dispatch centers can create a patch if they have the necessary equipment installed at their center. In Santa Clara County we have installed a permanent system of cross-connecting different frequencies. We call our system BayMACS (Bay Area Mutual Aid Communications System), which has equipment located at several different sites around the county. BayMACS cross-connects three common frequency bands creating one virtual channel that allows all users to hear radio traffic regardless of the frequency band of their radio. BayMACS is a good solution for short duration events involving a single location or small-scale transitional location events such as a high-speed chase that cross city limits within the county. Its limitations are that it provides good mobile coverage with some portable coverage. As a single virtual channel, its best use is for command and control as it can accommodate only a limited number of users before becoming congested.

Another gateway system available to us locally is our TransMACS system. TransMACS is a transportable multi-band, cross-connect system that can be moved to the site of an incident to provide inter-agency incident channels for the duration of the deployment. We are in the process of enhancing this system by obtaining a self-sufficient trailer based platform with a generator, technician workspace and an improved antenna system. The equipment is stored at the Santa Clara County Communications center and is available to any public safety agency that requests it. Some of the same BayMACS limitations apply to TransMACS; that is, limited coverage area and limited channel capacity.

Radio System Coverage Profile Differences

Another challenge to interoperability is the differences in coverage profiles between various public safety radio systems. Mobile and portable radios have limited range when they are used in a “talk around” mode, meaning that they are talking directly radio-to-radio as opposed to talking through a repeater system. Repeater systems are designed to capture these weak mobile and portable radio signals and retransmit them with higher power, thus making it possible for the conversation to be heard by everyone within the coverage area of the system. As an example, a portable radio in “talk-around” mode might be heard for a mile around its location, but when that same radio signal is retransmitted over a repeater system the radio could be heard for 10 or more miles depending on how that system is designed.

This is typically described as a conventional repeated radio system. A conventional system may have more than one audio receive site, but generally will have only one transmit site. Some wide area repeated radio systems have multiple transmitters operating simultaneously, these are called simulcast systems. Either way, topography limits radio signal propagation, which is the ability for the signal to travel out from its initial location. A radio transmitting from the bottom of a canyon will have less range than a radio transmitting from a mountaintop. The terrain blocks the radio signal in the canyon while the mountaintop radio propagates farther.

As a field user leaves their primary system coverage area they generally lose the ability to communicate with their host dispatch center or with other units from their agency, and can only communicate in a distance limited “talk-around” mode. An exception to this rule is when the radio can be programmed to access neighboring radio systems or when there is a larger system in place that acts in a similar fashion to how a cell phone call is handed off to a new cell site as the user travels down the road. Regional trunked radio systems can work in this fashion allowing the radio call to be handed off from site to site with the signal repeated from more than one site. This type of a radio system is similar to a conventional simulcast system, where multiple radio sites listen for the transmission from an individual radio, capture the best signal, and repeat it out from multiple locations, but differs in that users are defined by specific talk groups and dynamically share radio channels. The public safety radio systems in place today in Santa Clara County are mostly conventional systems; however, there are several with large coverage areas that have been upgraded to conventional simulcast systems. The City of Santa Clara is the only local jurisdiction utilizing a trunked radio system, and it is near its end of use life.

Radio System Capacity Limitations

Radio system capacity is more an issue of “operability” than interoperability, although interoperability can be negatively impacted when “operability” is limited. Conventional radio systems are designed to support a limited number of frequencies and/or channels. Frequency availability is the limiting factor as there are very few available frequencies in the traditional public safety bands. For the most part all available frequencies have been assigned, especially in metropolitan areas.

With a limited number of channels available, a radio system can reach capacity when there is a lot of radio traffic. When that happens, users have to wait their turn to talk or risk talking over each other which occurs when more than one radio transmits at the same time causing interference and missed or garbled transmissions. Almost all public safety radio systems in Santa Clara County have capacity limitations. In a large-scale event such as an earthquake or commercial plane crash today’s systems primary voice channels could reach or exceed capacity very quickly thus limiting communications capabilities.

A solution to limited frequencies is to move to a regional trunked radio system. In a trunked system frequencies are shared and assigned in a way that allows for greater capacity and optimum use of frequency resources. An analogy would be the difference between a grocery store's checkout lanes and a bank teller system. In a grocery store you pick one check out lane and wait your turn. Another lane may open up but you are stuck waiting in your particular line because the lane can process only one customer at a time. In a bank lobby everyone stands in one line and customers are routed to the next available open teller. In a similar fashion a trunked radio system assigns a radio call to the next available open channel. This process happens in the background without any user action other than pushing the "Push to Talk" button on their radio. Trunked systems can greatly enhance capacity and offer more flexibility and features than conventional radio systems.

The Silicon Valley Regional Communications System (SVRCS) is a design proposal for a trunked simulcast system. It would provide countywide coverage and would greatly enhance radio communications capacity. Although a shared system, individual agencies would communicate with field units in a manner similar to their historical radio systems. Each agency would operate autonomously as though the system were theirs alone.

Trunked radio systems use pre-defined talk groups instead of assigned radio channels and can be programmed with a variety of special talk groups which would be available for mutual aid response, special events or large-scale incidents. Day-to-day agency communications capabilities would be enhanced through expanded coverage and added capacity and features.

System interconnects to local legacy and other surrounding radio systems could be designed into the solution and could offer regional interoperability solutions. Mobile and portable radios could also be programmed to have access to other regional radio systems in a similar way to how your cell phone can roam to a different carrier. Careful planning would be necessary in order to provide enhanced features and capabilities while also making the best use of system capacity.

Today in Santa Clara County we have both operability and interoperability limitations when we look at our current public safety radio systems. Although shared radio channels within frequency bands and tools such as BayMACS and TransMACS are partial interoperability solutions, they are solutions with their own limitations. The two primary paths to enhancing interoperability would be to issue multi-band radios to field personnel and/or to transition to a countywide trunked radio system that would be shared by all public safety users. Enhancements to operability would primarily come from adding channel capacity. Since additional channels in existing frequency bands are extremely rare, the best path to increasing system capacity would be to transition to a trunked radio system using the 700MHz band recently made available by the transition to digital by broadcast television.

Data Interoperability

While we normally think of interoperability in terms of voice radio system issues, the interoperability of data is of equal importance. Public safety agencies have become more and more reliant on various systems that capture and store information. Systems such as Computer Aided Dispatch (CAD), Records Management Systems (RMS), and intelligence databases all contain important information that is of value not only to the home agency but also to other public safety agencies in the region. Crime or disaster respects no artificial municipal boundary and thus the ability for agencies within a region to share data easily is a core component of their ability to work efficiently and collaboratively.

Data interoperability challenges include data base structure differences and proprietary software applications. Today in Santa Clara County there are more than a dozen different CAD systems in place from either different vendors or from the same vendor but using different versions. There are almost as many different RMS systems. Most of these systems will not “talk” to each other without first modifying data file structures and/or without adding middle ware to broker the exchange of data.

We are in the planning stages of developing a CAD-to-CAD system that would allow data from our disparate CAD systems to be viewed and shared. Our project is a phased project due to the complexity of the effort and funding limitations. The goal is to put into place a CAD-to-CAD solution that would allow the different systems to easily share information and data. The practical impact of implementing such a system would be improved regional awareness (knowing the location and status of active events, key facilities and field resources) and operational efficiencies in requesting resources, which would speed up the process of managing and deploying ambulance transport and other public safety regular and mutual-aid resources. It also would provide the ability for one dispatch center to generate a dispatch incident from one dispatch center to another dispatch center without the need to repeat data entry (auto-aid requests, back-up call processing). A fully implemented CAD-to-CAD solution, combined with back-up telephone responsibilities and remote radio system connectivity through our regional microwave system (E-Comm) would also allow one dispatch center to temporarily take over 9-1-1 call answering and dispatch duties for another dispatch center if it went down or needed to be evacuated. It could also be used to help with “virtual dispatch” models where dispatch centers located in different places work closely with each other to level call volumes. For example one center that was particularly busy could send overflow calls to another center that could process the calls as if they were at the originating location. “Virtual Dispatch” would require additional actions and technologies beyond CAD-to-CAD to be fully implemented.

Last year Santa Clara County along with Monterey, Santa Cruz and San Benito Counties implemented an intelligence sharing system called CopLINK. This new system receives data from various RMS systems, modifies the data to a common

standard format, and makes the information available to the participating agencies via a secure access system. In simple terms, other agencies can now search for information regarding a person or an item and have that search access dozens of other agency databases. This sharing of information greatly enhances investigative capabilities and streamlines the process of seeking out information of interest.

Summary

Enhancing interoperability has a lot to do with applying the right technology solutions. Of equal importance, however, is the operational side of the equation. Adequate planning, training and procedural development are the real keys to taking full advantage of any technical solution. Together, the right tools and the right methods can improve efficiency, improve capabilities and reduce liability.

Over the past ten years Santa Clara County public safety agencies have made significant strides in fielding basic interoperability improvements and in planning for more significant enhancements. Solutions that are standards based (not proprietary) and flexible (extended life designs) should be sought out. Continued collaboration will minimize duplication of effort and ensure maximum compatibility of solutions and best economies of scale pricing.

Funding for significant improvements will continue to be a challenge, especially in today's struggling economy. We believe that the value of such major investments in regional public safety communications capabilities are both real and persuasive, however, we also recognize the current limitations on funding availability.

With reduced personnel numbers, the use of technology to improve efficiency and flexibility will become ever more important. The sharing of both human and technical resources across jurisdictional boundaries will become even more commonplace. In order to support that model, shared voice and data communications systems will also need to be fielded. How and when to move forward with such enhancements is the \$64,000 question.