SEVEN Solutions
When every nanosecond counts

Backbone Optimization by using the IEEE-1588-2019 & White Rabbit protocols in Telecom Applications

A telecom synchronization network 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 it. Due this fact, its optimization becomes a key and crucial factor considering the tradeoff between cost and performance.

User Challenges

- Distribute time and frequency with the best possible accuracy and precision.
- Provide interoperability by COTS devices based on Ethernet interfaces at the aggregation level.
- Allow the utilization of networking configuration and monitoring tools.
- Maximize the availability of the system and synchronization signals.
- Ensure the system scalability.
- Cost savings.
- Resiliency and traceability capabilities.

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Context

A telecom synchronization network 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 it. Due this fact, its optimization becomes a key and crucial factor considering the tradeoff that exists between **cost** and **performance**.

The core of the network relies on technologically advanced synchronization equipment such as resilient GNSS time servers, **atomic clocks**, or a combination of both, the **ePRTC** clocks to ensure accuracy, precision, stability and the robustness and resilience of the network.

However, some of these devices (atomic clocks, ePRTC, etc.) have a high cost and the core of the network, due to its deployment over long distances, presents a **distributed topology (Figure 1)**. So, the question here would be whether it would be necessary to equip all the nodes of the network with high-cost equipment or an intermediate solution might be reached.

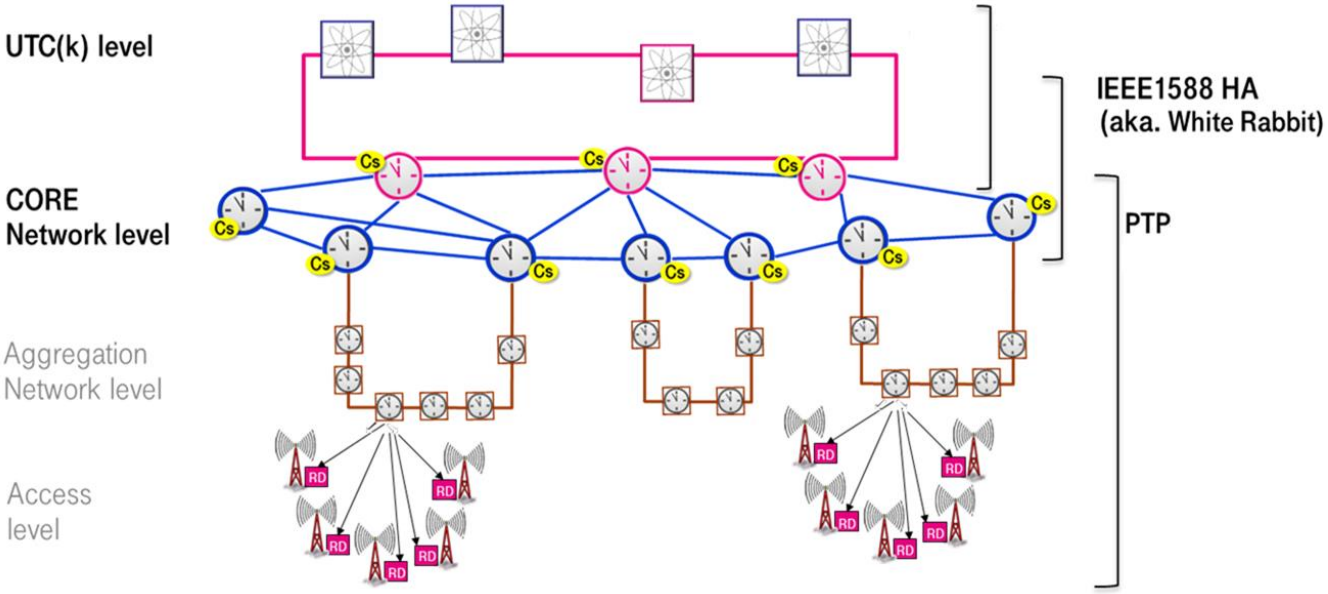

Figure 1: Backbone distributed topology - Source: Deutsche Telekom

The Solution

Seven Solutions proposes deployments of telecom synchronization backbones 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 **performance better than 1 ns** and a very low jitter. The goal is clear: to move from devices resilience to network resilience solutions and optimize the network time budget.

Considering the precise **time and frequency distribution capacity** of the new IEEE-1588-2019 protocol, some **node interconnection scenarios** such as the following ones could be considered (**Figure 2**):

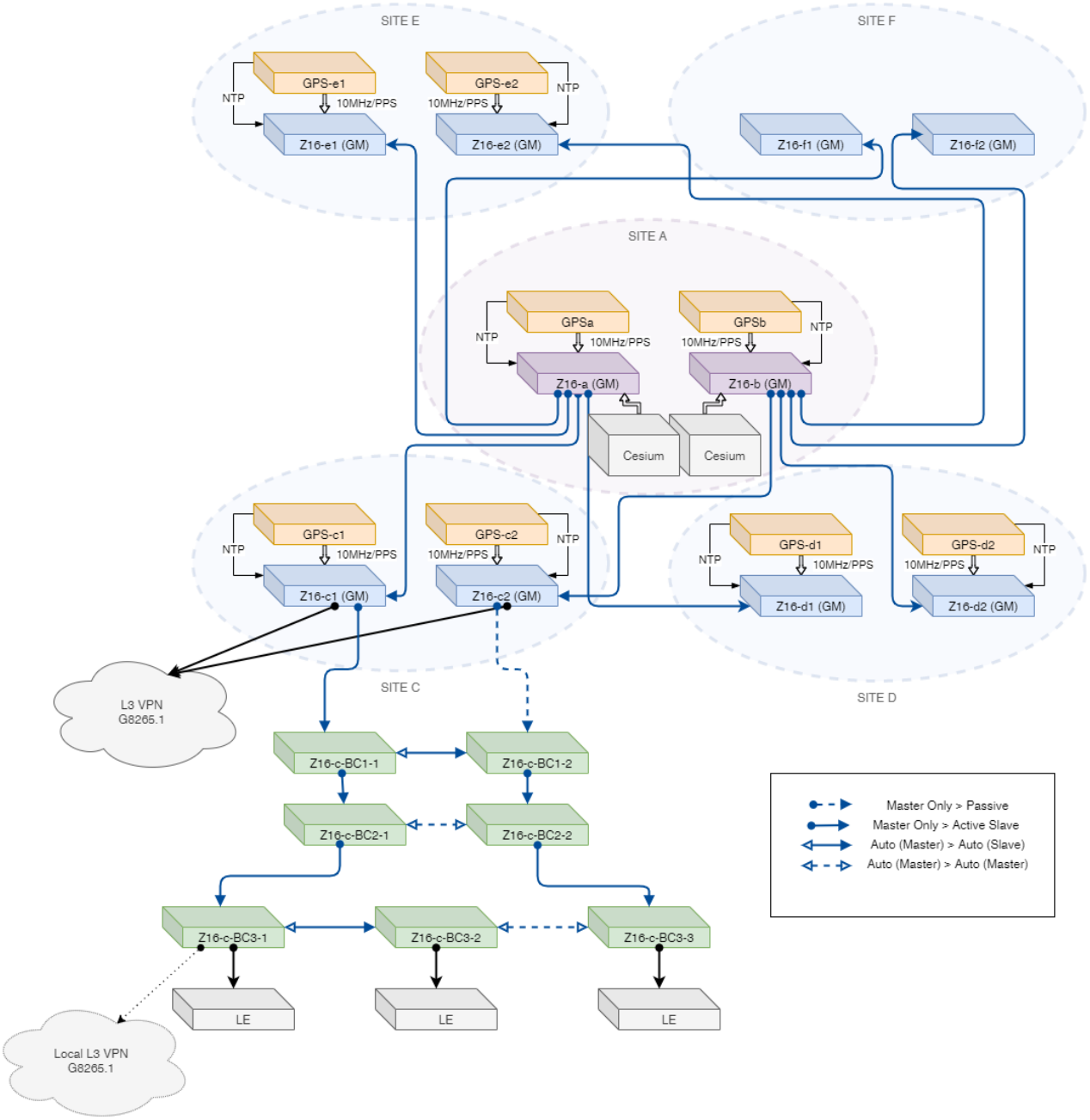

Figure 2: Node interconnection scenarios

As it can be seen in the following example, there is a **redundant central node** (**site A**) made up of **resilient GNSS time servers**, cesium atomic clocks and **time distribution devices** as the **WR-Z16** by Seven Solutions. From this site, the rest of the sites in the topology can be synchronized as follows:

Sites C, **D** and **E** have their own GNSS time servers so that through the time distribution devices they could receive the time provided by the GNSS server or the cesium atomic clock as a backup from site A.

Site F, however, has some special characteristics since it does not have clocks of any kind on the site. This may be due, for example, to the fact that the site might be located in an urban canyon where the GNSS

coverage is limited or the GNSS antenna installation is very difficult, or simply that the budget did not provide neither to install a GNSS server there nor a cesium atomic clock, etc.

To solve this situation, from site A, **site F** will be provided with the synchronization source that is being used at that moment, that is, the GNSS time server or the cesium clock if the former was being attacked by jamming or spoofing or it just was not working properly.

In this way, therefore, the final **backbone configuration** would then be as follows: Site A would have redundant GNSS and atomic sources at the site, sites C, D and E would have a GNSS source at the site and an external source (GNSS or atomic clock) as a backup from site A. Finally, site F would have the source that was running at that time at site A. In this way, all the sites would have redundancy and, with the cost savings that this deployment proposes, it would be solved all the accuracy, precision, stability, robustness, and resilience requirements that the customer might need in the network backbone.

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.

Finally, 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 3**), 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 3: Zabbix

Conclusions

Seven Solutions proposes the deployment of a network backbone optimizing its costs using time distribution devices through the IEEE-1588-2019 protocol and minimizing the number of high value-added equipment. To do this, a topology made up of five sites has been used as an example and different scenarios that could be solved have been considered. Finally, it can be seen that through correct planning of devices and the use of appropriate time and frequency distribution strategies, a satisfactory solution in cost and performance can be achieved for the network and, therefore, for the customers. Finally, note that having a subnanosecond synchronized backbone network will allow saving time budget for the whole network and relaxing the timing requirements of the aggregation or access level layer that now can be implemented with more cost-effective approaches.

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