OSCILLOQUARTZ
A division of Adtran

Solution Brief

Synchronizing 5G networks

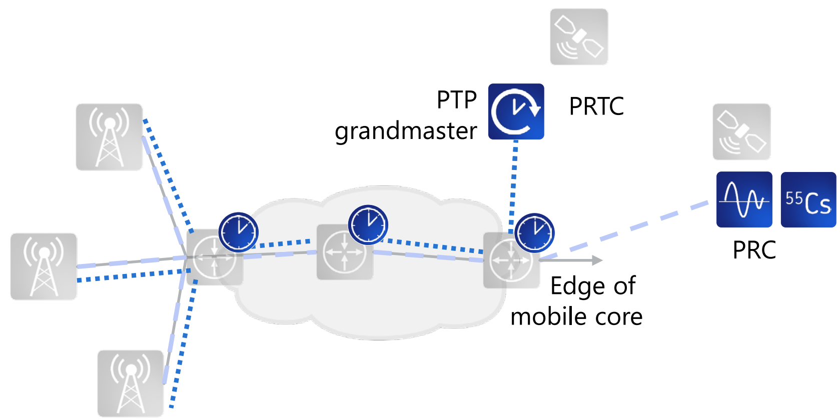
Overcoming the sync barrier

Highlights

- TDD , carrier aggregation and coordinated multi-point transmission require tightly synchronized base stations
- Location services need accurate time at base stations
- Mobile networks are implemented in a distributed way with precise timing needed at all sites
- Industrial control applications must be accurately synchronized
- Synchronization between distributed compute processes requires accurate timing

Many mobile networks are using highly stable, GNSS-synchronized core grandmasters backed-up by atomic clocks and a packet network with at least partial on-path PTP support. Such advanced synchronization networks will allow them to deliver 1µs timing accuracy to their base stations. This is sufficient for most of today's use cases. But this level of accuracy is not enough for emerging radio access features or lucrative new IoT services. What's more, mobile network operators applying satellite-delivered synchronization at the cell site need to develop strategies to mitigate the risk of GNSS unavailability.

Synchronizing 5G networks



Cell site timing with µs accuracy

Aiming at an ultra-precise 100ns timing accuracy and beyond

Demanding applications, such as location services, require ever-increasing timing accuracy at base stations. In order to locate a user device with sufficient levels of precision, time difference between base stations should be in the range of 100ns. Similar timing accuracy is required for radio technologies that aggregate multiple carriers for more bandwidth per user or that apply complex MIMO concepts to better utilize the scarce spectrum. The distributed implementation of mobile radio access networks requires precise synchronization at all mobile sites. End-user applications also require tight synchronization to efficiently run applications at the edge and in the cloud. Consequently, mobile network operators must identify ways to improve the accuracy of timing at their cell sites.

Improving all components

Standard bodies like ITU-T have taken action and tightened specifications for equipment used in synchronization networks. With G.811.1, an enhanced primary reference clock (ePRC) specification was released for ultra-stable clocks. G.8272 defined class A and class B primary reference time clocks (PRTCs), and G.8272.1 defines enhanced PRTCs (ePRTCs) with very stringent holdover requirements. Furthermore, boundary and transparent clocks in packet networks need to better compe nsate for transient delay. ITU has tightened the respective specification, with G.8273.2 defining improved boundary clock types C and D. It's now up to the equipment suppliers to provide products that meet these more stringent synchronization requirements for the delivery of ultra-accurate synchronization to the cell site.

Better clocks at the mobile core

There are two essential technologies for improving the accuracy of clocks and time clocks in the core of the network. Firstly, GNSS receivers used for synchronizing time to UTC must compensate for atmospheric delay variations. Multi-band receivers using multiple constellations can efficiently eliminate those inaccuracies and improve reliability. Secondly, the holdover capability of the clocks must improve. Today, magnetic cesium atomic clocks are applied as ePRCs. But this technology will not meet tighter specifications. Improvements to this legacy technology are required and optical cesium is the most promising candidate for meeting more stringent holdover requirements.

Improving synchronization over packet networks

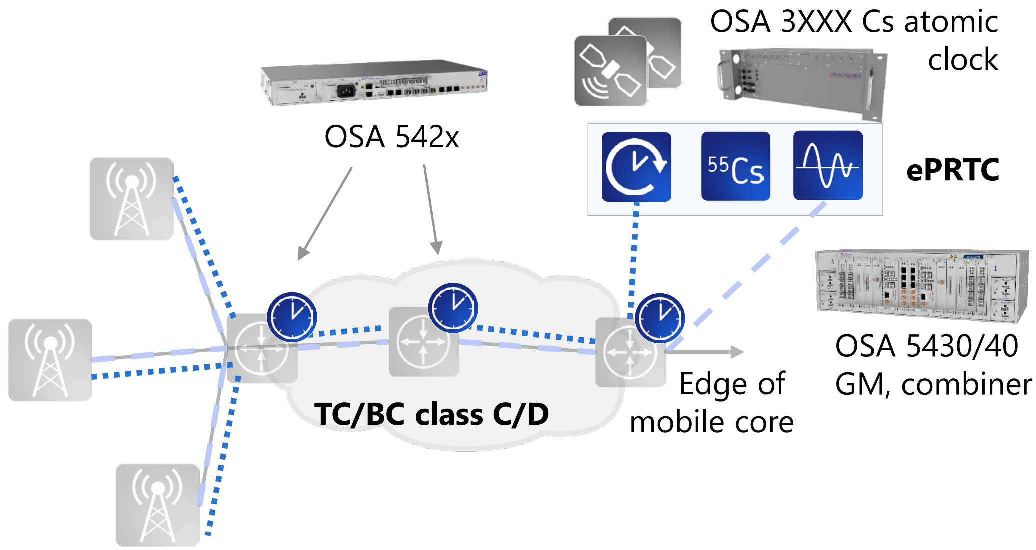
Jitter and asymmetric delay are impacting the quality of network-delivered timing. Boundary and transparent clocks on the data path significantly reduce the variable delays and asymmetric PTP delay caused by routers and switches. With tighter specification of those clocks, the delivery of time over packet networks can be significantly improved. Alternatively, the delay characteristics of the data path can be improved by allocating a separate transmission channel for the transport of synchronization information. This could be achieved with a parallel synchronization network using dedicated optical channels. This second alternative is gaining momentum as it proves to have operational advantages.

Improving mobile synchronization networks

- Packet network delivers PTP using enhanced boundary or transparent clocks
- Mitigate GNSS accuracy problems with multi-band GNSS receivers
- Combining network-based timing with satellite-based backup
- Assuring synchronization quality with sophisticated sync probes
- Optionally, using a parallel network for delivering synchronization over a dedicated path

Better clocks for mobile networks

Oscilloquartz is continuously pushing the limits of its synchronization portfolio towards higher accuracy, better performance and assured quality. The OSA 5430/40 Series of multi-technology core grandmasters have been equipped with multi-band GNSS receivers and clocks featuring improved holdover capability. OSA 5430/40 and the OSA 5420 Series boundary clock now meet even the most stringent class D specifications. With emerging optical cesium atomic clocks, this portfolio is ideal for building future-proof 5G synchronization networks.



Towards <100ns accuracy