Team achieves one terabit per second data rate on a single integrated photonic chip

February 28 2011

(PhysOrg.com) -- With worldwide Internet data traffic increasing by 50 percent each year, telecommunications companies that handle this digital torrent must be able to economically expand the capacities of their networks while also adapting to new, more-efficient data-handling technologies.

Over the last decade, a development team at Infinera Corp. in Sunnyvale, Calif. has pioneered the design and manufacture of photonic integrated circuits (PICs) aimed at meeting that need. This technology has enabled the team to achieve a record one trillion bits per second (1 Terabit/s) speed on a single integrated indium phosphide chip. The findings will be presented at the Optical Fiber Communication Conference and Exposition/National Fiber Optic Engineers Conference (OFC/NFOEC) taking place March 6 – 10 at the Los Angeles Convention Center.

“Traditional transponder-based system architectures are inflexible and costly and time-consuming to upgrade,” said Dr. Radhakrishnan Nagarajan, research fellow at Infinera and a senior member of Infinera’s PIC development team. “Our PIC approach enables us to make optical networks more powerful, flexible and reliable than ever before using equipment that is significantly smaller, less expensive and uses much less energy.”

Infinera’s latest PIC is at the heart of a new 10-channel receiver, each channel operating at 100 Gbit/s data rates. This is the first in the industry to achieve a capacity of 1 Terabit/s on a single photonic integrated chip.

It contains more than 150 optical components—such as frequency tunable local oscillator (LO) lasers, devices for mixing the LO and incoming signals, variable optical attenuators for LO power control, a spectral demultiplexer to separate the individual wavelength channels, and 40 balanced photodetector (receiver/transmitter) pairs—all integrated onto a chip smaller than a fingernail.

The key technical advance operating behind 100-Gbit/s-per-channel technology is the ability to detect incoming data encoded using the optical industry's most spectrally efficient modulation technique, called polarization multiplexed Quadrature Phase-Shift Keying, or PM-QPSK. To explain the acronym, first PM: it is similar to the wireless communications technique of alternating the polarization of adjacent channels. How does QSPK work? In virtually all types of data transmission, the information is encoded in ways that allow it to travel the farthest while occupying the least amount of signal spectrum. Just as radio's AM (amplitude modulation) and FM (frequency modulation) imprints information on, respectively, the amplitude and frequency of its broadcast waves, QPSK modifies the light's phase to represent the data. All in all, PM-QPSK permits four times more information to be conveyed each second than was possible with the previous method, which simply switched the laser light on and off.

The news here is not about the PM-QPSK modulation scheme per se, but rather that Infinera has, for the first time, integrated it all onto a single 10x100 Gbit/s photonic integrated circuit.

"But just as important as a transmitter's clever and efficient encoding method is a fast and reliable way for the receiver to convert the information back to its original form," said Dr. Nagarajan. "For PM-QPSK, we designed and integrated narrow-linewidth lasers that detect the phase encoded data very efficiently."

Infinera expects PICs with a capability of a terabit or more to be commercially available within a few years. The company has announced that a 500 Gbit/s PIC will be available in 2012. Infinera's 100 Gbit/s PICs are widely deployed in long-haul and metro networks worldwide.

Transmitter and receiver PICs are typically installed at critical nodes and at each end of "long haul" optical networks. Like non-stop flights between airline hubs, these intercity and intercontinental optical fiber links carry the bulk of Internet traffic. Worldwide, more than 20 exabytes—20 trillion trillion bytes (or 160 exabits)—have been estimated to pass through the Internet every month.

PICs enable massive amounts of cost-effective bandwidth and facilitate the networks at the heart of the Internet to become more scalable and quicker to react to sudden changes in demand. "In many ways, PIC-based optical networks are starting to take on the intelligent features of routed (IP) networks, like the ability to reroute traffic in the event of a break in the fiber—but at a fraction of the cost and power consumption," Dr. Nagarajan added.

More information: Dr. Nagarajan's presentation at OFC/NFOEC, titled "10-channel, 100Gbit/sec per channel dual polarization coherent QPSK, monolithic InP receiver photonic integrated circuit," will take place Monday, March 7 at 3:15 p.m. in the Los Angeles Convention Center.

Provided by Optical Society of America