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Project 25 Phase II

Author: **John Oblak**
EFJohnson Technologies Vice President of Standards and Regulatory Affairs
Chair TIA TR-8 Committee on Mobile and Personal Private Radio Standards

As public safety networks continue to evolve and achieve greater levels of interoperability, there are a host of different next generation technologies that offer public safety agencies with a multitude of capabilities, features and protocol options to improve user experience and network performance. One such technology that has been receiving a lot of focus and attention is the evolution of the APCO P25 standard to the P25 Phase II protocol. In this white paper, we present EFJohnson's perspective on the evolution of the standard and the key considerations for public safety networks as they plan to evolve their system for the future while continuing to maximize their investment and achieve interoperability goals across multiple agencies.

Evolution of P25 (Phase I & II)

One of the original goals of Project 25 was to create a standard for public safety digital radio that achieved better spectral efficiency than what was currently offered in analog systems. At that time, the predominant technology was either trunked or conventional analog radio using 25 kHz channels. In Europe the radio standard that was being considered was Terrestrial Trunked Radio (TETRA), which chose a digital technology called Time Division Multiple Access (TDMA) where a 25 kHz channel was divided into timeslots so that up to four users could share 25 kHz of spectrum. The decision makers of Project 25, however, realized that the United States market was quite different from the European market. In the VHF and UHF bands, for example, most of the radio systems were conventional. In many rural areas, radio systems tended to be small, consisting of only a few channels. The spectral efficiency of a four-slot TDMA system would be wasted in most of the United States because it is impractical for timeslots to be shared among users from different agencies. In addition, in a TDMA system it is more difficult to provide direct radio-to-radio communications, which is frequently used in many tactical situations. The predominant radio usage in the United States, therefore, dictated different technology decisions.

The direction that Project 25 chose was to split the existing spectrum into a larger number of narrower channels using Frequency Division Multiple Access (FDMA) technology. The current Project 25 Phase I uses this approach to achieve one voice call in a 12.5 kHz channel. This meets the FCC required channel efficiency for VHF and UHF bands both for today and for the January 2013 narrowband mandate. This also meets the FCC required channel efficiency for 700 MHz until January 1, 2017 under current rules, at which time users must migrate to 6.25 kHz channel efficiency.

With the need for further improvements in channel efficiency, the Project 25 process took on the development of a TDMA standard with a 6.25 kHz channel efficiency using a two-slot TDMA approach (a 12.5 kHz channel divided into two shared time slots resulting in two talk paths). A number of technology advances over Phase I technology needed to be made in order to accomplish this. The first of which is

a more efficient voice encoder/decoder (vocoder). The Phase II vocoder delivers speech in a 3600 bit data stream compared to the P25 Phase I technology that is based on a 7200 bit stream. Combining this improvement in vocoder efficiency with a more spectrally efficient modulation scheme, results in a digital bit stream that contains two voice paths within the channel bandwidth (12.5 kHz) of the original Phase I system.

Deploying Public Safety Networks for the Future

As public safety agencies look at evolving their legacy networks and migrating to P25, there are a host of considerations that need to be addressed in making a technology choice for the next generation P25 public safety system. We will discuss a few of these considerations below and provide EFJohnson's perspective on maximizing the benefits of public safety network investment today with solutions that provide the ability to address future growth in capacity, capability and interoperability.

Capacity

P25 Phase II provides the ability to increase channel capacity by providing channel efficiency of 6.25 kHz thereby doubling the number of talk paths from a P25 Phase I system. Agencies that immediately need this additional capacity and are channel constrained may decide to initially deploy a Phase II TDMA solution instead of deploying Phase I FDMA solution and later migrating to Phase II. Agencies that are not immediately capacity constrained or that can migrate from a conventional system to a trunked system to improve capacity can choose to take a staged approach by migrating to a P25 Phase I system today. In many cases, this can be a more economically viable alternative while retaining the ability to upgrade to the latest technology at a later date.

Compatibility/Interoperability

A P25 Phase II system is designed to be backward compatible with subscriber equipment that operates in P25 Phase I mode. In typical deployments today, there are multiple public safety and non-public safety agencies that use the same system for interoperable communications. An important consideration in deploying a Phase II system is that when there are Phase I subscribers present on the system, the channel will default to the Phase I mode to maintain compatibility with these users. When there are a large number of Phase I only subscribers, the Phase II system will be primarily operating in Phase I mode until such time that the subscriber equipment on these systems are predominantly Phase II, thereby providing the benefits of a Phase II technology. It is important for agencies to plan the upgrade of not only their system and subscriber equipment but also of other agencies and neighboring systems that inter-operate with the Phase II system to ensure all subscriber equipment is equipped with Phase II capability to maximize the Phase II investment.

Regulatory

Based on current FCC regulatory requirements, there are two specific narrowbanding mandates that relate to the 6.25 kHz operational mode for LMR equipment.

VHF (150-174 MHz) and UHF (450-512 MHz)	
New type certifications must have 6.25 kHz mode	January 2013*
700 MHz	
Type certification must have 6.25 kHz mode	January 2015
Public safety must go to 6.25 kHz	January 2017

** Recently changed by the FCC from Jan 2011*

Based on these FCC dates, the key driver from a regulatory perspective for deploying a P25 Phase II system is currently specific to the 700 MHz frequency band and is mandated to occur by January 2017. Starting in January 2015, the FCC will require such equipment to implement and demonstrate a 6.25 kHz operating mode to obtain FCC Type certification. In effect, any regulatory consideration for P25 Phase II deployment is restricted to agencies that either currently have 700 MHz licenses or are planning to procure 700 MHz licenses in the near future.

For agencies that are operating in or plan to procure frequencies in the VHF and UHF bands, there is no specific regulatory mandate that drives a P25 Phase II deployment consideration. However, for equipment that operates in the VHF/UHF bands, starting in January 2013, the FCC will require such equipment to implement and demonstrate a 6.25 kHz operating mode to obtain FCC Type certification. There is however no mandated deadline requiring VHF/UHF deployments using the 6.25 kHz mode.

Note: It is important to remember that the current FCC narrowbanding mandate for VHF/UHF bands to deploy and operate in 12.5 kHz mode is currently targeted for Jan 2013.

Upgrade and Migration Options

Public safety systems typically have a life span of at least 15 years with many systems operating well over 20 years. As a result, investment in public safety networks requires a long term investment view. In keeping with this trend, the LMR vendor community has developed many new technological solutions and capabilities into the P25 equipment design that allows for future upgrading via features such as multi mode protocol support, standardized interfaces (ISSI/FSI/CSSI) between network components, hardware and software upgradable equipment, and field replaceable units. As a result, one of the considerations that agencies should use in their system evaluation is the ability for the public safety subscriber and infrastructure equipment to migrate to future technologies in a cost effective and timely manner. Given the fast pace of technological advance and the uncertainty of investing in technology today for meeting requirements that are many years down the road, it is important to focus today's investment in meeting near term requirements while avoiding investment that locks the agency to technology that may become obsolete down the road. One approach to balancing these requirements is to leverage migration and upgrade options on current products that provide for the ability to interchange components via hardware/software upgrade to the latest product down the road thereby protecting today's investment while retaining the option to upgrade to the latest technology at a later date.

Architectural Considerations

Network interfaces can help in migration to Phase II in an organized manner. In a distributed network architecture, various system configurations including a mix of Phase I and Phase II sites can be tied together allowing seamless migration between the two technologies. This also allows for migration from Phase I to Phase II on a site-by-site basis, while the entire system maintains uninterrupted communication.

Economic Considerations

In today's budget constrained environment, economic considerations are a key factor in selecting the most cost effective solution that meets critical public safety requirements. Public safety entities today are faced with a variety of options to deploy mission critical communication equipment that provides them the critical life saving solutions needed to meet their requirements while also ensuring the long term viability of systems deployed today.

As discussed earlier, capacity/coverage, interoperability, technical and regulatory considerations will influence the choice of deployment option above. In general, deployment options can be captured in three broad categories:

1.) **Deploy P25 Phase I System**

This option provides the most cost effective option for deployment today. The P25 vendor community has been developing and deploying P25 systems for over 10 years. As a result, the industry can leverage on economies of scale to provide public safety agencies with competitive, open standards based interoperable equipment in a very cost effective manner. In addition, the maturity of the technology and P25 standards provide public safety agencies with fully certified equipment that has been whetted through a mature testing and certification program via the P25 Compliance Assessment Program (P25CAP) effort. As a result, public safety networks based on P25 Phase I offer a very high degree of reliability, interoperability and stable technology platform to build public safety communications infrastructure and subscriber equipment.

2.) **Deploy P25 Phase I System with an Option to Upgrade to P25 Phase II at a Later Date**

In the recent few years, P25 equipment vendors have also been incorporating features and capabilities into the systems and subscriber equipment that provide public safety networks with the ability to deploy a P25 Phase I system that can then be upgrade to P25 Phase II at a later date. This has been accomplished by a mix of software and hardware upgrade paths that protect investment by providing a future path to upgrade the networks and incurring an incremental cost at a later date to complete the migration to Phase II. Although, this option is not as cost effective as option 1, it still provides a path forward for agencies that wish to upgrade to P25 phase II at an intermediate term in their system's life.

3.) **Deploy P25 Phase II System**

For those agencies that have immediate requirements for meeting capacity or other criteria provided by P25 phase II, this option provides the ability to move to Phase II immediately. This is a fairly recent trend in the P25 community and most of these networks are in planning stage or in very early stages of deployment. The P25 Phase II standard has recently been published and P25CAP compliance efforts are not yet underway for Phase II. Due to the early stage in the life cycle, the industry needs more time to achieve the deployment experience, economies of scale and widespread adoption of this technology across the vendor and user community. As time goes, there will eventually be more deployment experience and competition to achieve the necessary economies of scale to reach the levels of cost effectiveness available in P25 Phase I today. However, for entities requiring P25 Phase II benefits today, the early adoption likely addresses immediate requirements and needs.

Closing Comments

At EFJohnson, we have been committed to P25 standard from the beginning. We have contributed toward the development of Phase I and Phase II standards, and continue to support P25 in the standards, and regulatory bodies. EFJohnson has a complete line of fully compliant P25 Phase I equipment, and has also leveraged advanced technology to enable multi-mode operation, as well as hardware and software upgrades to enable smooth migration to P25 Phase II. EFJohnson continues to work on developing and deploying fully Phase II compliant systems. EFJohnson maintains its commitment to support and work with public safety agencies to cost effectively deploy P25 systems, whether it is P25 Phase I or with an upgrade path to Phase II.