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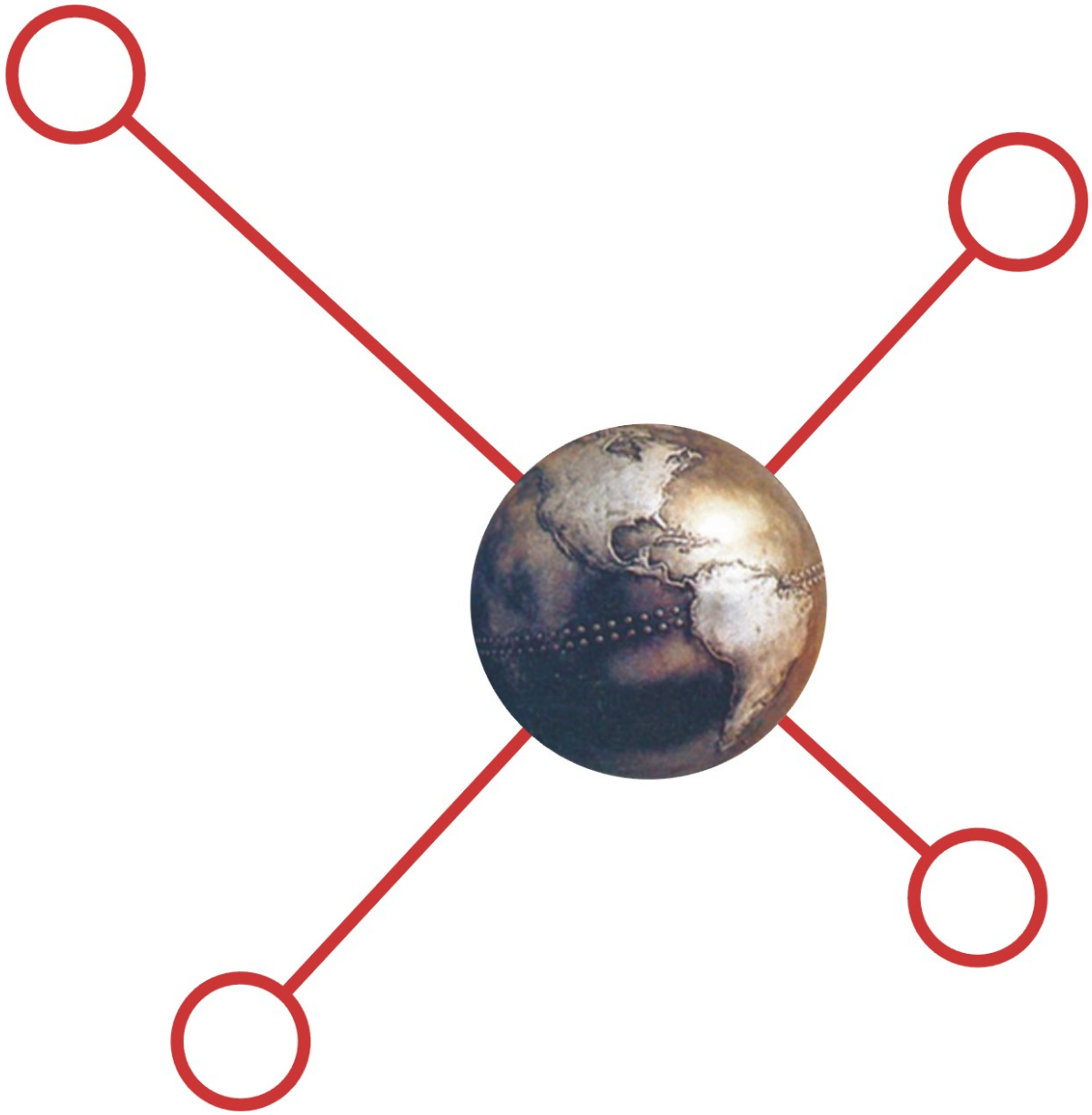
IEEE 802.16e Standard

What Will it Mean for Fixed Wireless Applications?



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Abstract

The Institute of Electrical and Electronics Engineers (IEEE) 802.16-2004 standard, commonly referred to as 802.16d, was published in 2004. The 802.16e amendment to the standard is expected to be completed in the first half of 2005. Whereas the 802.16-2004 standard addresses fixed wireless applications only, the 802.16e standard can serve the needs of fixed, nomadic, and fully mobile networks.

Although 802.16e is generally perceived as the mobile version of the standard, in reality it serves the dual purpose of adding extensions for mobility and including new enhancements to the Orthogonal Frequency Division Multiplexing Access (OFDMA) physical layer. This new enhanced 802.16e physical layer is now being referred to as Scalable OFDMA (SOFDMA) and includes a number of important features for fixed, nomadic, and mobile networks.

Because of these advantages, most of the industry will build their 802.16e-based products using SOFDMA technology. However, the 802.16e standard is not just for mobility. There are also many compelling reasons for using SOFDMA in fixed broadband wireless access (BWA) networks. This paper focuses on the advantages that SOFDMA provides for fixed wireless applications.

WiMAX Forum™ Compliance

The 802.16-2004 standard, published in 2004, includes options for three different Physical (PHY) layers: single carrier, OFDM256, and OFDMA. The WiMAX Forum has thus far supported the OFDM256 physical layer within the 802.16-2004 standard for first-generation WiMAX products.

Since volume deployment of WiMAX-certified equipment is expected to be driven by nomadic and mobile applications, it is important to observe the direction of the 802.16e standard to understand the technology that will be used for these mass-market deployments. Support within the IEEE for SOFDMA grew significantly throughout 2004, with many of the mobile vendors becoming more active. Momentum continues to build in 2005.

In Korea, the Telecommunications Technology Association (TTA) has recently decided to align its wireless/broadband (WiBRO) high-speed Internet standard with SOFDMA as well. Intel has also announced at industry conferences that SOFDMA will be the PHY layer of choice for future fixed and portable WiMAX applications, such as indoor customer premise equipment (CPEs), notebooks, and Personal Digital Assistants (PDAs). This recent industry shift is important because SOFDMA is not backward compatible with OFDM256, which is the basis of most early "pre-WiMAX" equipment.

The availability of WiMAX-certified products should help to significantly increase the overall competitiveness of fixed wireless equipment versus other technologies. Fixed BWA remains SR Telecom™'s primary focus; however, we also recognize that the volumes possible for fixed wireless access will never approach the same level as those expected for nomadic and mobile applications, such as notebooks and PDAs.

History has shown that fixed wireless equipment that rides the cost curves of higher volume applications rapidly becomes more cost-effective than equipment built on technologies that are used exclusively for fixed wireless applications. Fixed BWA must leverage the investment for these higher-volume applications to reach the price points that are required to make BWA a resounding success. Economies of scale from nomadic and mobile networks, including notebooks and PDAs, will drive down the cost of all SOFDMA solutions.

SR Telecom is a pioneer of OFDMA technology with our **symmetry**™ product line. We have the industry's only field-proven OFDMA technology and are convinced of the benefits that OFDMA brings to fixed wireless networks.

SOFDMA Benefits

The benefits of SOFDMA for fixed wireless applications, include the following:

Lower Cost Driven by Volume Opportunity

- Fixed wireless CPEs will be able to use the same modem chipset used in personal computers (PCs) and PDAs.
- Base stations will be able to use the same chipsets being developed for low-cost WiMAX access points.
- Increased volume will also justify the investment for higher-level integration of radio frequency (RF) chipsets, further driving down costs.
- Peak-to-Average-Power-Reduction (PAPR) techniques incorporated within the standard will enable lower cost power amplifiers to be used for SOFDMA without compromising system gain.

Non-Line-of-Sight (NLOS) Coverage

- Basic capabilities of SOFDMA will offer similar coverage as OFDM256. Above these basic capabilities, there are several areas listed below where SOFDMA should outperform.
- Important optional techniques for improving NLOS coverage, such as diversity, space-time coding, and Automatic Retransmission Request (ARQ), are included as a part of SOFDMA as they are for OFDM256. In some cases, the capabilities are further enhanced for SOFDMA; for example, hybrid-ARQ and additional diversity schemes.
- Finer granularity of sub-channelization improves SOFDMA system gain to enable deeper indoor penetration.
- Higher performance coding techniques; for example, Turbo Coding and Low-Density Parity Check (LDPC), are being implemented in first-generation SOFDMA chipsets, further improving system gain and NLOS coverage. (Optional higher-performance coding also exists with OFDM256, but is not implemented in most first-generation WiMAX chipsets.)
- Downlink sub-channelization of SOFDMA enables additional flexibility for trading-off coverage versus capacity.
- Volume opportunity for nomadic applications is encouraging lower-cost solutions (chipsets) to enable Adaptive Antenna Systems (AAS) and Multiple-Input-Multiple-Output (MIMO) for improved coverage.
- SOFDMA sub-carrier spacing is independent of channel bandwidth. Scalability ensures that system performance is consistent across different RF channel sizes (1.25-14 MHz).
- Larger Fast Fourier Transform (FFT) sizes of SOFDMA can cope with larger delay spreads making the technology more resistant to multipath fading that is characteristic of NLOS propagation, particularly with larger RF channels.

Capacity

- SOFDMA provides greater flexibility to trade-off data throughput with mobility. Fixed CPEs are still able to access the full bandwidth within any sector to get the same peak rates as with OFDM256.
- Improvements in system gain enable the delivery of peak data rates to more subscribers within a cell, increasing the effective throughput of each base station.

Improved Frequency Reuse

- By using Partially Used Sub-channeling (PUSC) mode on the downlink, SOFDMA can achieve better frequency reuse than what is possible with OFDM256; as a result, less spectrum will be required to deliver the same overall network capacity.

Improved Security

- 802.16e includes Advanced Encryption System (AES) functionality that service providers have been encouraging the WiMAX Forum to make mandatory for all WiMAX-certification.

Option to Conveniently Upgrade Fixed Networks to Combined Fixed and Nomadic Networks in the Future

- SOFDMA-based CPEs and base station sectors deployed initially in a fixed network will be compatible with the eventual deployment of nomadic-enabled networks.
- Building fixed wireless networks using SOFDMA provides a future-proof solution for carriers considering evolution to nomadic or fully mobile WiMAX networks.

Conclusion

The 802.16e standard is not just about mobility. A key part of the new amendment to the standard is the introduction of the SOFDMA technology that offers a number of technical advantages for fixed wireless applications, as well as a migration path to mobility.

The 802.16e standard is about volume. By leveraging the same technology being integrated into notebooks and PDAs, networks based on SOFDMA will become the most cost-effective solution for carriers to also deploy for fixed wireless applications.

Corporate Headquarters
8150 Trans-Canada Hwy.
Montreal, QC
H4S 1M5
Canada
info@srtelecom.com
www.srtelecom.com

SR Telecom
Broadband. Everywhere.