Remote access to the UTC(k) primary reference clock

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Access to UTC(k), time scale provided by National Metrology Institute (NMI), is widely recommended and available through various sources and distribution protocols. However, it can be challenging or even impossible to check the entire distribution chain thoroughly enough to calculate the uncertainty of each connection and establish the traceability of time transfer with maintenance of the required accuracy, trustiness and reliability, while the use of GNSS signals may be questionable and carrying risk. When using either the NTP or PTP protocol for a time distribution within open or dedicated network over long distances, the accuracy and stability of time transfer degrade with each network node (Fig. 1a) and other methods should be employed for link calibration. The same applies to long dedicated White Rabbit (WR) cascade links. Therefore, it is useful to find ways to provide to the end user with time signals (e.g. 1PPS) and frequency (e.g. 10MHz) that have the precision of a highly stable atomic clock (PRTC – Primary Reference Timing Clock, Stratum 0), as well as the time scale (information about the current second number) determined and disseminated by NMI (Fig. 1b).

The fibre-optic time-frequency distribution system, ELSTAB[1], is widely used for ultra-precise distribution of 10 MHz and 1PPS signals generated by NMI, but until now has not been able to provide the time-of-day (ToD) information needed to fully control remote timing distribution node, eg. with PTP servers or WR switches. This paper presents an application of the ELSTAB system for the simultaneous transmission of time and frequency signals in dark fibre with embedded information on the number of transmitted seconds. The Remote module provides a copy of the PRTC/Stratum 0 reference clock signals, which are enhanced by time information available in NTP-compliant format. This enables a clear determination of the uncertainty of time signal transfer and the traceability of the time scale carried by the homogeneous transmission system.

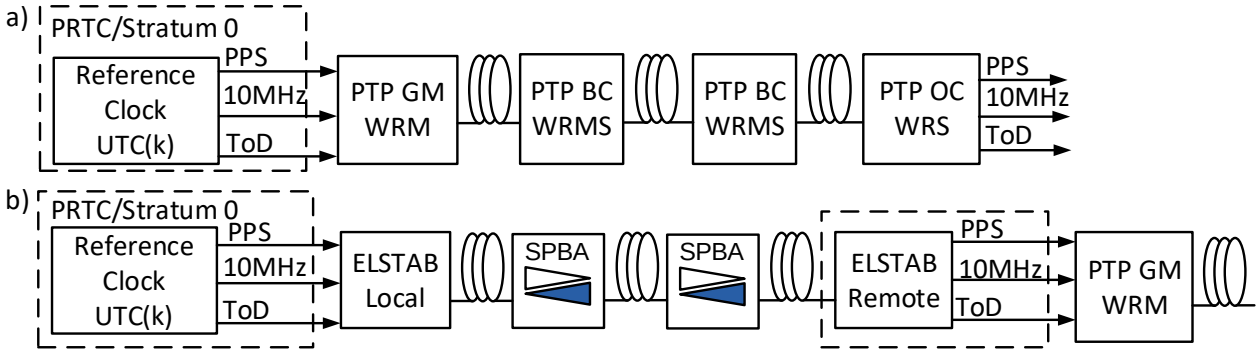

Fig. 1: Time and frequency distribution network: typical solution (a) and remote access to the UTC(k) primary reference clock (b); PTP GM, PTP BC, PTP OC – Grand Master, Boundary Clock, Ordinary Clock in PTP, WRM(S) – White Rabbit Master (Slave) Switch.

[1]Krehlik P., and others, ELSTAB-Fiber-Optic Time and Frequency Distribution Technology: A General Characterization and Fundamental Limits, IEEE Trans Ultrason Ferroelectr Freq Control. 2016 Jul;63(7): pp. 993-1004.