ProCurve Networking by HP

ProCurve Networking Technical Brief

# 10-Gigabit Media Alternatives

## Introduction

For the IT manager, the future is optimistic but confusing. Having 10-Gigabit backbones within your network infrastructure is going to allow performance levels, and scalability for future applications, that is mind boggling. But also boggling the mind will be choosing which of the various 10-Gigabit media options to use, and making sure your selections live as long as your network.

Following is some information on the 10-Gigabit media options available or on the horizon, to help you navigate the thicket of 10GBASE alternatives.

## 10GBASE-SR, -LR, and -ER

In 1999, the IEEE 802.3 committee started a project to develop a standard for 10-Gigabit-per-second Ethernet. As committees often find themselves pulling diverse groups together, they also find themselves in disagreement over how to solve a particular problem. When it came to lowest-cost media, multimode fiber was the clear choice because the committee was convinced that copper would not make the grade at that speed. So **10GBASE-SR** was defined as the low-cost optical solution to support multimode fiber with 850 nm Vertical Cavity Surface Emitting Laser (VCSEL) optics. To run up to 10 km on single-mode fiber, a 1310 nm wavelength was needed and so **10GBASE-LR** was adopted. To run extremely long distances, **10GBASE-ER** was defined with 1550 nm optics to run as far as 40 km on single-mode fiber.

## 10GBASE-LX4

Unfortunately, life could not be as simple as three options. The 10GBASE-SR optics could run only 26 m on existing FDDI-grade fiber, which severely limits its application. While SR can run up to 300 m on OM3 grade fiber, the installed base of this fiber is very small. So another technology known as **10GBASE-LX4**, which uses four wavelengths of light on a single fiber running at one-quarter the speed, was chosen to fill the gap. 10GBASE-LX4 runs on multimode and single-mode fiber, but it requires four times as many optical components and a special optical multiplexer that makes it pricey, as well as difficult to integrate into smaller optical form factors.

## 10GBASE-LRM

In order to improve the cost/performance benefits of 10-Gigabit on multimode fiber, the IEEE 802.3 committee started a project in 2003 called **10GBASE-LRM**. Using long wavelength optics on multimode fiber with a technology called Electronic Dispersion Compensation (EDC), the IEEE developed a long-distance multimode solution that operates with a single wavelength. The EDC function is one that can be integrated into the serializer, and perhaps even done in CMOS over time, which suggests that it can achieve a very low cost and fit into very small form factors. EDC is a form of signal processing that removes interference from the received optical signal and recovers an open “eye” from a closed eye.

The **10GBASE-LRM** specification was adopted in November 2006.

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## 10GBASE-CX4

Because 10-Gigabit Ethernet (10-GbE) had only optical solutions, the cost remained very high and the adoption low. To ease this situation, in 2002 ProCurve Networking drove the development of **10GBASE-CX4**, an extension to the existing XAUI interface, through the IEEE standards process in record time. "CX4" provides a very low-cost interconnection for wiring closet switches and aggregation within a data center. While very inexpensive, it has a limited range of 15 m and requires prefabricated cables, which will limit its application to stacking and aggregation within short distances.

## 10GBASE-T

The IEEE is made up of engineers, and everyone knows that a group of engineers cannot be stopped by mere physics alone. As a result, the **10GBASE-T** project to provide a solution over unshielded twisted pair (UTP) was also born in 2002.

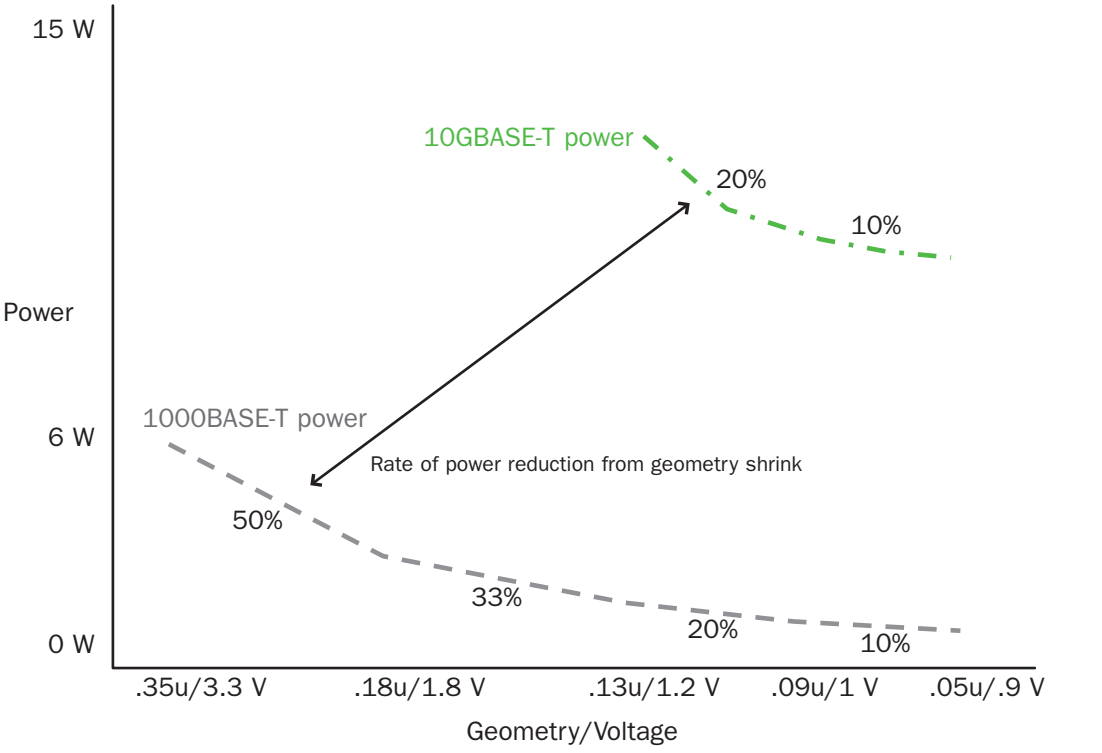
While originally touting the ability of 10GBASE-T to support Category 5 (Cat 5) cable, the IEEE has been forced to face reality. The IEEE realized that only limited distances on Category 6 (Cat 6) cable can be supported, and a new Cat 6A cable has been defined to ease the effects of "Alien Crosstalk," a form of interference that comes from cables that are located near the link being used.

The IEEE was sold on 10GBASE-T, and the project began with a lot of talk about scaling CMOS process geometries down and the ability to use DSP to lower the cost and power by leveraging "Moore's Law"—which says the cost of complexity in CMOS devices will drop rapidly as time goes on. Unfortunately, Moore's Law, like most elements of this physical universe, has a limit. CMOS transistors require around 1 V to operate properly. Because CMOS processes at 0.13u already operate on 1.2 V supplies, 10GBASE-T won't be able to reduce its power projections as rapidly as 1000BASE-T did, because it can't plan on reducing power supply voltages by a factor of four. 10GBASE-T is looking at a brick wall in power reduction, and, if so, its ability to obtain port density and thus reduce cost-per-port is going to be limited.

The figure below demonstrates that 10GBASE-T is unlikely to achieve Moore's Law with regard to the benefit of geometry reduction. While more gates can fit into a given package, the power dissipated by that package will drive its cost, size, and, ultimately, the number of ports in a switch that supports it.

The **10GBASE-T** specification was finalized in June 2006, but the technology is difficult to implement. Early products with power requirements on the order of 10 W per port appeared in late 2007.

## Enterprise data center with 10-GbE backbone



## Conclusion

The table summarizes the various flavors of 10GBASE options discussed in this paper.

IT managers will need to pick and chose carefully among the range of 10-Gigabit media alternatives, to come to the decision that's best for each specific network environment.

| PMD | Media type | Cost est. | Wavelength | Modal BW (MHz*km) | Operating range (meters) |
|---|---|---|---|---|---|
| SR | 62.5u<br><br>50u | L | 850 nm | 160<br>200<br>400<br>500<br>2000 | 2–26<br>2–33<br>2–66<br>2–82<br>2–300 |
| LR | 9u | M | 1310 nm | n/a | 2–10,000 |
| LRM | 62.5<br>50 | L | | 500<br>400<br>500<br>1500 | 220<br>100<br>220<br>220 |
| ER | 9u | VH | 1550 nm | n/a | 2–40,000 |
| CX4 | 4X twinaxial<br>w/media adapter | VL<br>VL | 3.125 Gb x 4<br>3.125 Gb x 4 | n/a<br>2,000 (ribbon) | up to 15<br>1–300 |
| LX4 | 62.5u<br>50u<br><br>9u | MH | 1310 nm | 500<br>400<br>500<br>n/a | 2–300<br>2–240<br>2–300<br>2–10,000 |
| BASE-T | Cat 6<br>Cat 6A<br>Cat 7 | M<br>MH | Multilevel PAM with substantial DSP | n/a | Short haul up to 30<br>Long haul up to 100 |

IEEE standard

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