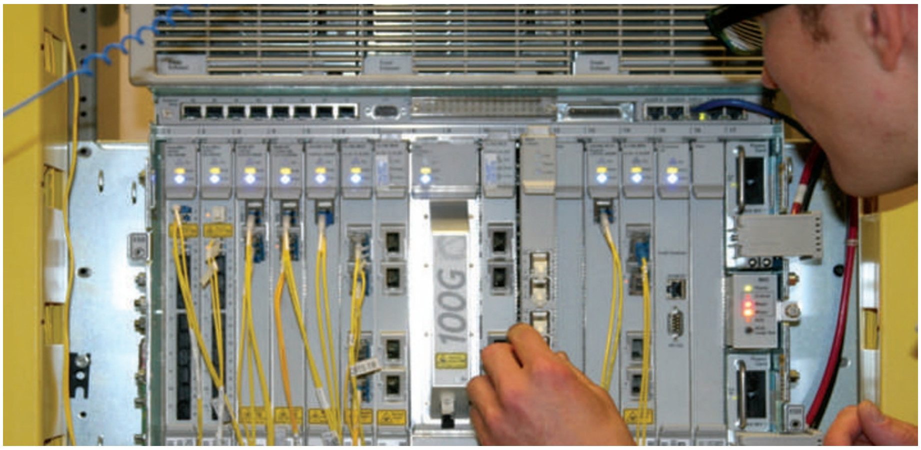
Ultrafast networks gear-up for deployment

This year looks set to be the point at which optical networks operating at data rates of 100 Gbit s^{-1} (100G) per wavelength channel become a commercial reality. Although 40G networks are still just starting to be rolled-out, there has been considerable activity in the 100G market, and analyst company Ovum believes that 2010 will see the first revenue-generating deployments of 100G technology. It estimates that the global demand for transponders (integrated transmitter–receiver units) for 100G dense-wavelength-division multiplexing communication systems will grow rapidly over the next five years, reaching $455 million by 2014. This summer, the IEEE standards for 40G and 100G Ethernet technologies will be ratified, after which the market can start to grow in earnest.

The end of 2009 saw a plethora of announcements regarding 100G trials and deployments from telecommunications operators such as Verizon and Deutsche Telekom, and system vendors such as Huawei, Nortel, Ericsson and Alcatel-Lucent. The US operator Verizon claimed it was the first telecommunications carrier to successfully deploy a commercial 100G ultralong-haul optical system for live traffic between Paris and Frankfurt, based on Nortel technology. At around the same time, Huawei announced the successful completion of a 100G long-haul transmission field trial with Telefónica in Spain, covering a distance of more than 1,000 km without electrical regeneration. Ericsson and Deutsche Telekom announced a joint 100G field trial on an existing optical platform as part of the European 100GET project, and Nortel made several 100G announcements including a successful trial over a 600-km 100G link spanning from New York to Boston.

Developers of 40G and 100G technology are of course acutely aware of the need to keep costs down. For this reason, there is a strong drive to make the technology compatible with existing fibre infrastructure.

"Our coherent frequency-division multiplexing solution includes digital signal processing, enabling us to achieve the full 112 Gbit s^{-1} capacity using 10G-class components. Rather than using intensity-modulated direct detention, Nortel is using dual-polarization quadrature phase shift keying with coherent receivers, together with advanced digital signal processing," says Helen Xenos, 40G/100G product marketing manager at Nortel.



NORTEL

The commercial 100G transmission system recently announced by Nortel, which has been adopted by the US carrier Verizon.

Dual-polarization quadrature phase shift keying is a modulation format that effectively sends four times as much information as traditional optical transmissions of the same speed. When paired with a coherent receiver that can detect this modulation format, the optical transmission rate can be slowed, which reduces the effects of signal distortions such as chromatic dispersion and polarization mode dispersion. Any remaining signal distortion resulting from dispersion is eliminated by integrated electronic dispersion-compensation technology, which adjusts for distortion at the receiver-side of the transmission. By using these advanced signal processing technologies, Nortel's solution can transmit a 100G signal — even over an impaired fibre that cannot be used for traditional 10G transmission — without the need for separate compensators for chromatic dispersion and polarization mode dispersion.

"Regardless of the modulation format used, a critical element for achieving 100G transmission over long- and ultralong-haul distances is to decrease the transmitted baud rate so that optical impairments such as dispersion are controlled, and to have an effective coherent receiver to be able to recover the modulated signal," says Ron Kline, principal analyst for network infrastructure at Ovum.

For their trial, Ericsson and Deutsche Telekom used an existing link of mixed 10G and 40G traffic with a 50 GHz channel spacing. A line rate of 112 Gbit s^{-1} was achieved using polarization-multiplexed return-to-zero differential quadrature phase shift keying over 600 km of standard single-mode fibre. The link included multiple reconfigurable optical add-drop multiplexers and amplifiers. With carefully optimized links, transmission distances of more than 1,200 km are possible and have been demonstrated in the lab.

Huawei's 100G field trial in Spain was based on the company's OSN 6800 wavelength-division multiplexing/optical transport network platform and standard G.652 optical fibre. The link featured ten sets of reconfigurable optical add-drop multiplexers, 33 optical amplifiers and two sets of multiplexer–demultiplexers. Transmission of a mixture of 10G/40G/100G data with a 50 Hz channel spacing was achieved without interfering with the existing network.

Alcatel-Lucent used proprietary digital signal processing algorithms to optimize coherent detection of data in its 100G tests. The 112 Gbit s^{-1} field trial spanned 1,088 km between four cities in Spain and took place over an existing heavily loaded fibre link carrying live traffic on the Telefónica network.

"Although it is exciting to see so many successful 100G trials, the technology must be cost-effective before it will take off," warns Kline. "The aim with 40G was to make it 2.5 times the cost of 10G, while giving four times the bandwidth. We are not yet at that stage with 40G, and prices for 10G are dropping. So many companies are questioning whether or not to invest in 40G, let alone 100G. The 100G solution needs to be more cost-effective than ten separate 10G wavelengths, and we are several years away from achieving this." ❐