Sustaining the Cloud with a Faster, Greener and Uptime-Optimized Data Center

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Introduction

Our world is in a rapid state of change in terms of the way we communicate and are connected with each other. We are constantly experiencing new advances in communications, be it the smart phone, tablet computers, internet gaming, social networks or e-services such as e-money or e-education. It is well recognized that backbone, metro and access networks need to deliver higher capacity in order to provide pipelines big enough for all this data to flow. But what's happening at the source and storage points for all this data? Both LANs and data centers are undergoing their own personal revolutions in terms of the ways they are built and operated, yet more specifically it is the data centers, with their high volume throughput of data, that are at the forefront of these changes and are therefore worthy of more detailed investigation.

Datacenter Dynamics' Market Research: meeting the challenges

As more and more businesses and individuals elect to operate in the cloud, growing pressure is being placed on data centers to increase their capacity and deliver higher data rates whilst also meeting expectations to be energy-efficient. This pressure means that virtualization, next generation speeds and the green data center have become key global trends. In striving to cope with these trends, data center managers are destined to encounter certain specific challenges.

Datacenter dynamics (in collaboration with Corning) recently conducted a survey of 160 data centers in the 6 key markets of the UK, Germany, The Netherlands, France, the Middle East and the US including the top 100 data center owners and operators in those regions. The results of this survey confirmed that downtime, energy and cooling costs, space utilization and the ability of installed cabling to meet the needs of next generation networks are the top concerns of enterprise managers and therefore need to be considered carefully in the context of cable innovation advances.

Next Generation Networks: fiber enabling higher data rates

Data from the Ethernet Alliance (figure 1) shows that data rates throughout the networks are growing significantly each year, with 10Gb/s systems now commonplace and 40Gb/s systems increasing in adoption. The capability of data centers to migrate to higher data rates is essential; and doing this requires careful consideration of cabling technology choice. The platforms available today are copper wire-based cabling and multimode optical fiber cabling.

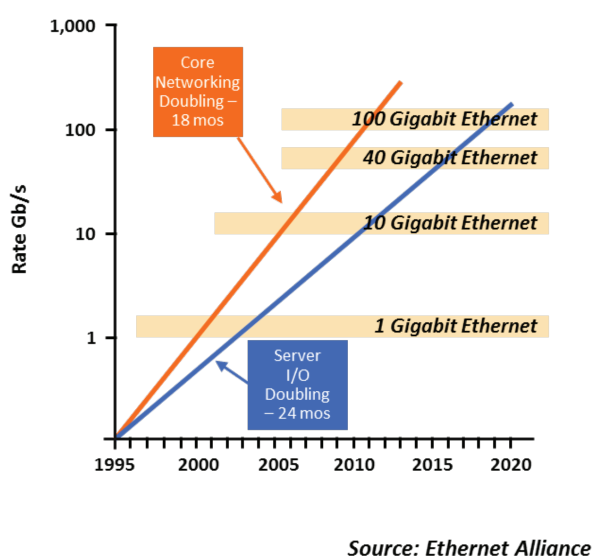

Figure 1. Data rates forecast from Ethernet Alliance

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Both copper and optical fiber platforms have evolved over time but what is clear is that the OM3 and OM4 categories of gigabit transmission optimised multimode fiber have laser bandwidth capabilities that far outstrip the electrical bandwidth capabilities of all 5 generations of copper cabling from Cat 3 through to Cat 7 (figure 2). The greater bandwidth capability of multi-mode optical fiber naturally translates into greater system reach capabilities at a given data rate; or conversely far higher data rate capability at a given system reach. Optical fiber would therefore be the technology of choice to deliver next generation connectivity and speed.

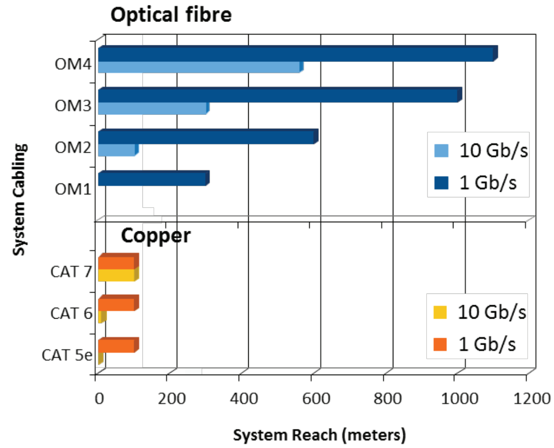


Figure 2. Optical systems networks allow higher data rates and system reach

The Green Data Center

Reducing the energy consumption of a data center is a multi-faceted challenge. Lowering overall energy consumption demands a reduction in the power used by the active components, as well as reducing the energy required to cool those components. This challenge can be met though by a sensible technology choice. Small diameter multi-fiber optical cables, coupled with multi-fiber connector innovation (like MTP connectors) enable high-port density racking systems. This combined with the fact that 10G optical fiber cabling offers greater than 20 times the data density of Cat5 or 6 copper cable, means an optical network can provide highly optimized pathway and occupy less space in racks, cabinets and trays, thereby reducing a data center's footprint.

Optical fiber-based networks are also inherently more energy-efficient than copper networks due to the high insertion loss of copper cables and their heavy reliance on digital signal processing. The lower power consumption of an optical transceiver and the fewer number of switches required in an optical system compared to the copper equivalent, effect energy savings from 55% to 70% (see figure 3) when using the optical cabling solution.

Hence if space savings and energy consumption are a challenge at higher data rates, optical fiber cabling is the optimum solution.

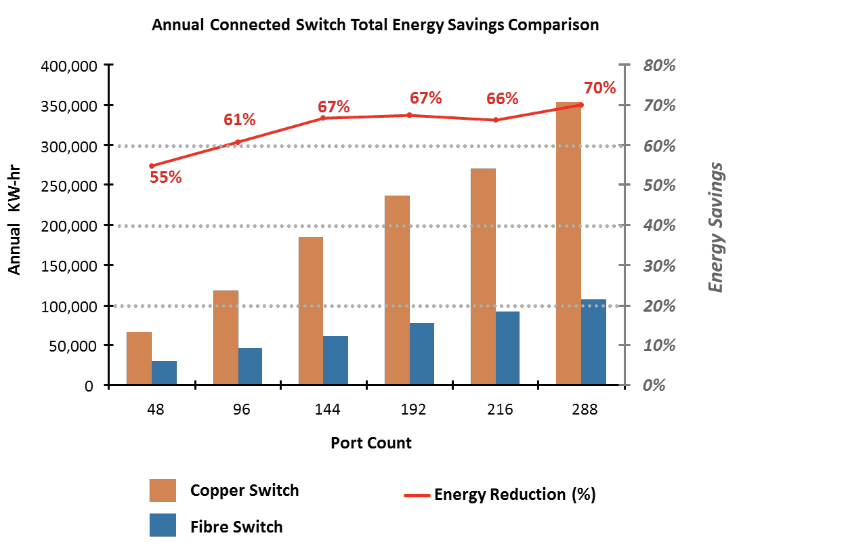


Figure 3. Energy savings comparison of fiber vs copper based systems

The Impact of Cloud Computing in System Uptime and Availability

Data centers are responding to the demand for capacity driven by cloud computing by incrementing the level of virtualization of their servers. Virtualization entails consolidating several servers into one physical processor upon which multiple applications run in parallel, potentially increasing server utilization efficiency by up to 90%. As a consequence of virtualization, the level of redundancy in a network is reduced. Therefore if it is not managed carefully, it can reduce the reliability of a system and increase the risk of downtime. The Datacenter Dynamics and Corning data center survey revealed that the sectors where uptime and availability is most critical (Financial, IT and Telecoms) are more sensitive to downtime risk, making the reduced redundancy associated with virtualization a far less attractive proposal. Therefore downtime is a key challenge in the new world of advanced data centers and cloud computing.

When surveyed, 43% of data center managers reported planning some form of scheduled downtime in the previous twelve months. But they also reported a significant level of unscheduled downtime (overrun or abnormal happening) which represent costly events. According to our data center study outages cost an average of $14,000 per hour. Managers identify cabling choice and cable management as significant players in the cause of data center downtime. According to their responses (see figure 4), the cost of unplanned downtime due in whole or in part to cabling fault is about $750,000 in only 1 year of operation ($400m per year or 8% to 9% of the total downtime losses).

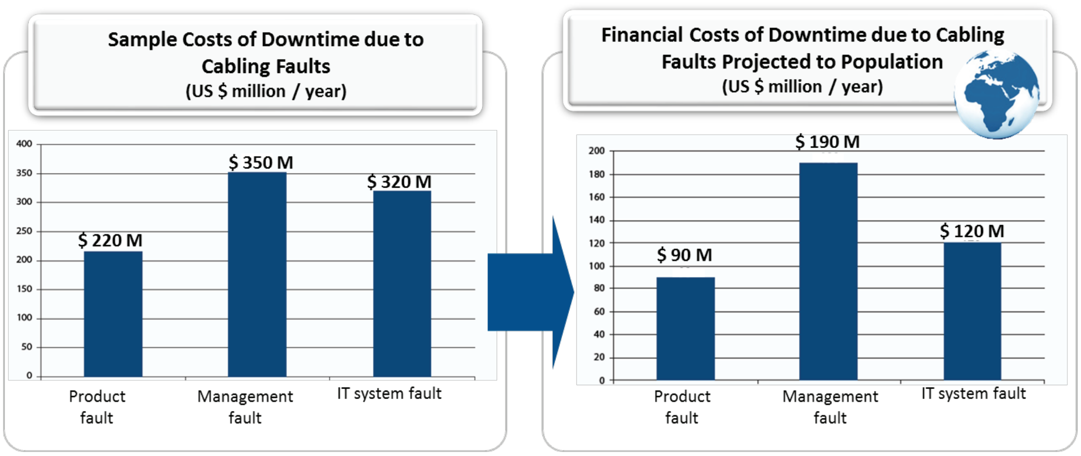


Figure 4. Estimated cost of unplanned downtime due in whole or in part to cabling fault.
Source: Datacenter Dynamics Market Research

Hence, if optical fiber cabling is the technology of choice both from the perspective of enabling the green data center and next generation networks is there any recent cabling innovation that can really help to minimize downtime and maximize uptime and availability? To answer this question we need to explore the concept of data center entropy.

The Effect of Entropy in Data Centers

Data center entropy is defined as the gradual increase of cabling complexity which inevitably happens over time due to moves, additions and changes in data center connectivity. As a result of entropy, data center ducts become overcrowded leading to tight bends or pulled connectors, such as in figure 5. If legacy multimode optical fiber cabling is exposed to this entropy, a significant amount of signal loss is incurred. Most systems have power budgets and operate within certain parameters to protect against signal failure. Bending fibers can result in the system loss exceeding the power budget and the system failing due to the signal power being too weak at the receiver.

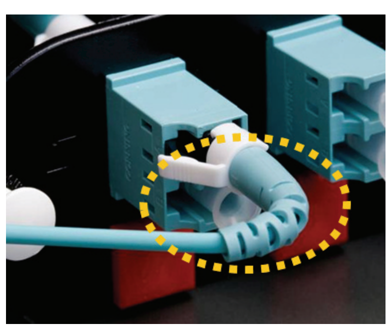


Figure 5. Pull connector as a result of entropy effect over time

An overwhelming 94% of IT managers surveyed as part of our data center market research confirmed that cabling entropy results in a higher risk of downtime over time. Furthermore, 74% of them also expressed the belief that management of downtime becomes more complicated over time, with our research confirming that incidences of downtime become more frequent as data centers reach maturity in terms of lifespan and entropy starts to take effect.

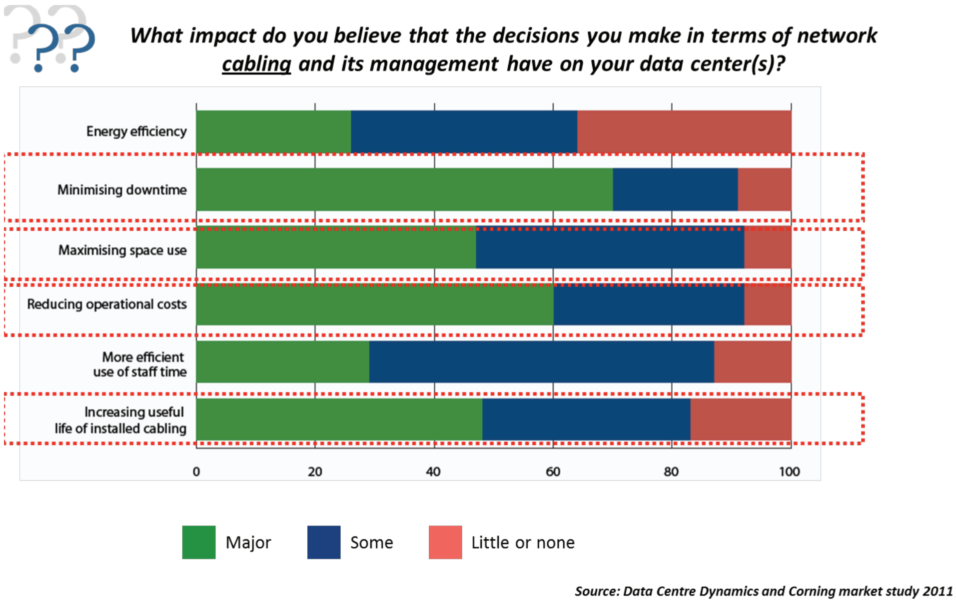


Figure 6. Perceived impact of cabling and cabling management in data centers

Beating Entropy with Bend Insensitive Fibers

When a conventional or legacy multimode fiber (MMF) is bent tightly, light will leak out of the fiber's core at the point of the bend. This is called macrobend loss. Recent innovations in multimode fiber design resulted in the development of bend insensitive fibers (e.g. Corning® ClearCurve® Multimode Fiber) that effectively have a barrier around the core to minimize macrobend loss. The result is an optical fiber that exhibits up to a tenfold reduction in loss at the point of a bend (see Figure 7). If a system operates with bend insensitive multimode fiber, the bend induced loss will be ten times lower than with a conventional multimode fiber, thereby protecting the system margin or power budget headroom and ensuring that the system continues to operate and unscheduled downtime is avoided.

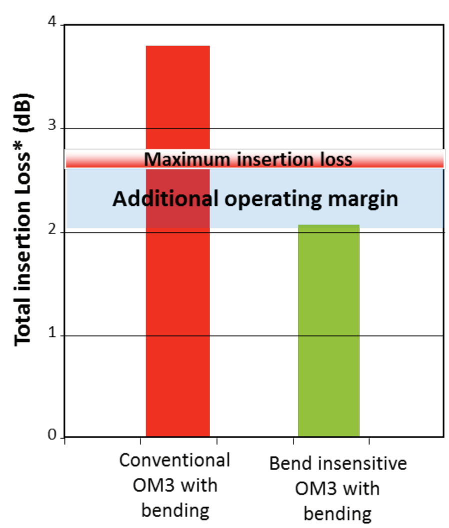
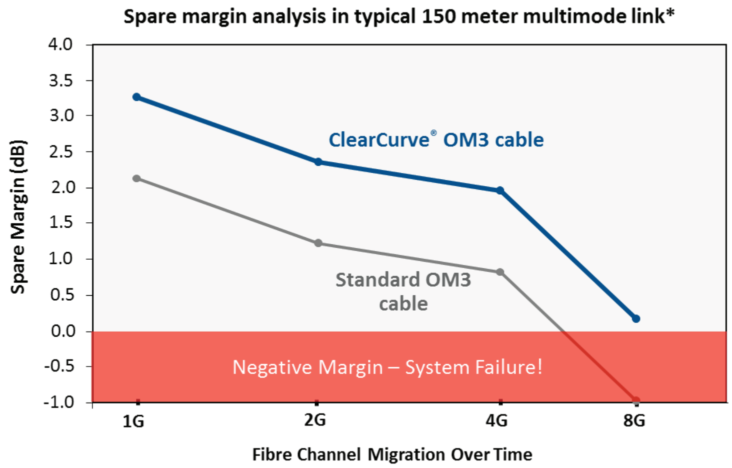


Figure 7. Bend insensitive OM3 fiber macrobend performance versus standard multimode OM3 fiber

Bend insensitivity also inherently addresses the issues of next generation networks and the green data center. Eradicating virtually all bend loss frees up additional system margin to enable the path to higher data rates (figure 8). Moreover, the higher tolerance to bends means thinner and more flexible cables and small components. This enables increased density in the racks reducing a data center's footprint and ultimately increasing airflow to aid cooling.



*Assumptions:
- 1.5dB connector loss, 20x ¼ turns @7.5 mm
- 20 ¼ turns is representative of typical data centre link
- "Spare margin" is the total available power beyond that which is used up by link components losses and induced power penalties

Figure 8. Spare margin analysis with Fiber Channel migration

With new technologies, there is always the question of backwards compatibility and interoperability. Corning® ClearCurve® Multimode Fiber is totally backwards compatible with legacy or conventional systems. Hence it addresses all key common areas of concern: bandwidth, standards compliance and connectivity. Over one million kilometers of this fiber has been sold globally since its launch and no functional issues whatsoever have been reported from the field, this despite (by nature of its capabilities), the fiber being deployed in the most demanding of data center applications.

Bend Insensitive Fiber Technology: a necessity, not a luxury

As we have noted, we are in the midst of a communications revolution meaning enterprise data center networks need to work hard to keep pace with ever increasing capacity demands. Not only do data centers need to enable high data rates for next generation solutions, they are also faced with the additional challenges of maximizing uptime and availability and becoming green.

With copper and optical cabling as the main two technologies of choice at the infrastructure level, the study has identified that optical fiber is significantly better at enabling higher data rates for next generation solutions and reducing power, cooling and footprint for the green data center.

Moreover, results from Datacenter Dynamics' survey demonstrated that cabling issues often related to data center entropy or cabling complexity increasing over time are a major cause of unscheduled downtime. Innovative bend insensitive multimode fiber reduces the impact of cabling entropy and protects the network from downtime. In addition to freeing up additional system margin, bend insensitive fibers like Corning® ClearCurve® Multimode Fiber bring further advantages in terms of upgradeability to next generation data rates and also reduction of data center footprint.

So if uptime matters, green matters and the future of your network matters in order to sustain super-connectivity or cloud computing, our conclusion is that bend insensitive optical fiber cabling is not a luxury, it is a necessity.

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