Symmetricom

Synchronization Requirements for Next-Generation WiMAX Networks

Summary

- **WiMAX is a very promising technology for delivery of fully mobile personal broadband services**
- **WiMAX relies on precise synchronization to deliver consistently high quality of service**
- **Global Positioning System (GPS) provides the most accurate and robust source of synchronization for WiMAX networks**

The New WiMAX Standard: Ready for Prime Time

Symmetricom is actively working with the wireless industry to standardize and drive deployment of worldwide interoperability for microwave access (WiMAX) networks, the next-generation platform for long-haul broadband wireless delivery and the technology of choice for high bandwidth wireless broadband access (WBA). WiMAX will feed a number of applications including "last-mile" broadband connections, hotspots and cellular backhaul as well as fully mobile high-speed broadband access.

With pre-WiMAX equipment shipments rapidly increasing, WiMAX is gaining momentum in the access market today as the technology of choice for high bandwidth wireless broadband access (WBA). The fall of 2005 will mark the first wave of WiMAX-certified IEEE 802.16 standard-based equipment to hit the market, addressing fixed point-to-multipoint broadband access applications. To follow will be the move to fully mobile broadband access. Full mobility will be enabled with version E of the IEEE 802.16 standard (IEEE 802.16e), scheduled for ratification in late 2005. Mobile trials are targeted for 2006 with mass market deployment to begin in 2007.

WiMAX Network Architecture

As shown in Figure 1, WiMAX network topology leverages an internet protocol (IP) core to create an open architecture for mobile data networks. Advanced IP architectures significantly reduce network cost and complexity for delivery of high bandwidth personal broadband services that include a suite of applications including internet access, streaming services, interactive gaming, video-on-demand, and voice-over-IP (VoIP) services with high quality-of-service (QoS) levels. The WiMAX media access control (MAC), architected to assure low latency and low jitter to support real-time services, is designed to provide a wide range of QoS levels appropriate for a variety of applications and subscriber requirements.

Synchronization Requirements within WiMAX Networks

In every digital communication network, precise synchronization and timing is required for the reliable transmission of voice, video and data. Synchronization paces the flow of information and ensures the network performs at peak efficiency, which is critical for delivering real-time services with the end user's quality of experience in mind. Synchronization and timing requirements vary with the service being offered. "Best effort" internet access applications have relatively loose synchronization requirements, while real time voice, video, and gaming applications have more stringent requirements. Since carriers cannot control the mix of traffic, networks must be designed to meet the most stringent requirements to ensure that customers consistently are provided the best service quality.

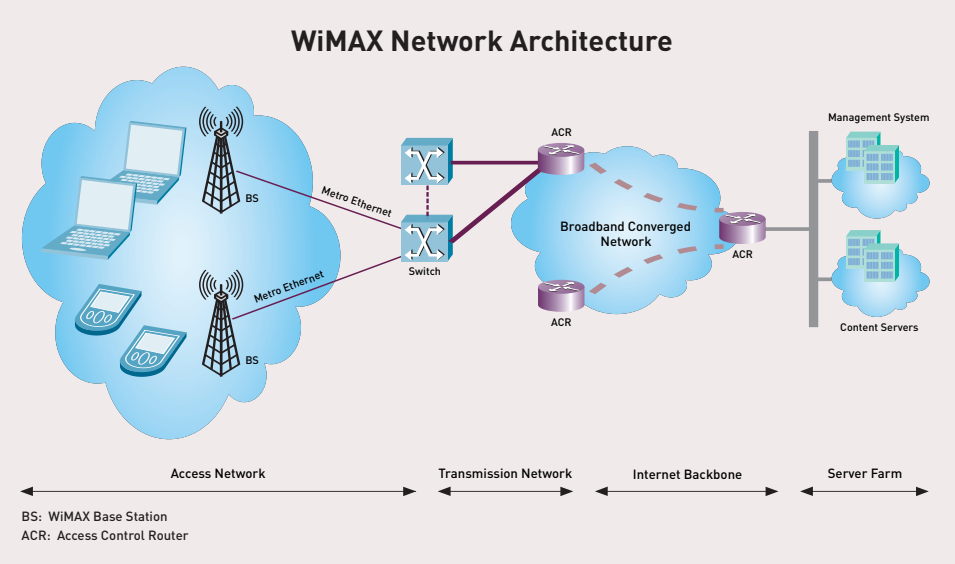

FIG. 1 WiMAX Network Topology: Leveraging Core IP Network for Simplicity & Lower Capital and Operating Costs

GPS provides the most accurate and robust source of synchronization for WiMAX networks.

WiMAX networks support both frequency division duplex (FDD), and time division duplex (TDD) modes of operation. In FDD mode, the available spectrum is split into an uplink frequency channel and a downlink frequency channel. In TDD mode, the full spectrum is divided into timeslots dedicated to uplink and downlink traffic. Both FDD and TDD modes require that the carrier frequency be locked to an accuracy of 8EE-6. TDD mode adds the requirement to time synchronize the base stations to a common time reference to assure that transmitters are able to synchronize their uplink and downlink timeslots to avoid interference. Guardband gaps are established between the uplink and downlink transmission bursts to allow the base stations and subscriber stations to "turnaround" from transmit to receive modes of operation (figure 2).

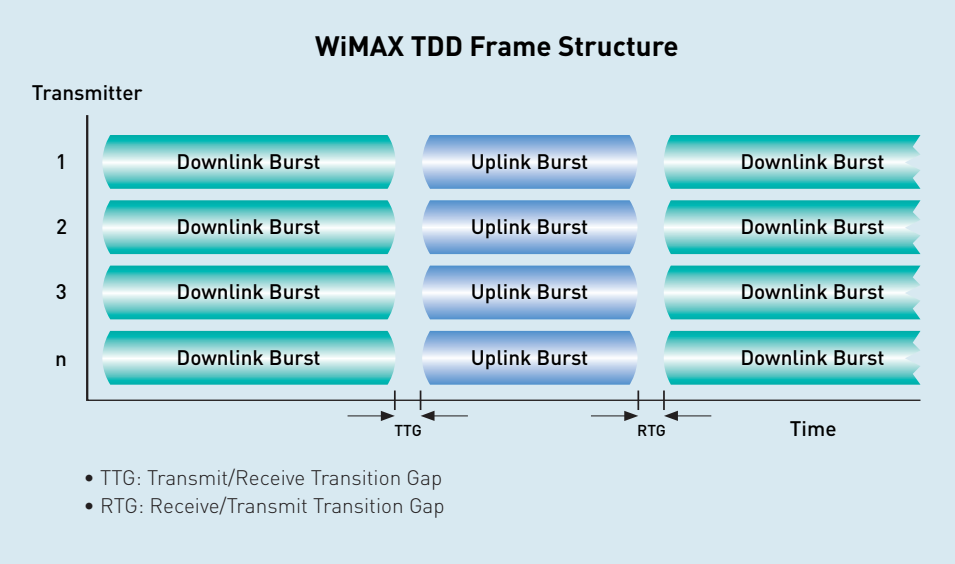

FIG. 2 TDD mode requires tight time synchronization to prevent interference.

The IEEE 802.16-2004 standard for WiMAX networks defines these guardband gaps as the receive/transmit transition gap (RTG) and the transmit/receive transition gap (TTG). To avoid interference, all transmitters must time-synchronize the transmit-and-receive bursts with RTG and TTG, providing the guardband between uplink and downlink bursts. It is highly desirable to minimize the RTG and TTG gaps to minimize dead-air time that can result in reduced system capacity. To maximize capacity, the standard allows for RTG and TTG gaps as small as 5 µs but requires very precise synchronization. As shown in Table 1 below, the IEEE 802.16-2004 standard calls for use of global positioning system (GPS) receivers to provide the precise time reference for synchronization of WiMAX networks. GPS provides the most accurate and robust source of synchronization for WiMAX networks. Symmetricom has fielded tens of thousands of GPS based timing solutions for wireless networks around the world.

Summary

WiMAX is attracting a high degree of attention from network operators who want to provide fixed and mobile broadband services. WiMAX is built on an IP core network structure and must rely on precise synchronization to deliver latency and jitter sensitive application, thus maximizing network capacity to provide speed and mobility for personal broadband access. Symmetricom provides a wide range of solutions for synchronization of WiMAX networks.

Precision synchronization improves network reliability, efficiency and bandwidth utilization.

Section 8.2.3.1 Channel Frequency Accuracy The frequency accuracy of the base station shall be within ± $8x10^{-6}$ of the selected RF carrier over an operating temperature range of -40 to +65°C, up to ten years from the date of equipment manufacture.
Section 8.3.7.1.1 Network Synchronization For TDD and FDD realizations, it is recommended (but not required) that all base stations be time synchronized to a common timing signal. In the event of the loss of the network's timing signal, base stations may continue to operate and shall automatically resynchronize to the network timing signal when it is recovered. The synchronizing reference shall be a 1 pps timing pulse. A 10 MHz frequency reference may also be used. These signals are typically provided by a GPS receiver.
Section 8.4.5.3.2 Frame Duration Codes Both RTG and TTG shall be no less than 5 µs in duration.

TABLE 1 Key IEEE 802.16-2004 Synchronization Requirements for WiMAX Networks

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