Smart Cabling: Constructing a cost effective reliable and upgradeable cable infrastructure for your data centre/enterprise network

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Introduction

As data centre and enterprise network facilities today are under unrelenting pressure to deliver higher capacity, highly reliable systems with sound technology robustness for the future, facilities continue to adopt the truly future proof technology of optical fibre. The reasons for converting to optical fibre away from legacy copper based cabling systems are numerous, but include high data rate scalability, enhanced power and cooling efficiencies, reduction in pathway and space utilisation, low latency and ease of testing and installation.

But as with all new technologies it is often considered easier to maintain old technology than to craft and deliver the technical arguments necessary to steer management decisions in the direction of the new. This is often true of cabling and connectivity infrastructure when planning system upgrades or MACs (moves adds and changes). Here we set out to provide a clear guide as to why optical fibre should be the technology of choice for 21st Century enterprise and data centre networks and explore innovations in optical fibres, such as bend insensitive fibres, that have opened up a whole new world of cost efficiencies through uptime protection and space utilisation.

Towards the Green and Cost Efficient Data Center

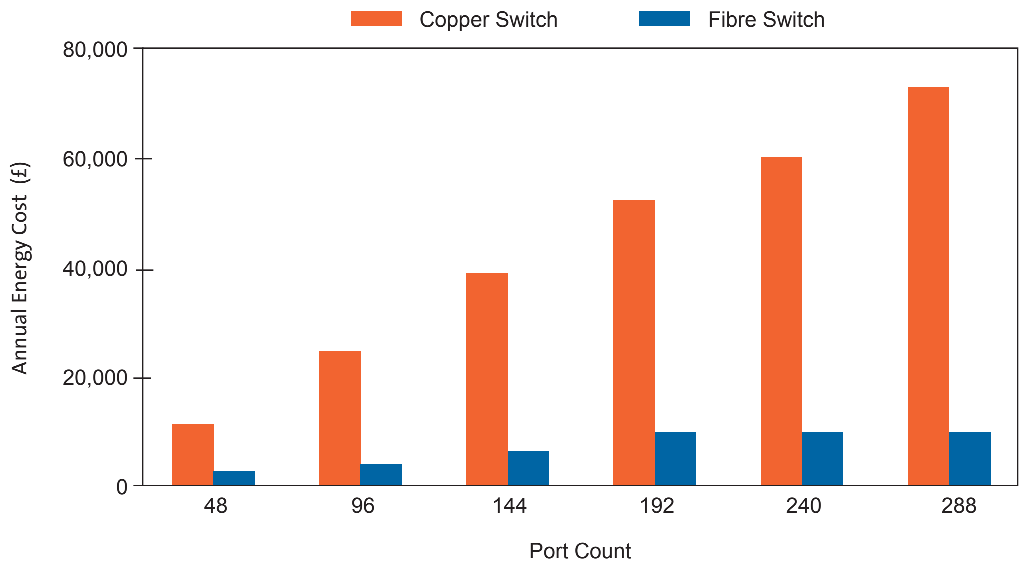
As demands on data centres increase so too does their consumption of electrical energy, but with the growing focus on a green data centre philosophy, solutions to mitigate energy requirements, to reduce CO_2 emissions and to support environmental initiatives are being widely adopted. Optical connectivity provides the reduction in power consumption (electronic and cooling), higher port density and optimized pathway and space utilisation necessary to support the movement to greener data centres. Comparing systems at 10G, the optical switch electronics and server adapter cards require less power to operate compared to 10G copper: 10G optical transceivers consume a maximum of 1.0 watt (typically 0.5 watt) per port compared to 3-5 watts per port for a 10GBASE-T copper switch.

10G copper systems require substantially more power to operate their electronics due to increased insertion loss at these high data rates, as well as the need to overcome significant internal and external cross talk issues with extensive power hungry electronic digital signal processing (DSP) in order to deliver an acceptable bit error rate.

In addition to the lower power requirements, a 10G optical system requires far fewer switches and line cards for equivalent bandwidth capability of a 10G copper system.

When scaled up to encompass the entire data centre or enterprise network, fewer switches and line cards, drawing up to 80% less power, translate into a lot less energy consumption for electronics and cooling, not to mention a reduction in power provision for back energy sources and UPSs.

CORNING



Comparison of the total electronics and cooling energy cost of 10GBASE-SR optical and 10GBASE-T copper (source: Corning Cable Systems)

Small is Green

Copper cables such as CAT 6A have a large diameter to increase the separation of the internal copper wires and alleviate internal and external cross talk noise issues. The large outer diameter impacts conduit size and fill ratio as well as cable management due to the increased bend radius. This contributes to significant pathway and space congestion issues when routing in wire baskets, trays, conduits, patch panels and racks. Copper cable congestion in pathways increases the potential for damage to electronics due to air cooling damming effects and interferes with the ability of ventilation systems to remove dust and dirt. Bundled copper cable also interferes with removal of abandoned cable and presents serious alien cross talk issues in raised floor and aerial pathways. Eight CAT 6A cables consume the same area equivalent of a single 216-fibre ribbon cable.

Hence in addition to the lower power consumption of the transceivers, optical fibre systems feature greater system and cable management density and so relieve air flow obstructions in racking thereby enabling enhanced cooling efficiency which in turn also lowers power consumption.

One optical cable of 15 mm diameter provides the same amount of connections as 48 CAT 6A cables

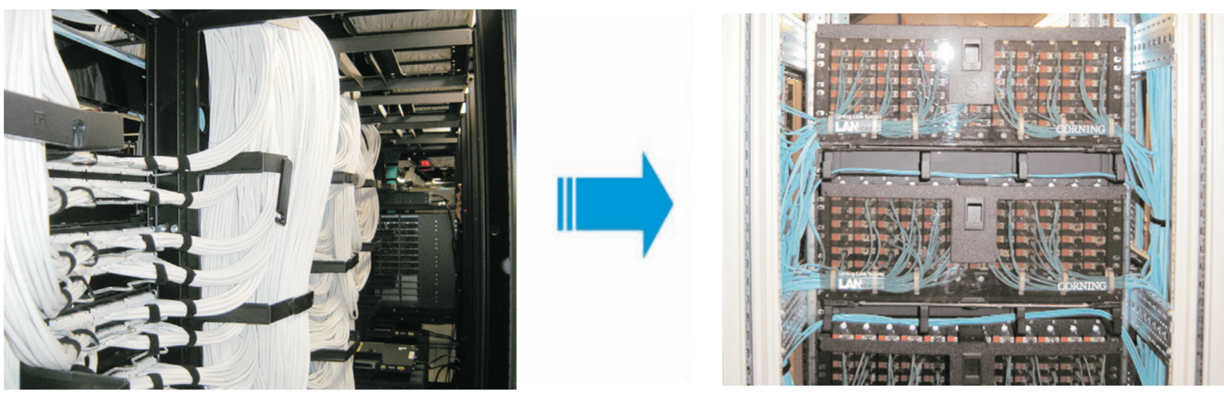
Port density is also an issue. At 10G copper systems are expected to be limited to 4-8 ports per card. In contrast optical switches can support up to 48 ports per line card. Higher densities lead to greater space utilisation which will drive co-location costs down.

Optical is Easier

Contrary to what many may think, the installation and testing of optical cable systems is a relatively simple procedure. As copper is being pushed to the limits of its capabilities in terms of data rate and reach, it becomes much more complex to install accurately and field test, requiring well-trained technicians, as well as expensive and sophisticated test equipment. The tests on copper cable are numerous including insertion loss, return loss, pair-to-pair and power sum cross talk, propagation delay, length and delay skew testing on each cable across the 1-500 MHz frequency spectrum. Further tests include complex alien cross talk measurements and the whole process can take well over 3 hours per cable. Conversely, field testing for optical fibre simply requires one standard simple end-to-end link loss measurement that can be done in a matter of seconds. Considering that time is most certainly money in the enterprise and data centre world, a technology, like optical fibre cabling, that is fast and easy to install during planned downtime, makes excellent commercial sense.

Time is Money

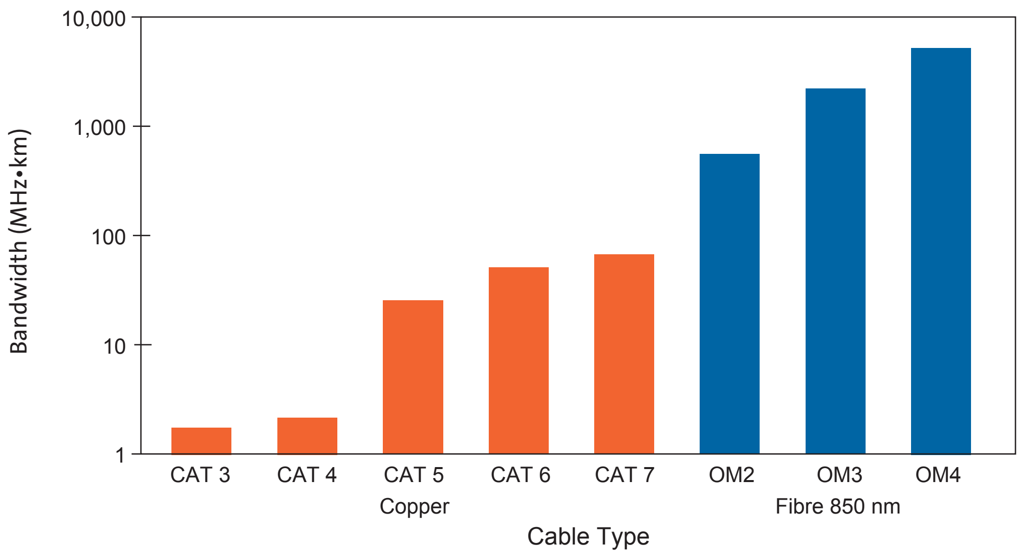
It is said that a one-millisecond advantage in trading applications can be worth $100 million a year to a major brokerage firm. As a result Data centres now seek out and differentiate on low latency performance. Those same power hungry electronic DSP techniques that are required to recover transmitted data packets from internal noise impairments and deliver an acceptable bit error rate (BER) at 10G on copper also introduce a significant, inherent and therefore unavoidable time delay, otherwise known as latency. Most 10G interfaces will be on servers, switches, high-performance computers and storage systems used inside corporate data centres, where high latency is not acceptable. 10G optical has typical PHY latency measurable in the nanosecond range, whereas 10G copper has PHY latency in microseconds such that 10G optical PHY latency has 1000 times better latency performance than 10G copper. Hence optical fibre delivers an unbeatable advantage over legacy 10G systems when it comes to latency.



Low density and larger copper cables (left), cause congested pathways resulting in difficult cable management and increased cooling requirements compared to compact optical fibre systems (right): both systems shown here are running at 10G

To Infinity and Beyond...

As optical fibre continues to revolutionise the world of communications, making all that we know today in terms of a super-connected world possible, with the internet spurring a plethora of voice, video and data applications, copper cable technology has been struggling to keep up with bandwidth demands virtually ever since it entered the enterprise market. As a result, in the past 20 years, there have been six generations of copper cabling with each one designed to address the next wave of bandwidth demand and each one becoming more complex to design around and install... Cabling upgrades and redeployment are not without significant cost and impact to daily operations, requiring prolonged scheduled downtime and so it begs the question: “why deploy a cabling infrastructure that will soon be made obsolete by your network’s inevitable growth and will require early removal to make way for a next-generation cable design”. Early generation 50/125 optical multimode fibre (500/500 now classified as OM2) continues to offer higher bandwidth capability than the latest specifications for twisted copper pair cables such as Cat6a or Cat7. However, given the implications of overall system cost economics and continual bandwidth growth demand now mapped out to 40/100G speed solutions, higher bandwidth multimode fibre such as OM3 and OM4, which are 40G and 100G ready, are now favoured for new cabling in DCs. Fibre optic cabling boasts an unrivalled technology robustness so that when deployed now to meet your needs today, it provides assurance that it will be providing your cabling needs many years from now. In particular the leading edge laser optimised OM4 multimode optical fibre solutions, like Corning ClearCurve OM4 fibre, that are available today provide the ultimate in migration paths for supporting your higher data rates of the future like 32G Fibre Channel and 100G Ethernet.



Bandwidth comparison of copper* and fibre cables. OM2 fibre bandwidth capability has outlived all generations of copper cable design; OM3 and OM4 bandwidth and link length capabilities are even further beyond that of copper. *Bandwidth frequencies for copper are typically referenced to 100m, here they are normalised to 1km. **Fibre bandwidth refers to laser bandwidth at 850nm (Source: ISO/IEC 11801)**

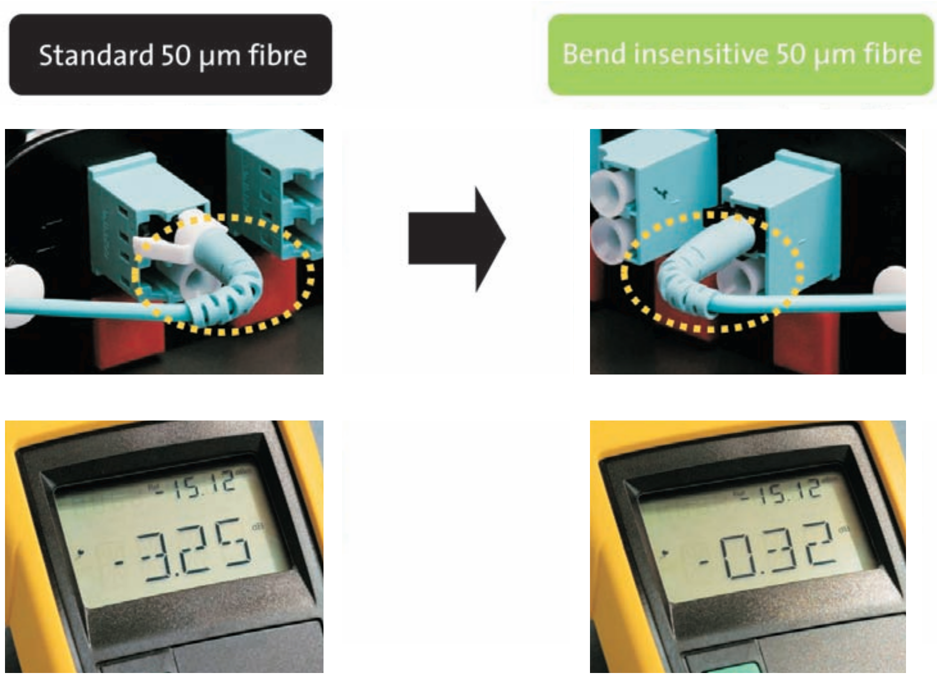
Fiber Innovation Brings Even More Benefits to Connectivity

When conventional or legacy fibres are bent tightly, some of the signal will leak out of the fibre at the site of the bend due to macrobend loss. In any cabling system, in the absence of constant and rigorous cabling management, natural entropy will result in unwanted bends in the cables. If those bends are severe/tight enough, sufficient signal can be lost at the bend site resulting in the signal power at the receiver becoming too low for the system to run and the system consequently failing, causing unplanned downtime. However recent advances in optical fibre technology have resulted in a new innovation: bend insensitive multimode fibre (BIMMF), such as Corning ClearCurve® Multimode fibre.

This new bend insensitive multimode fibre from Corning, which is available in all laser optimised grades, OM2, OM3 and OM4, exhibits 10 times less signal loss in tight bend scenarios and therefore protects enterprise and data centre systems from unplanned downtime due to signal loss and associated significant revenue loss.

In addition these new bend insensitive multimode fibres enable new possibilities for cable and patch panel design to further improve the benefits of using fibre. Optical cable manufacturers can now design thinner, more flexible trunk cables, making for easier cable installation and further improving airflow in conduits, patch panels and racks. Due to the ability of the fibre cable to be bent tightly with significantly less signal loss, connector modules can be made smaller which in turn leads to an increased density within racks and smaller racks: a fine example of this being the highly successful Corning Lanscape® Pretium EDGE™ system which uses, as its foundational enabling technology, new bend insensitive Corning ClearCurve® multimode fibre. Such greater utilisation of shelving space may help reduce the number of racks and in turn enable a smaller data centre foot print with associated lower real estate or co-location costs.

Corning ClearCurve® multimode OM2, OM3 and OM4 bend insensitive fibres are fully standards compliant and have been well proven in the market since their launch two years ago, with many hundreds of thousands of kilometres being successfully deployed in data centre and enterprise networks all over the world. Corning ClearCurve® multimode bend insensitive fibre is fully backwards compatible with existing legacy and laser optimized 50 µm multimode fibres (OM2, OM3 and OM4), providing low connector insertion loss and up to ten times better bend performance than conventional 50 µm multimode fibre.



A single tight bend can cause a signal loss of over 3 dB, that's a 50% power reduction: such power loss would cause a 10 G link to fail! A bend insensitive multimode fibre under the same condition will exhibit 10 times less loss and so maintain a strong signal and no link failure.

Looking Ahead

With Steve Ballmer, CEO of Microsoft, recently having been quoted as saying that by 2011 "90% of Microsoft employees will be working on cloud related projects" and Google launching its Chrome book, it appears that cloud computing is about to go mainstream. This is anticipated to more than double the utilisation of a data centre operating as a cloud. Cloud based applications coupled with insatiable demand for high-bandwidth applications such as video on demand has meant that the drive for 100 GbE interfaces has been intense. IEEE 802.3ba 100 Gb Ethernet standards are now in place with early end-user adoption increasing and significant industry adoption expected by 2013. Current devices are based on running 10 channels at 10 Gb/s but considerable industry effort is also directed at a 4 x 25Gb/s solution.

In answering the high speed and scalable capacity requirement of today's data centre and enterprise networks the optical fibre is proving to be an unbeatable asset, but an asset that also offers "green" benefits in terms of lower power consumption, unbeatable latency performance, ease of test and install and increased rack and cabling density. But the demand on data centres to provide more services and increased performance while minimising downtime and lowering maintenance costs means that deployment of not just optical fibre but bend insensitive optical fibre that enables even greater system reliability and space utilisation is a necessity rather than a choice.

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