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Desktop to data centre
-
the real battlelines for copper and optical fibre

In 1986, I vaguely recall giving an interview to a publication, probably defunct by now, that was predicting the end of copper cabling in commercial premises, the home and virtually everywhere else within five years. Now, and for the last twelve months, we have heard little in the cabling magazines other than how copper is to replace optical fibre as the primary distribution method for 10 Gigabit applications. I was more than sceptical of the predictions in 1986 – and that scepticism continues today.

The volume market in commercial premises cabling is the horizontal cabling i.e. to the desk. Depending upon which country you live in and which market survey you read, an average horizontal cabling channel is 59 metres in length, includes up to three sockets and five plugs (or seven if you count the ones that connect to the transmission equipment). In comparison, building backbones comprise a small fraction (typically 1%-6%) of the components if we exclude conventional voice circuits. Campus backbones (where they exist) constitute an even smaller element of the overall cabling spend. Data centres, anything from a "comms room" in an office block through to a complete data hosting/co-location facility, may contain substantially more cabling than either of the backbone systems since data centre cabling is, in some ways, a mirror image of the premises distribution system. The market to fight over is therefore the horizontal and the data centre.

This is to some extent quite convenient for the copper cabling guys - they cannot compete to deliver the high data rates over the extended lengths of campus and backbone cabling sub-systems but it is a relatively small market so who cares - let the optical fibre guys keep that market. Instead, the battlelines are drawn in the dust of the office floor and the data centre. In this article, which is purposely contentious, I wish to both de-bunk the old chestnut of "fibre-to-the-desk" and challenge a few of the positions taken by the copper cabling fraternity. No doubt they will respond most vociferously but as Bob Hoskins once said "it's good to talk".

….changing perceptions of optical fibre and its advantages…

Experienced cabling designers are well aware of the list of advantages ascribed to optical fibre. BS 7718, developed in 1989, contained one version of the list which is shown in Figure 1. It is interesting to note that top of the list was bandwidth. It is funny how perceptions change. Although the bandwidth offered by singlemode optical fibre is enormous, we will soon see copper, or more correctly, balanced cabling provide 10 Gigabit Ethernet (10GBASE-T) over 100 metres as compared to the 300 metres maximum achieved by the best multimode optical fibres. Not so different?

Further down the list came "non-radiating transmission medium", "freedom from electromagnetic interference" and most interestingly of all "freedom from inter-element crosstalk". However, one principle advantage not listed in BS 7718 is the ability to support large numbers of connections. It was never mentioned because BS 7718 was written in the days before anyone wanted to produce plug-and-play data centres or high resilience backbone systems. We will return to these advantages later in the article.

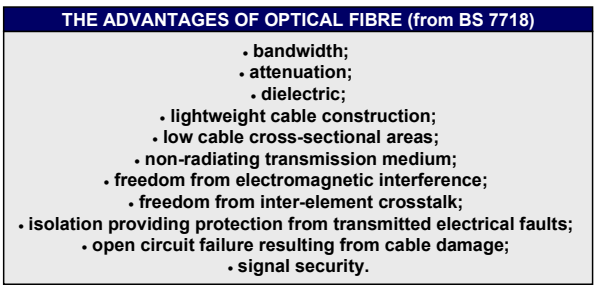

Figure 1 - The legendary advantages of optical fibre

The one advantage that optical fibre can never claim is cost. The success of optical fibre as transmission medium does not depend upon the comparative costs of cabling. Strangely, high performance singlemode cabling can be cheaper than multimode cabling and both are on a par with the most expensive balanced cabling systems. It is the cost of the optical fibre transmission equipment that defines the cost equation. Singlemode opto-electronics are significantly more expensive than their multimode equivalents and so while singlemode cabling may be installed in parallel with multimode, it would only be used if there was no alternative.

Faced with this overwhelming imbalance, the repeated attempts by optical fibre component suppliers to reduce installation-related costs such as the cost of termination have been somewhat farcical and actually drawn attention to a cost issue that, to the user, is largely irrelevant. No user is going to replace copper with optical fibre just because it takes 5 minutes rather than 15 minutes to terminate each end. It might be relevant to the installer – but he or she will never get the chance to exploit the new termination technique anyway - because the user chose copper.

In order to use optical fibre a user has to justify the cost in terms of the benefit that will be re-couped. If we analyse the places in which cabling is installed it will rapidly become clear where optical fibre can win and why - irrespective of cost.

….balanced cabling is the winner in the horizontal - independent of data rate…

Horizontal cabling provides the “desktop” data rates within premises over carefully controlled distances. These data rates have increased from 4Mbits/s to 100Mbit/s and now to 1Gbit/s but the idea that “fibre-to-the-desk” would become mainstream because of this growth has been misconceived from the outset. It is a matter of fact that networks targeted at the desktop are first standardised over copper cabling. Conversely, applications initially destined for use in the backbone are first standardised over optical fibre and are then migrated to balanced cabling once the demand for that network to the desktop can be market-justified. Why? - because balanced cabling has an unfair advantage - it conducts electricity - and that advantage is becoming more, not less, prominent.

Horizontal cabling channels have always been required to provide telephony services that, in general, require a power supply. Providing power along an optical fibre is not an option - in fact the very opposite is listed as an advantage in Figure 1. More recently IP telephony, after a faltering start, has teamed up with the IEEE 802.3af standard that ensures that pairs in a balanced cable can provide up to 13W of power at the end of the 100 metre horizontal channels. There is even talk of increasing this power under certain circumstances thereby widening the range of devices that could be powered or re-charged.

There is no ongoing battle between optical fibre and balanced cabling in horizontal cabling systems as data rates rise. The principal reason why fibre-to-the-desk will not become mainstream is not a question of data rate but of the delivery of power to IP-devices.

It is possible that in some special cases the advantages of optical fibre can be cost-quantified to offset the techno-commercial benefits offered by balanced cabling. For example, a demand for totally secure transmission may render the cost argument irrelevant. Overall though, horizontal cabling channels are considered to be “low criticality” which means that a failure of a given desktop to provide a service is easily solved - by physically moving and reconnecting that service at another outlet. Low criticality environments rarely justify excessive investment.

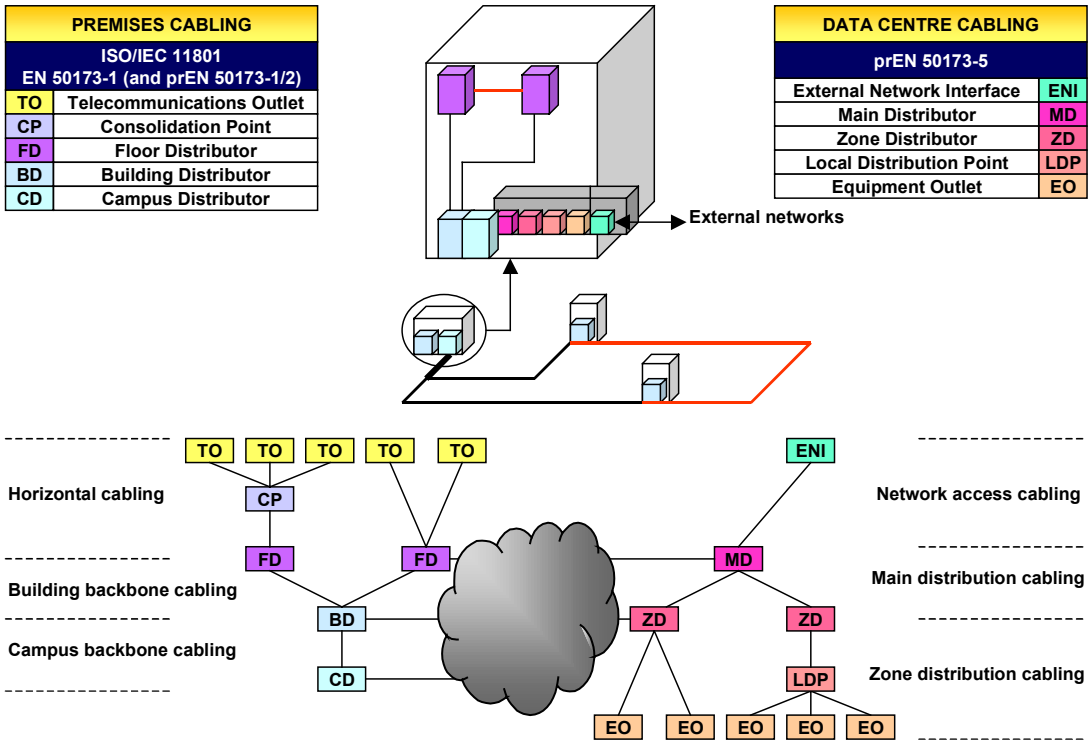

Figure 2 – Cabling structures

….plug-and-play resilience favours optical fibre in the backbone…

In contrast to its horizontal counterpart, backbone cabling has lengths that are defined by the design of the premises and has to support data rates equal to or higher than those found in the horizontal. It does not have to provide power from one distributor to another. For these three reasons, and no others are necessary, optical fibre is an established transmission solution in backbone cabling.

The use of switches/hubs/routers at the floor distributors significantly reduces the number of backbone ports but increases the criticality of their failure. The failure of one backbone channel will affect many horizontal channels and the failure of an entire backbone cabling route may affect multiple floors. In the face of such network criticality, the decision to use optical fibre is commercially less sensitive and brings into play the one advantage that balanced cabling can never claim - the ability of optical fibre to support large numbers of connections without degrading bandwidth capacity. This ability allows resilient routes to be created that can, if necessary, support plug-and-play configuration changes.

Optical fibre networks up to and including 10GBASE-SR can support more than ten mated connections over multimode optical channels lengths of up to 200 metres (with some cabling system suppliers offering even greater support). While such complexity is rarely needed in even the most resilient building backbone constructs the data centre is a different world altogether.

….the looking-glass world of data centres…

What is a data centre? It may easier to describe what it does - rather that what it is. A data centre contains switching equipment at the zone and main distributors that connects the premises distribution cabling to data sources inside the building (i.e. servers) and the outside world (i.e. broadband connections). Standards such as EN 50173-5 and similar work in the United States are creating a structure for the cabling of these amorphous entities.

Structurally, as can be seen in Figure 2, data centre cabling systems are the mirror image of the premises distribution cabling with the zone distribution cabling of the data centre being similar to horizontal cabling and the main distribution cabling taking the part of the backbone. In terms of resilience and data capacity the

comparison holds true. However, the real mirror-image nature of the data centre is more fundamental. Premises cabling is designed to produce channels by reconfiguration of fixed cabling links.

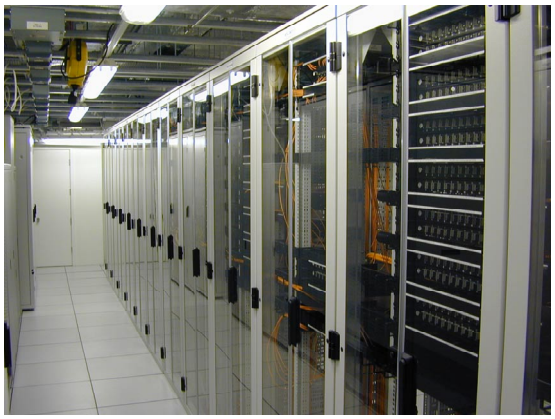

Figure 3 – The world of data centres

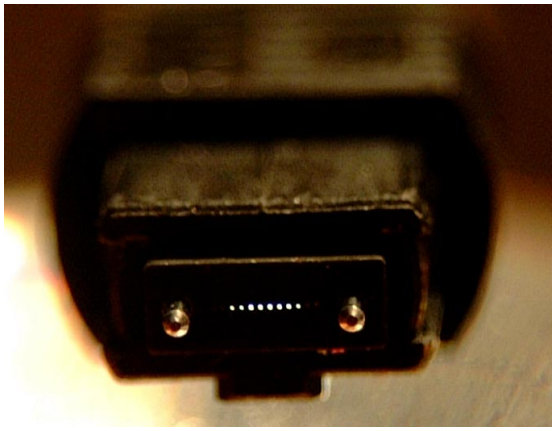

Figure 4 – High density interconnects

Changes are made to the routeing of services over the fixed infrastructure work undertaken at patching fields. In contrast data centres can, and regularly do, evolve by the addition of equipment, cabinets and even rows of cabinets. This demands additional cabling links rather than reconfiguration of existing ones. Enabling this type of growth very quickly, avoiding massive disruption and risk of service provision failure is a key objective of the top data centre designers.

Let us return to the advantages shown in Figure 1. Optical fibre is a “non-radiating transmission medium”, it provides “freedom from electromagnetic interference and from inter-element crosstalk”. In a high data rate, high density cabling environment where cables are packed tightly together these advantages are critical. Not only does optical fibre cabling reduce the electromagnetic signature within the data centre, it can provision multiple circuits in a single cable without risk of interference thereby reducing the size and weight of the cabling. Optical fibre, using MPO and similar connections, can deliver twelve circuits in a connection no bigger than the end of your little finger and we know that we can use lots of these connections to allow rapid build of new sub-systems.

…so what about 10GBASE-T…

10GBASE-T will be the balanced cabling implementation of 10 Gigabit Ethernet. Standards-compliant products are expected to ship in 2006 and, according to IEEE, are aimed initially at data centres with eventual migration to the desktop. The pros and cons of the debate over 10GBASE-T products to the desk is somewhat academic. What does matter at this stage is the development of cabling in support of 10GBASE-T.

According to IEEE, 10GBASE-T cabling requires characterisation up to 500MHz with most of the parameters meeting the requirements of Class E (Category 6 in the USA) channels extended to that frequency. The exact details of the channel performance are largely irrelevant because whatever they are, existing Category 6 cabling is not guaranteed to meet them. Here the story gets more complicated because there are two separate performance specifications being developed – one to confirm that existing cabling can support 10GBASE-T, the other for a new Category 6/Class E product set.

The main balanced cabling system suppliers seem to be intent on selling new products to meet the requirements of a new Category 6 product specification. So with 1000BASE-T running quite happily on Category 5e/Class D:2002 channels and 10GBASE-T support being forced onto new products the existing Category 6 products and the cabling installed using them are left much in the same position as Category 4 (so useful that it was not even included in the EN 50173 published in 1995).

…augmented Category 6/Class E: 2006 cabling - who needs it?…

It is interesting, not to say unnerving, that the characterisation of cabling in support of 10GBASE-T has to address, for the first time, the issue of alien crosstalk – the electromagnetic interference between adjacent cables ("inter-element crosstalk" for optical fibre). Models used to determine the viability of 10GBASE-T determined that the control of alien crosstalk is "mission critical" since random signals originating external to the channel cannot be cancelled by the digital signal processing. A variety of means may deliver alien crosstalk control including the use of physical mitigation techniques (randomising cable lays) or electromagnetic mitigation techniques (screening). One thing us for sure, it is going to be virtually impossible to measure on an installed system. The number of connections in the 10GBASE-T channel will still be limited to four and alien crosstalk will be a key concern at those panel connections.

With all these issues still being addressed it hardly seems feasible that 10GBASE-T cabling will considered as a credible replacement for optical fibre in the most critical areas within data centres of the type described above.

…drawing to a conclusion…

So why all the fuss? With the cry "Cat. 6 is dead, long live Cat.6" ringing in our ears it could be that the real target for the cabling suppliers is the horizontal cabling market. If so, 10GBASE-T cabling could be said to be targeted at a horizontal cabling market that might not need it, because the data centre market that could use it - probably won't.

This should not concern the optical fibre industry because the horizontal market, except in very special circumstances, is not our domain. The use of optical fibre in the building and campus backbones is not under threat.

In the data centre environment, any serious designer knows that there is no such thing as a cost-reliability balance. If you need reliability in the five 9's region then the cost to deliver it is not a primary issue. If you need high density interconnects, low cabling volumes and plug-and-play evolution, cost is not a primary issue.

When I was at Manchester University studying physics, nuclear fusion was quoted to 25 years away. Today nuclear fusion is still 25 years away. So when will optical fibre challenge copper to the desktop?

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