

OWIN's Decision Process Regarding Adoption of a
700 MHz Solution for the OWIN Statewide Radio
System

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Federal Engineering Conceptual Design:

In its instructions to Federal Engineering, OWIN told FE to do a conceptual radio system design based on use of VHF (150 MHz frequency band) frequencies and to design a radio system that would be compliant with the Project 25 digital standards. Because of the limited time in which to do a complete inventory and needs analysis, FE was instructed to only consider existing State sites unless those State sites would not produce an estimated 95% mobile coverage by county. OWIN told FE to use the number of existing State transmitters at each site in order to design the needed system capacity. The rationale was that through trunking, that same number of transmitters would greatly improve the number of talk paths available.

Original Conceptual Design:

In compliance with OWIN's instructions, FE delivered a conceptual design that increased the number of VHF transmitter sites from 164 to 183. FE did a significant amount of work trying to make a frequency plan that would reach the OWIN capacity goals using the 183 sites. FE and OWIN agreed that the design goal for interference within the OWIN radio system should be kept below 5%. In public safety radio engineering this is a prudent figure. FE advised OWIN that given the capacity and the number of sites Oregon would need, there were not enough VHF frequencies period to build an OWIN, statewide VHF trunked radio system.

FE Hybrid Design:

FE asked OWIN if OWIN would consider a hybrid conceptual design that used both VHF and 700 MHz radio frequencies. OWIN and FE then worked out an approach that would use 700 MHz the length of Oregon's Interstate 5 corridor and from the ridge of the Coast Mountain Range to the ridge of the Cascade Mountain Range. This would give a buffer between the VHF systems on the Coast and the VHF systems in eastern Oregon. This design resulted in an additional 74 transmitter sites based upon projections of less coverage per site using the 700 MHz channels as opposed to the VHF channels. FE used the existing State sites and recommended use of additional sites where State sites would not provide the required coverage.

Value Engineering:

OWIN had FE do a "Value Engineering" effort. In essence, this was a look at lowering the total cost of the OWIN system through prioritization of State needs. As part of this, the State agreed to reduce the original coverage requirement from 95% mobile coverage by county to "at least as good mobile coverage as the best

State agency enjoys. In most cases, this was whatever the estimate coverage was for OSP in each county as OSP has the greatest number of transmitters located throughout the state.

OWIN's Modification of the Value Engineering proposal:

Because of the need to reduce the total cost of replacing the State's radio infrastructure and in consolidating its radio systems, OWIN took a fresh look at coverage in each county. Whereas FE was restricted in the first instance to using State sites, OWIN took a completely new look at as many existing sites OWIN could identify (irrespective of ownership) in each county. OWIN's goal was to come up with an "Optimum Design" that used the fewest number of sites that produced the required coverage. OWIN's coverage engineering work also inserted one more requirement. That requirement was to reach the required coverage percentage but at the same time address handheld radio coverage on U.S. and State highways in each county. This is in recognition of the greatly increased use by most law enforcement personnel in the use handheld radios when outside of their vehicle. All existing State radio systems were developed over 50 years or more to support radios in vehicles whereas for the past 20 years, there has been greatly increased use of much less efficient handheld radio.

Colorado's Anecdotal Comments:

Personnel from the State of Colorado have consistently said over the past 10 years or so that in their move from analog VHF to a statewide digital 800 MHz system, that the coverage difference was far less than they originally thought. This thought generally goes against the laws of physics that says that loss of signal is much greater as the frequency goes up. OWIN's Director, Lindsay Ball, asked the question, "Is there any study to point to that either verifies Colorado's experience or says they are not right?" The internal answer was that nobody in OWIN or in FE knew of such a study, so OWIN contracted with FE to actually do a drive test to gain field measurements.

OWIN's Drive Test:

OWIN contracted with FE to conduct a drive test of representative sites in Oregon. OWIN chose two sites in Clatsop and one site in Tillamook County. The reasons these sites were chosen included:

- The sites had tower and building space for the test equipment
- The generally mountainous terrain
- The heavy foliage
- The ability to reach the sites during winter snows
- The presence of U.S. and State roads that should be passable to drive
- The close proximity to the test participants mostly coming from Salem

The Drive Test used two receivers in two vehicles and a two transmitter in the three mountaintop transmitter sites. ODF, OSP, and ODOT installed VHF and 700 MHz antennas at each of the three sites. FE tested and installed the radios

and the computer control system in each of the three sites. All of the equipment except for the antenna systems was borrowed from industry. A communications company in Eugene loaned OWIN VHF frequencies for the test, and OSP produced the 700 MHz frequencies.

The Drive Test used computers in each vehicle that had GPS inputs (so that the system knew where the vehicle was) and it had inputs between the computer and the VHF and the 700 MHz radios in the vehicle. The program that made all of this possible is from an Oregon company in Beaverton. Basically, at each test point, the computer recorded the vehicle location, the signal strength of the VHF test signal (coming from the test transmitter on the mountaintop), the signal strength of the 700 MHz test signal, the Bit Error Rate (BER) of the recovered signal from the VHF signal, and the BER of the recovered signal from the 700 MHz signal. OWIN chose to only measure digital performance (no analog was tested). The reason for this was the much greater complexity in getting two simultaneous measurements in each band and the need for coming up with more frequencies. Since OWIN is committed to evolving to a digital system anyway, it seemed to make more sense to test what will be rather than what was.

Drive Test Results

The number of test locations was:

Mount Wilson: 65,143

Megler Mountain: 42,982

Nicolai Mountain: 50,262

At each location, four measurements were recorded. 1) VHF signal strength. 2) VHF BER. 3) 700 MHz signal strength. 4) 700 MHz BER.

The results showed that the law of physics was correct. That is, the 700 MHz signal did fall off much more than the VHF signal did. The BER test, however, confirmed the anecdotal information from Colorado. Although the strength of the 700 MHz signal fell off, the recovered quality of the signal remained very close. That is, the useable signal was close.

Confirmation Test:

Because the three tested sites all produced similar results, OWIN extended the FE contract to test a site in Eastern Oregon. The OWIN thought was that we should test a dissimilar site to see if the results followed. Equipment was installed in Gleason Butte near Hermiston in order to test radio propagation in both bands in the rolling hill county in Morrow and Umatilla counties. Although a little different, basically the results were the same. The digital information on the signal that is recovered from the 700 MHz system is close to that recovered from the VHF signal. The Gleason test involved 65,536 more test locations. In all, 223,923 locations were tested with a total of 895,692 measurements.

State Agency Recommendations

Independent of OWIN's Drive Test, State agencies had been meeting in different groups coming up with recommendations for OWIN's future. One such

recommendation from all of the affected agencies was that OWIN should build a statewide 700/800 MHz system rather than the hybrid. Their reasoning was basically along the lines of the much greater difficulty in actually getting and keeping interference free frequencies in the VHF band versus the wide open and unused 700 MHz band. The second reason was the single band design would require only one radio in the vehicle as opposed to two radios in the hybrid design.

OWIN's Revised Plan:

OWIN adopted the Agency Recommendations for a single band and went back to engineering coverage estimates using the Optimum Siting approach in each county. In each case, OWIN's requested similar estimates from Federal Engineering once the sites were selected by OWIN. In all cases, Federal Engineering said that if anything OWIN's results were a little more conservative (less estimate coverage) than their computer models predicted. This reinforced OWIN's estimates that will be used in the OWIN RFP.

The OWIN RFP Direction:

OWIN is developing a Request for Proposal for the OWIN radio system. In that RFP, OWIN will stipulate the sites that the Proposer is to use. The RFP will strongly suggest use of the 700 MHz band, but if the Proposer believes that is not possible, the Proposer is to make a Proposal that will deliver the system that OWIN's coverage and capacity requirements need. OWIN will also stipulate the coverage requirement for each county. It is then up to the Proposer to do a system design that meets the coverage requirements. If the Proposer cannot reach the coverage percentage in each county (using the OWIN provided sites), then the Proposer must suggest additional site(s) that are needed to get the required coverage. Finally, once the Proposer estimates the amount of coverage they can get from their design, the results will be tested after installation, and the Contractor has to stand behind their design.

Epilog:

OSP, OWIN and Federal Engineering personnel will be presenting a discussion of the Oregon Drive Tests at the International Wireless Communications Exposition (IWCE) on March 18 in Las Vegas. This is an hour and a half presentation telling industry what our empirical experience has been. In essence, however, the process has taken much of the risk out of the selection of the sites and the thought that a single band (700/800 MHz) solution will best work for Oregon, and it will be most cost effective for Oregon.