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A new generation of optical fibre components

Introduction

After almost fifteen years of technical stability the selection of optical fibre products for the local area network environment is undergoing rapid evolution.

Firstly, the introduction of 1Gigabit (1G) Ethernet initiated a trend back towards 50/125 multimode optical fibre (MMF) solutions. Now, the advent of 10 Gigabit (10G) Ethernet backbone technology, for which the IEEE standards are to be ratified in 2002, has emphasised this move by forcing the development of new multimode optical fibre (MMF) specifications.

At the same time, connector manufacturers have been trying to persuade the market of the viability of a new breed of duplex Small Form Factor interfaces.

Another area demanding significantly more attention is that of the “dark fibre” private network connections offered by an increasing number of third party providers.

Finally, because of both “dark fibre” connections and the more general increasing use of LASER technologies in support of the high bit rate transmission solutions, the issue of optical safety has come the fore.

These changes have brought with them a whole feast of previously unconsidered problems for installers and users alike; problems that, while being far from unexpected by the “old hands” in the industry, have arrived unannounced for many. In 2000, the Fibreoptic Industry Association began the publication of a series of Technical Support Documents to cover the issues raised by these and other market moves. In this article, we only have space to cover the changes that are affecting the selection of optical fibre within premises cabling.

The latest optical fibre standards

Multimode optical fibre (MMF) LAN standards can be described as either attenuation-limited or bandwidth-limited. The split between the two regimes can be considered to occur at 100Mb/s. Put simply, the distance over which the low bit rate, attenuation-limited, applications can be delivered is defined by the overall power lost through the cable and connectors. This allows simple design rules to be followed and makes acceptance testing of the installation very straightforward. In comparison, the transmission distances for the high bit rate bandwidth-limited applications are not defined by the power lost through the cabling but by signal re-shaping known as dispersion. The amount of dispersion reduces as the bandwidth of the optical fibre increases therefore higher bandwidth optical fibre allows greater distances of transmission.

This has led to proposals, currently in their final stages of standardisation, for the establishment of performance Categories of optical fibre that are in effect “bandwidth” based. OM1 is the lowest performance option with OM3 providing new levels of performance primarily in support of 10G Ethernet. The Categories will appear in the second editions of premises cabling design standards (BS EN 50173 and ISO/IEC 11801) and in amendments to the US standard ANSI/TIA/EIA 568B.3. They may not be called Categories in all three standards but they certainly will be in the BS EN since they are, to all intents and purposes, similar to the Category concepts adopted for copper cables. The expected publication timescales for the European and international standards (which also contain the Category 6/Class E and Category 7/Class F specifications for balanced cabling) will be Q3, 2002. The US will not be far behind.

		Multimode OF				Singlemode OF
		50/125 or 62.5/125		50/125		
	Wavelength	OM1	OM2	OM3	Wavelength	OS1
Attenuation coefficient (dBkm^{-1} max)	850nm	3,5			1310nm	1,0
	1300nm	1,5			1550nm	1,0
Modal bandwidth OFL (MHz.km min)	850nm	200	500	1500		
	1300nm	500	500	500		
Modal bandwidth RL (MHz.km min)	850nm	-	-	2000		
	1300nm	-	-	-		
Propagation delay (ns.m^{-1} max)	850nm	5			1310nm	5
	1300nm				1550nm	

Figure 1: The optical fibre Categories

The performance specifications are shown Figure 1. All three multimode optical fibres have the same attenuation specification indicating that attenuation-limited applications will have a common level of support. However, the principal differences are seen to be in terms of bandwidth specification. Two different bandwidth specifications are provided - designated OFL (over-filled launch, appropriate for low bit rate LED-based applications) and RL (restricted launch, applicable to LASER-based applications). The RL specification is new and only applies to Category OM3.

OM1 is the “old” 62.5/125 MMF used in widely in Europe and constitutes a significant proportion of the legacy cabling in UK installations (although some 62.5/125 product sometimes called “FDDI-grade fibre” was, and is, made to a slightly lower specification). OM2 is, in reality, a 50/125 MMF has been installed by “bandwidth-conscious” users and clearly OM3 is a 50/125 MMF.

Figure 2 shows the maximum distances of transmission for typical applications over the different Categories. The figure shows that for low bit rate applications OM1 provides superior drive distances due to the greater light capture of the 62.5/125 optical fibre core. However, this really only benefits those users trying to drive distances in excess of 1500 metres. At higher bit rates, the picture reverses with OM2 and OM3 providing significantly greater supported distance. For 1G Ethernet, OM3 should provide longer transmission range than shown in Figure 2 but the IEEE has not considered this as yet. Instead OM3 flaunts its superiority by concentrating on 10G Ethernet where it is the only low cost network solution that offers a useful range.

Application			Optical Fibre		
			62.5/125 (OM1)	50/125 (OM2)	50/125 (OM3)
Mb/s	Network	λ	Max. length (m)	Max. length (m)	Max. length (m)
4	Token Ring	850 nm	2000	1857	1857
10	Ethernet		2000	1514	1514
16	Token Ring		2000	1857	1857
100	Ethernet	1300 nm	2000	2000	2000
1000	Ethernet	850 nm	275	550	550
10000	Ethernet	850 nm	33	82	300
Calculated values using 1.5dB of connecting hardware losses					

Figure 1: Transmission distances

There are other transmission techniques, not shown in Figure 2, which allow increased distances of delivery for OM1 and OM2 optical fibres but these come with a hefty price tag. For distances beyond those shown in Figure 2, the only real option is the implementation of singlemode solutions which, although low cost from the cabling perspective, involve high cost transmission equipment. OM3, albeit more costly than the other two multimode Categories, aims to defer the time of transition to singlemode by increasing the capabilities of the multimode technology.

Marketing opportunity or common sense?

The MMF Categories mirror the development of the copper cable Category concept that delayed the eventual migration to optical fibre for high bit rate networks. Certainly manufacturers have not been slow to adopt the new OM3 technology within marketing literature for both basic cable supply and as part of overall cabling system solutions. However, the comparison with the claims and counterclaims made for Category 6 and 7 products does not bear significant examination since the benefits of optical fibre modal bandwidth are clear for all to see - OM3 does not need a hard sell.

The development of OM3 specifications should not be seen as a continuation of the perceived crusade by the FTTD-AAC (fibre-to-the-desk at all costs) zealots. They have spent time concentrating on try to persuade the world that

terminating optical fibre can be made simpler, cheaper and faster. They have achieved some of these goals but users are still faced with significant cost differentials between the cost of balanced cable and optical fibre transmission cards. In reality, the battle has moved on to a realm where copper cannot compete successfully – that of the high bit rate backbone – and where even the legacy MMF solutions cannot offer effective implementations.

The Impact on Designers

Faced with the capability of the OM3 specification MMF, the designer of optical fibre infrastructures for LAN support has to look very carefully at the selection of product. However, to understand the full impact of this we need to review what designers should already be selecting to support 1000 Mb/s networks.

For distances of up to 275 metres, OM1 and OM2 appear to offer little to choose between them since they can both provide support for 1000BASE-SX; the VCSEL-driven, low cost equipment solution for Gigabit Ethernet. Beyond that distance and up to 550 metres, OM2 is the obvious candidate since OM1 installations would require the use of 1000BASE-LX equipment with a four-fold price increase. However, this simple analysis needs to be looked at in more detail because OM2 MMF enables a 1 dB higher channel insertion loss and can therefore support more connectors than OM1 for channels of the same length. This may be important for diverse routed resilient systems.

That being said, anyone designing to support 1 Gigabit networks today will no doubt be considering the use of 10 Gigabit within a short time and the key design rules revolve around the highest data rate application. In this area there is little real choice. Delivery of 10GbE over distances up to 300 metres can be done over multimode optical fibre in two ways. The low cost implementation is 10GBASE-SR (again VCSEL based) over OM3. The alternative is 10GBASE-LX4 that uses four-lane coarse wavelength division multiplexing using LASERs at a probable sixteen-fold cost increase. Few users will thank a designer for choosing the wrong option.

The Impact on Installers

One of the questions regularly asked by installers is about possible incompatibility between OM2 (50/125) and OM3. In order to achieve the significant rise in modal bandwidth performance, optical fibre manufacturers have had to modify the refractive index profile of the optical fibre core. Therefore, installers are justified in seeking confirmation that the splicing of, connection to and testing of OM3 systems with OM2 50/125 MMF will provide no problems. Based upon the evidence of thousands of splices of OM3 optical fibre to OM2 pigtails (due to lack of OM3 availability) and an equivalent number of OTDR and LSPM tests the author can state that no problems were observed.

What are the information sources

The FIA LAN Application Support Guide, first published in early 2001, already discusses the importance of OM3 specifications and provide s the basic design guidance needed. This document is being updated imminently to address the fine detail of the 10GBASE-xyz standards and to address the need for, and rules for usage of, mode conditioning cords within 1000BASE-LX networks. No doubt training houses will adopt many of the elements of the LAN ASG in their higher level courses aimed at designers and estimators. Elsewhere, the FIA is involved with the updating of the City & Guilds 3466 qualifications to take into full account the existence of the new standards to be published this year.