A new era

for 5G synchronisation

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5G signifies a new phase of connectivity delivering super-fast, low-latency bandwidth that is reshaping all industries and sectors. We have just started scratching the surface of new use cases and innovation potential. However, rolling out 5G is neither simple nor straightforward. In fact, the 5G rollout varies across different telecoms operators, geographies, and markets — and meeting its requirements can be costly and complicated.

The 5G infrastructure market is growing exponentially with a CAGR of 60% and is estimated to reach a total market size of about $50 billion by 2027. 5G networks are evolving to bring new mission-critical applications to life, including robotics, real-time industrial applications, self-driving cars, and bluelight communication. 5G relies on stringent requirements, especially around time synchronisation. Any failure to deliver precise and accurate time synchronisation leads 5G services to cease to work. A faulty synchronised base station will interfere with the 5G operations of other operators as well, creating more problems across networks.

It's essential for telecoms operators globally to deliver accurate and secure 5G synchronisation across their networks. So far, this requires significant investment which raises 5G rollout costs dramatically. According to a report by Kearney (April 2020), the synchronisation cost is estimated between 3-5% of the total 5G network rollout cost, i.e., $1.5-2.5 billion in 2027 and can in many cases require a large forklift upgrade of old infrastructure to enable PTP network synchronisation — these costs are too cumbersome for a large number of operators.

Moving forward, we will be seeing an increasing number of telco companies leveraging 5G synchronisation to ensure they're keeping pace with 5G rollout across markets. To ensure they're not left behind, operators need to consider technology solutions that can help them meet network synchronisation requirements quickly, securely, and cost-effectively.

Understanding 5G network synchronisation

Network synchronisation is critical for mobile networks. These networks are expected to deliver higher capacity and speed to serve new applications and services. The requirements for 4G/LTE network synchronisation are already demanding. However, 5G is bringing new and more stringent synchronisation expectations for mobile networks.

5G brings an increased focus on TDD (Time Division Duplex) technology, which requires a much tighter synchronisation, compared to, for instance, FDD (Frequency Division Duplex)

as in most 4G/LTE networks. Moreover, new features and advanced network techniques such Massive MIMO, Carrier Aggregation (CA), License Assisted Access (LAA), and Coordinated Multi-Point (CoMP) transmission and reception technologies require further enhancements in synchronisation. The synchronisation requirements cover both neighbouring base stations and devices across the network.

GPS-based synchronisation is ineffective

Up to now, mobile networks could deliver synchronisation to base stations and small cells with Global Navigation Satellite System (GNSS) such as the Global Positioning System (GPS) and Precision Time Protocol (PTP).

GNSS solutions deploy GPS receivers together with the base station antennas. Although, they provide highly accurate network synchronisation, there are also several downsides. The densification of mobile networks with many small cells makes GNSS-based solutions very costly. These solutions are also vulnerable as it is easy to jam out GNSS signals, either by blocking them out completely ("jamming") or by replacing the GNSS signal with a similar but incorrect signal ("spoofing"). Today, we're seeing an increasing awareness of GNSS jamming and/or possible spoofing due to the current geopolitical situation, with the Russian invasion of Ukraine. In fact, the European Union Aviation Safety Agency (EASA) issued a safety information bulletin on March 17, 2022 warning of GNSS outages leading to navigation/surveillance degradation that have intensified in geographical areas surrounding the conflict zone as well as in other areas.

The Swedish regulator, Swedish Post and Telecom Authority (PTS), are explicit that a GNSS independent solution to transport synchronisation is a mandatory requirement for operating the 5G network.

5G mobile networks also bring increased demands on cell density, indoor cell coverage, and deployment in challenging geographical areas, such as tunnels, buildings, and factories where satellite visibility is compromised. Likewise, deployment in areas with limited satellite visibility, such as urban areas where buildings obstruct the view and rural areas with deep forests and canyons, demonstrates the limitations of GPS-dependent solutions.

PTP solutions lead to skyrocketing costs

An alternative method to GNSS 5G synchronisation solutions is network-based timing based on packet switching technology, mainly Precision Time Protocol (PTP or IEEE1588v2), supported by Synchronous Ethernet (SyncE). PTP solutions experience the vulnerabilities of GNSS-based timing in terms of safety, robustness, and ease of deployments. However, there are still considerable challenges when introducing support for PTP and/or SyncE in mobile networks. In particular, the transition to network-based timing requires considerable investments in new or upgraded hardware equipment and software since PTP require every node to provide on-path PTP support (in HW) to ensure accuracy. High-precision synchronisation may require existing networks to be reorganised to enable the communication of timing information. Alternatively, new, parallel infrastructures may need to be established exclusively to carry this information. As a result, many operators will find it challenging to transition their full networks to network-based timing.

In addition to the main approaches described above, there are other synchronisation technologies that could be considered for 5G mobile networks. One is White Rabbit, which combines PTP and SyncE and introduces additional mechanisms to improve synchronisation accuracy. It is specifically designed to meet the stringent requirements for particle accelerators and is typically used in dedicated fibre or LAN environments. Another approach is Over-the-Air Time synchronisation (OTA), which is designed for ultra-reliable and low-latency communications (URLLC). OTA is a radio interface-based synchronisation solution that has been used for synchronising base stations in 4G/LTE and is an alternative that is put forward for 5G mobile networks in the RAN (Radio access Network).

Ushering a new era in 5G synchronisation

Time synchronisation is becoming critical for various market segments, including power networks, synchronisation of distributed databases, stock exchange trading, distributed video production, and defense networks. The synchronisation challenge is highly relevant for other real-time critical network installations, such as digital terrestrial television (DTT) networks with stringent frequency, phase synchronisation, and accuracy of ~1 µs requirements.

To address this challenge, telecom operators can leverage solutions, provide distribution of absolute time with very high accuracy over the existing IP network. These solutions do not require all nodes to be upgraded for on-path PTP support. This means that they may significantly reduce CAPEX and OPEX and speed up rollout times. GPS-independent solutions create a virtual synch network over the existing IP network that distributes time from clock sources such as atomic clocks out to base stations or the radio access network while managing all redundancy, security, and asymmetries in the IP network.

Additionally, they are augmented with software for running over public managed IP networks with possible delay asymmetries. A key benefit of GPS-independent solutions refers to their openness and interoperability, enabling operators to integrate them within their existing network infrastructure. In fact, they operate in a complementary way to GPS-based solutions, addressing their security challenges.

GPS-independent solutions enable geographically disadvantaged regions such as rural areas to access good bandwidth and contribute to closing up the digital divide by removing the cost of replacing the entire underlying network infrastructure to enable 5G deployment. They are also environmentally sustainable as they drive the reutilisation of existing communication equipment, minimising the telecom network footprint.

Telecom innovation is here now

5G revolutionises telecom and mobile communications as we know it, driving change and bringing new use cases and business models to life. So far, 5G synchronisation has been a key roadblock in achieving 5G rollout, slowing down the pace and increasing costs.

GPS-independent solutions redefine what's possible in 5G synchronisation. They leverage existing telecom networks without requiring additional CAPEX. In doing so, they deliver the accuracy, security, and low latency operators need to deploy 5G today. They also enable the openness and interoperability telcos need to integrate them within their current infrastructure, delivering efficiencies across the board. Removing the key challenges of 5G rollout opens up the door for telco operators across the world to transition to 5G smoothly and in a streamlined way. Innovation in 5G synchronisation makes the shift to 5G a reality and it's time for operators to harness its benefits today.