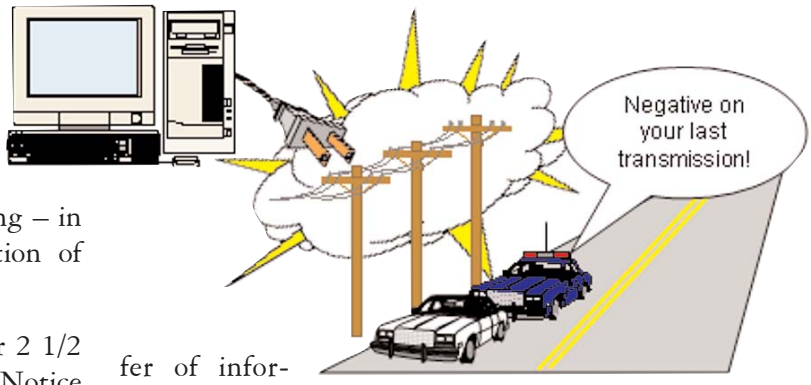
spectrum
The Newsletter of the National Public Safety Telecommunications Council Volume 4, Issue 2, December 2004

FCC Issues Report and Order on Broadband Over Power Lines

Despite widespread opposition from the amateur radio community, public safety, and numerous other wireless users, the Federal Communications Commission (FCC) proceeded with the adoption of rules for the deployment of Access Broadband over Power Line (Access BPL) technology at their October 14, 2004 open meeting – in the name of increased competition and promotion of broadband service to all Americans.



The regulatory history of BPL spans a little over 2 1/2 years. The proceeding began with the release of a Notice of Inquiry (NOI) in April 2003, ET 03-104: *"Inquiry Regarding Carrier Current Systems, including Broadband over Power Line Systems,"* which was followed by a Notice of Proposed Rulemaking (NPRM) as ET 04-37: *"Carrier Current Systems, including Broadband over Power Line Systems; Amendment of Part 15 regarding new requirements and measurement guidelines for Access Broadband over Power Line Systems,"* and finally with the adoption of a Report and Order (R&O) in October 2004. Prior to Sunshine Status, the number of comments received was nothing less than phenomenal at over 6,100.[i] An easy majority of the comments were not in favor of deploying BPL.

The question that begs to be asked is why so many communications users are opposed to the deployment of BPL? The simple answer is because of its interference potential to *licensed* radio services. BPL technology operates over the range of radio frequencies spanning 2 MHz to 80 MHz. Because BPL utilizes unshielded power lines as the network media for the transfer of information, electromagnetic radiation will propagate in the same manner as it would from any wire antenna. Skywave propagation characteristics of the 2 to 80 MHz band make it possible to propagate interference over great distances, under the right conditions.

The possibility of out-of-band emissions (OOBE) is another issue that should not be ignored. The interference potential of BPL should be given serious consideration because public safety operations are inherently mobile in nature and may frequently operate in the neighborhood of overhead power lines. Part 15.209 (f) rules require performing measurements beyond the tenth harmonic for spurious emission. Strict adherence to this safeguard would make BPL providers responsible for ensuring they will not disrupt communications to public safety all the way up to 800 MHz or higher.[ii] If Part 15.209(f) is not sufficient to protect the interests of public safety, perhaps the rules should be updated to reflect advances in receiver technology.

There are other issues that could have an effect on the future of BPL as a competitive alternative for delivering broadband services. At the October 14, 2004 open meeting Commissioner Michael Copps noted that issues such as "universal service, disabilities access, E911, pole attachments, competition protections, and, critically, how to handle the potential for cross-subsi-

(Continued on page 4)

TECHNICAL CORNER

4.9 GHZ PUBLIC SAFETY OPERATIONS

PART II OF III, WHAT TECHNOLOGIES ARE OUT THERE?

Last time around we began to look at the issues involved with supporting public safety operations at 4.9 GHz. Specifically, we focused on some of the types of applications and deployment scenarios associated with 4.9 GHz. In this follow-on discussion, we will look at the technologies and standards that can, should, or will be available in 4.9 GHz devices.

Broadband is a Different Animal...

Many of us operate on broadband spectrum allocations frequently, but usually do not give the enabling technologies much thought. The ease of plugging in a WiFi card and the benefits of achieving high-speed wireless access simply overshadow the sophistication and complexity of the underlying technology that pulls everything together for us.

Most current public safety data systems use narrowband technologies, with typical channel bandwidths between 12.5 and 25 kHz. These narrowband technologies limit data rates to fairly low speeds, on the order of 9.6 kbps (kilobits per second) to 28.8 kbps, with symbol detection periods between 0.1 and 0.2-*msec*. (mill-sec) Because of these relatively long symbol detection periods, multipath effects are usually not much of an issue and only lead to signal fading effects that are typically counteracted by including a predictable fade margin in the system design.

On the other hand, wideband and high-rate data communications systems face significant impairments from wireless channel conditions. First, because these technologies use very short symbol detection periods (e.g., 3.2-*msec* (micro-sec) for 802.11a using a 20 MHz channel bandwidth), they are sensitive to multipath effects. Also, broadband channels suffer from a phenomenon known as *frequency-selective fading*, which occurs when non-uniform fading effects distort the signal over its channel bandwidth (see the RX Power Spectrum subplot in *Figure 1*). In order to combat these channel effects, broadband technologies must utilize sophisticated error mitigation and signal equalization techniques (see bottom left and bottom center subplots in *Figure 1*).

OFDM Rules Mobile Broadband

Because a mobile wireless channel is such an unfriendly place for a broadband signal, certain technologies that handle these conditions particularly effectively tend to dominate in equipment offerings. To date, *Orthogonal Frequency Division Multiplexing*, or *OFDM*, has clearly been the technology solution of choice for most mobile broadband equipment providers.

In OFDM, a high-rate data stream is multiplexed onto a large number of closely spaced subcarriers, with a high degree of spectrum overlap. On a spectrum analyzer, the resulting signal looks like a contiguous broadband signal, but embedded in the technology is a clever technique for de-multiplexing the overlapping signal at the receiver and effectively equalizing the channel as if it were a set of narrowband channels treated individually. Although a detailed explanation of how this occurs is beyond the scope of this discussion, NPSTC provides a helpful PowerPoint® tutorial on OFDM technology on their website at *www.NPSTC.org*.

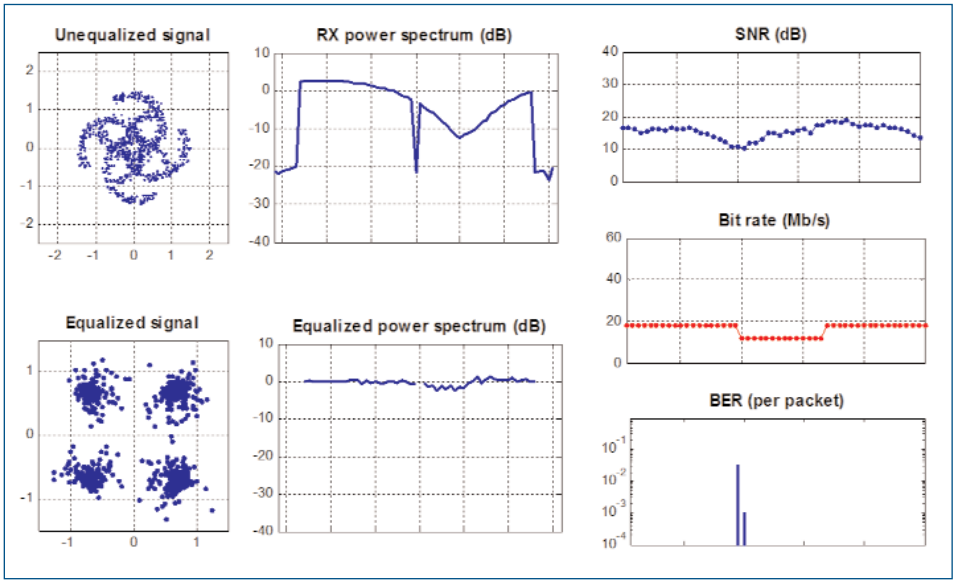


Figure 1: 802.11a PHY (Physical Layer) Simulation

Mobile Broadband Technologies

There are several technology offerings that have the capability to meet the mobile broadband needs of public safety.

First, and most mature, are IEEE 802.11a/j-based wireless local area network (WLAN) technologies. 802.11a is an OFDM technology that operates in the unlicensed 5 GHz U-NII (Unlicensed National Information Infrastructure) bands using a *(Continued on Page 3)*

(Continued from page 2) 20 MHz channel bandwidth. 802.11j is nearly identical to 802.11a, but intended for the Japanese marketplace – and with a highly desirable 10 MHz channel bandwidth mode. Note that 802.11-based OFDM technologies are also represented within the 2.4 GHz unlicensed allocation (802.11g). An industry-based group, the *WiFi Alliance,* brings a large number of manufacturers together so that WiFi equipment from multiple vendors is interoperable.

Note that WiFi equipment has experienced explosive growth in recent years and offers a massive global market from which public safety can leverage benefits such as reduced cost and increased research and development innovation. With regard to these innovations, 802.11-based technologies continue to add features, such as enhanced security and AES [Advanced Encryption Standard] encryption (802.11i), QoS [Quality of Service] (802.11e), higher throughput (802.11n), power control and dynamic channel selection (802.11h), Radio Resource Management, (802.11k), fast roaming (802.11r), and extended service set mesh operations (802.11s). Also note that most mesh-based broadband solution providers utilize routing technologies based on 802.11a, b, g, or j physical layer technologies.

Dedicated Short Range Communications (DSRC) is closely related to the 10 MHz channel bandwidth mode of 802.11j, using the same physical layer, with a modified media access layer function set. DSRC is intended to operate in the ITS (Intelligent Transportation Systems) public safety allocation, but could be adapted for 4.9 GHz operations as well. It offers a high power control channel and is optimized for fast communications set up and payload transfer of short messages to moving vehicles. Originally an American Society for Testing and Materials (ASTM) standard, it is in the process of being added to the 802.11 family as 802.11p (tentative). DSRC is supported by a large number of automotive manufacturers as well as the Federal Highway Administration.

IEEE 802.16 is another OFDM-based broadband technology that was originally developed as a solution for licensed fixed point to multipoint metropolitan area networks (MAN) in the 10-66 GHz bands. It has since been modified to allow for operations in both licensed and unlicensed bands below 10 GHz, with 802.16b serving the U-NII unlicensed allocations at 5 GHz. As with 802.11, an industry group, the *WiMAX* Alliance ensures that interoperability is achieved when utilizing equipment from multiple vendors. Current work within 802.16 is focusing on 802.16e or *Mobile WiMAX*. 802.16e promises to be a very powerful licensed broadband technology for serving public safety's needs, offering greater range than 802.11, along with priority and QoS, encryption, support for speeds up to 150 kilometers per hour (kph) and high delay spread tolerance. The 802.16e standard is expected to be completed before the end of 2004.

802.20 is yet another OFDM-based MAN broadband technology standard under development, which has been developed specifically for mobile broadband from its inception. It is currently targeted for licensed wireless access systems operating in bands below 3.5 GHz and is optimized for Internet Protocol (IP) data transport, with peak data rates per user in excess of 1 megabits per second (Mbps). It also supports vehicular speeds up to 250 kph. Although not specifically intended for the 4.9 GHz band, it may prove applicable as public safety deployments within 4.9 GHz start to flourish or may serve public safety broadband needs in the 700 MHz commercial spectrum allocations. The final 802.20 standard is expected to be complete by the end of 2006.

In addition to the standards-based WLAN and MAN technology solutions, there are also several non-standards-based solutions for meeting public safety's fixed point-to-point operations. These include general U-NII band offerings such as Motorola's Canopy product line, as well as specific 4.9 GHz equipment such as that offered by LPN Wireless of California.

NPSTC and Standards

For several years now, NPSTC has been participating in many standards development activities related to broadband technologies. NPSTC is a voting member of both IEEE 802.11 and 802.18, and also participates in and tracks 802.16, 802.20, and 802.22 activities. NPSTC also works closely with industry within the Software Defined Radio Forum to leverage state-of-the-art technologies and capabilities into the realm of public safety communications. Within these groups, NPSTC (1) ensures that industry understands and reflects the requirements of the public safety community within their technology development processes, and (2) ensures that the public safety community understands what technologies it can leverage to meet their communications needs.

NPSTC also contributes within several public safety-specific broadband standards activities. One (Continued on page 4)

Tech Corner, continued

(Continued from page 3) of these is the 5.9 GHZ DSRC (also known as *IEEE-WAVE*) standards development process, which is currently becoming yet another member of the IEEE 802.11 family. Another is the Telecommunications Industry Association's (TIA) TR-8.8 Working Group, which is focused solely on developing a public safety standard for the 4.9 GHz allocation.

Next Time

In the next and final issue on this topic, we will move into a discussion of deployment strategies and spectrum management issues that are important to consider when deploying a 4.9 GHz system data solution. Until then, feel free to contact me at *ohara@syrres.com* if you have questions or comments. Also, please feel free to send in requests for future articles on other technical, technology, or spectrum management topics as well.

FCC Issues Report, continued

(Continued from page 1) dization between regulated power businesses and unregulated communications businesses remain up in the air."[iii] The Universal Service Fund requires that all services constituting interstate telecommunications must contribute 6.8 percent of their long distance and international calling revenue.[iv] Under FCC pole attachment rules, the Commission is authorized to regulate the rates, terms, and conditions imposed by utilities on cable television systems or providers of telecommunications service that have attachments to utilities poles, ducts, conduits, and rights of way.[v] If pole attachments are applied to BPL, the additional costs would need to be considered in the overall economics of deployment. Lastly is the issue of cross-subsidization – making someone else fund your services. Utilities have the advantage when it comes to BPL; they own the delivery medium – power lines. Profits derived from their electrical power distribution could be used to pay for BPL network services. In the case of BPL services the question that arises is: Will they affect electrical distribution quality and give a provider an unfair advantage in delivery of network services?[vi]

What are we to expect in the issuance of the final R&O when it is available? According to the October 14 press release by the Commission, it sets forth rules imposing new technical requirements on BPL devices, such as the capability to avoid using any specific frequency and to remotely adjust or shut down any unit; establishes "excluded frequency bands" within which BPL must avoid operating entirely to protect aeronautical and aircraft receivers communications; and establishes "exclusion zones" in locations close to sensitive operations, such as Coast Guard or radio astronomy stations, within which BPL must avoid operating on certain frequencies. The R&O also establishes consultation requirements with public safety agencies, Federal government-sensitive stations, and aeronautical stations. It establishes a publicly available Access BPL notification database to facilitate an organized approach to identification and resolution of harmful interference, changes the equipment authorization for Access BPL system.

For More Information on BPL

1. ARRL's BPL Information page: *http://www.arrl.org/tis/info/HTML/plc/*
2. Audio/video recordings of BPL: *http://www.arrl.org/tis/info/HTML/plc/aud-vid.html#Audio*
3. EMC: The Impact of Power Line Communications, Part 1: *http://www.ce-mag.com/archive/03/ARG/hansen1.html*
4. Interference Measurements in HF and UHF Bands Caused by Extension of Power Line Communications Bandwidth for Astronomical purpose: *http://www.savebf.org/lib/isplc2003/isplc2003a7-1.pdf*
5. Technical EMI Problems in PLC Systems, Part 2: *http://www.ce-mag.com/archive/03/ARG/hansen2.html*
6. Access Broadband LLC: *http://www.accessbroadband.com/*

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[i] FCC To Act on BPL Report and Order *http://www.arrl.org/news/stories/2004/10/08/2/?nc=1*

[ii] Part 15.209 Radiated emission limits; general requirements, (f) "In accordance with § 15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device."

[iii] Statement of Michael Copps, Amendment of Part 15 regarding new requirements and measurement guidelines for Access Broadband over Power Line Systems; Carrier Current Systems, including Broadband over Power Line Systems (R&O), *http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-253125A3.pdf*

[iv] Edison Electric Institute, Broadband over Power lines, March/April 2004 edition page 5, *http://www.eei.org/magazine/editorial_content/nonav_stories/2004-03-01-Broadband.htm*

[v] Pole Attachment Complaints, Jurisdiction *http://www.fcc.gov/eb/mdrd/PoleAtt.html*

[vi] Edison Electric Institute, Broadband over Power lines, March/April 2004 edition page 5, *http://www.eei.org/magazine/editorial_content/nonav_stories/2004-03-01-Broadband.htm*

Latest News on the 800 MHz Rebanding Effort

There has been a lot of activity since the last NPSTC *spectrum* newsletter appeared regarding WT Docket 02-55, otherwise known by the short title of "Improving Public Safety Communications in the 800 MHz Band." On September 16, 2004, Nextel filed an *ex parte* presentation seeking clarification/modification of certain aspects of the Report and Order that was issued on August 6. On October 22, 2004, the Commission issued a Public Notice seeking expedited comment on the issues raised by Nextel. Comments must be filed no later than 10 days after publication of the Public Notice in the Federal Register. That had not occurred at the time this newsletter went to print.

On November 2, 2004, Verizon Wireless and Nextel issued a joint news release that reported Verizon Wireless and Nextel had reached an agreement to resolve all legal disputes and Verizon Wireless had agreed not to oppose the Federal Communications Commission's (FCC's) decision to realign the 800 MHz band, including Nextel's receipt of spectrum in the 1.9 GHz band.

On November 8, 2004, the United States Government Accountability Office (GAO) issued an opinion on the legality of the 800 MHz interference issue at the request of Senator Frank Lautenberg. The GAO considered only the legal question of the 800 MHz spectrum swap. The GAO opinion was that the Commission's actions were legal. They also made it clear their opinion did not reflect an endorsement of the plan to resolve interference at 800 MHz. The issue of whether the Commission's exercise of authority under the Communications Act was done with a balance of policies, powers, and constraints is a matter left for Congress to consider.

The resolution of these very important issues is very good news for the public safety community. Once the proceeding has appeared in the Federal Register, Nextel will have 30 days to accept or reject the plan. At that point, if no other opposition remains, or no further petitions for reconsideration are submitted, we can finally get to work on solving the interference problem many public safety entities are suffering across the country.

RapidCom Enhances Short-Term Interoperability in Ten Cities

In May 2004, the Department of Homeland Security (DHS) initiated the Rapid Emergency-Level Interim Communications Interoperability (RapidCom) program in ten key urban areas to provide minimum communications interoperability to incident commanders within 1 hour after an event. The mission for RapidCom was to provide assistance that enhanced near term interoperability capabilities based upon each urban area's ongoing programs and specific needs by September 30, 2004.

Ten key urban areas—New York, New York; Chicago, Illinois; National Capital Region; Los Angeles, California; San Francisco, California; Philadelphia, Pennsylvania; Houston, Texas; Miami, Florida; Boston, Massachusetts; and Jersey City, New Jersey—participated in RapidCom and received assistance that included technical engineering, testing, and implementation assistance; interoperable solutions training; communications policy and procedures development; and tabletop exercise development. The use of tabletop exercises provided a hands-on opportunity to assess the operational strengths and weaknesses of communications policies, procedures, plans, available assets, and communications capability gaps in the systems that the different agencies would use and experience in response to a multi-jurisdictional event.

Managed and coordinated by DHS's Science and Technology (S&T) Directorate under the SAFECOM Program and in partnership with the Office for Domestic Preparedness (ODP's) Interoperable Communications Technical Assistance Program (ICTAP) and the Department of Justice (DOJ), RapidCom was meant to enhance the use of currently available systems and technologies, not to serve as a comprehensive public safety communications solution.

The ten urban areas were selected by DHS as part of ODP's Urban Area Security Initiative (UASI) to enhance the security of urban areas with high-density populations and critical infrastructure, ports, and mass transit systems. RapidCom also coordinated efforts with DOJ's At-Risk Metropolitan Area Interoperability Project to enhance and streamline assistance to these key urban areas.

Important Dates - 2005

Date	Event	Location
January 10-14	P25/TIA Meeting	Mesa, AZ
January 17-20	SDR Forum	Austin, TX
January 24-26	NPSTC Governing Board Meeting	Orlando, FL
February 16-18	IAFC/Wildland Fire 2005	Albuquerque, NM
March 1-3	ISART	Boulder, CO
April 4-8	IWCE	Las Vegas, NV
April 18-22	SDR Forum	Singapore
April 18-22	TIA TR8	Charleston, SC
April 20-22	IAFC/Fire Rescue-Med 2005	Las Vegas, NV

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