Publishable Summary for 15SIP04 TIMEFUNC
Time Synchronisation IMpact Enabling FUture Network Communication

Overview

The aim of this project was to support the uptake by industry and/or commercial organisations of time and frequency synchronisation techniques via optical fibre networks as developed in previous EMRP project JRP SIB02 NEAT-FT. This project has been focused on the application of White Rabbit Precision Time Protocol (WR-PTP) in existing telecommunication networks. To stimulate the uptake of WR-PTP, a hands-on training programme was organised for the supporters, Tallgrass and OPNT, on the design, implementation, operation and maintenance of a WR-PTP synchronised network. The training material was made publicly available in the form of a best practice guide on the VSL website and on the WR website.

Need

JRP SIB02 NEAT-FT developed the technology and knowledge to be able to transfer accurate time and frequency (TF) signals through optical fibre networks, one particular synchronisation technique investigated was the WR-PTP.

The network service provider and primary supporter, Tallgrass, has recognized that improving synchronisation of nodes in the telecommunication network beyond the current limitations of GPS-based synchronisation is the key to enhancing network performance in terms of increasing data transfer capacity for developing new data-intensive services such as video and audio streaming. Tallgrass also recognises that embedding accurate "Timing as a service" in the network is a strong concept for a wider range of new telecom-based applications such as positioning services based on a cellular network. Implementing Timing as a service requires that timing signals are efficiently distributed through the network and easily accessible to the consumers. Therefore, Tallgrass (and other telecom service providers) need the knowledge obtained in JRP SIB02 NEAT-FT to design optical fibre time and frequency distribution networks. Tallgrass selected WR-PTP as network synchronization technique, because of the high technology readiness level, the low cost compared to other optical fibre synchronization techniques, the performance which is at about the same level as other existing techniques

For implementation and maintenance of the WR-PTP technology, Tallgrass relies on services from OPNT, an industrial party that provides the required hardware and implements time distribution services. Both Tallgrass and OPNT are aware that the timing service will be most valuable if it guarantees traceability to SI units. Therefore, OPNT intends to set up an accredited calibration service for equipment to be installed in the optical fibre time and frequency distribution networks. The knowledge regarding delay calibration and delay asymmetry calibrations obtained in JRP SIB02 NEAT-FT is of great value and needs to be made available to commercial calibration laboratories.

Objectives

The overall objective was to create impact from the results of JRP SIB02 NEAT-FT by making the knowledge and experience on TF distribution by optical fibres available to industrial and commercial organisations.

The project addresses the following objectives:

1. To provide Tallgrass with knowledge on how to design and implement a TF distribution network based on WR-PTP at an uncertainty level of 1 ns for time and 10^{-13} Hz/Hz for frequency**.** In addition, to provide OPNT with knowledge on how to operate, maintain and calibrate a TF distribution network based on WR-PTP at an uncertainty level of 1 ns for time and 10^{-13} Hz/Hz for frequency**.** A Best Practice Guide on the design, implementation, uncertainty evaluation, operation and maintenance of a

TF distribution network based on WR-PTP will also be written, as well as a plan will also be written describing the steps towards the dissemination of the Best Practice Guide amongst relevant commercial organisations**.**

Objective 1 will be achieved by providing a dedicated training programme to experts from the supporters, Tallgrass and OPNT. Further uptake of the WR results from JRP SIB02 NEAT-FT by other organisations will be facilitated by making the training material openly available.

Results

The project has resulted in support of network and telecommunication services by transfer of knowledge on WR-PTP synchronisation. The work was divided in three main tasks.

- VSL has prepared material for a series of hands-on training sessions for Tallgrass on the design and implementation of TF distribution network based on WR-PTP.
- VSL has prepared material for a series of training sessions for OPNT on the theory and practice of delay calibration of equipment related to WR-PTP links and on the calibration of the delay asymmetry of long optical fibre links.
- VSL has prepared a Good Practice Guide summarizing the training sessions on the design, implementation, operation and maintenance of a time and frequency distribution network based on WR-PTP. The guide has been made available on the VSL website and on the WR website. Contact persons from relevant organization have been informed by e-mail or via the WR discussion forum about the availability of the guide on this web page. The guide was published on May 9, 2019.

Impact

In this project, dedicated training programmes were set up for dissemination of knowledge on design, implementation, operation and maintenance of time and frequency synchronisation in an optical fibre network with an uncertainty of less than 1 ns on time and 10^{-13} Hz/Hz on frequency, by using WR-PTP. Hands-on training was organised for the supporters Tallgrass and OPNT. For the benefit of other organizations, the training material was collected in a Best Practice Guide for dissemination via the VSL website and via the White Rabbit project website. The availability of this Guide will be brought to the attention of contact person of relevant organisations via e-mail messages.

The outcome of this project is that its supporters, Tallgrass and OPNT, now have the knowledge to design, implement, operate and maintain time and frequency synchronisation in an optical fibre network with an uncertainty of less than 1 ns on time and 10^{-13} Hz/Hz on frequency, by using WR-PTP. This technique is more accurate and less vulnerable than currently applied synchronisation techniques based on global navigation satellite systems (GNSS). Specifically, based on the results from this project, Tallgrass is now offering a synchronisation service traceable to universal coordinated time (UTC) to financial institutions in the Amsterdam region. OPNT has implemented a demonstration of WR-PTP-based synchronisation in a sub-network of one of the leading providers of mobile phone services in the Netherlands. In the framework of the ASTERICS project, OPNT has also implemented a WR-PTP synchronisation link between two sites for radio astronomy in the Netherlands. Besides the projects mentioned here, OPNT is active on an international scale. With the knowledge and training material received in 15SIP04 TIMEFUNC, OPNT will further create impact both in the Netherlands and abroad.

With support of Tallgrass and OPNT and the training material developed in this project the optical fibre synchronisation by WR-PTP developed in JRP SIB02 NEAT-FT is ready to be taken-up by a larger group of end users, including: electrical power grid operators, telecom service providers, financial markets and scientific organisations collecting data from geographically spread locations like radio astronomy and particle detectors. For electrical power grids, synchronisation is essential for monitoring the balance between energy production and consumption. In case of unbalance, the grid will go down, causing severe social and economic damages. For telecom applications, more accurate synchronisation is essential to keep up with increasing consumer demands of data transfer capacity. This allows for improved or new services including high quality video conferencing, video and audio streaming on demand, on-line gaming, remote surgery, etc. These new services create both socially and economically positive impact. Financial markets benefit from

synchronisation of all electronics transactions, because it makes the trading more transparent and avoid fraud. WR-PTP is an excellent tool for synchronising trading servers with a reliable source of UTC. Scientific organisations collecting data from geographically spread locations profit strongly from synchronising clocks at all locations, because it improves analysis of correlations between events on multiple locations and significantly reduces the computational power required for the correlating analysis.

Furthermore, in a follow-up collaboration between VSL and OPNT, a transnational time transfer link based on WR-PTP was implemented between Brussels (Belgium) and Noordwijk (Netherlands). This link was built as a demonstration project with the intention to use the results for future applications related to the synchronisation of ground stations for the Galileo satellite navigation system.

Project start date and duration:	01 June 2016, 36 months	
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