Modern Problems with Fibre Networks

Introduction

One of the modern issues with fibre cabling is the growing number of types of MultiMode cable out there, creating a knowledge gap on the differences between them.

Most people are aware of SingleMode (SM) and MultiMode (MM) and, mostly, don't confuse the two. However, with the introduction of the fifth type of MultiMode cable recently, the opportunity for mistakes is increasing.

One basic area where its all going wrong is the colour of the cable. SingleMode has done a pretty good job of making everything yellow, to the point that its pretty widely accepted that yellow fibre cable is SM, end of! People just don't seem to mix yellow cables and that's a good thing.

Life just isn't that straight forward for MM cable unfortunately. It starts with the fact that although there is a colour coding scheme for the different types of MM, it's not followed with any reliability, which means you can't trust it.

Colour Coding schemes and Core sizes

When you look at a patch panel these days, most of them contain a mixed bag of colours which can cause alarms to go off in our head. It also doesn't help that the naming conventions can also lead to confusion as well, but we will get to that later in this paper.

If you look at the standards there are actually proposed colours for the different fibre types:

Ref	Colour	Basic type	Core Size	Possible Colours
OS1	Yellow	SingleMode	9 micron	Yellow
OM1	Orange	MultiMode	62.5 micron	Orange/Grey
OM2	Orange	MultiMode	50 micron	Orange/Grey
OM3	Aqua	MultiMode	50 micron	Orange/Aqua/Purple
OM4	Aqua	MultiMode	50 micron	Orange/Aqua
OM5	Green	MultiMode	50 micron	Green

Part of the issue here is cost, part is people treating fibre patch leads like copper leads and creating their own colour schemes based around things like Data, Voice & wireless, and part of the issue is actually military requirements.

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When fibre cabling first started to be used in IT it was expensive and factories didn't want to gear up to make lots of different colours, they just wanted to make cable a cheaply as they could. The military specified everything in grey, no matter the specification, so some factories just produced grey cable and sold it to the public as well. Other factories latched on to the early use of orange cable, and everything since has been orange!

Many IT departments have tried to organise their UTP patch leads into colour schemes based on functionality and then tried to extend such practises into their fibre patching as well. This leads to all sorts of possible confusion in terms of the precise performance of the lead versus what traffic is running down it.

The only cable I have yet to see be mixed up is the OM5 in green. This is probably because it's the newest, it's the most expensive and there's not a lot of it out there, but given the above its probably only a question of time.

Perhaps all the above can be summarises in the following two lines:

- What ever the colour of the cable, check it, don't assume
- If the cables are orange be very careful, they could still all be different

The biggest single issue is mixing up the core sizes. A lot of legacy MM cable is the OM1 type, someone needs to make more cores live, so buys the latest MM patch leads, connects it up without realising and this is how easily it all goes wrong!

- If you ask for the best performing leads you will probably get OM3 or 4, as your supplier may recommend those. This is no good if your installed cable is the older 62.5 type.
- If you say the orange ones, well you could get anything!

What happens if you mix cores?

When you mix the cores of the cable, the following situations can happen:

- 62.5 patch leads on a 50 micron cable – the light in the bigger core can't all go into the smaller core, so some of it is lost and reflected back to the device transmitting it. You get a step loss in the power, reduced distance and you can get reflections back to the transmitter.
- 50 micron patch leads on a 62.5 cable – when the light in the smaller core hits the bigger core, its no longer controlled properly (known as modal dispersion) and effectively is out of control. This reduces the effective distance of the cable as the receiver won't be able to understand what's being sent.
- MM leads on a SM cable – 90% of the time this just won't work, but I have seen two examples of where it was working, one of which was deliberate (see below).

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It's the 50 leads on the 62.5 cores which confuses people as they think they are doing the right thing but actually make it worse. This also causes a strange anomaly in the fibre testing world known as a "gain". The results show the amount of light going up at this join, which is caused by the light no longer being controlled in a single mode and is now free, although loses its data!

Why so many MultiMode types, what is OM5?

The change from 62.5 core to 50 cores was driven by the need to support 1Gig data speeds over reasonable distances. At this time SingleMode was still seen as prohibitively expensive so this was the technical way out. Since then, the fibre manufactures have found ways to control the light in the cores better and with less loss (OM3 and OM4), hence the performance characteristics have improved which when combined with better optics (higher specification SFPs) we are now seeing 10 and 40Gig speeds over MM cabling.

The latest version of all this is OM5, which has the ability to run 4 x 10Gig channels over a single pair of OM5 cables. To achieve this the cable has been optimised to carry 4 different wavelengths (also referred to as colours) at the same time, so each wavelength carries 10Gig and you get 40Gig of traffic from one pair of cables. You will need the specific SFPs to achieve this, but in data centres which are running short of spare cores, this is seen as a major benefit to them.

Why not SingleMode everything?

This is certainly an approach that some businesses have taken, and there is a lot going for it:

- No confusion in fibre types
- Only need to keep one type of SFP and patch lead
- The best performance possible is available to you
- The standards have been stable for a number of years

However, there are a couple of major issues to contend with as well:

- The optics (SFPs) are significantly more expensive
- For short runs, it doesn't work very well

Due to the nature of SingleMode existing for longer runs, the light sources (usually laser SFPs) push in a lot of power to drive the data many kilometres. If the run is across your server room, then it can hit the far end as basically full power, which the receiver will not be able to understand as its designed to recover a weak signal that covered a long distance. There is also the issue with the light being reflected straight back at the transmitting device and interfering with the signal there too.

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We have seen server rooms full of SM cable where people have learnt the hard way that they needed to lose some of the light very quickly to make it work. Some of the solutions we have seen are:

- Mode conditioning patch leads
- Air gap attenuators to drop the power, typically 5dB or more
- Patching in and out of the same cabinet to introduce some loss into the cable run
- Using MM patch leads on SM runs (I can't say this is recommended but I have seen it work)

None of these things is a show stopper if this is the way you want to go, just be aware that SingleMode is designed to go long, so you might have to compensate for the short runs.

Other issues you need to be aware of

A very common problem with fibre is dirt. Many fibre cores have been in place for years before they get made live, dust caps go walk about, and the quality and condition of the end faces can really be anything. The difference in performance between a clean end face and a dirty or damaged one, can be huge. Proper cleaning kits are cheap, so don't skimp on this part.

Next comes connectors. There are no standards or rules as to which ones are used, they all work and typically people end up with a mixture over time. In the beginning there was ST, then with development in manufacture for space and ease of use along came SC, then LC which are smaller still and take up less space in the patch panel. It doesn't matter what you have, however if you are buying a tester, just make sure you have the correct patch/launch cords to plug in to all the different connector types you have.

Summary

When you order the wrong connector type, you tend to get some instant feedback in the form that it doesn't work! However, when you order the wrong type of MM patch leads the differences can be more subtle and take time to surface. As a general rule always use the same type of patch lead as the installed cable, which is easier said than done. As this article has hopefully demonstrated, even with the best of intensions mixing MultiMode cable is very easy to do.

The only way to be sure is to read the labels on the side of the cables, which for those of you who have tried to do this, these labels are very small and hard to find. If you find an engineer in the back of your data cabinet looking closely at the cladding trying to read some very small writing, take heart, they know what they're doing!

As a general rule, the smaller the core, the faster and further it can go, but the more expensive it is to make and the more precise (expensive) the optics needed to get the information into the cable. This table summarises the combinations of speed and distance.

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	Type	Core / Cladding (um)	Fast Ethernet 100Mb	Gigabit GbE	10Gigabit 10GbE	40Gigabit 40GbE	100Gigabit 100GbE	40G SWDM4	100G SWDM4
Multimode	OM1	62.5 / 125	2km	275m	33m	-	-	-	-
	OM2	50 / 125	2km	550m	82m	-	-	-	-
	OM3	50 / 125	2km	800m	300m	100m	100m	240m	75m
	OM4	50 / 125	2km	1100m	400m	150m	150m	350m	100m
	OM5	50 / 125	2km	1100m	400m	150m	150m	440m	150m
Singlemode	OS1/OS2	9 / 125	40km	100km	40km	40km	40km	-	-

The different types of fibre testers

Basic Light Loss tester

By this we mean you have a source and a receiver and you plug them back-to-back to get a reference, then run them over the link to get a loss measurement. In theory this is all you need to Pass a link but in practise it can give false positives; it could pass links that should fail if a more detailed test was run. Usually bought on price (they're the cheapest option) and if anything is wrong they don't come with any diagnostics. Fluke Networks SimpliFiber.

Certification tester

There are more advanced Light Loss testers on the market and these have Pass/Fail criteria, so you can certify installations. You select within the tester the standard (speed) you want to test the link to and the tester will issue you with a PASS/FAIL certificate at the end. These are easy to use and understand and popular with installers as strictly speaking this is the minimum requirement to certify fibre cables and produce a warranty on installation. However, they cannot pick up individual events and do not give distance to events and/or breaks (as the basic standards do not require these measurements), hence the diagnostic capability is poor. Fluke Networks CertiFiber.

OTDR (Optical Time Domain Reflectometer)

These are the best tools for troubleshooting fibre as you get the performance data for every connection and join in the link. These are becoming the most popular tools as you actually get useful diagnostics as to where the issues are. Recent developments also mean that they are easy to use and draw pictures of what's going on and where the issues are. Fluke Networks OptiFiber

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