Considering Holdover in a Telecommunications Network

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Synchronization and timing are essential to telecommunications networks to ensure optimal performance and prevent packet loss, dropped frames and degradation of quality of experience that will affect end user services. Precise synchronization is especially critical in mobile networks for the successful call signal handoff and proper transmission between base stations, as well as for the transport of real-time services. Holdover is the time period required to keep the network sync-stabilized when the source of sync is disrupted or temporarily unavailable.

In traditional digital telecommunications networks (TDM), sync was maintained by employing two types of synchronization elements, Primary Reference Clocks and distribution clocks (PRS or PRC), over a physical circuit. The PRC or PRS (using either Cesium or GPS) provides the reference signal for the synchronization of other clocks within a network, or section of a network. Distribution clocks (called BITS, SSU or SASE depending on configuration) select one of the external synchronization links coming into a station as the active synchronization reference. These two types of clocks attenuate jitter and wander, maintain operation in hold-over mode, and provide synchronization outputs to all Central Office network elements.

As networks transition from TDM to packet-based next generation networks, choosing a sync technology becomes more challenging because packet-based networks do not deliver synchronization naturally as the TDM network elements did. So synchronization (and QoS, quality of service) must be engineered into the packet backhaul. If individual base stations drift outside the specified frequencies, subscriber performance will be impacted by call interference, dropped calls and impaired data services. In the event that timing or synchronization reference is temporarily lost, a network’s ability to maintain time or “holdover” becomes critical to ensure optimal network performance.

The Importance of Holdover

In certain geographical areas where GPS signals are received only intermittently, holdover is crucial for the operation of base stations. Holdover technologies are also

necessary to maintain sync during GPS outages caused by external events, such as in 2007 in San Diego when the US Air Force's wide-scale denial of GPS caused a major GPS outage. Criminals can also jam GPS signals locally, given the commercial availability of GPS jammers, and environmental factors such as sun spots also contribute to GPS disruptions. Further, if telecommunications regulations such as E911 requirements are violated, the operator may incur additional expenses of reporting outages and carrying out audits.

Holdover Requirements and Technologies

Holdover is achieved by equipping base transceivers stations (BTS) with oscillators that temporarily "hold over" sync signals. Holdover capability can range from several hours to several days depending on the quality of the BTS's oscillator. Holdover requirements are not standard; they vary depending on the type, complexity, and operator requirements. LTE TDD networks have stringent timing requirement, + 1.5 microseconds.

Location based services (LBS) and E911 impose exacting sync requirements in order to accurately locate the handset by triangulating from base stations; this imposes extremely precise sync requirements (up to 0.2 microseconds).
The most commonly used holdover source is an Oven Controlled Crystal Oscillator (OCXO) which can ensure 8 microseconds of holdover from 8 to 24 hours, depending on its performance level (different grades of OCXO deliver varying holdover performance). The OCXO performance can be enhanced (with software and processes) to provide either longer holdover or more precise holdover. Rubidium oscillators deliver a much higher level of performance and precision with up to 7 days holdover.

Holdover Technology of the Future

A better solution that will further extend the holdover range of OCXO will combine Sync-E, IEEE-1588 (PTP), and GPS are currently being designed and tested for deployment. Sophisticated optimization and monitoring algorithms are used to combine GPS (primary) and other sync signals to produce the 'best of all worlds' sync output. PTP and GPS can deliver the time (phase sync) and frequency sync while syncE and the OCXO provide frequency output (extension of 'SETS' concepts). In this solution, multiple technologies aid one another to achieve optimum holdover.

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