Microsemi re-architects Phase Synchronisation with Gateway clock for LTE and 5G

Growing data demand is driving densification of mobile networks using small cells together with advanced techniques to increase spectrum efficiency. Peak performance requires tight phase synchronisation between cells which is being widely deployed by the more advanced cellular networks.

I spoke with Eric Colard, Head of Emerging Line of Business at Microsemi, to learn how they have responded with a new architecture that combines resilience, scalability and performance.

We've been talking about the need for Phase Sync for some time. How urgent is the market demand?

Phase Synchronization is becoming really important for cellular networks today as they start to deploy the more sophisticated features of LTE Advanced. It allows them to make very efficient use of their spectrum, increasing the capacity from existing base stations and making best use of their existing investment.

We are working with advanced planning departments within a number of leading operators worldwide as they look to refresh and update their timing systems to support LTE Advanced and 5G.

In addition to the latest equipment, there remains a considerable amount of legacy base stations and backhaul to support, with most networks having at least two base station vendors, each with several generations of products serving 2G, 3G and 4G. There is also a mix of transmission/backhaul routers and switches, some fully compatible with phase sync transmission using IEEE 1588v2 and some not.

This leads to a need to supply a wide variety of different synchronization mechanism at different points throughout the network, everything from frequency timing on older E1/T1, to IP over Ethernet using both SyncE and 1588 packets connected via RJ45 copper cables and optical fibre. The timing solution must also be able to supply a variety of different PTP timing profiles.

Microsemi have developed a comprehensive new product, the TimeProvider® 4100, to serve these new market requirements. It complements their TimeProvider® 5000 GrandMaster and is centrally monitored through their TimePictra synchronization management platform.

What is the primary timing source?

Originally Frequency synchronization was distributed through SDH/SONET in the frame structure of the E1/T1 physical signal.

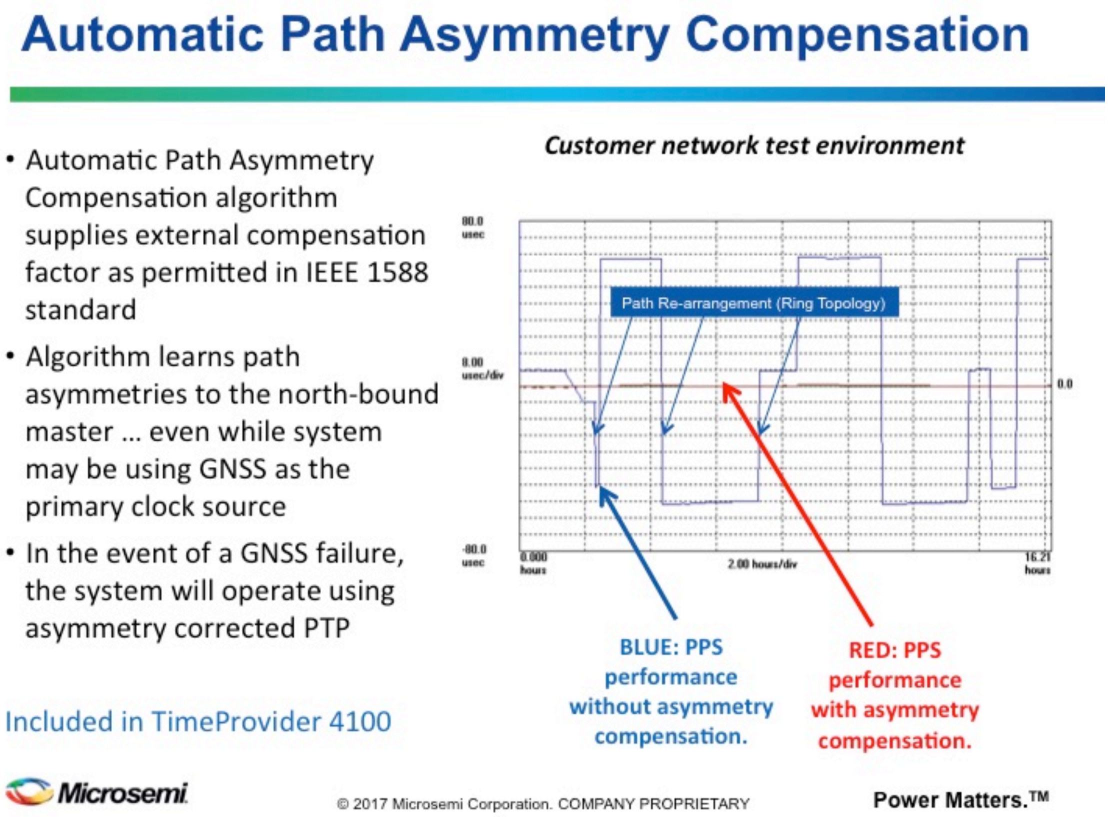
With the advent of all IP networks, timing is more commonly distributed by a combination of SyncE and PTP.

3G and recently LTE FDD networks have typically been driven from central GrandMaster clocks with over 400 operators having deployed our popular TimeProvider® 5000 system to achieve extremely high performance and stability.

With the advent of phase, on LTE TDD and LTE-Advanced, additional challenges have emerged as the timing requirements have become stricter and the impact of the network needs to be taken into account. For this reason GrandMaster clocks need to be deployed closer to the network edge in order to stay within the ITU-T defined time error budget.

One key aspect to consider is the impact of asymmetry of the network. Downlink and uplink paths are usually different lengths thus creating an asymmetry that needs to be assessed and corrected. Of course operators wish to not have to correct this asymmetry manually; this is why it is critically important for a GrandMaster to be able through sophisticated algorithms to automatically compensate for the asymmetry.

The chart below illustrates the improvement from Automatic Path Asymmetry Compensation utilized in the TimeProvider® 4100 system.



Another approach to synchronize the base stations and small cells is to use a direct input from external GNSS satellite clocks, such as GPS. These are easily accessible anywhere you have sight of the sky and generally very reliable. However there is a risk of disruption from jamming or technical fault. 1588v2 GrandMaster clocks play an important role as a backup mechanism to GNSS failure.

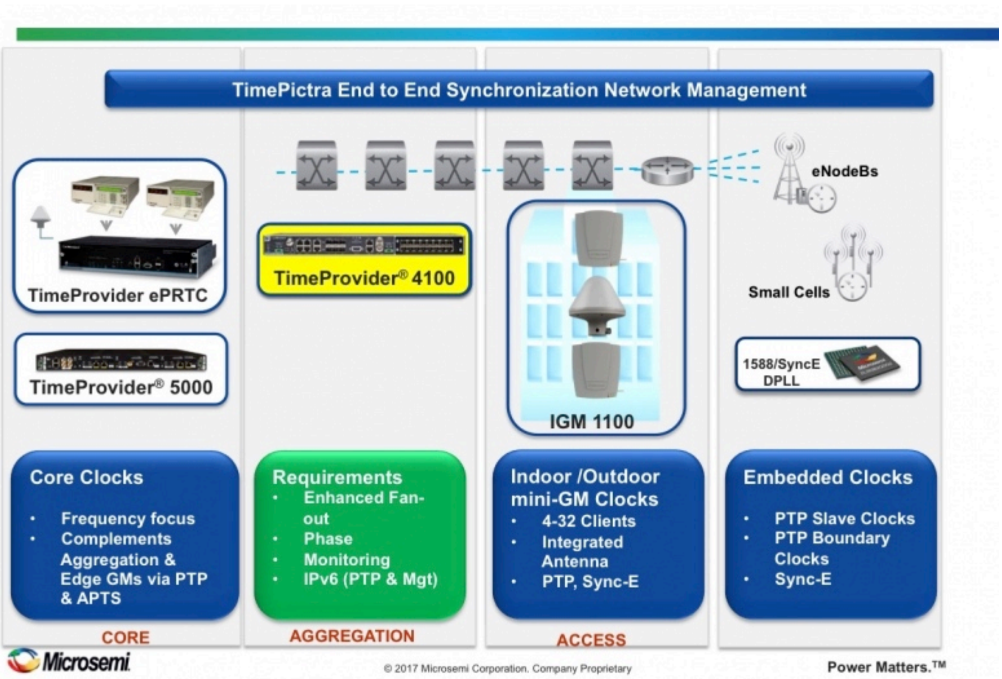
The oscillator of the GrandMaster clock can enable continued operation in holdover mode which can be extended by using a high quality oscillator such as a Rubidium atomic clock which Microsemi designs and manufacturers as well.
In addition Grandmasters deployed in the core of the mobile network such as a TimeProvider® 5000 can be connected to a TimeProvider® 4100 at the aggregation layer to provide very precise frequency and phase via SyncE and PTP while utilizing the advanced asymmetry compensation features discussed above to provide maximum resilience and robustness in end to end network synchronization.

How do you achieve high resilience and redundancy?

If the timing signal is lost or goes out of specification then the base stations may downgrade performance or even stop transmitting to avoid interfering with the rest of the network. A complete loss of clock sync may take quite some time to resync fully, leading to outages of tens of minutes or more before recovery. It's best not to lose sync at all if you can avoid it.

This is done by locating timing sources at different points throughout the network:

- Centrally (major switching centres)
- Major Aggregation Points (backhaul hubs)
- Locally (close to base stations)



The central grandmasters will have the highest specification oscillators, such as Rubidium clocks, capable of maintaining accurate phase timing unassisted for days. Aggregation points are more likely to be OCXOs with a shorter but adequate standalone holdover time. Local clocks at the edge could use mini-OCXOs at lower cost but we expect most shipments will use an OCXO as a minimum. PTP distribution with advanced asymmetry compensation allows the benefits of the highly accurate central rubidium clock to the shared throughout the network.

Redundancy is built into each product – there are dual independent power inputs, dual external distribution feeds and automatic failover to external slave clocks in case of outage.

What is a Gateway Clock ?

The TimeProvider® 4100 is a gateway clock, a new class of synchronization product that accepts multiple inputs from Global Navigation Satellite Systems (GNSS), Synchronous Ethernet (SyncE), and 1588 PTP and E1/T1 digital transmission links, and distributes timing flows to multiple end points such as base stations. A gateway clock benefits from multiple layers of protection leveraging other assets in the core of the network.

TimeProvider® 4100 is a best-in-class 1588 grandmaster complemented by extensive port fan-out for PTP, Network Time protocol (NTP), SyncE, and legacy building integrated timing supplies (BITS). With multiple ports for current, legacy, and future networks that can be connected to multiple base stations for 4G and 5G deployments, the device offers customers a cost-effective solution that can be easily adapted for a wide variety of use cases.

The standard product can drive up to 64 clients with software upgrade to as many as 512. Each client is sent packets at the full 128 packets per second rate, where other simpler products on the market may need to reduce their PTP message rate to support increased client capacity. This makes it more difficult to engineer a robust and predictable timing environment.

Alternatively, you could architect your network with more boxes closer to the network edge each driving fewer end clients.

Where legacy equipment is used through E1 or T1 ports, we can connect up to 20 per box. A second box operating as a slave could be used to expand capacity to 40 physical E1/T1 timing links where needed.

The wide range of connectivity options, from legacy E1/T1 through to SPF optical fibre ensures flexibility for both short and long term network evolution. You can mix and match PTP profiles, and configure different PTP services on any port.

The photo below shows the wide range of physical ports available. The bottom picture includes the optional 16 extra E1/T1 physical sync ports for legacy equipment.

Will this meet future needs for 5G?

The leading operators we are working with are designing for an end-to-end budget of 1.5 microsecond phase timing which is adequate for all 4G features. A few have been asking for as little as 500 nanoseconds in the near future.

The TimeProvider® 4100 is based on our latest architecture and will evolve as standards become more stringent. This is true for PTP standards as well as other topics such as prominent GNSS constellations support. TimeProvider® 4100 for instance supports today GPS, GLONASS, BeiDou as well as Galileo.

Read more about Microsemi's latest TimeProvider® 4100 product on our website or watch me demonstrate the product in this YouTube video.