Wyoming's Statewide Public-Safety Interoperable Radio Communications System

Project Report

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WyoLink is Wyoming's statewide public-safety interoperable radio communications project. The project involves developing a 57 site, statewide, VHF, Project-25 digital, trunked radio system. When completed, this radio system will be capable of supporting all public safety users in Wyoming. WyoLink will enhance public safety by enabling first-responders to communicate effectively on a daily basis and during critical incidents.

This report provides current information on the state of the WyoLink project and answers questions that are of common interest.

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A. Project Funding

With the recent completion of the 2006 session of the Wyoming Legislature, the WyoLink project is fully funded. The funds appropriated by the Legislature are sufficient to:

- Complete WyoLink infrastructure development.
- Increase the capacity and reliability of the supporting microwave and radio sites.
- Install a second zone-controller, which provides capacity to connect all Wyoming dispatch centers and to connect additional radio sites to improve portable radio coverage.
- Assist public safety dispatch centers with the cost of upgrading console systems and connecting to WyoLink. *(The Wyoming Public Safety Communications Commission will administer the dispatch center assistance funds through a grant process. Please contact the PSCC for information.)*

In a related development, the Wyoming Transportation Commission authorized and funded the addition of three staff positions for the WyDOT Telecommunications Program. The additional staff will support the WyoLink infrastructure, work with user agencies to configure user radio templates, and manage the complex database that controls WyoLink operation.

Combined, these two developments assure the completion and support of WyoLink.

B. Project Schedule

I am pleased to report that the Pilot Phase is substantially complete. As of this past week, only minor punch-list items remain for both the WyoLink infrastructure project and the Master site remodel project. The work for which the master site had been shut down has been completed; the master site has been reactivated and the Pilot Phase sites are functioning in wide-area trunking.

Installation of the Pilot Phase low-level site was postponed, as the proposed location was found unsuitable. A final location will be selected based on a functional evaluation of coverage provided by the primary sites and following a need assessment.

The next step for the Pilot Phase will be to begin programming radios for trial use and evaluation exercises. With the operational planning that has been conducted by the Interoperability and WyoLink Operations workgroups, a model talkgroup plan is in place and will be the basis for initial programming. I am grateful for the efforts of Bob Symons and the workgroups in developing these plans.

Present indications are that Laramie County will begin migration to WyoLink in the fall, and will take advantage of the intervening time for trial use.

With the restructuring of the WyoLink frequency planning effort and the adjustment of deliverable due dates, adjustments in the development process have been made. To keep radio site development going, the radio site equipment will be ordered without the transmitter and receiver combining equipment. That equipment must be ordered with the exact frequencies for each radio site, and the engineering of those frequencies is still underway. Once the final frequency plan for a given radio site is completed the combiners will be ordered, the equipment installed, and the site will go on the air. Those final steps for each site will not be lengthy. By ordering without the combiners, installation work will move forward.

Work on Phase-2 is underway. The current goal is to have the engineering completed in early April. Allowing time for manufacture and delivery, this will have the required equipment on site for installation this summer. Completion of the 18 radio sites in Phase-2 is anticipated by the end of September 2006.

WyDOT Telecommunications is currently bidding the building and tower upgrades for the radio sites in Phase-3, which is in northeast Wyoming. The Motorola engineering team will begin design work for those sites as soon as the Phase-2 design work is complete. The installation schedule will be coordinated with the civil engineering work. The goal will be to install these sites in late 2006 or early 2007, weather permitting.

Training elements of the project are also proceeding. Several sessions of technician training have been conducted to familiarize the WyDOT Telecommunications radio technicians with the inner workings of the WyoLink system. Recently, the first of two "Master Trainer" sessions was held. Participants in these training sessions will be the first tier of a network that will provide WyoLink user training.

C. Frequency Planning

The frequency planning work, which is vital to the success of WyoLink, has been restructured and is moving forward.

The frequency engineering process being conducted by Motorola involves a complex series of engineering steps. Thus far, Motorola has conducted a search of all unlicensed VHF frequencies. The results of that search, along with a listing of VHF frequencies presently licensed for WyoLink use, is the raw data for the frequency planning process. Motorola

engineering team is presently evaluating interference contours for each proposed WyoLink radio site, along with the interference contours of adjacent radio users. That evaluation will sift the raw data to eliminate frequencies that would cause interference to or receive interference from other existing radio systems. The process involves thousands of calculations. Motorola expects to have that work completed in April, as the second milestone. The third milestone, an initial frequency plan, is anticipated in July. The final frequency-planning milestone is scheduled for December of this year.

It should be noted that Motorola engineering is using a higher criteria for separation between radio users sharing the same radio frequency or using an adjacent frequency. Reports of interference received following activation of the Pilot Phase radio sites support the use of the higher criterion. The Denver Fire Department reported nuisance level interference from the 85-South radio site control-channel. Likewise, Boulder County law enforcement reported nuisance level interference from the Russell Hill site. Recently, the City of Rawlins reported interference from the Sherman Hill radio site. These reports are typical for VHF co-channel and adjacent-channel frequencies where geographic isolation is limited. The use of higher criteria is intended to minimize interference from other users that would impact WyoLink as well as interference that WyoLink would cause others. This will help ensure quality communications for WyoLink users.

The WyoLink frequency planning effort was previously following a draft VHF re-banding plan, referred to as the Ritter Plan. Use of that model plan was identified as a hindrance to the project and has been abandoned on that basis. Consultation with neighboring states found none using the plan. Participation of Federal agencies opens the possibility of using federal frequencies in WyoLink. Those factors, combined with the necessity of considering frequencies outside the FCC Public-Safety Pool, mean that a band-plan designed for the FCC Public-Safety Pool will not fit the requirements of WyoLink. This was clearly identified in the frequency plan information provided by South Dakota. Consultation with other managers of statewide radio system confirms that the steps being taken to develop the WyoLink frequency plan are appropriate for a project using the VHF band. The frequency band-plan for WyoLink will be based on a careful analysis of all available frequencies and would be structured to ensure the implementation and long-term success of the WyoLink radio system.

D. WyoLink Participation

"Intent to Participate" documents continue to be received from agencies at all levels of government in Wyoming. Responses range from small volunteer fire departments to the Federal Bureau of Investigation, to the National Weather Service, and many counties with all departments. Multiple counties have reported that all subscriber equipment has been purchased and that the county is ready for WyoLink to be developed in their area. Recent developments indicate that public safety on the Wind River Reservation will participate in WyoLink. These responses indicate that WyoLink will indeed be a shared communications system serving and connecting agencies across the state.

National Weather Service participation will be a vital resource to Wyoming public safety agencies. It has already been determined that dedicated talk-groups will be provided for each National Weather Service office. This means that during a fire or hazardous materials spill the Incident Commander will be able to speak directly with the weather service office serving the area to receive detailed and specific information.

E. Questions & Answers

Questions continue to be received regarding some of the terminology and concepts used to describe WyoLink project. In response, an updated "Frequently Asked Questions" (FAQ) document is being prepared. In the meantime, here are a few answers to common questions:

What is Project-25, and why is WyoLink using it?

The terms “analog,” “digital,” and “high-definition” are coming into common use today. *(WyoLink has nothing to do with “high definition.” That’s only television.)* Analog, from the word “analogy” is the transmission of a signal using a complex waveform that represents the original signal. Digital, from the word “digits” — which are your fingers — is the transmission of a signal that has been converted to a stream of binary numbers. Digital radio signals are able to send data as well as voice messages. Digital radio signals provide greater signal clarity than analog when there is noise to overcome.

Project-25 (P25) is a public safety digital radio communications standard. Actually, it is an entire suite of technical standards. The project to develop the standards was initiated by the Association of Public-safety Communications Officers (APCO) several years ago. The Telecommunications Industry Association (TIA) is now managing the standards development process. The standards committees are made up of representatives from public-safety user agencies, representatives of various manufacturers, and other technical experts. Ultimately, balloting of the committee members approves each technical standard, which is preceded by a great deal of technical discussion, engineering, debate, testing, and negotiations.

The P25 standards define the features and functions of a public safety digital radio communications system. Public safety users drive the inclusion of any feature or function. The actual technical requirement, defining how a feature will be accomplished, is where the engineering, testing, and negotiations take place. To date, 35 technical standards have been finalized; other technical standards are still in development. The standards that have been developed thus far are sufficient to allow WyoLink development to proceed.

The important thing to remember about Project-25 is that it is an "open" standard. This means that the technical standard is available for any manufacturer to use in making equipment. The opposite of an "open" standard is a "proprietary" standard. A proprietary standard is intellectual property that belongs to a manufacturer and can only be used by others based on the granting of a license. The advantage of an open standard is that, with multiple manufacturers offering products, competition works to lower the cost of equipment.

WyoLink is using Project-25 technology for three reasons.

First, it conforms to the FCC mandate for narrow-band radio operation, which must be implemented no later than 2013. The FCC mandate requires that radio signals be smaller, which allows the creation of more channels. Using digital technology allows the same amount of information to be transmitted using less radio signal, or bandwidth.

Bandwidth is the amount of radio spectrum required to send a given signal. Each television station uses 6 MHz of bandwidth (6,000,000). A wide-band analog radio signal uses 25 kHz of bandwidth (25,000). Each digital two-way radio signal uses less than 11 KHz of bandwidth (11,000).

Second, and even more important, it offers the features and functions that Wyoming public-safety users require. These features include: mobile data communications and voice encryption.

Third, using Project-25 creates opportunities for partnership. Partnerships with Federal agencies are possible because WyoLink and Federal agencies are both adopting Project-25 as a standard for digital radio. Public safety agencies in neighboring states have also adopted Project-25 and are implementing radio systems using those standards.

What does the term "Interoperability" really mean?

In a nutshell, it means that people that must work together can communicate with one another.

On the surface one would think that is a readily recognized and easily solved issue. However, as demonstrated in the September 11 attacks and the recent hurricanes, interoperability is a problem for public-safety responders.

Interoperability is created by providing a common and shared means of communications. The Wyoming Mutual-Aid radio channel is one form of interoperability. Creating a shared radio communications system, offering features and functions that serve the needs of public safety responders, is how WyoLink will create interoperability.

Creating interoperability is more than a technical issue. Technology is a tool to aid interoperability. However, two other elements are critical: operational planning and user training. Operational planning involves thoughtfully describing how public-safety responders will work together and communicate with each other before a critical event occurs. Technology provides the tool; planning describes how would will be used. User training is required that equips the public-safety responder to use the communication tools provided and understand how to use them according to the operational plan.

What is trunking and why was it selected for WyoLink?

To answer that question will require a quick look at how radio systems operate.

Simplex: The simplest method of radio communication is for radios to use one radio frequency. All radios tuned to that frequency hear any other radio that is within range.

The advantage of simplex operation is that it involves the least amount of technology and is therefore reliable.

The disadvantage of simplex operation is that the operational range is limited. (This can be an advantage in some situations.)

Duplex or Repeater: A repeater requires two frequencies; thus the term “duplex” that comes from ‘dual.’ Repeaters were introduced to overcome the range limitation of simplex radio.

A repeater is a radio that receives on one frequency and simultaneously transmits on another frequency. To use a repeater, the user radio must transmit on the repeaters receive frequency and must receive the repeaters transmit frequency.

The advantage of a repeater is that users within range of the repeater can communicate with one another even when separated by some obstacle, such as the mountain on which the repeater is installed. The greater the coverage area of the repeater with the greater will be the operating area where users can communicate. An orbiting satellite offers the greatest coverage area of any repeater, but servicing the repeater is really expensive.

The disadvantage of a repeater is added complexity and cost, and that failure of the repeater radio will stop communications. (If a repeater fails, uses can go back to a simplex channel.)

Trunking: An advanced communications system that allows the sharing of and interconnection of communication resources will employ trunking technology.

The telephone system employs trunking. Whenever a call is placed a wire from an individual telephone is connected through a number of shared pathways to assemble a circuit that reaches the desired destination. The telephone switching system looks at the digits that are dialed to determine how to assemble the required circuit. When the call is completed the telephone switching systems disassembles the circuits used to create the call and makes them available for another caller. If sufficient resources are not available to assemble the route for a

call, which happens on Christmas Day and other occasions, the caller will hear, "All circuits are busy."

A trunked radio system does much the same thing: it assembles the path for a call using network resources (repeaters), and when the call is complete those resources are available for other calls. If the call is going to take place between users that are close together the trunked radio system may assign one repeater at one radio site to create the call. On the other hand, if the call is going to take place between users that are widely separated the trunked radio system may assign different repeaters at multiple radio sites to create the call.

This latter case is called "**wide-area roaming**." Without a trunked radio system, such a call would require patching multiple repeaters together manually or having a dispatcher repeat messages between widely separated users.

In describing communications using a trunked radio system the term "frequency" becomes meaningless to the user, because the trunked radio system manages which frequencies the radio will use. A channel in a trunked radio system is called a **talk-group**. A talk-group is nothing more than a group of users that need to talk to one another. Each talkgroup is a separate communications channel.

One advantage of a trunked radio system is that it will accommodate a wide range of talk-groups. Programming the trunked radio system creates talk-groups. There can be two users on a given talkgroup or thousands of users, depending on the operational requirements of the moment. The number of possible talk-groups is a function of programming software. The WyoLink system can have as many as 16,000 talk-groups and 64,000 users.

Talk-groups can be organized into clusters. For example, if four different teams are attacking a wild-land fire, each team may be operating on an individual talkgroup. A **multi-group** is a specially programmed talkgroup that would allow an incident commander to immediately communicate with all four talk-groups simultaneously. This would save having to send the same message four times, which could save a life.

The operational planning for WyoLink proposes a number of talk-groups. Some talk-groups will be allocated to individual agencies for their specific operational needs. Other talk-groups are planned as shared communication resources, to be used when communication between public safety responders is important. These talk-groups are termed, “Multi-Agency talk-groups” (**MAT**).

Another major advantage of a trunked radio system is that system is highly reliable because resources are shared. Should a repeater fail, rather than one group of users losing communication, the trunked radio system will assign other resources to create calls. The system works around the problem. When problems arise, a monitoring and alarm system will notify the support technicians.

The disadvantage of a trunked radio system is far greater technical complexity and cost.

For a system like WyoLink, the advantages justify the added cost and complexity. WyoLink is being developed as a trunked Project-25 digital radio system because it offers features and functionality well suited to the requirements of Wyoming public safety responders.