ACM optimizes backhaul networks

Ron Nadiv and Tsachi Rosenhouse

(07/23/2008 6:00 PM EDT)

Wireless point-to-point (PtP) microwave solutions, used in more than 50 percent of all mobile backhaul deployments worldwide, offer operators a simple, cost-efficient path for upgrading and expanding their networks. Microwave is instant, reliable and relatively low-cost. Such solutions support higher data rates than copper T1/E1 lines and easily overcome the high cost and limited availability associated with fiber.

Nonetheless, wireless backhaul has its constraints. Network planners are often caught between the need to increase network capacity and availability and the need to limit costs. But a unique new technology called adaptive coding and modulation (ACM) has made high-capacity PtP microwave even more attractive.

Adaptive coding and modulation refers to the automatic adjustment that a wireless system can make in order to optimize over-the-air transmission and prevent weather-related fading from disrupting communication on the link. When extreme weather conditions, such as storms, affect the transmission and receipt of data and voice over the wireless network, an ACM-enabled radio system automatically changes modulation and/or coding, allowing real-time applications to continue to run uninterrupted. Varying the modulation and/or coding also varies the amount of bits transferred per signal, thereby enabling higher throughput and better spectral efficiencies. For example, 256-QAM modulation can deliver approximately four times the throughput of 4-QAM (QPSK).

The world of wireless telecommunications is changing. Voice is no longer the main generator of mobile traffic. Today, data generates significantly more traffic than voice, albeit with only marginal added revenue. But there's a bright spot, too. Unlike real-time services, such as voice or video, most data applications do not require stringent, five-nines (99.999 percent) availability. For instance, whereas even a 50-millisecond delay is unacceptable during a voice conversation, waiting several seconds for a Web page or e-mail message to download is tolerable.

Planners now can flex their networks, guaranteeing sufficient bandwidth for voice and delay-critical services with 99.999 percent availability and allowing for a range of data services at slightly lower availabilities (99.99 percent or 99.9 percent).

Compare a legacy TDM solution with a native Ethernet solution using ACM. In this particular case, a DS3 service is delivered over a 50-Mbit/second link at 99.999 percent availability. Alternatively, the same system can provide a single service carrying 155 Mbits/s at 99.99 percent availability to deliver an STM-1/OC-3 service. When introducing ACM into the equation, the Ethernet link, using the same frequency spectrum and radio equipment, can offer the carrier-grade 50 Mbits/s at 99.999 percent availability, a second service providing 105 Mbits/s at 99.99 percent availability and a third service delivering an additional 45 Mbits/s at 99.9 percent availability. That constitutes a total of 200 Mbits/s using the same link budget.

For operators who are looking for ways to increase their network capacity without investing in a totally new infrastructure, this is great news. ACM can help maximize the performance of existing infrastructure and achieve higher capacities per link. This is true even in cases where the network is already planned, including given antenna sizes and spectrum planning.

Aiding migration

This scenario is also very relevant during network migration phases from voice-centric to data-centric architectures. Adding data services to an existing network requires much more backhaul bandwidth. With ACM, an operator can use the same antennas and radio-frequency channel (keeping the same frequency license from the regulator) and get the same availability for the legacy services, with additional "free" bandwidth for the new services.

By implementing full dynamic ACM, backhaul solutions can significantly improve user bit rate. The user bit rate is calculated as: symbol rate x modulation bits/symbol x coding rate. The actual user bit rate (or "net" bit rate for user traffic) over a given channel with a given symbol rate is determined by two main factors: the modulation scheme efficiency (modulation bits/symbol) and the coding rate.

Modulation scheme efficiency is actually the amount of bits carried by each transmitted symbol. For example, QPSK carries 2 bits/symbol; 256-QAM carries 8 bits/symbol. The coding rate determines the percentage of payload bits from the total amount of transmitted bits (in contrast to the redundancy bits used for coding). For example, a coding rate of 0.9 means that a single redundancy bit is added for every 9 bits of payload. In this particular case, the code consumes 10 percent of the bandwidth. When the system needs to use a stronger code (to make up for bit errors, for instance), the coding rate is changed to 0.8. This ensures better quality of transmission but reduces the percentage of payload bits, since more bandwidth is consumed by coding