Simply Speaking: Mobile Communications at the Utility

Introduction

Many utilities are re-evaluating their mobile communications alternatives. They are looking at the "big picture" of their mobile voice and mobile data, and considering the possible impact of mobile communications on backbone infrastructure. The most important step in this evaluation exercise is to develop a mobile communications plan. In order to get started, several main questions need to be answered.

1. First, should the utility invest capital in upgrading their aging or obsolete analog private mobile voice radio system, or should they retire their private mobile voice system and migrate exclusively to commercial cellular service?

If the answer is to invest capital in their private system, utilities move forward by considering the key questions below:

2. Is the utility required to be compliant with the Federal Communications Commission (FCC) 12.5 kHz narrowbanding mandate by the January 2013 deadline? Should they plan for a system that is 6.25 kHz bandwidth compliant[1] if (or when) the FCC mandates a reduction from 12.5 kHz to 6.25 kHz bandwidth?

3. Should the utility move forward with digital radio modulation or an analog radio solution?

4. Should the mobile data applications be separated from the mobile voice system?

5. What direction are the mobile voice radio vendors heading with their product offerings, given some of the new technologies being introduced?

This article will provide information on trends in mobile communications that will help answer some of these questions.

Private versus Cellular: Mobile Voice

Many utilities are using their private radio system as the primary communications technology. However, the use of cellular for many mobile and fixed data applications is evolving in the area of utility automation, such as take-out points for wireless Advanced Metering Infrastructure (AMI), Distribution Automation (DA), Mobile Workforce Management (MWM) and Automatic Vehicle Location (AVL).

Many utilities also supplement their communications in urban areas with cellular; however, it is extremely rare for cellular to completely replace the utility's private radio system. In fact, many private systems are being purchased today in response to cellular coverage gaps in secondary

[1] Per the FCC, 6.25 kHz compliant is: one voice path in a 6.25 kHz channel, or two voice paths at 12.5 kHz, or 4800 bps at 12.5 kHz or 2400 bps at 6.25 kHz. Refer to the 47 C.F.R (Code of Federal Regulations) § 90.203(j).

markets and rural areas with a track record of system congestion, capacity limitations, and site reliability issues during major events. In addition, many utilities prefer the functionality advantages of a private system over commercial cellular service, such as group calling, call latency, and dispatch integration.

FCC Narrowbanding Requirements

12.5 kHz Channel Bandwidth

The FCC narrowbanding mandate requires utility-based mobile radio systems that operate with 25 kHz licenses in the VHF/UHF bands (150 to 174 MHz and 450 to 512 MHz) to be off the air by January 1, 2013, unless the system meets the efficiency standard, or equivalency, of two or more voice paths per 25 kHz. If you have not narrowbanded by this date, the FCC has stated they will cancel the affected license(s). This ruling, a part of the FCC WT Docket 99-87, applies to all VHF (high band) and UHF licenses. Narrowbanding will require filing a new license or a major modification to existing licenses.

If your organization is affected by this FCC narrowbanding mandate, it is better to move forward sooner rather than later because of the timing challenges involved in obtaining frequencies and procuring and deploying needed hardware. If your organization already has appropriate hardware in place for narrowbanding, then modifying the license can be a much smoother process.

6.25 kHz Channel Bandwidth

On March 22, 2007, the FCC declined to approve an order to mandate a migration from 12.5 kHz to 6.25 kHz for the VHF/UHF bands. An FCC release on this matter "strongly urges licensees to consider migrating directly to 6.25 kHz"[2] bandwidth rather than 12.5 kHz first and then to 6.25 kHz. The order did not set a required transition date, resulting in marginal motivation for manufacturers to move to 6.25 kHz. However, the FCC mandate requires any equipment that will be Type Accepted[3] after January 1, 2011, to have 6.25 kHz - or equivalent - emission capability.

Digital Mobile Radio (DMR) II & III, P25 Phase 2 and other digital modulated radios will often address 6.25 kHz narrowbanding rules. The current industry feeling is that narrowbanding to 6.25 kHz bandwidth will be mandated by the FCC several years after 2013, and possibly beyond 2030 based on the historical timeframe for the migration to 12.5 kHz. If the historical timeframe holds true, then utilities building a new 12.5 kHz system in 2009 should have over 15 years of usable life for the system.

Digital versus Analog Modulation for Private Systems

Analog frequency modulation (FM) has been the primary mobile voice radio technology in the industry for years. Analog conventional and trunked mobile voice communications are still the

[2] Federal Communications Commission (March 22, 2007). "FCC ADDRESSES RULES FOR PRIVATE LAND MOBILE RADIO SYSTEMS TO TRANSITION TO 6.25 kHz NARROWBAND TECHNOLOGY". www.fcc.gov

[3] "FCC Type Accepted" refers to the testing/certification process the FCC requires for any new radio frequency device available for commercial sale.

most economical solutions for new radio systems, and the technologies presently available are viable solutions to be considered for new systems. However, commercially available analog FM technologies will typically not comply with the proposed 6.25 kHz bandwidth.

There are several digital modulated products currently available (or soon to be available) that will satisfy the proposed FCC defined 6.25 kHz compliance. Unfortunately, the cost of digital solutions is typically higher than analog solutions. Considering that the FCC has not set a date for the 6.25 kHz bandwidth compliance, the questions faced by many utilities are: (1) is it better to deploy a digital modulated radio solution versus an analog solution?, (2) are there business reasons to deploy a 6.25 kHz versus a 12.5 kHz system?, and (3) what is the anticipated service life of the new product selected? The answers to these questions will vary by utility. For some, a 12.5 kHz product will be preferred and for others, a 6.25 kHz product will be preferred. If a utility implements a 12.5 kHz radio solution, it is recommended that a strategic migration plan to 6.25 kHz bandwidth should be in place.

Direction of Private Mobile Voice Suppliers

There are several emerging mobile technologies that recently have been release – or are nearly released – for production. Information on capabilities and vendor progress in regard to some of these new technologies is provided below:

TETRA Release 2

Globally, Terrestrial Trunked Radio (TETRA) has been offered since the mid to late 1990s with a large following of loyal customers. TETRA Release 2 was standardized in 2005. However, due to an intellectual property claim (IP) in the standard, TETRA is currently not available in the US market.

There are many features of TETRA Release 2, including:

- Time Division Multiplexing with four independent slots in a 25 kHz channel
- Full duplex capable (a two-way conversation like that of a cell phone)
- Open Standard developed by European Telecommunications Standards Institute (ETSI)
- Standards for data rates up to 538 Kbps when using aggregated channels
- Ability to field deploy an ad hoc network to pass audio to a radio where there is no infrastructure

The following are answers to some commonly asked questions about this technology:

1. ***Is any TETRA hardware FCC Type Accepted?*** Not currently, but the US TETRA Initiative[4] is trying to find a solution for the IP issue.

2. ***What US vendors presently manufacture and sell TETRA?*** M/A-Com, Motorola, Thales Group, Nokia; outside the US only.

[4] Source: www.tetra-us.us

3. ***Will TETRA meet the 6.25 kHz proposed mandate?*** Yes, it is a 6.25 kHz equivalent technology.

4. ***Can a mobile voice call and a data session be sent/received at the same time?*** Yes

5. ***What is the mobile data throughput with TETRA?*** There is a lot of data flexibility with TETRA. See Table 1 for TETRA's packet data throughput.

Table 1 TETRA Packet Data Throughput (Downlink kbits/s)

	Channel Type			
Modulation	25 kHz	50 kHz	100 kHz	150 kHz
π/4 DQPSK	15.6			
π/8 D8PSK	24.3			
4-QAM	11	27	58	90
16-QAM	22	54	116	179
64-QAM	33	80	175	269
64-QAM	44	107	233	359
64-QAM	66	160	349	538
Note: All channels are 4 slots				
Source: http://www.tetra-association.com/tetramou.aspx?id=1186				

6. ***What frequencies does this technology operate on?*** Currently licensed at UHF in other countries.

7. ***What impacts to the coverage may exist when converting from a 25 kHz analog trunking system to a 6.25 kHz bandwidth compliant technology like TETRA?*** For a variety of reasons - assuming the same frequency range - the coverage with 6.25 kHz compliant technology will most often be less than coverage delivered by 12.5 kHz and/or 25 kHz technology.

NEXEDGE

Several companies (including Kenwood, Icom, Trident, Ritron, Daniels, etc.) have created the NXDN Forum[5] to promote a new digital radio protocol. NEXEDGE is now available in a conventional mode and trunking mode. It is narrowbanded to 12.5 kHz and allows for two voice channels over a single 12.5 kHz channel in trunking and conventional mode. NEXEDGE also allows one voice channel in 6.25 kHz in conventional mode. Some of the key features of NEXEDGE include:

- Already narrowbanded to 6.25 kHz or equivalent
- Available at both VHF and UHF for conventional or trunking

[5] Kenwood Corporation, Icom Incorporated, Aeroflex Wichita Inc., Daniels Electronics Ltd., Ritron Inc. and Trident Micro Systems jointly established the NXDN Forum for the purpose of promoting the NXDN protocol in the Americas and contributing to the development of land mobile radio in this region.

The following are answers to some commonly asked questions about this technology:

1. ***Are NEXEDGE products FCC Type Accepted?*** Yes, with Kenwood and Icom.

2. ***What US vendors manufacture and sell NEXEDGE?*** Kenwood and Icom at this time. Several other manufacturers have joined the NXDN Forum, but it is unknown whether they will actually build or support products.

3. ***How many deployments are in place or have occurred in the US?*** Fewer than 10.

4. ***What about Test Equipment?*** Aeroflex Wichita has joined the NXDN Forum and should have test equipment available relatively soon.

5. ***What frequencies does this technology operate on?*** VHF (High), UHF.

6. ***What impacts on coverage may exist when converting from a 25 kHz analog trunking system to a 6.25 kHz compliant technology like NEXEDGE?*** For a variety of reasons - assuming the same frequency range - the coverage with 6.25 kHz compliant technology will most often be less than coverage delivered by 12.5 kHz and/or 25 kHz technology.

DMR-III

DMR is a set of standards advanced by the ETSI. DMR II is the Conventional and Simulcast mode and is 12.5 kHz or 6.25 kHz. DMR-III is the trunking specification and has been referred to as digital MPT-1327. It includes two Time Division Multiple Access (TDMA) voice channel slots in a single 12.5 kHz channel.

According to the standard, DMR-III supports voice and short message handling similar to MPT-1327 with built-in 128 character status messaging and short messaging (including GPS) with up to 288 bits of data in a variety of formats. It supports packet data service in a variety of formats including support for IPv4 and IPv6[6] and data at up to 1800 bps per virtual voice path (with link bonding): this would be 3600 bps or 3.6 kbps. Also, while the DMR-III standard does not specify the vocoder, which may be an interoperability issue, several leading vendors have agreed to use a common vocoder.

The following are answers to some commonly asked questions about this technology:

1. ***Are there DMR products FCC type accepted?*** Yes, MOTOTRBO. Other vendors are working towards FCC Type Acceptance of DMR products.

2. ***What US vendors manufacture and sell DMR-II and III?*** Tait has committed to building DMR-III and Motorola is focusing development on their MOTOTRBO product.

3. ***How many deployments are in place or have occurred in the US?*** Unknown.

4. ***What about test equipment?*** Aeroflex Wichita advertises MOTOTRBO equipment.

[6] IPv4 and IPv6 are Internet Protocols for packet-switched inter-networks.

5. ***What frequencies does this technology operate on?*** VHF (High), UHF, 800 and 900 MHz.

P25 Phase 2

Project 25 (P25) is a set of Telecommunications Industry Association (TIA) standards. P25 is a suite of open system standards for digital land mobile radio that is targeted, but not limited, to public safety agencies. P25 defines the interfaces and operation of compliant devices and is intended to assure interoperability between all compliant equipment and legacy systems.

P25 Phase 1 systems utilize 12.5 kHz bandwidth per voice (or 9600 bps data) channel in digital, analog, or mixed mode, and are currently being produced and deployed. P25 Phase 2 is currently under development with the goal of increasing spectral efficiency to either obtain a single voice channel or a data channel capable of 4800 bps or greater per 6.25 kHz bandwidth. Also being developed is P25 Phase 3, which is planned to address high-speed data applications for the public safety sector. TIA and ETSI are working jointly on the P25 Phase 3 effort.

The following are answers to some commonly asked questions about this technology:

1. ***Are there P25 Phase 2 products FCC type accepted?*** Not currently, the standard is still in development.

2. ***What US vendors manufacture and sell P25 Phase 2 equipment***? None yet. Several vendors are working on Phase 2 equipment but are awaiting final approval of the standard.

3. ***How many deployments are in place or have occurred in the US?*** None.

4. ***What about test equipment?*** Unknown.

5. ***What frequencies does this technology operate on?*** VHF (High), UHF, 700, 800, and 900 MHz.

6. ***What are the core benefits of P25?*** Interoperability with other P25 systems and availability of products from many suppliers.

Table 2 is a collation of available data on more mature available private radio technologies.

Table 2 Other Commonly Available Networked Private Radio Products

Technology (in alphabetic order)	Mode	Current Narrowbanding Lower Limits	Mobile Data kbps add-on or not	Frequencies Available	Telephony	Core System: Standards-based or Proprietary	Mfgrs
ASTRO	Digital, Trunked	6.25 kHz Equivalent	3.6 inherent	VHF (High) UHF, 700, 800 and 900 MHz	Half Duplex	Proprietary	Motorola
EDACS	Analog, Trunked or Digital, Trunked	6.25 kHz Equivalent	4.8 inherent	VHF (High) UHF, 800 and 900 MHz	Half Duplex	Proprietary	Tyco Electronics/ M/A-COM
iDEN	TDMA	6.25 kHz Equivalent	7.2 inherent	800 MHz	Full Duplex	Proprietary	Motorola
LTR-Net	Analog, Trunked	12.5 kHz	2.4 add-on	VHF (High) UHF	Half Duplex	Proprietary	Smart-Link (Cal-Amp)
MPT	Analog, Trunked	12.5 kHz	1.2 & 2.4 inherent	VHF (High) UHF, 800 and 900 MHz	Half Duplex or Full Duplex	Standards-based	Many
OpenSky	Digital, Trunked	6.25 kHz Equivalent	14.4 inherent	700, 800 and 900 MHz	unknown	Proprietary	Tyco Electronics/ M/A-COM
P25	Digital w/ Analog fallback, C4FM	12.5 kHz	9.6 add on	VHF (High) UHF, 700, and 800 MHz	Half Duplex	Standards-based, Proprietary	Systems-Few Products-Several
PassPort	Analog, Trunked	12.5 kHz	4.8 Add-on	VHF (High) UHF	Half Duplex	Proprietary	Several
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Summary

We are seeing breakthroughs with mobile technology in the private voice sector as well as on the cellular side. Many utilities are beginning to select a combination of technologies to address their mobile data needs with both licensed and unlicensed private technologies, and also with commercial technologies.

The private radio vendors provided aggressive migration of their products to 12.5 kHz bandwidth, and they are currently developing new 6.25 kHz products. Based on the FCC historical approach to narrowbanding and general industry feeling, the proposed mandate for 6.25 kHz is viewed as being 15 years away at the minimum, but no one knows for sure (not even the FCC).

As the industry gets closer to the 2013 deadline, it is anticipated that the available frequency, vendor equipment, and resources to support the deployment will be stressed. If you have an older radio system, it is logical to start now on a migration plan to address the issues of replacing your existing private system.

About the Author:

Rick Schmidt leads a group of engineers and consultants at Power System Engineering, Inc. (PSE) in an automation, integration, and communications practice area. The group focuses on an array of diverse projects relating to technology and communications including: design and procurement of Land Mobile Radio; microwave and fiber backbone; fixed wireless and PLC AMI; and substation communications. His team also lead projects involving SCADA, substation automation, Demand Response, GIS, OMS, etc. Project scopes involve strategic planning, business cases, design, procurement, and deployment project management. Rick has over 25 years of communications experience. He has received an MBA from Cardinal Stritch University in Milwaukee, WI. Rick can be reached at schmidtr@powersystem.org or 608.268.3502. PSE is a full service engineering consulting firm with more information available at: www.powersystem.org