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OPTICAL TIME TRANSFER BETWEEN IPE AND BEV

Use Case of Photonic Services

This use case describes a Photonic Service for the advanced application of time transfer between the Czech national time and frequency laboratory in the Institute of Photonics and Electronics (IPE) in Prague and the Austrian national time and frequency laboratory in the Federal Office of Metrology and Surveying (BEV) in Vienna.

Background

Comparison of the time scales generated by national time and frequency laboratories is an important function of time metrology. While very accurate methods, based on two-way satellite links exist, these are very expensive. The methods more often used, although less accurate, are based on Global Positioning System (GPS) receivers.

Dedicated optical fibres are sometimes used to link the atomic frequency sources of geographically close laboratories – such links typically have a length of up to a few tens of kilometres – and thus create a local point-to-point network. The increasing number and coverage of all-optical networks, used mainly in telecommunication, open up the possibility of using these networks for time and frequency

Photonic Service on the Optical Path

In 2011, CESNET set up a bi-directional optical path between IPE in Prague and BEV in Vienna by combining dark fibre last miles and a dedicated Dense Wavelength-Division Multiplexing (DWDM) channel in the CESNET production network. The path crosses a multi-vendor network, because one part of it is equipped by Cisco ONS 15454 MSTP and another part by the CzechLight open transmission system, as shown in Figure 1 below. Details of the logical segments of the Photonic Service are given in the table that follows the figure.

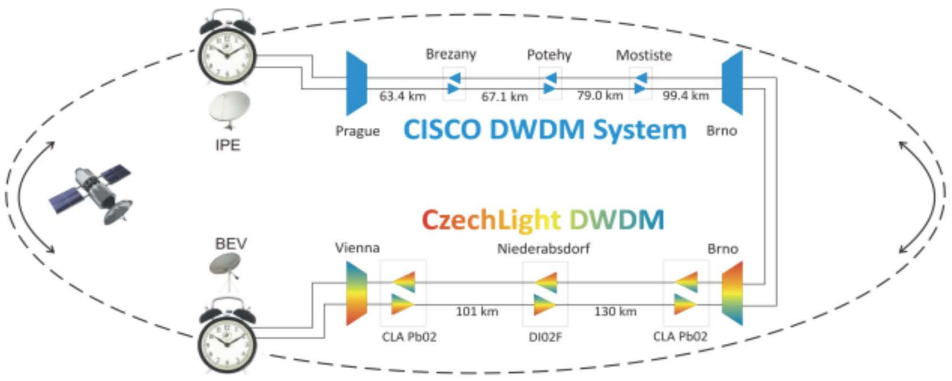

Figure 1: IPE–BEV optical path across multi-vendor network

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Time Transfer Method

Two end-user devices are connected by a bi-directional all-optical link without optical-electrical-optical (OEO) conversion. Each of these devices has a 1 Pulse per Second (PPS) signal from a local clock as its input and produces an optical pulse sequence representing the 1 PPS signal. The time-interval counter measures the interval between local and remote 1 PPS signals.

Segment	Country	Length	Attenuation	Technology
IPE – Prague	Czech Republic	16 km	7.0 dB	Dark fibre
CESNET – Brno	Czech Republic	309 km	78.6 dB	Cisco ONS (DWDM channel)
Brno – Vienna University	Czech Republic – Austria	220 km	50.0 dB	CzechLight (DWDM channel)
Vienna University – BEV	Austria	5 km	1.5 dB	Dark fibre

Results

The Photonic Service for accurate time transfer between IPE and BEV has operated continuously since August 2011. This method of accurate time-signal transfer demonstrates the capabilities of an all-optical network. More information about both the advanced application of time transfer and its network solution by Photonic Services can be found in [1] or [2]. Both of the time and frequency laboratories involved are also equipped with metrological GPS receivers that allow the evaluation of local offset against Coordinated Universal Time (UTC) standard time with an accuracy of a few nanoseconds (using the GPS Common View method). The Photonic Service for accurate time transfer shows better short- and long-term stability compared with the GPS Common View method. The end-user devices have been specially designed for this application by CESNET and are able to transfer 1 PPS from the local atomic clock to the remote site. The setup is symmetrical – time is also transferred in the opposite direction – and therefore transport delay variation, caused mainly by temperature changes, is cancelled.

Although the optical path is bi-directional, it is implemented as a pair of uni-directional fibre segments and is therefore not absolutely symmetrical. As mentioned above, this advanced application runs successfully over two optical transmission systems: the open DWDM CzechLight system and Cisco DWDM. Therefore it is a fully operational Photonic Service over a multi-vendor network. The path from Prague through Brno to Vienna is all-optical, as shown in Figure 1 above. The Photonic Service is well suited to other advanced network applications.

References [1] V. Smotlacha, A. Kuna, W. Mache: "Optical Link Time Transfer between IPE and BEV", in Proceedings of 43rd Precise Time and Time Interval (PTTI) Meeting, Long Beach, CA, USA, November 2011

[2] V. Smotlacha, A. Kuna: "Two-Way Time and Frequency Transfer between IPE and BEV", in Proceedings of European Frequency and Time Forum (EFTF), Gothenburg, Sweden, April 2012

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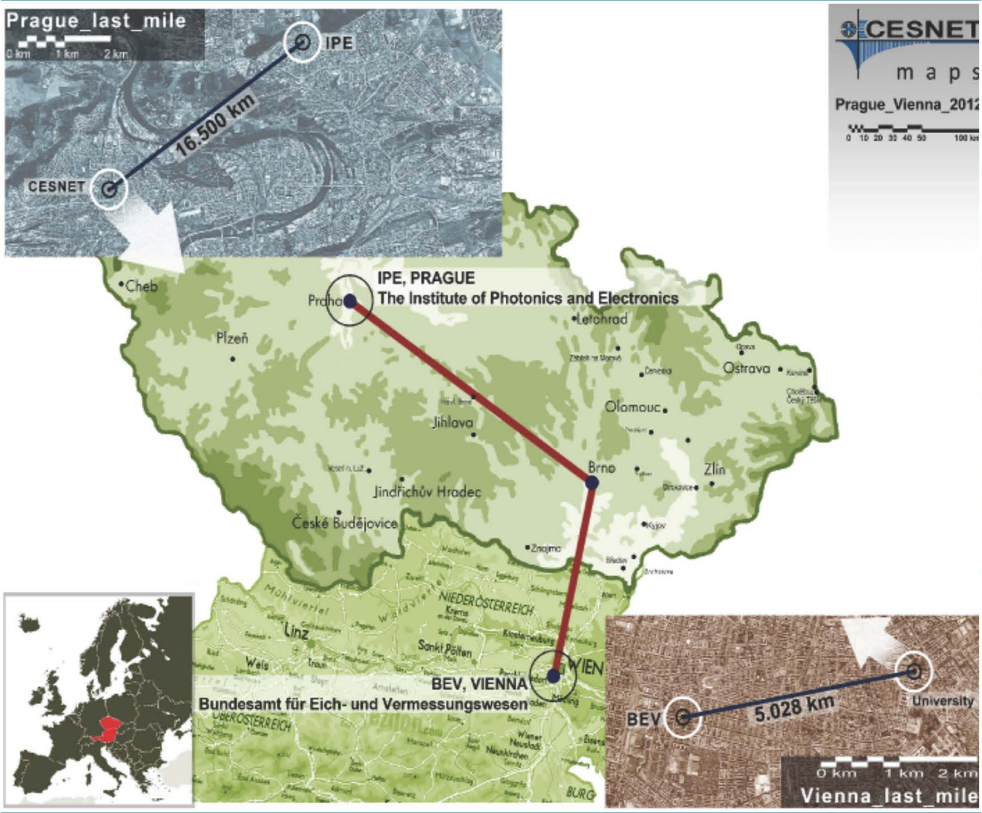
Map - Prague to Vienna



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