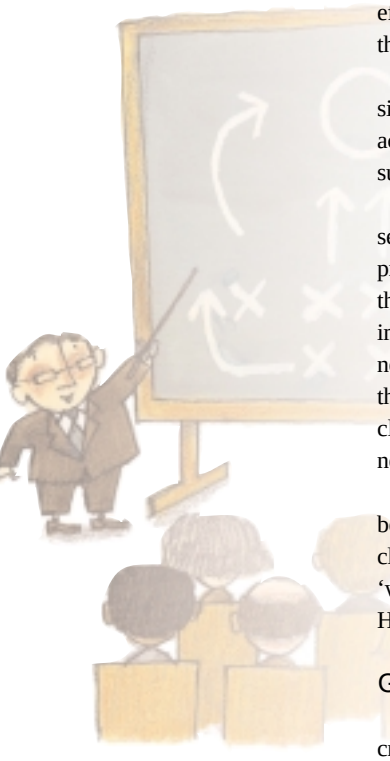
The Business of Being In Sync

Covering Products, Services, Applications and Technologies for Public and Private Networks

By Don Skipwith and Phil Mann

Forward-thinking carriers beware: before you move to new, more bandwidth-efficient packet-based technologies such as Voice over ATM (VoATM) or DSL, make sure they work first.

That's exactly what Telephone Electronics Corp. (TEC), which offers both local and long-distance services, was doing just a few short months ago when it discovered a problem. In its labs in Dallas, Texas, TEC was extensively testing its VoATM services to work out the bugs before the company rolled out this cost-efficient technology to millions of customers throughout the country.



As the testing began, TEC compressed the voice signals to squeeze more traffic across the network and achieve bandwidth savings. But TEC was in for a surprise: the VoATM system didn't work.

Billy Young, TEC vice president of broadband services, was at the lab during the testing. Based on his previous experience at another telecom carrier, Young thought he knew what was wrong. Young knew the importance of having accurate clocking in telecom networks, but he was having some trouble convincing the rest of the engineers at TEC they needed accurate clocks to improve the operations of the carrier's network.

"When the VoATM services didn't work, it suddenly became very apparent to them that we needed accurate clocking," Young said. "They turned to me and asked, 'what is that technology you've been talking about,'" His answer? Synchronization.

Getting in Sync

As a progressive carrier, TEC is focused on using creative new technologies to provide the highest quality, most cost-effective service to its customers. But as always, when new technology is involved, new challenges arise.

"The faster we try to move information, the more a lack of synchronization becomes a serious problem," Young said. "If we're not synced together, the data is not going anywhere."

This is especially the case with continuous bit rate, real-time services such as voice and video. Traditionally, networks using technologies such as Internet protocol (IP) or asynchronous transfer mode (ATM) were engineered for data-only communications. As technology improves and new industry standards emerge, voice and video traffic are increasingly moved to packet-based networks, and this traffic requires more accurate timing. Accurate timing wasn't needed in traditional IP data networks, where synchronization generally required nothing more than recovering time from an upstream clock or using a free-running clock in the network element. But as companies increasingly add voice to their wide bandwidth IP or ATM networks, they find synchronization a key aspect of any network carrying voice or video.

Don't Slip

Synchronization – providing stable frequency and precise time – is not a new concept. It evolved as a requirement for the public switched telephone network (PSTN) when timing deficiencies caused data transfer problems and poor service quality. In the worst case, these problems would render networks inoperable. Network timing problems were particularly noticeable with the advent of digital switching systems and the need to transmit applications such as digital data services via time division multiplexed (TDM) networks with no loss of information; this made synchronization a requirement.

The exchange of bits in a digital network must be regulated by clocks that drive the transmitters and receivers in the elements. When these clocks fail to operate with the same "heartbeat," bits are lost. This is called a "slip." A lack of proper synchronization can result in jitter, wander and phase transients, any of which can cause slips and thus result in lost information.

The effect of a slip caused by any of these impairments depends on the type of traffic carried. For voice traffic, a slip may be unnoticeable or cause audible clicks. Digital data transported via the PSTN requires retransmission if a slip occurs. For analog data, slips have a more serious effect. For example, a slip during a fax transmission results in a missing line at the receiver or a dropped call. Analog data (the typical connection for e-mail and the Internet) is most vulnerable to slips. In the case of an analog modem, a slip could cause the modem to retrain, resulting in several seconds of outage.

To combat slips, the telecommunications industry has specified two types of synchronization equipment: the synchronization supply unit (SSU), or, in the United States, building integrated timing supply (BITS), and the primary reference source (PRS). These elements support varying levels of network synchronization precision.

A BITS takes a frequency reference, either from a PRS or a network source such as an incoming transmission line, and provides that reference to all elements at its location. Should that reference fail, BITS provides a local holdover oscillator, typically redundant, allowing continuous network operation while the reference failure is corrected. The BITS concept is a vital one to carry into new IP and ATM networks. BITS calls for one master clock in each telecom office and ensures that there is one – and only one – reference steering all of the free running clocks within network elements. Relying on free running clocks in network elements – no matter how good they may be – will result in slips.

A PRS provides an absolute frequency reference, typically from the global positioning satellite (GPS) system, and provides it as a Stratum 1 reference – the most precise timing reference available – to BITS.

The Benefit of Being in Sync

In TEC's case, according to Young, the synchronization products that were deployed have not only helped TEC in its implementation of new technologies, but the company has also experienced significant decreased maintenance costs in its legacy TDM platform by implementing synchronization as well.

Like many independent competitive telephone companies, TEC did not originally install an internal clock into the central offices of its local operations. Instead, it was "daisy chaining" the network, relying on external sources and shared timing for its synchronization needs. "We were having a number of clocking problems," Young said, "which in turn often led to service degradation and even outages and thus increased maintenance costs."

Young said installing a complete synchronization system has resulted in a marked reduction in TEC's ongoing maintenance problems. "There is definitely a cost savings anytime you can eliminate a customer-affecting problem," Young said. And, he no longer has to fight the synchronization battle at TEC. "We've now installed our own high-quality clocks throughout the network," Young said. "For the benefits we've received, I don't think you have to convince anyone here." •

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Syncing Up

While synchronization can benefit the quality of service (QoS) of any telecom network, the need for synchronization is driven by the nature of the technology used (packet or circuit) and the nature of the services offered (data or voice). Below is a list of technologies and the relative importance of synchronization within each:

IP/ATM data services: Protocols have been optimized in the past decade for data transport and delivery. While packets are dropped occasionally due to network congestion and poor synchronization, networking protocols allow re-transmittal. Since data is bursty and non-real-time in nature, data communications are very forgiving in the area of network latency and associated non-real-time delivery. Improving synchronization typically will not provide sufficient benefit to pay for the investment.

Residential voice: Customers, especially residential customers, are always looking for lower-cost telephone services, both local and long distance. Residential customers are therefore more forgiving than corporate customers regarding quality of service. With today's limited deployment of VoIP networks, residential VoIP networks typically will not make the investment necessary for improved voice communications. The result: residential customers enjoy the benefits of lower costs but must put up with decreased quality such as clicks on the lines and/or dropped calls. However, as new, more bandwidth-efficient technologies continue to arise, many of these will require synchronization if they are to work at all. In this case, the lower costs that carriers derive from the increased bandwidth efficiencies more than outweigh the cost of installing proper synchronization.

Legacy analog modem communications: residential and small office/home office (SOHO) applications will continue to depend on dial-up modems in certain locations where more advanced techniques such as DSL and cable modem are not available. Analog modems are the most sensitive to IP backhaul systems that use rudimentary synchronization. Precise network timing from a PRS will allow analog modems to operate properly in IP networks.

Corporate voice communications: Corporate voice communications always has and will continue to demand "toll quality" voice as defined by the Bell System. Toll quality, for corporate voice communications, requires a synchronization investment at each major office. Only through proper synchronization -- placing a PRS at each corporate office and associated queuing algorithms that give priority to real time services -- will "toll quality" be preserved.

Legacy fax communications: Analog fax machines -- 100 million of which are deployed around the world require transmission via analog circuit emulation and are very intolerant of any slips that result from poor synchronization. Faxes that contain missing information must typically be re-sent, requiring a telephone conversation between receiving and sending parties and then a re-faxing of the document in question. Proper synchronization will help solve this problem.