THE DEVIL'S IN THE DETAILS

AND THERE ARE PLENTY OF THEM AT THE DESIGN-AND-ENGINEERING STAGE OF AN LMR SYSTEM DEPLOYMENT

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Last month, we examined the crucial first steps to designing and engineering a land mobile radio system. These include conducting a user-needs survey, which will provide insight into such important considerations as budget, radio-coverage requirements, capacity planning and equipment/system engineering. Once the user-needs survey is complete, the next big step is to determine the frequency band in which the system will operate. After that, the system designer/engineer needs to decide were the site will be located.

When all of these items have been checked off the list, the system designer/engineer might think that he's home-free — and he would be dead wrong. There are myriad details that must be considered before deployment can begin. Let's examine a few of the most important ones.

Antenna systems. They have a major impact on the operating budget. The number and size of the antennas, microwave dishes and coaxial transmission lines typically dictates the amount of loading on the site facility and the rent for co-locations.

Link budgets. While planning for the appropriate antenna systems to meet the user needs, the system's link budget can be calculated using the industry specifications from TSB-88, or from the vendor or integrator community. The link budget consists of an uplink and downlink (or talk-in and talk-back) path. It is ideal to have a balanced link budget to allow the subscribers to have the same ability in uplink as in the downlink.

Redundancy and single points of failure. Redundancy allows for hot and/or cold standby in case there is a component or system-level failure. The redundancy can be co-located or geographically separated. The minimization of single points of failures in the system is another design concept to allow the user more control on the operation of the system. Typical single points of failure are a duplexer in an antenna system and the end of a microwave system spur. They also occur in radio system controllers.

Fleet mapping. In radio communications, fleet mapping establishes the system's operational method. Users are divided into groups, known as fleets and sub-fleets, by rank or functional requirements. This mapping is then used to determine how the system is used and how it is to be managed. An example of fleet mapping is a city that has police, fire and EMS as the primary users. Each primary user represents one fleet; within that fleet, managers, officials and tactical users are grouped into sub-fleets. Police may be in one group while fire and EMS are in others. All-call, interoperability and special-event groups then are established with different priority levels.

Space planning. The amount of space that the equipment requires must be determined, and each site must be analyzed to ensure that the equipment will fit comfortably into the space. If not, more space must be obtained. In some cases, new radio buildings will need to be added to certain tower sites. Besides the physical space, the heat dissipation and cooling required for the equipment must be determined. In most cases, there will be a requirement for air conditioning; in some cases, a redundant air-conditioning system will be required, as some LMR systems will fail if there is no air conditioning available. There also is a requirement for lighting and power outlets. If the engineer forgets some component of space planning, it will be quite apparent. There is no tolerance for omissions at this stage of system design.

Power. There is a need for primary power at every site, and in many cases, the radio system is so critical that multiple layers of backup power are required. Most sites will require commercial AC power, with uninterruptible power supplies for some systems and battery backup supported by generators for other systems.

Linking to other sites. Almost every system requires data and voice connectivity between every site. This can be accomplished via high-speed data lines and fiber-optic systems. At some sites, it is easier and more reliable to use microwave systems to provide this connectivity.

Grounding. Because lightning does occur and can cause major damage to an unprotected site, a good ground system is required to protect each and every site. If a site is properly grounded, the chance of the site being incapacitated due to a lightning strike is reduced substantially.

Towers. The range of a system is greatly affected by the height and placement of its towers. Many engineering decisions must be made to ensure optimal performance. This is true whether you are building a new tower or adding equipment and hardware to an existing tower. Since all towers have unique weight and wind-loading thresholds, never assume that adding even one more antenna will not cause the tower to collapse. If ice and snow are factors in your region, you must consider that extra weight when adding antennas and transmission lines to your tower.

If your tower is more than 200 feet high, you also need to contend with lighting and painting requirements. And if your tower is less than 4 miles from an airport runway, the overall height of the tower and the manner in which the lighting is deployed will be affected. An FAA study may be required in some circumstances.

Multicast vs. simulcast. Because many systems are located in very large cities or are used over large geographic areas, systems have been designed that allow the mobile and subscriber units to move throughout the area without the person using the radio needing to change channels while roaming through the territory. This can be accomplished using a method called simulcast, where every transmitter in the system is on the same frequency at the same time, and the audio is transmitted with the identical information on each site's transmitter. To accomplish this, the time base for each transmitter is locked to GPS time, and the audio is delayed on the close-in transmitters so that the near transmitters and the far transmitters all send out the same information at the same time to the key areas in the network.

A less expensive way to accomplish wide-area coverage is to have different transmitters on different radio channel frequencies, but have the modulation the same on each channel. Then the system automatically switches the user to the proper channel. This is called multicast. Regardless of whether your modulation schemes are analog or digital, both multicast and simulcast will work if the stations are set up properly.

Voting systems. Voting systems on the uplink path allow balancing and are common among simulcast radio systems. This technology allows for multiple base station sites to have common receive frequencies. The radio signals from the subscribers are seen by multiple base station receivers and then the signals are sent via backhaul to a common location where there is a voting comparator. This comparator then looks at all of the common signals and uses header information to vote in digital protocols or votes on the signals themselves in analog systems. For digital systems, there is a mathematical processing gain that sometimes is considered a system uplink gain. For analog systems there is a signal-processing gain; for example, there is a 3 dB system gain for every two signals, a 6 dB gain for every four signals, and so on.

The voted signal is resubmitted to the base station sites and then broadcast via the transmitters in the system. Transmitter steering allows the best-quality signals to be sent back to the site or sites where the signal was detected and then to be rebroadcast in that area for the best use of spectrum.

Conventional vs. trunked systems. In a conventional radio system, the user simply chooses the channel or channels upon which they want to communicate. If you have multiple groups and have access to multiple channels at each site, you can increase the efficiency of your radio system by upgrading it to a trunking system. In a trunking system, the user chooses the group with which he wants to communicate. But when a user within the group pushes the transmitter button and keys the radio, the system chooses the radio channel that will be used for the transmission. Each radio manufacturer uses its own proprietary method to establish the requisite trunking protocols that make such determinations.

Part 1: Class is in session: Basic LMR and FCC definitions
Part 2: Start at the beginning: Understanding LMR user needs
Part 4: Decisions, decisions: The procurement process

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