EU-funded project improves global data transmission

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Researchers have developed two new components that could help Europe meet some of its most pressing communication challenges in optical amplifier research.

The EU-funded team, from Denmark, Greece, Ireland, Japan, Sweden, Switzerland and the United Kingdom, developed an ultra-low noise amplifier and an optical regenerator for phase-encoded signals. These innovations could improve the transmission capacity and energy efficiency of optical communication networks.

Writing in the journal Nature Photonics, the team describe how these new data transmission systems came about. The study was given a

funding boost of EUR 2 698 947 as part of the PHASORS ('Phase sensitive amplifier systems and optical regenerators and their applications') project, funded under the 'Information and communication technologies (ICT)' Theme of the Seventh Framework Programme (FP7).

Noiseless optical amplification is the ultimate goal of optical amplifier research, as it offers the potential to significantly improve the performance of a wide range of applications such as optical communication (fibre based or free space), optical spectroscopy and sensing, and photon detection.

At the moment, data transmission through optical networks is restricted by 'phase noise' - the rapid, short-term, random fluctuations in the phase of a signal, which affects the quality of the information sent. It results in data transmission errors, and in 'cross talk' brought about when the signal interacts with other signals on different wavelengths.

The scientists on this study set out to test the theory that noiseless linear amplification can be realised in a non-deterministic or phase-sensitive manner. While noiseless linear amplification suffers from low success probability and is impractical for mainstream applications, scientists have pinned their hopes on phase-sensitive amplifiers (PSAs), long recognised as capable of realising practical, deterministic noise-free amplification. Today, all commercial optical amplifiers remain phase insensitive.

The scientists successfully developed an optical amplifier which can amplify light with extremely low noise. The researchers were able to reduce the noise figure to 1 dB by using a 'phase-sensitive fibre-optic parametric amplifier'. In traditional erbium-doped fibre amplifiers, the noise figure is often at least 3 dB, something which makes the signal patchy and unreliable.

The researchers believe that their groundbreaking findings could now easily be applied in various applications such as high-capacity optical communication systems. 'This is the ultimate optical amplifier. It enables connecting cities, countries and continents more efficiently by placing the amplification hubs at much greater intervals. The signal can also be modulated more effectively. In addition, the amplifier is compatible with any modulation format, with traditional laser transmitters, and can be very broadband, making it compatible with many lasers at different wavelengths,' says one of the study authors, Professor Peter Andrekson from Chalmers University of Technology in Sweden.

The second development from the PHASORS project, which ran from 2008 to June of this year, was an optical regeneration subsystem that eliminates interference for high-speed binary-phase-encoded signals. Unlike previous devices developed, this new device gets rid of phase noise directly without the need for conversion to an electronic signal, which slows things down somewhat.

As well as telecommunications, these new devices could have significant applications across a range of disciplines such as optical sensing and metrology.

The broad scope of the PHASORS project is to target the development and application of fiber-based PSA technology in 40 Gb/s broadband core networks. The overall aim is make sure Europe stays ahead in this relatively new area of technological development.

More information: Tong, Z. et al. (2011) Towards ultrasensitive optical links enabled by low-noise phase-sensitive amplifiers. *Nature Photonics*. DOI: 10.1038/nphoton.2011.79

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