APPLICATION BRIEF

Symmetricom®
YOUR NETWORK. OPTIMIZED.

NGN SERIES

Advantages of Carrier Class IEEE 1588 PTP Grandmaster Clocks

Grandmaster Hardware Redundancy Protects Slave Clock Performance

Summary

- IEEE 1588 Precision Time Protocol is the technology of choice for synchronization of Next Generation Networks
- Slave clocks rely on continuous communication with the IEEE 1588 PTP grandmaster to hold synchronization for advanced network requirements
- Best-effort, network-level failover scenarios cannot assure slave clock performance
- True carrier class grandmaster clock implementations are required to meet stringent synchronization requirements for NGN networks

Telecommunications networks are rapidly shifting from circuit switched to packet switched technologies to meet exploding demand for bandwidth in both core and access networks. Traditional circuit switched TDM networks were engineered to carry precise frequency synchronization throughout the network. Access platforms, such as wireless base stations, rely on synchronization delivered over the network backhaul connection to assure high QoS for end user applications. A key dependency in the evolution to Ethernet backhaul in telecom networks is the ability to deliver carrier grade synchronization over Ethernet to remote wireless base stations and access platforms.

IEEE 1588 Precision Time Protocol (PTP) is rapidly gaining traction as the technology of choice to deliver synchronization to remote telecom elements over Ethernet backhaul connections. Figure 1 shows a typical example of PTP synchronization for wireless networks. All GSM and UMTS base stations must be frequency synchronized to +/- 50 ppb (parts per billion) to support handover as mobiles transition from one base station to another. Failure to meet the 50 ppb synchronization requirement will result in dropped calls.

Base stations have traditionally met this requirement by locking their internal oscillators to a recovered clock from the T1/E1 TDM backhaul connection. When the backhaul transitions to Ethernet, the base station becomes isolated from its traditional network sync feed. New base station designs are incorporating IEEE 1588 PTP slave clocks to meet the 50 ppb requirement. PTP slaves in the base stations rely on access to a carrier class PTP grandmaster clock deployed in the mobile switching center (MSC).

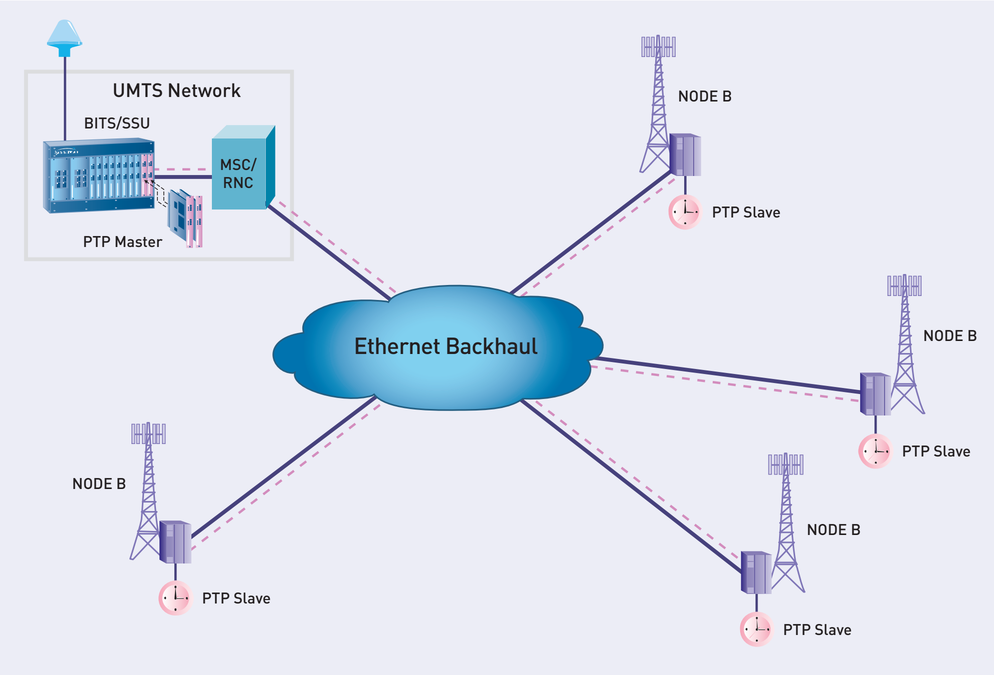


FIG. 1 Delivery of synchronization to next generation UMTS base stations will rely on PTP grandmaster clocks deployed in the MSC/RNC. Sync packets flow from the grandmaster clock to the slave clocks in the base stations.

Deployment and Provisioning Considerations

Network deployment and reference network test models have been established to assist carrier engineering staffs to develop specific deployment rules for IEEE 1588 synchronization solutions in their networks[1]. A key consideration is slave clock performance during a grandmaster clock failover scenario. IEEE 1588 slave clocks must be provisioned to access a specific IEEE 1588 grandmaster clock to establish a synchronization flow. The slave clock establishes communication with the grandmaster by making a synchronization flow reservation specifying parameters such as sync rate and reservation duration. Upon initial connection to the grandmaster, the slave clock goes through the stages outlined in Table 1 to "lock" to the master.

IEEE 1588 PTP Slave Clock Locking

Stage	Description
Acquisition	Establishes sync flow and determines initial offset
Qualification	Monitors sync packet stability to qualify the master clock for tracking
Tracking	Begins reference oscillator alignment process to "tune" the slave oscillator to the grandmaster
Lock	Slave oscillator is now locked to the grandmaster and will begin long-term tracking to hold the frequency stability inside the application limits

TABLE 1 IEEE 1588 PTP slave clock acquisition and locking process.

Typical IEEE 1588 slave clocks for stringent telecom applications can take on the order of an hour to achieve fully locked status. Grandmaster failover provisioning is an important consideration for overall network performance (Figure 2). IEEE 1588 PTP slave clocks can be provisioned to switch to a backup grandmaster if the master clock it is locked to goes offline, but this may cause the slave clock to drift outside the application limits while it is acquiring, qualifying and tracking to the new grandmaster. The backup grandmaster could be in an entirely different network location with a significant sync offset that the slave clock will need to contend with.

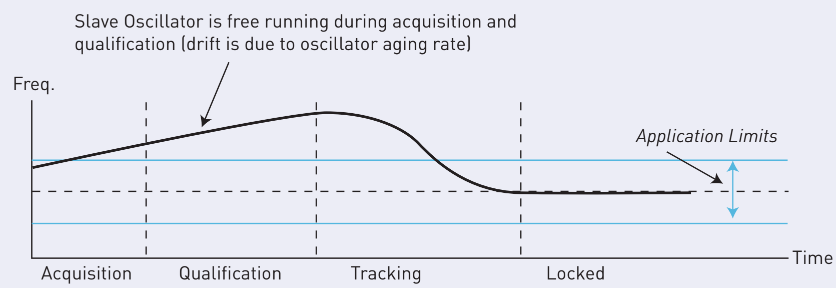


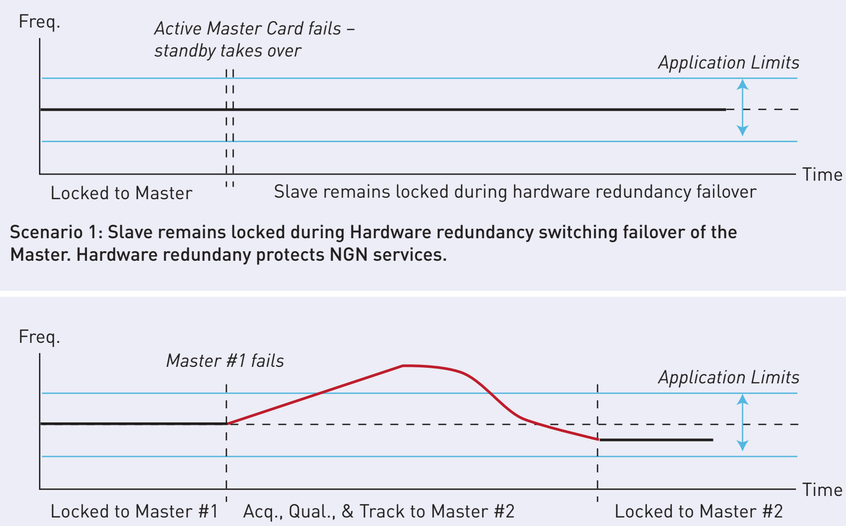
FIG. 2 Illustration of IEEE 1588 PTP slave clock acquisition and locking process. When the oscillator is locked, it can be held within the application limits for the target deployment requirements.

1 Refer to the white paper: Deployment of Precision Time Protocol for Synchronization of GSM and UMTS Base Stations. See www.symmetricom.com.

Hardware Redundancy Protects Network Performance

A far superior method is to implement a carrier class IEEE 1588 PTP grandmaster clock with hardware redundancy. A fully redundant grandmaster clock will employ an active and standby card-based configuration. The active clock will connect through the network switching fabric to service all PTP slave synchronization flows in its timing domain. The standby master will shadow the active master with all settings including the IP address, but will remain dormant until either the active master fails, or the link to the switch goes down. At that point, the standby grandmaster will go active and take over the IP address with a gratuitous ARP to the switch. All PTP sync flows will be switched to the redundant master with no impact to the IEEE 1588 slave community. Since the active and standby clocks share a common reference, the IEEE 1588 slave devices see no synchronization offset during a failover switching scenario. The slave clocks will all remain locked to the redundantly protected grandmaster, and will not be forced to acquire, qualify and track to a new grandmaster clock with an unknown offset.

Figure 3 illustrates the benefits of IEEE 1588 PTP grandmaster redundancy. The IEEE 1588 slave clock in scenario 1 remains locked throughout the redundant switching and in practice does not even know that the event has taken place. On the other hand, the IEEE 1588 slave clock shown in scenario 2 goes out of lock as it switches to its backup master clock's IP address and initializes the acquisition, qualification, tracking, and locking process with the new grandmaster clock. The re-locking duration and resulting phase and frequency offsets are functions of the slave clock design, grandmaster performance, and network path and delay differences, much of which can be avoided by deploying a carrier class IEEE 1588 grandmaster clock with hardware redundancy.



Scenario 1: Slave remains locked during Hardware redundancy switching failover of the Master. Hardware redundany protects NGN services.

Scenario 2. Slave switches to a back-up Master. Potential service impact while slave is out of lock while it acquires and tracks to the new Master reference frequency.

FIG. 3 IEEE 1588 PTP grandmaster clocks that employ hardware redundancy protect slave clocks from potential service impact during failover scenarios.

Summary

As advanced network elements begin to see deployment with IEEE 1588 PTP slave clocks, consideration must be given to how synchronization is protected during failover events. IEEE 1588 slave clocks rely on continuous communication with the grandmaster clock. Deployment of carrier class IEEE 1588 grandmaster clocks with hardware redundancy assures that all slave clocks remained locked and fully protected during clock failover events.