

Power Substation Synchronization

Time in Power Industry

Digitalization of the power industry requires a comprehensive measure to automation and synchronization of power control systems. This digitalization of the power grids essentially means that substations along the power transmission path must incorporate modern power control system to automate control functions while improving efficiency and productivity of the system. The substation automation system must also enable repetitive corrective actions to prevent failures.

Solution

Thunderbolt GM200

Industry leading edge grandmaster and boundary clock.

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Overview



With the rapid development of the power grid and the large-scale application of automation equipment in power stations, the requirement of high precision time synchronization for power system production and control has become a de facto and central to proper operations.

Global demands for digitalization of power stations increasing and so do the precise synchronization of power control systems to improve efficiency and productivity of power distribution.

CHALLENGE

Globally power grids are operating at maximum capacity, customers are demanding more power and better power quality. To meet these needs, power utilities must increase infrastructure capacity by optimizing existing infrastructure and adding on-demand capabilities with new infrastructure. To optimize infrastructure and provide on demand capabilities, power transmission system including substation must be digitized to improve operational efficacy, automate power control and minimize/correct failures. For example, prepare the substations with abilities to automate corrective actions and clearing of fault as soon it occurs while providing improve capacity.

More importantly, the substations network design must consider time stamping of sampled values (IEC61850-9-2) of current, and voltages.

This means systems throughout substations must be synchronized with high precision clock. The following table depicts various synchronization requirements for power substation design.

Unlike traditional IRIG-B, IEEE1588 better known as PTP (Precision Time Protocol) is not limited by cable distance and separate installation of cable. One of the major challenges has been for many power utilities to implement IEC61850 standards and accommodate precision synchronization needs for modern equipment that requires for digitalization of the substations. The IEC61850 standard requires consideration in many aspects of the practical implementation of substation design including functional hierarchy, topology, communications protocols, inter-changeability of devices, data integrity and maintainability issues etc. The implementation of IEC61850 also means an appropriate highly precision distributed sync design that adheres to its functional hierarchy, topology and communications requirements.

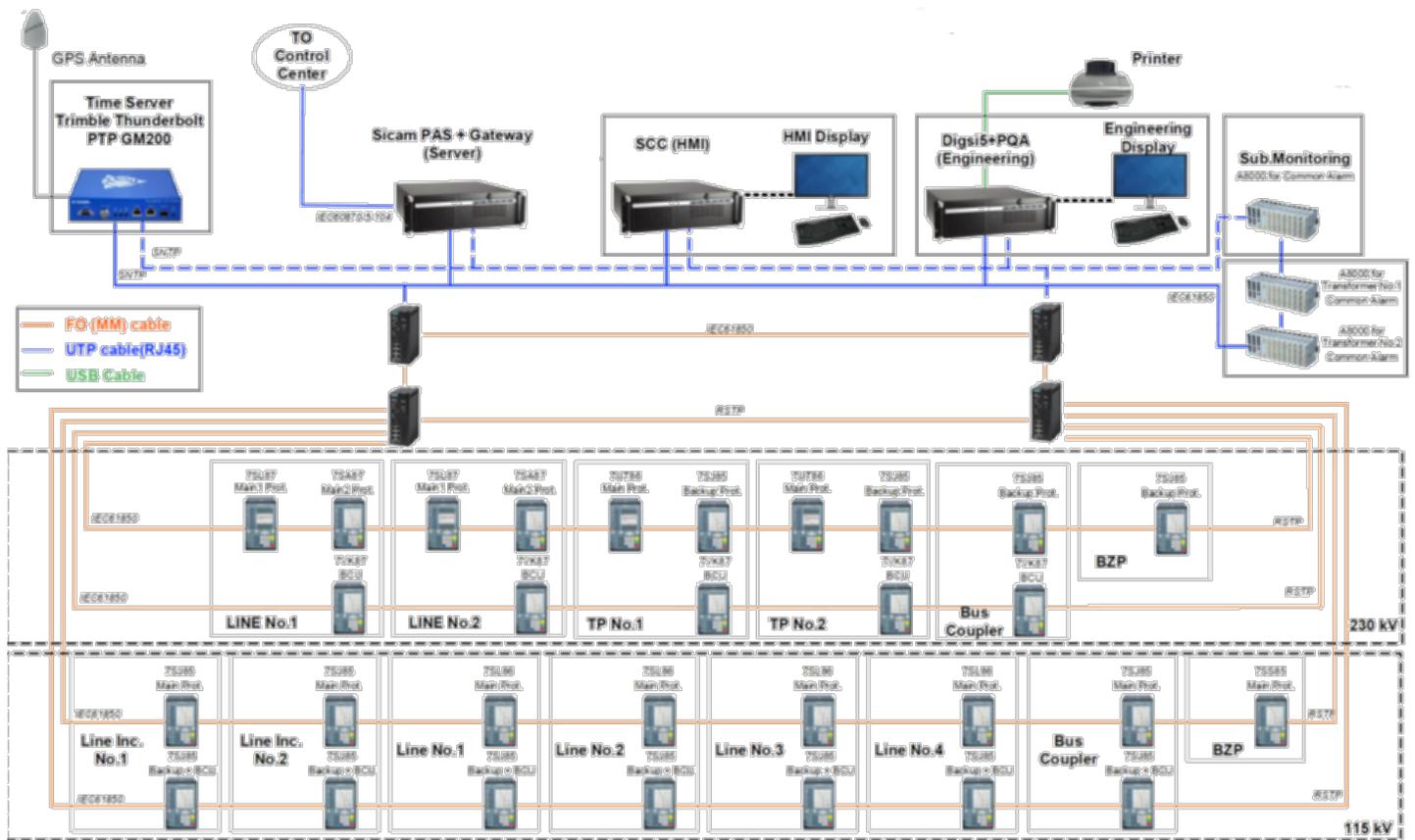
Application	Measurement	Optimum Accuracy	Signal Required
Fault Locator	300 m	< 1 μ s	IRIG/IEEE1588
Relaying (Line Protection)	1000m	3 μ s	IRIG/IEEE1588
Phasor Measurement	\pm 0.1 degree	< 4.6 μ s	IRIG/IEEE1588
Network Controls	\pm 0.1 degree	4.6 μ s	IRIG/IEEE1588
Stability Controls	\pm 1 degree	46 μ s	IRIG/IEEE1588
Event Recording	Record Compare	1 ms	IRIG/IEEE1588
Generation Control (AGC)	Freq. Time Error	10 ms	IRIG/IEEE1588
Telecommunications	2 MHz/ 2 Mbps	1 x 10 ⁻¹¹	2 MHz
Local Area Network	Time Offset	< 1 S	NTP/IEEE 1588



SOLUTION

Substation automation or digitalization requires careful consideration of both network segmentation and synchronization. As depicted in the table presented earlier. Different substation system and applications will require different sync consideration as shown in the table above. While creating an overall precise network is good, there may be constraints to such design due to support for PTP in all devices.

The diagram below depicts a typical substation deployment. In this example, customer used mainly a combination of SNTP and PTP to build their substation network while adhering to IEC61850 standards for substation automation. It is to be noted that industrial (due to environmental requirements) switches are typically used to build the underlying network connectivity for the substation.



contd.

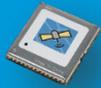
The Thunderbolt™ GM200 provided both PTP and SNTP to the applications respective to their synchronization needs, e.g. Power automation System (PAS) gateway and application server thereof used SNTP while Relays, IEDs and merging units were using PTP. In the substation design presented above, four industrial switches are used for the network connectivity. Two switches are considered leaf switches and other two IEC 61850 compliant switches that act as fabric switches. To eliminate the loop, leaf switches are using RSTP (Rapid Spanning Tree Protocol). It is to be noted that in cases where leaf switches are not PTP aware, care must be taken to calculate network, asymmetry, link level asymmetry and PDV (packet delay variation) to estimate time error for the network. Depending upon network traffic, a PTP unaware switch may induce upto 3 to 4 microseconds time error (TE). In such cases, a boundary clock must be used to improve clock accuracy.

The GM200 is very versatile for such deployment as it supports both grandmaster and boundary clock in the same device making it easier to deploy as a distributed clock source. Additionally, the product supports both NTP and PTP providing backward capability and accommodates varied time requirements typical substation deployments. Moreover, the product is hardened to withstand environmental elements of typical power substations.

Protempis (formerly Trimble's T&F division) has 35 years of time sync experience with thousands of deployments which enables the team to offer unparalleled engineering and product services to vendors and operators.

Precision Time. Perfected.

Learn more at <https://www.protempis.com>



Timing module



Time Servers



Disciplined Clock



Smart Antenna



Dual-band and Single Band Antennas

