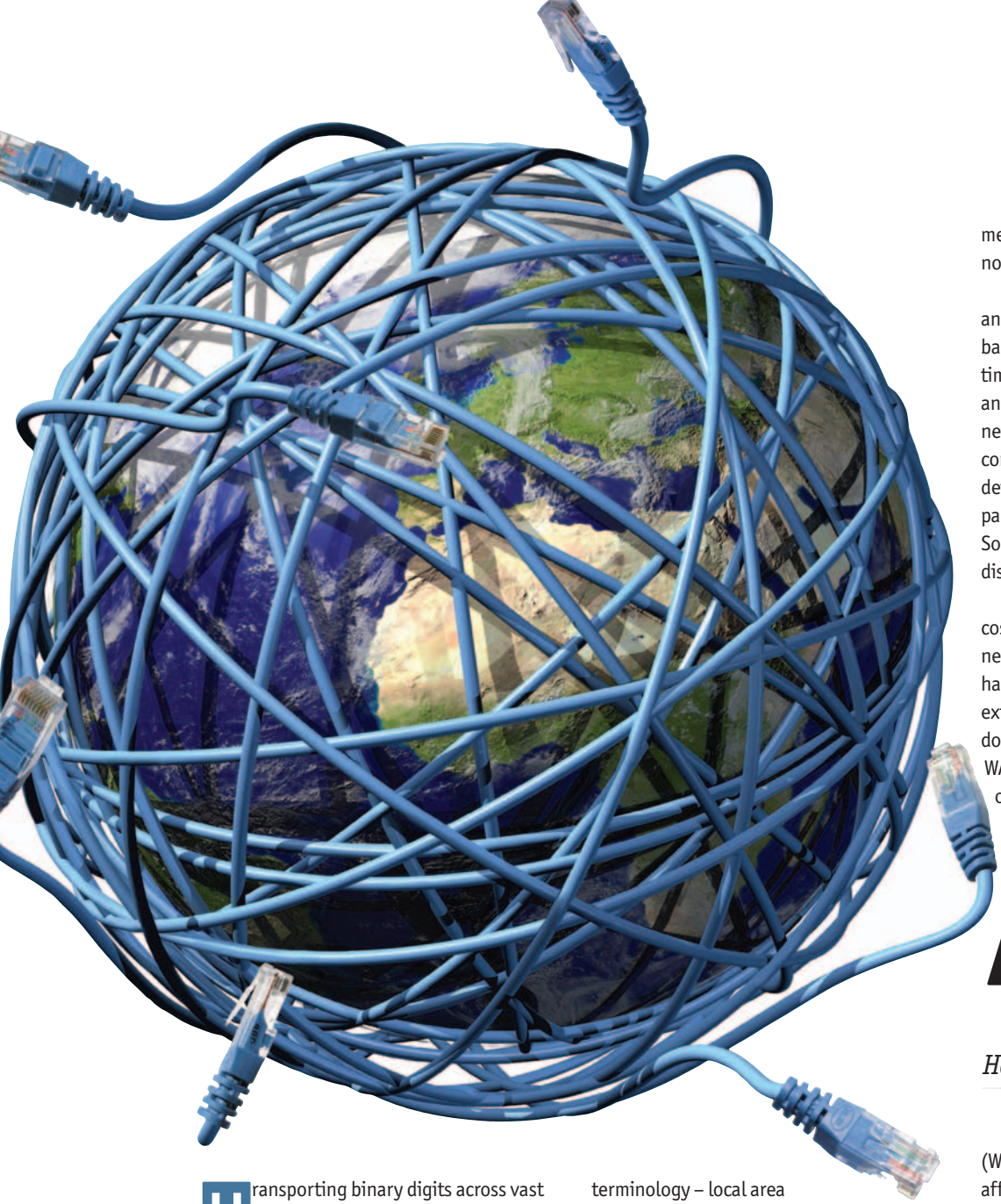

Illustration: DebutArt: Jürgen Ziewe

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How long haul networks can embrace

Transporting binary digits across vast distances may be predominantly seamless, but it is not effortless. Nor is it without cost; digital bandwidth is one of the few commodities that can be broken down to its smallest denomination for financial purposes.

Not only can the cost/bit of data transmission be determined, but the increasing volume of traffic also contributes to the cost of transporting each bit. But it isn't the cost/bit of transmitting data that is of concern; rather, it's the cost/bit of moving data between different types of network. This is significant and could present a financial bottleneck in the expansion of digital networks.

The problem is partly masked by the terminology – local area networking (LAN), metro area networking (MAN) and wide area networking (WAN) imply use of the same transport protocols. In reality, there is a disconnect between LAN and MAN/WAN, and it is bridging this disconnect that represents the bottleneck.

Ethernet goes Metro

The problem is further masked by the fact that Ethernet is ubiquitous in LANs, where its low cost means it is integrated into every kind of office device and many consumer ones, enabling them to share data and services across a relatively simple network topology. Long haul networking requirements are distinctly different, as is the infrastructure. Most prominent amongst these differences is the transport mechanism – MAN/WANs use Sonet/SDH, not Ethernet.

Fundamentally, the former is optical and circuit based, whilst the latter is wire based and uses a packet protocol. So each time data originating from – or flowing to – an end device connected to an Ethernet network is transferred across a long haul connection, a termination/regeneration device is needed. These devices translate packet data in an IP stream to and from Sonet/SDH frames, necessary due to the disparate transfer mechanisms employed.

In light of Ethernet's dominance and cost effectiveness and in order to avoid the need for termination/regeneration, a trend has been emerging since the late 1990s of extending Ethernet into the MAN/WAN domain. During this period, the capacity of WANs increased through the introduction of Wavelength Division Multiplexing (WDM). Although this provided an affordable increase in bandwidth, it increased the termination challenges.

Sonet/SDH is far more robust than Ethernet. However, this advantage is reflected in the transmission cost/bit which, relatively, is much higher than the Ethernet domain can currently support.

For some time, Applied Micro Circuits (AMCC) has been addressing this disparity with a range of mappers and framers; technologies that bridge between the Ethernet and MAN/WAN worlds. The Volta family, for instance, offers an 'any service, any port, any time' solution, supporting a wide range of protocols, which can all be mapped on to Sonet/SDH using the Virtual Concatenation and Generic Framing Procedure.

With the Niagara family, AMCC added

enhanced forward error correction (EFEC) to its mapper/framer technologies to provide the basis for the Rubicon family, which runs in both EFEC and GFEC (generic FEC or Reed-Solomon code) modes.

Next generation solutions

The significant increase in bandwidth provided by WDM, coupled with the explosion in network data (typified by the demand for video based services), means there is renewed effort behind the migration of Ethernet to next generation MANs/WANs. This has manifested itself in the form of Carrier Grade Ethernet and Metro Ethernet Services; efforts aimed at making Ethernet robust enough to meet the demands of carrier grade transport.

Figure 1 shows how this transformation is taking place, where WDM is being augmented using G.709, the 'digital wrapper' recommendation proposed by the ITU-T. This recommendation is also known as the Optical Transport Network (OTN) for transmission over WDM or non WDM optical networks. OTN is proposed as a transport layer for various protocols, including Sonet/SDH, Ethernet, ATM and IP.

The problems found here can be described by relating the issues facing the transmission of voice over a packet based network. Data is transmitted in packets, which find their own route through a network based on the routing information embedded within each packet. With this 'best efforts' approach, there is no guarantee that packets will arrive in the original order or in the same timeframe. For non time critical data, this isn't a problem, but it is for voice data, hence the introduction of VoIP.

The use of Ethernet in MANs/WANs faces a similar challenge, which is why the Metro Ethernet Forum and the IEEE802 organisation are working towards standards which will support the necessary quality of service and operation provisions.

However, these measures alone do not overcome all of the issues; optical noise and signal impairments – including chromatic dispersion, polarisation mode dispersion and a low optical signal to noise ratio – aren't easily addressed at the protocol layer.

Applying the OTN framing structure around the Ethernet frame before transmitting can overcome these issues, as the G.709 and G.795 specification includes FEC technology, along with electronic dispersion compensation (EDC), which can attenuate the optical impairments sufficiently for long haul transmission over an optical network.

Pemaquid, which integrates OTN framing with FEC and EFEC, is the first device in AMCC's MEtrON product family. Designed for Metro Ethernet and Carrier Grade Ethernet solutions, a single Pemaquid can replace a FEC/Framer/Mapper, an SFI4.1 to Serial 10G PHY and a bridge device to connect a 10Gbit MAC to the FEC/Framer/Mapper device.

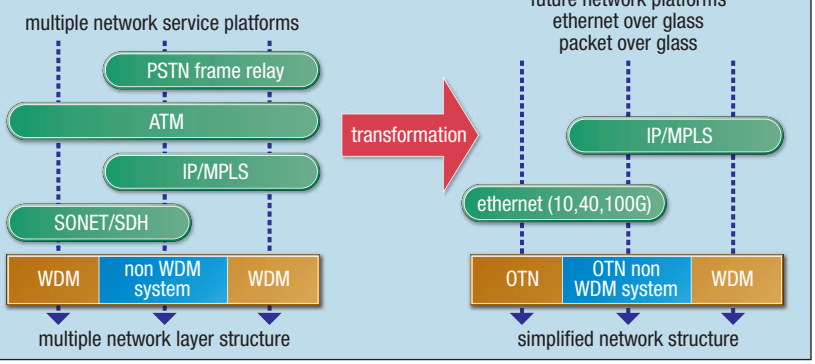
It also supports synchronous Ethernet; essential if next generation networks are to accommodate legacy TDM services, such as T1/E1 voice traffic, as well as mobile cell services.

By using OTN with FEC and EDC technology, it will be possible to build next generation Metro Ethernet equipment without exceeding 'cost/bit' targets. By maintaining Ethernet throughout the LAN/MAN/WAN infrastructure, edge WDM equipment could be eliminated in some cases, as Metro Ethernet equipment could connect direct to a long haul WDM network. Whether this will herald the long awaited 'all optical network', however, remains to be explored. ■

rea, any network

the cost savings of Ethernet through innovative solutions. By ***Mark Donovan*** *and* ***Keith Conroy****.*

Figure 1: Extending ethernet over MAN/WAN



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