Wyoming's Statewide Public-Safety Interoperable Radio Communications Systems

Project Manager's Report to the PSCC

Date: March 16, 2005

Mr. Chairman,

As the WyoLink project has reached a substantial milestone, in addition to reporting the status of the project, it is appropriate to review significant project issues, identifying where changes in process and scope have occurred in.

PROJECT STATUS

I am happy to report that the Pilot Phase is substantially complete. As of this week, only minor punch-list items remain for both the WyoLink infrastructure project and the Master site remodel project.

The next step 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.

Installation of the Pilot Phase low-level site has been 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.

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.

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. (See attached project phase map.)

WyDOT Telecommunications is currently bidding the building and tower upgrades for the radio sites in Phase-3. 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.

BUDGET

Differences exist between the budget contained in the PSMC plan, which laid the groundwork for WyoLink and the current project budget. The differences are in two categories: scope change and variations from planning assumptions. Scope change items include the addition of project contingencies, a second zone-controller, and funds to further upgrade microwave and

radio site capacity and reliability. Differences between the planning assumptions and actual costs are primarily in the areas of frequency engineering, the cost of radio site equipment, and the cost of master site equipment.

The first table is a comparison of the PSMC Plan estimate and the actual project cost.

Description	Plan Budget	Actual Cost
Infrastructure Development Contract (Motorola)	$ 16,349,500	$ 20,512,455
Project Contingency (was 10%)		$ 405,866
Coverage Contingency (add 5 sites)		$ 1,202,663
Frequency Licensing (with Change Order)	$ 1,000,000	$ 3,076,178
Project Staff (Tom Mahon, Bob Symons, & Tech Lead)	$ 500,000	$ 834,000
Master Site remodel (Unplanned requirement)		$ 400,000
Support Contract & Support Staff (Beginning of recurring)		$ 515,849
Spectrum Purchase — contingency (to mitigate risk)		$ 2,500,000
Infrastructure Additions		$ 10,950,000
Dispatch Upgrade Assistance — (Local Support)		$ 10,050,000
	$ 17,849,500	**$ 50,447,011**

Following contract negotiations, in revisiting the project budget, a 10% project contingency was added. This contingency has been used to address project changes; the figure listed above is the present contingency balance. (Contingency funds have been expended for the master site remodel and the frequency engineering change-order.)

A second contingency, to address portable radio coverage adjustments was added. The figure is based on the cost of additional radio sites. The PSMC plan proposed portable radio coverage enhancements would be required for 10% of the coverage area. The plan budgeted for satellite receivers and receiver voting. Satellite receivers and voting are not recommended in a trunked radio system for technical reasons. Therefore, the 10% portable radio coverage enhancements was revised as six additional radio sites. A low-level site was allocated to the Pilot Phase and five additional sites were allocated as a contingency to address coverage requirements.

The next table provides examples where the assumptions in the PSMC plan budget differed from the actual costs. (Costs have been rounded.)

Description	PSMC Plan	Actual
Redundant system AVL	$ 80,000	$ 235,000
DCI interface (PMDC Server)	$ 20,000	$ 700,000
4-channel sites	$ 150,000	$ 250,000
6-channel sites	$ 215,000	$ 310,000
Network Control (Master Site)	$ 900,000	$ 3,800,000
FCC licensing	$ 1,000,000	$ 2,500,000
Frequency Purchases		$ 2,500,000

As described in this table: The cost and complexity of servers to provide automatic vehicle location (AVL) and mobile data communications (MDC) differ significantly. The PSMC plan underestimated the cost of radio sites — the $100,000 difference is the added cost of transmit / receive combining equipment and the larger antenna installations required for VHF. The amount budgeted in the PSMC plan for Network Control was appropriate for a trunking system

controller supporting fewer radio sites and offering less sophistication than the WyoLink system. The cost of frequency engineering and the potential need to purchase additional spectrum was also an underestimated in the plan.

Supporting local migration to WyoLink constitutes a significant scope change. Console interconnection was viewed as a subscriber-equipment cost and on that basis the resulting infrastructure issues were not addressed in the PSMC plan. Funds were requested to provide direct assistance with the upgrade of local dispatch consoles and establishment of microwave or leased T1 circuits to connect those consoles to the WyoLink system. This was done to remove an obstacle to WyoLink participation and thereby further the goal of interoperable communications. The Governor and the Legislature approved the requested funds.

Additional infrastructure was requested to support the connection of local dispatch consoles and the addition of low-level radio sites to improved portable radio coverage. The addition of a second zone-controller will increase system reliability by distributing control and will provide greater capacity to connect additional radio sites and dispatch consoles to WyoLink. Additional funds were requested to make the microwave system and radio sites more robust, with greater capacity and reliability.

In summary, differences between the PSMC plan budget and the actual project cost are related to the planning assumptions regarding the scope and cost of a statewide trunked radio system. While the resulting project cost is higher than projected in the PSMC plan, the total is in line with comparable projects in other states.

ONGOING COSTS

It is important to recognize that implementing the WyoLink infrastructure is the first of the commitments made when the decision was made to implement a statewide Project-25 trunked radio system. There will be ongoing costs and ongoing technical issues.

One should not view WyoLink as a radio system, in the traditional sense, when considering the ongoing issues. A better understanding would be to recognize that the core of WyoLink is a very sophisticated computer network. In the IT world, supporting a complex data network, made up of servers, routers, and switches, is an ongoing process of maintenance and software upgrades. It is unlikely any public safety IT network is using Windows 98. Changes in features and functionality, and the resolution of technical issues, mandate that operating systems be constantly updated. This will be true for WyoLink as well, which will represent a significant ongoing cost and technical issue.

Supporting WyoLink will require a sophisticated technical staff. The days of a radio technician with a voltmeter and a soldering iron are gone. Today's radio technician is someone with all of the skills of an IT network specialist. Beyond that, technicians must also understands the complex issues of radio frequency engineering and troubleshooting, be willing to get to remote radio sites, and climb a tower. People with these skills are in high demand nationwide; the demand currently exceeds the supply. Supporting WyoLink will require cultivating and retaining some very special people. Be warned, other public safety agencies will try to recruit them away.

In a nutshell, developing WyoLink is just the beginning. Operating it and keeping it current will be an ongoing process and expense. The complexity and expense of that effort should not be underestimated. Surprises will arise from time to time; plan accordingly.

SCHEDULE

Three issues have impacted project schedule: the frequency planning process, the necessary expansion of the WyDOT Telecom Main Equipment Room that holds the WyoLink master site, and the default and bankruptcy of a tower contractor. Each of these factors would individually represent a delay to be worked-around; in concert they have slowed the implementation.

To mitigate the delay caused by the frequency planning issue (discussed later), the project team is proceeding with the design, ordering, and installation of WyoLink radio sites, exclusive of frequency specific components. This means that radio site construction will proceed and that the installation of the transmitter and receiver combining equipment will take place when the final frequency plan is established. To do otherwise would delay all radio site installation work one year. Using this approach, important radio tower work, such as antenna installation, may proceed without delay. The RF combining equipment cannot be ordered until the final frequency plan is established for each radio site. Once that is accomplished ordering time will be roughly 12 weeks and the installation time for each site will be a couple of days.

The equipment room designated for the WyoLink master site was sized based on planning assumptions that are not entirely evident. A review of master sites in Colorado and South Dakota show equipment rooms larger than even the expanded version available to WyoLink. Equipment room size at the WyDOT facility is limited; expansion required utilizing space that was allocated to the Wyoming Highway Patrol for records and evidence storage.

The process to expand the equipment room was delayed. The original schedule was to complete the remodel and begin WyoLink equipment installation at the beginning of July 2005. Work was delayed by the engineering process, the procurement process, and by equipment availability issues related to the 2005 hurricane season in the southern United States. As noted, the remodeling is substantially complete.

The default and bankruptcy of a tower contractor was an unanticipated project issue, which essentially wiped out an entire construction season. Chuck Kakalecik, of WyDOT Telecommunications, has been designing, procuring, and installing the necessary digital microwave interconnections to support the WyoLink system. He worked diligently with WyDOT Purchasing to manage this unexpected difficulty. A replacement contractor was selected and the work that was delayed is nearly complete. The completion of that work is why Phase-2 will have 18 radio sites. The WyoLink project team is working to apply available resources to accelerate the remaining site development and microwave work. Our intention is to do all we can to make life easier for Chuck as his work is so critical to the success and timely completion of WyoLink.

The remaining potential for delay is that a small number of radio sites may require the filing of environmental impact studies. Sites where this may be a factor are in the final phase of the project. Acquisition work for those radio sites is now underway, to mitigate the risk of delay. Should a significant delay be encountered, the impact on WyoLink would be limited. WyoLink functionality and coverage would be available to the vast majority of users.

Overall, though delays have been encountered, the goal of completing WyoLink infrastructure development by December of 2007 remains realistic. Assuming the revised frequency planning effort stays on track and site development work proceeds as envisioned, WyoLink should be completed on schedule.

FREQUENCY PLANNING

As previously reported to the PSCC, the frequency engineering issue has been a significant project adjustment. The planning assumptions in the PSMC plan was shown to be overly optimistic and the initial process contained problems.

The critical indicator of trouble was that the initial frequency planning and licensing process did not provide the required deliverables in a timely manner. Procurement for that process was completed in the spring of 2004. The Pilot Phase required workable frequency plans for five radio sites by January of 2005. By the due date, incomplete frequency plans were provided for which important engineering steps had not been completed. To address this deficiency, Motorola provided additional engineering services (that were not invoiced). Multiple frequency plan iterations were passed between Motorola and the WyDOT frequency planner. By April of 2005, workable plans were in place for four of the five Pilot Phase radio sites. At that point, as Project Manager, I elected to proceed with the equipment order, deferring the Sherman Hill RF combining equipment until the frequency plan for that site was completed. By August of 2005 the Sherman Hill frequency plan had six workable frequency pairs; to avoid further delay the combining equipment was ordered with the intention of adding the seventh channel through a subsequent change order. It was quite evident that the pace and quality of deliverables represented a significant project risk.

That project risk prompted a thorough evaluation of the radio frequency planning process. Reviewing the process revealed that $230,358 had been expended and that problems greatly limited the likelihood of success.

First, the PSMC plan lacked a detailed analysis of spectrum availability and engineering issues. Planning assumptions were based on assurances by the WyDOT frequency planner that no problems would be encountered licensing sufficient VHF spectrum. The accuracy of this assumption was challenged in during the planning process. Evaluating the validity of this planning assumption was not in the scope of work contracted to Federal Engineering. Spectrum availability and licensing is always a high-risk issue for any radio communications project. As such, it is imperative that a radio communications business plan be based on well-documented research and adequately validated engineering assumptions. Completing spectrum acquisition and frequency licensing prior to infrastructure procurement is the best method to validate the assumptions and mitigation this project risk. The FCC allows for "Extended Implementation," the granting of frequency licenses five years before the construction deadline, for this reason.

Second, the methodology establishing the initial frequency planning process was nonstandard. Sole-source procurement was recommended based on the assertion that APCO, as a frequency-coordinating agency, was the most qualified to provide the supporting engineering. No objective evaluation was offered to validate this assertion. Furthermore, an appearance of a conflict-of-interest exists in that a sitting member of the APCO Executive Council recommended the sole-source procurement to APCO. Standard procedure is to conduct the required engineering and generate application documents either in-house or using the services of a consulting engineering firm. Frequency-coordinating agencies, such as APCO, specialize in the review and processing of FCC applications. They do so under authority delegated by the FCC; they are staffed and equipped for that role. A competitive procurement for engineering services would have generated multiple responses, as evidenced by the number of well-qualified engineering firms that have subsequently offered their services.

Third, the initial frequency planning process did not adhere to its own technical requirements and engineering steps. The required engineering processes and technical requirements were

accurately defined in the WyoLink RFP and in the Statement of Work issued to APCO. A review of work completed showed that the frequency plans provided did not conform to the stated technical specifications (transmitter to transmitter separation, transmitter to receiver separation, intermodulation and interference requirements, etc.). The required engineering steps were being addressed out of order and the frequencies listed on FCC applications had not been fully vetted through the engineering process. This invalidated the deliverables, requiring rework.

Fourth, a proposed VHF re-banding plan, known as the Ritter Plan, was recognized as a hindrance to success. The APCO engineer conducting the initial frequency planning clearly stated that the re-banding plan limited the use of available frequencies, which has been subsequently documented. Neighboring states were contacted to ascertain their use of the plan; none indicated they were following the proposed re-banding plan. A review of published articles, though not academically thorough, shows only the WyoLink project attempting to implement any VHF re-banding plan. In June of 2005, the WyDOT frequency planner was directed by the WyoLink project team to discontinue use of the VHF-rebanding plan, as it was deemed an impediment. The directive was never carried out.

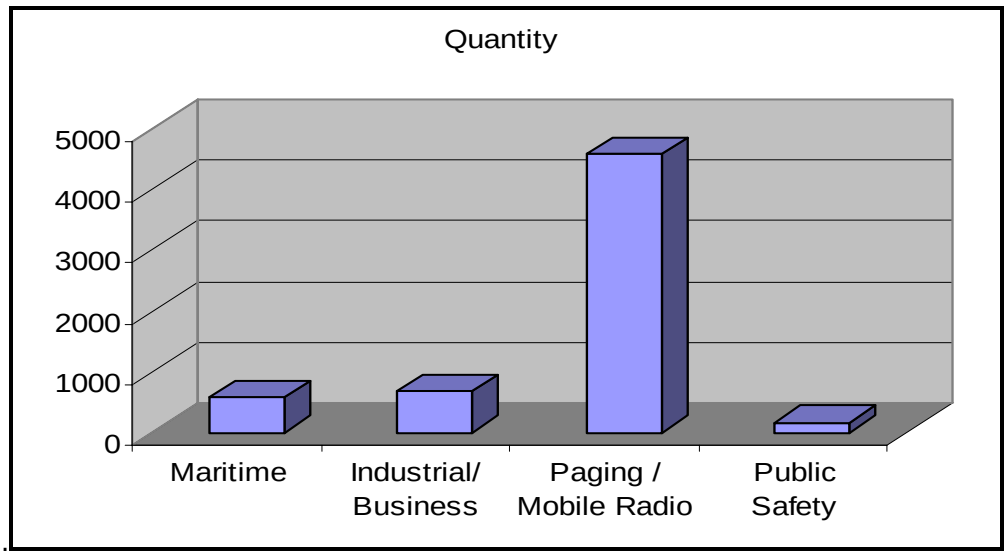
Fifth, that the initial frequency planning effort limited its search to the FCC Public Safety Pool (CFR 47 part 90). This limited the number of available frequencies, increasing project risk. Consultation with the project managers of other statewide VHF radio systems revealed that each has been required to pursue the use of frequencies in other FCC allocations — Maritime, Paging / Mobile Radio, and Business / Industrial — and to pursue inclusion of federal frequencies to achieve success. Based on their experience, each predicted failure if the search was limited to the Public Safety Pool.

These findings were reported to the PSCC in September along with an evaluation of alternatives and a recommendation to revise the frequency acquisition process. To keep the project on schedule the best option was to transfer the frequency engineering work to Motorola through a change-order.

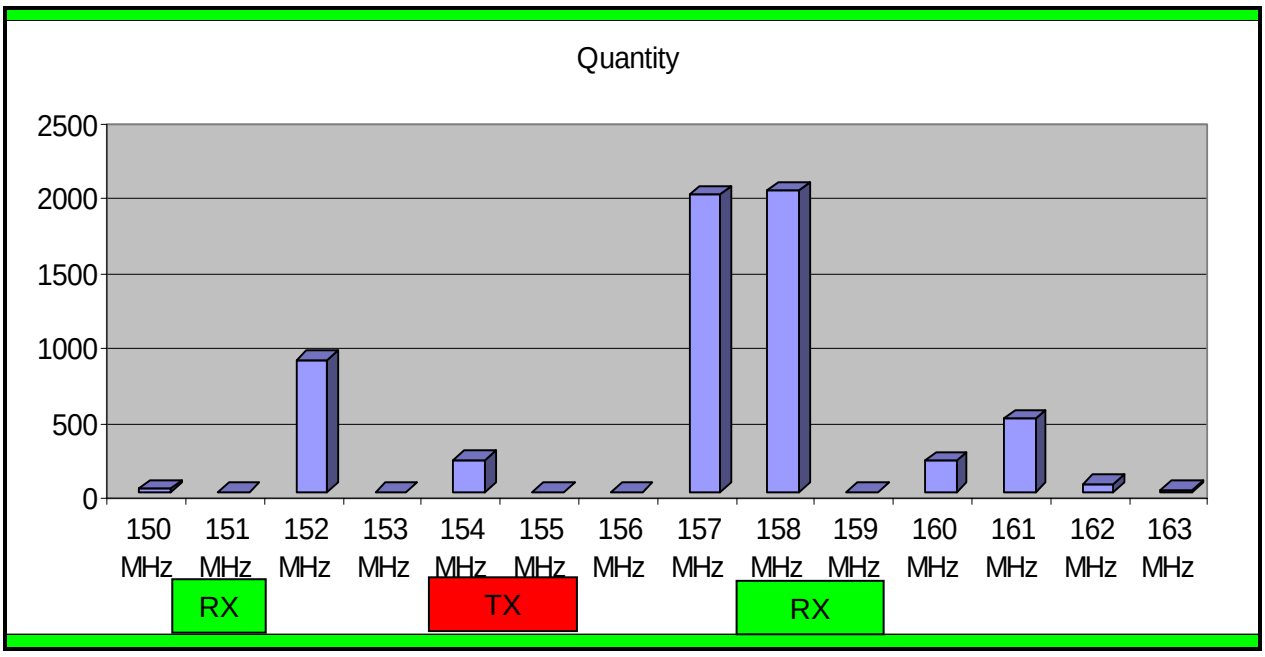
The frequency engineering process being conducted by Motorola involves a complex series of engineering steps. (Please refer to the attached "WyoLink Frequency Planning Process" chart.) Thus far, Motorola has conducted a search of all unlicensed VHF frequencies. The results of that search, along with 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. The 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.

A review of the available frequencies data supports the necessity of searching frequencies outside the Public Safety Pool and the exclusion of the proposed VHF re-banding plan.



This first chart depicts of the available frequencies at all WyoLink radio sites sorted by the FCC allocation. The Public Safety Pool offers the fewest available frequencies. Based on this depiction, expanding the search for frequencies beyond the Public Safety Pool increases the likelihood of success.



This second chart depicts the available frequencies sorted in 1 MHz increments. The red and green markings indicate the proposed VHF re-banding plan. Clearly, the Ritter Plan negatively impacts the process. The final band-plan will be based on the distribution of frequencies that remain after the sifting process.

Federal agencies have been solicited and indicate interest in WyoLink participation, which creates an opportunity to further lower project risk in the frequency planning area. Precedent is already established in other states for the shared use of statewide public safety communications and, based on that shared use, the contribution of federal frequencies. The process of building these partnerships and securing authorization to use federal frequencies is ongoing as a high project priority.

In reviewing this issue, three caveats must be kept in mind: (1) There is no established methodology to accurately estimate the cost of frequency acquisition. (2) As the complexity of the project rises, the accuracy of a cost estimate falls. (3) A statewide VHF system is the most complex project possible.

In summary, though assumptions within the PSMC plan and the initial frequency planning process were flawed, the revised frequency planning process is showing positive results in terms of deliverables and schedule. While a special $2.5 million contingency was included in the recent funding request, it is hoped this contingency will be only minimally required.

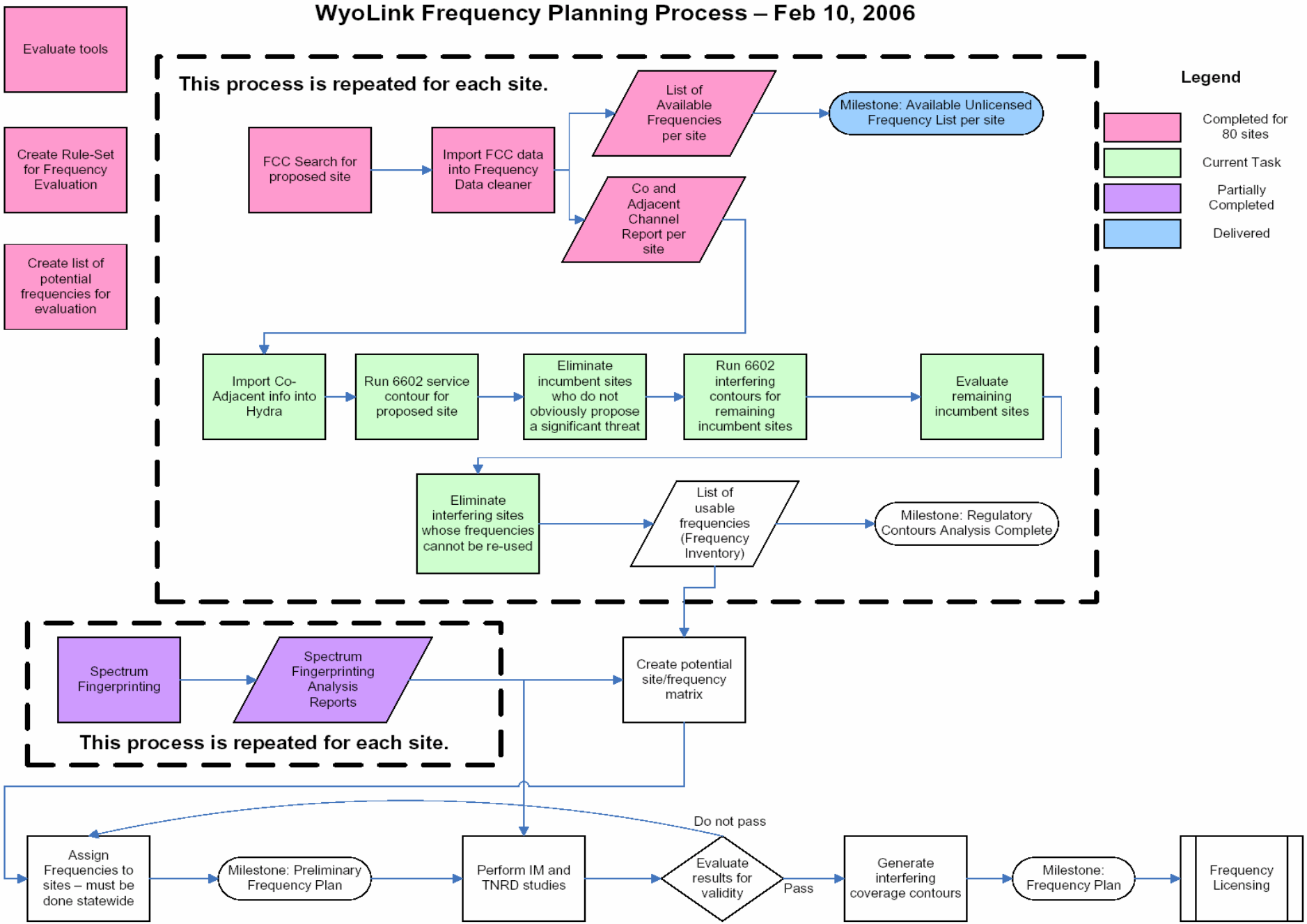
PROJECT-25 UPDATE

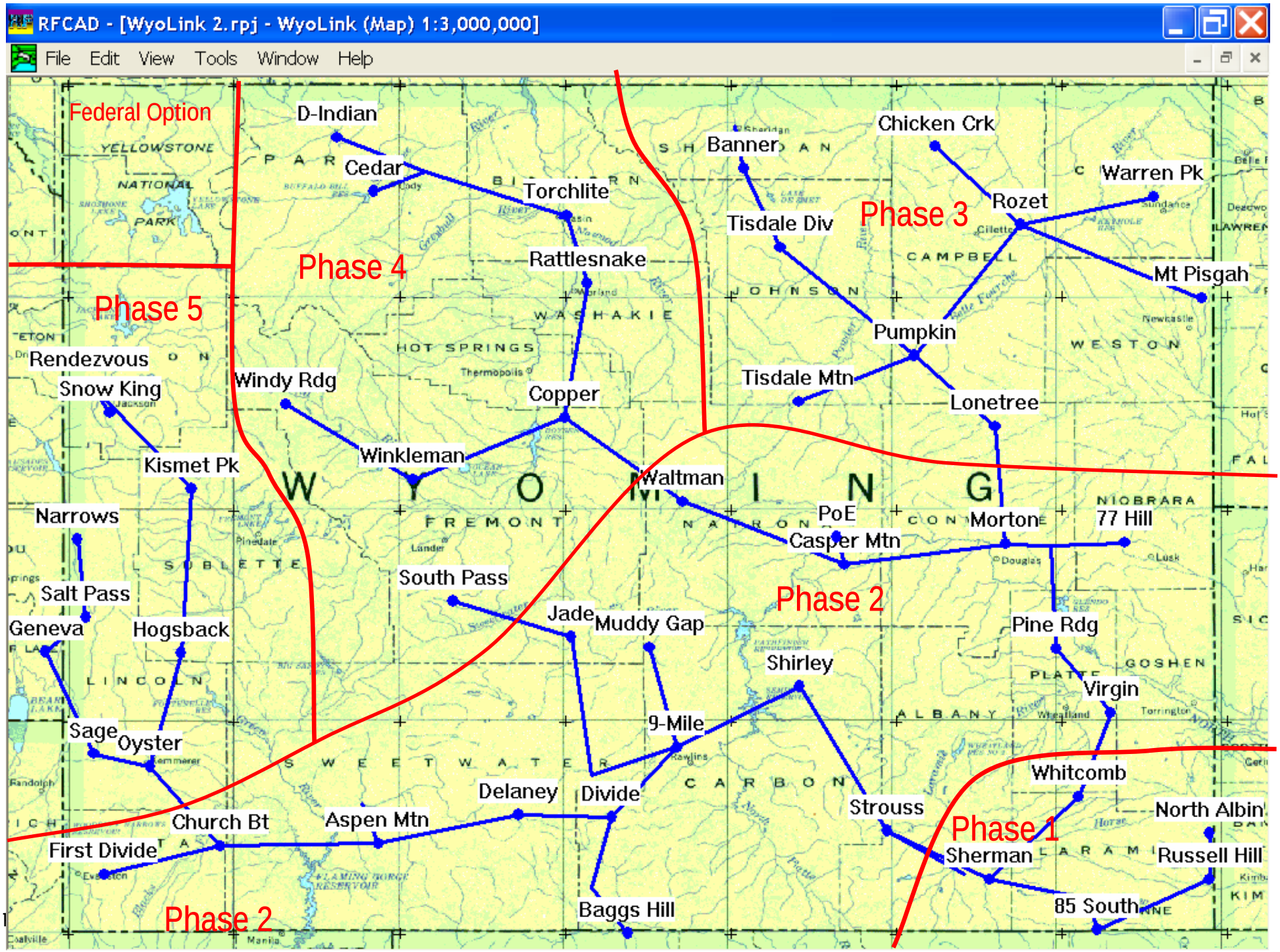
Yesterday I participated in a panel discussion with representatives of the Project-25 committee. Information from that meeting has direct bearing on the future of WyoLink and the ongoing costs to maintain this technology.

Project-25 standards are evolving. While 35 technical standards have been produced, others are in process. The intra-sub-system-interface (ISSI) standard is presently being balloted. The console-interface standard should be completed later this year. The fixed-station-interface is nearly complete also. The committees are working on the Project-25 phase-2 transmission standard, and are debating the merits of four-slot versus two-slot encoding. This will allow either two or four voice channels to be transmitted on each carrier, conforming to the FCC's goal of 6.25 kHz bandwidth per voice channel. Also, an improve vocoder, the algorithm that converts voice to digital, is being developed to improve Project-25 audio quality.

It is worth noting that the Statement of Requirements for Project-25 calls for manufacturers to implement a new ‘mandatory feature’ within 15 months of adoption of the technical standard. This means that new standards that are currently in process would be available to WyoLink as a subsequent project or as an upgrade that would be available after the infrastructure development is complete.

It was also pointed out that DES and a Double-DES encryption are no longer endorsed by Federal agencies. This means that where encrypted interoperability is required with Federal agencies, AES encryption will be mandatory.


WyoLink Frequency Planning Process – Feb 10, 2006
Evaluate tools
Create Rule-Set for Frequency Evaluation
Create list of potential frequencies for evaluation
This process is repeated for each site.
FCC Search for proposed site
Import FCC data into Frequency Data cleaner
List of Available Frequencies per site
Milestone: Available Unlicensed Frequency List per site
Co and Adjacent Channel Report per site
Import Co-Adjacent info into Hydra
Run 6602 service contour for proposed site
Eliminate incumbent sites who do not obviously propose a significant threat
Run 6602 interfering contours for remaining incumbent sites
Evaluate remaining incumbent sites
Eliminate interfering sites whose frequencies cannot be re-used
List of usable frequencies (Frequency Inventory)
Milestone: Regulatory Contours Analysis Complete
Legend
Completed for 80 sites
Current Task
Partially Completed
Delivered
Spectrum Fingerprinting
Spectrum Fingerprinting Analysis Reports
This process is repeated for each site.
Create potential site/frequency matrix
Assign Frequencies to sites – must be done statewide
Milestone: Preliminary Frequency Plan
Perform IM and TNRD studies
Evaluate results for validity
Do not pass
Pass
Generate interfering coverage contours
Milestone: Frequency Plan
Frequency Licensing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Tisdale Mtn
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Phase 4
Phase 5
Rendezvous
Snow King
Windy Rdg
Copper
Winkleman
Kismet Pk
Waltman
PoE
Casper Mtn
Morton
77 Hill
Narrows
Salt Pass
Geneva
Hogsback
South Pass
Jade
Muddy Gap
Phase 2
Shirley
Pine Rdg
Virgin
Sage
Oyster
9-Mile
Whitcomb
Delaney
Divide
Strouss
North Albin
Church Bt
Aspen Mtn
Phase 1
First Divide
Sherman
Russell Hill
Baggs Hill
85 South
Phase 2
WYOMING
FREMONT
SUBLETTE
LINCOLN
SWEETWATER
CARBON
ALBANY
GOSHEN
PLATTE
NIOBRARA
CAMPBELL
JOHNSON
WASHAKIE
HOT SPRINGS
WESTON
YELLOWSTONE NATIONAL PARK