SEVEN Solutions
When every nanosecond counts

IEEE-1588-2019 & White Rabbit for the Mobile Backbone

Telecom Applications

The ITU-R defines three main application areas for the enhanced capabilities of 5G: Enhanced Mobile Broadband, Ultra Reliable Low Latency Communications, and Massive Machine Type Communications, being the last two several years away in most locations, but at the same time drivers of the most advanced 5G applications. This imposes demanding synchronization needs for the mobile networks, making the correct timing a critical factor for achieving the expected 5G performance and mandatory for the future critical mission and low latency applications.




User Challenges

- Distribute reliable time and frequency with the best possible accuracy and precision.
- Deterministic time delivery: guarantee worst case time accuracy for critical mission applications.
- Provide failover mechanisms, cybersecurity, and timing error detection features.
- Provide countermeasures against interference, jamming and spoofing.
- Provide interoperability with COTS devices based on Ethernet interfaces at the aggregation level.
- Provide single deployment with minimal calibration through DWDM networks.
- Maximize the availability of the system and synchronization signals.
- Ensure system scalability.
- Allow the utilization of networking configuration and monitoring tools.

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Context

With the arrival of 5G, the synchronization needs of telecommunication networks have grown due to the diversity of applications that are provided on the infrastructure. Although it is true that the time requirements are not very demanding for the first 5G elements, the Enhanced Mobile Broadband, the situation for upcoming applications of Ultra Reliable Low Latency and Massive Machine Type Communications is very different, imposing significant challenge in the accurate and deterministic time provision. Now, timing has become a critical factor more than ever because critical mission applications cannot operate with average-good and best effort timing.

There are several protocols (mainly NTP and PTP) to carry out the synchronization of a mobile network, but both are designed to work over data networks and their accuracy is affected by the load on the network and the number of hops in the topology. They are on average-good time transfer solutions, but in the worst-case time delivery cannot be ensured. Time is a first order concept, it cannot be easily patched, and its degradation is very difficult to detect and measure on later deployment stages. Mobile networks need to be designed having these issues into account from the very beginning.

For this reason, operators could consider developing specific synchronization networks to have total control over time and how it is distributed throughout the network, guaranteeing the correct operation of the system and the services offered on it. It can also be a key element of the visibility network to verify the network quality of service (QoS) during operation.

A network of this type would consist of three distinct layers: the core or backbone, the aggregation level, and the access level, being the backbone the most critical part of the topology since the rest of the network will depend on its resilience, accuracy, and precision.

The Solution

Seven Solutions proposes to develop a long-distance telecommunications **backbone** (**Figure 1**) relying on the next generation of the time transfer protocol **IEEE-1588-2019** and concretely on the High Accuracy (HA) profile (widely known as **White Rabbit** protocol). This new version of the protocol includes an extension for wide area network (WAN) utilization, cybersecurity mechanisms and the High Accuracy (HA) profile to distribute time and frequency with a deterministic performance better than 1 ns and a very low jitter.

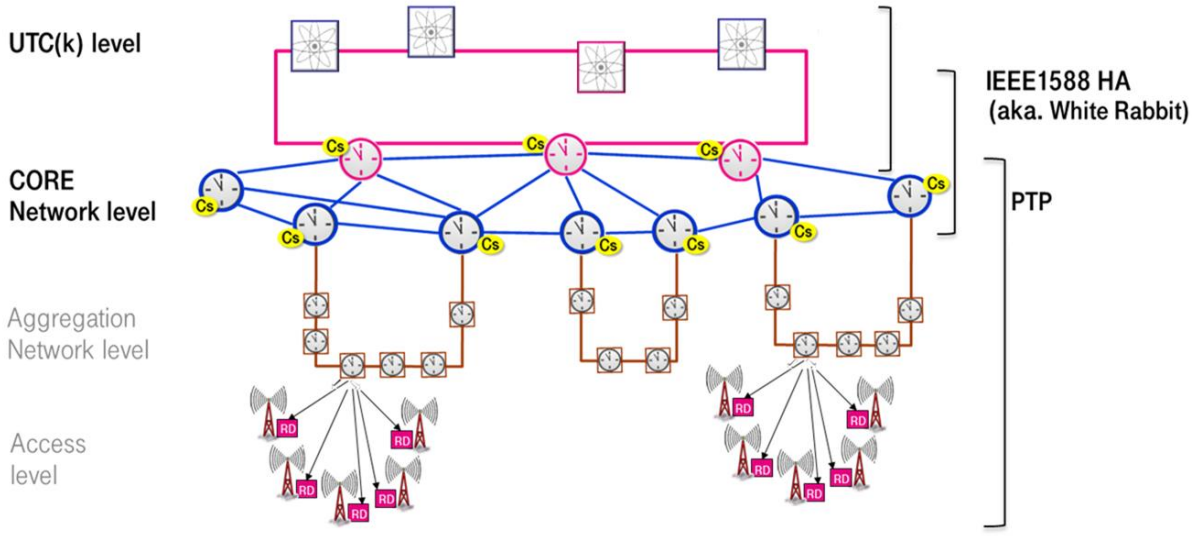

Figure 1: Long-distance telecommunications backbone – Source: Deutsche Telekom

The solution, based on this new profile, uses an infrastructure of redundant as a base and calibrated GNSS time receiver distributed and fibre optics links, whose references are scattered across hundreds of kilometers. In this way, the system will be able to get and distribute the time references available from multiple (and safe) locations to those ones that are experiencing a failure or under attack (**Figure 2**).

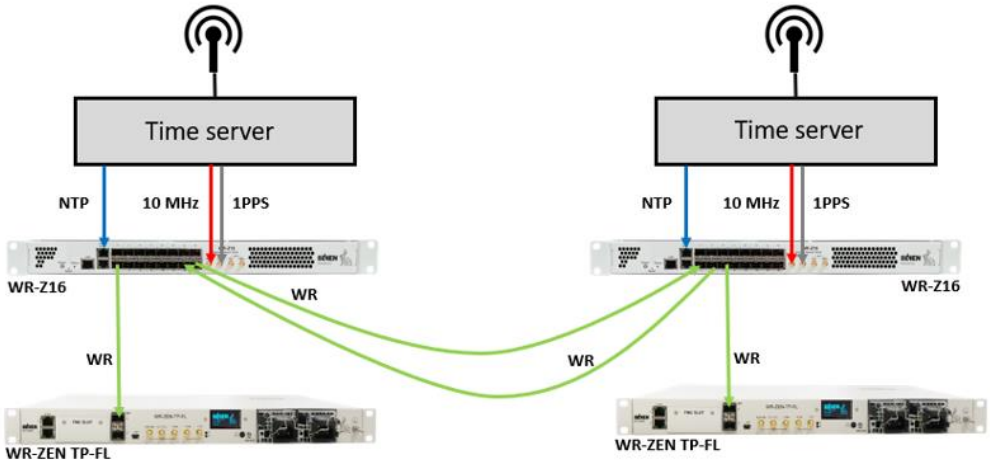

Figure 2: Example of the resilience GNSS link for 2 locations.

In the configuration presented in this case, two **DWDM links** are being used to interconnect both locations. This is recommended to improve the resilience of the system and as mechanism to remove the network asymmetry (**Figure 3**). Any lambdas could be used, and calibration can be easily done using protocol parameters or directly from the calibrated GNSS receivers.

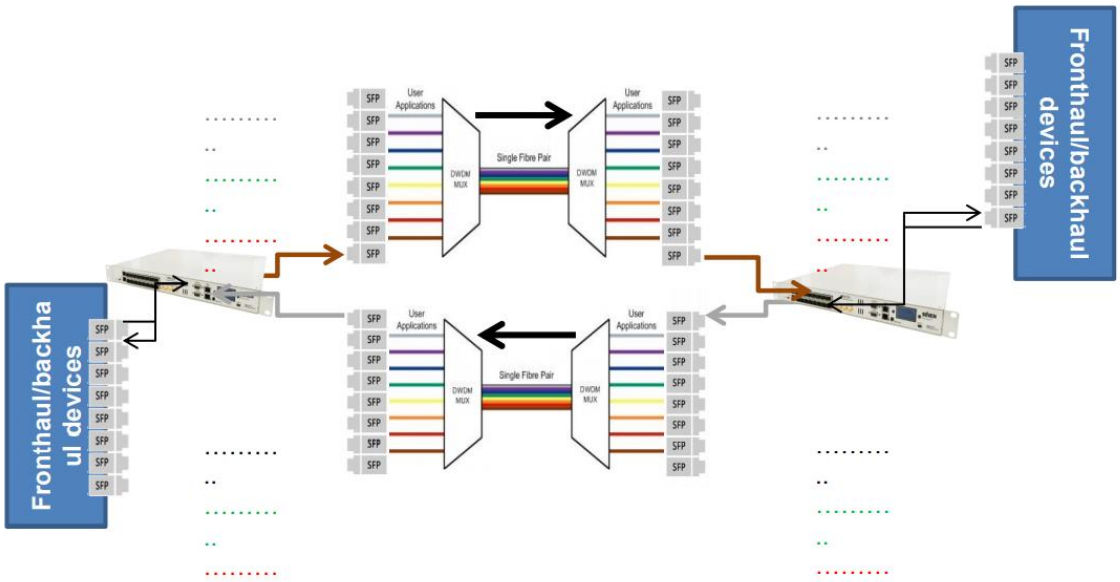

Figure 3: DWDM links

Regardless of this cross-protection mechanism, the key to make the core of the network resilient and secure is to protect **each node** in the network backbone. These ones, as it can be seen in **Figure 2**, are

implemented using a **WR Z16** by **Seven Solutions**. This device stands out for their **security mechanisms** and among them it is worth highlighting the following features:

WR Z16

- **Failover Clock Algorithm** (**FOCA**) which has been designed for the purpose of automatically switching from one timing source to another in case a failure in the active timing source has been detected.
- **Holdover** which permits a maximum time drift of 1.5 usec after 24 hours.
- **Multiple time sources survey capabilities** for timing references cross-validation towards a highly resilient and secure solution.
- **Enhanced API for integration with logs, metrics, configuration, and alerts with third-party tools** including not only SNMPv2/v3 but also support for ELK, Telegraph, InfluxDB, Zabbix, Graphana, Kivana and many other widely use libraries and tools.
- **Security features**, including latest IEEE-1588-2019 authentication and security features against cyberattacks, making possible to deploy flexible security policies according to the security level required for the infrastructure.

As an added benefit, Seven Solutions products support a wide range of interoperability options with different interfaces and timing protocols and third-party equipment (PTPv2, NTP, PPS/10MHz, White Rabbit Integration, etc). These options are relevant for allowing the possibility of extending the capillarity of the network by providing **interoperability protocols** downstream from the backbone to a lower network stratum.

Seven Solutions has developed specific templates which facilitate the integration of their devices via SNMP with the most used external tools for **monitoring and management** of networks, such as **Zabbix** (**Figure 4**), InfluxDB, Graphana, Cronograph, etc. This integration, which requires configuration and customization of the monitoring tools, is complex, but once carried out by Seven Solutions, the client will be able to monitor their system in a **very visual and easy-to-use way**.

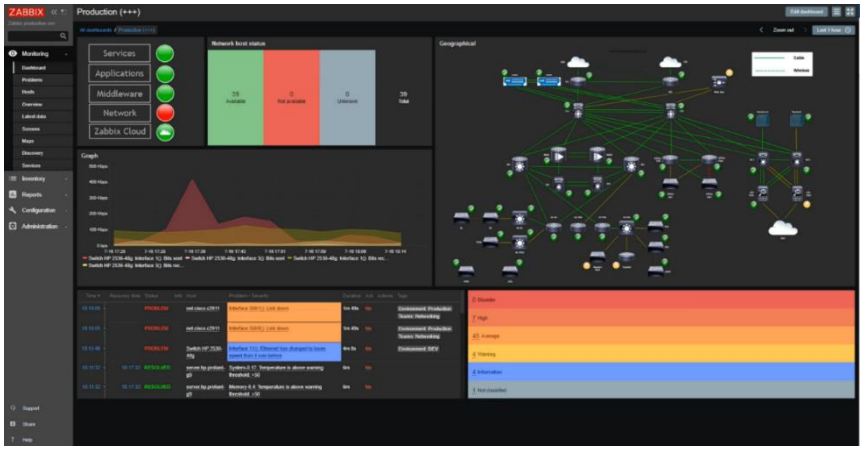

Figure 4: Zabbix

Conclusions

Seven Solutions proposes the deployment of a long-distance network core based on a redundant and resilient GNSS system. To do this, the network nodes that will present from radio frequency security to

network cybersecurity, including redundancy mechanisms and threat detection such as jamming, and spoofing are set up. These network nodes will communicate through DWDM links and the IEEE-1588-2019 network protocol to achieve sub-nanosecond precision between them. Furthermore, this backbone will allow to extend the capillarity of the network by providing interoperability protocols downstream to a lower network stratum and finally, the entire system will be able to be monitored by the most powerful and used tools in the market.

In this way, the solution will bring not only high accuracy and resilience but also a deterministic way to deliver time across the mobile network, a unique advantage for the upcoming 5G critical mission applications, as well as a key element to be used by the 5G visibility network.

About Seven Solutions

Seven Solutions S.L. is a privately held company with high expertise in embedded systems and leading accurate sub-nanosecond time transfer and frequency distribution for reliable aerospace and defense, industrial and scientific applications. With more than ten years of expertise in embedded systems design (electronics, firmware, embedded software), we offer the best-in class full turn-key solutions as well as customized solutions for timing applications. We are leaders in time and frequency distribution solutions based on White-Rabbit technology and derived standards (IEEE-1588-2019-HA). www.sevensols.com

About Open PNT Industry Alliance

Seven Solutions is a member of the **Open PNT Industry Alliance** which is a coalition of manufacturers and service providers that have dedicated themselves to helping their customers back up GPS/GNSS by delivering alternative forms of positioning, navigation, and timing (PNT). https://openpnt.org/