Same pipe, **more data**

With data rates of 10Gbit/s and beyond, is copper getting to the end of the road? By ***Vanessa Knivett****.*

As data rates increase, manufacturers at each element of the signal chain must react to meet new requirements – and cabling manufacturers are no different.

"Cable technology has had to move forward considerably in the last few years", says Eric Gaver, global business leader for advanced digital interconnect at WL Gore. "Demand for high speed capabilities has predominantly been fuelled by data centres, where there has been a move towards modular, 'pay as you grow' computer hardware."

Trends that have played into creating this demand, explains Gaver, include multicore processing, open source platforms like Linux and the introduction of standards based hardware and software.

Modern interconnects, such as Infiniband and 10gigabit Ethernet (10GE), have made such high speed applications possible. Infiniband was quick to make inroads into high performance computing. With line rates of 2.5Gbit/s per channel, single data rate Infiniband was quickly followed by double data rate. "Quad (QDR) solutions at 10Gbit/s will be shipping before the end of this year," said Gaver, "and there's an expectation of 80Gbit/s if things continue to scale like this."

Meanwhile, Ethernet is developing just as quickly – 10GE was published as a standard in 2002. Gaver recounts: "The Ethernet Alliance has just configured a 40Gbit/s solution which will use QSFP – four channels at 10Gbit/s. And, 100Gbit/s will be out there in time … it's a breakneck development pace."

Is copper on the risk list?

You might have been forgiven for thinking that such developments might signal the end of the road for copper and a wholesale move to fibre optics in high end computing applications.

Carl Booth, director of sales and marketing at gigabit copper cabling manufacturer Amphenol Spectra-Strip, comments: "The typical users we sell to are HP, Dell, Google and the giant server farms. Their choice is between copper and fibre optic, but the primary driver is cost and acceptable 10Gbit/s performance." Acknowledging the importance of size and weight, which has typically favoured optical fibre, he says: "In a data centre, cables are typically underneath a raised floor. They are very big and heavy and there is a strong push to reduce cable size, weight and stiffness."

However, copper cable manufacturers don't want to give up the opportunity in data centres just yet, so how are they getting round copper's limitations?

Gaver says roughly 40% of the cables Gore supplies to data centres are less than 5m long. "If you can hit 20m in a data centre, you have served the vast majority of needs, even for supercomputing."

Hence, whilst the standards generally provide for much longer cable runs – 10GbaseT, a low cost 10Gbit/s solution over twisted pair copper introduced in 2006, offers lengths of up to 100m. In practice, cabling of that reach is rarely required. In Gore's case, it responded to the release of 10GbaseT with the introduction of a short reach (15m) CX4 product.

Gore's latest Extended Reach cable assemblies, shown at DesignCon 2008, address protocols such as InfiniBand QDR, 40GE, 10GE and 8G FiberChannel. The advances can be attributed to factors including the move to 'active' cabling.

Extended Reach cables integrate Quellan's Q:ACTIVE silicon technology, which reduces impairments such as link jitter and crosstalk. Gaver says: "Quellan's active equaliser chip provides three times the reach for a given gauge. It doesn't involve boosting the signal on the incoming side; instead, reconstructing the signal at the receiving side allows even small gauge cable to provide good reach and reduced density."

The DesignCon demonstration featured Gore's Advanced Cable Technology, thinner and lighter copper cables than previous versions. Explaining the achievement, Eye Opener+ reduces jitter by 40%, effectively lengthening cable runs by 40%.

Incremental gains

Each cable manufacturer is using broadly similar technologies to meet 10Gbit/s signal speeds and beyond. Amongst the most important factors, says Booth, are cable attenuation, skew and crosstalk – though the latter, he notes, is more a function of connector termination than cable design itself. "This is the weak link," he adds, "as most cables have plenty of crosstalk isolation."

"There's an expectation of 80Gbit/s if things continue to scale like this." ***Eric Gaver,*** *WL Gore*

Gaver said: "Gore has one of the broadest material sets available in cable construction. We deploy a variety of dielectrics and, for the most demanding applications, we use expanded PTFE. This is our core technology – next to air, it has the lowest dielectric constant. Using it alone, it is possible to reduce the size of a given cable by 20 to 30%."

On the conductor side, Gore incorporates what its Eye-Opener+ technology – a silver plated resistive core which employs the 'skin effect' to flatten frequency response. Says Gaver: "A more resistive inner core and highly conductive plating forces the signal to travel on the outer surface of the conductor, leading to better fidelity and reliability." Gaver says

Spectra-Strip Amphenol has developed a shielding technology called EXD to eliminate high frequency resonance. As the frequency gets higher, cables have a resonance that can distort the signal content severely. Notes Booth: "This is especially important when you are looking at harmonic signal frequency, which is difficult to deal with at 10Gbit/s." EXD preserves the harmonic signal content, ensuring there is no resonance at the third and fifth harmonics – the most vulnerable when it comes to obtaining acceptable signal quality. "EXD involves the application of aluminium Mylar shields on each pair. How we apply it is proprietary. It means there's no 'suck out' or resonance up to 20GHz, and it has the added benefit of having less cable attenuation than traditional shields."

Booth explains that Spectra-Strip Amphenol uses foamed polyethylene material as a dielectric for the pairs. "We use a conservative dielectric constant so our cables are more resistant to degradation when bent. We also use a number of buffering materials to cushion one layer of pairs against the adjacent. The goal is for each to sit comfortably together." The challenge is that, at 10Gbit/s and beyond, electrical and physical issues continue to counteract each other; the trade off being that plenty of buffering material doesn't aid flex.

Says Gaver: "The concern for cable suppliers is the amount of development needed to go from one generation to another. A new cable might have a year's payback, so we always ask the question of whether something is worth doing. The result is that cable manufacturers will make a case for the easiest, lowest risk route, which is why the development path is copper, rather than fibre optic."

However, Gaver acknowledges the opportunity for fibre optics in data centre applications. "The optics guys sees paralleled optics as the next technology progression. There's a wonderful opportunity for paralleled optics to come and take that [data centre business], but it is not evolving fast enough."

Meanwhile, cabling manufacturers continue to develop based on copper. Concludes Gaver: "Next generation silicon, such as the SerDes chips from Broadcom and Melanox, will enable the signal to go further. We'll continue to evolve our manufacturing processes and designs to minimise impedance loss characteristics and, with active technology, we can scale." ■