SM Fibre Selection

In the past, Fibre Network Owners (NFO's) deployed *s*ingle-mode fibre (SMF) in the following fashion:

National Long Distance (NLD)	G.655.D
Long haul	G.655.D and/or G.652.D
Metro, backhaul, distribution, and feeder cables	G.652.D
Last drop	G.657.A2

The oldest and most widely deployed SMF has always been G.652.D.

Today the industry is moving towards a G.657.A1 specification in SMF, because the industry is moving towards smaller denser cables in the network and the bend resilience is a requirement for the cable design. The industry will not move wholesale towards a G.657.A2 specification because this is not necessary in all cases.

The trouble with G.655.D is that it is too expensive:

- G.655.D = R 460.00 per km, per fibre.
- G.657.A1 = R 77.00 per km, per fibre.

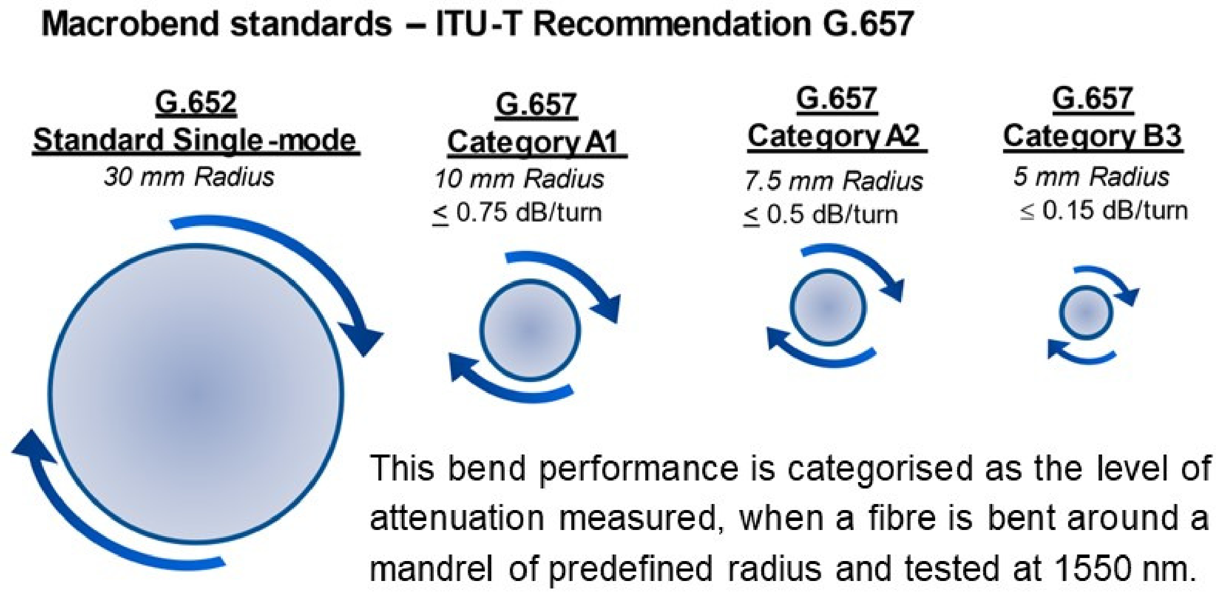
What's more, with G.655.D's cutoff wavelength of 1480 nm, it does not give consent to deploy economically sensible 1310 nm type lasers.

The ITU Recommendation for G.652.D specifies (amongst other things) a fibre with:

- a minimum bend radius of 30mm
- a nominal Mode Field Diameter (MFD) between 8.6 - 9.2 um at 1310 nm
- Low water peak. With maximum attenuation of 0.4 dB/km across a band from 1310 nm to 1625 nm.

The ITU Recommendation G.657.A complies with G.652.D. In other words, any fibre that has a G.657.A specification will comply with the G.652.D recommendation. The only aspect defined in the G.657.A specification is the bend characteristics.

- G.657.A1 defines a G.652.D fibre with a minimum bend radius of 10mm and a loss of 0.75 dB/turn at 1550 nm.
- G.657.A2 defines a G.652.D fibre with a minimum bend radius of 7.5 mm and a loss of 0.5 dB/turn at 1550 nm.
- There is a G.657.B3 category that has a minimum bend radius of 5mm - but this is generally used in very specific circumstances indoors and so we won't speak more on this herein.



Now, that's all black and white, it starts to get more confusing when we add in the specifications of different manufacturers.

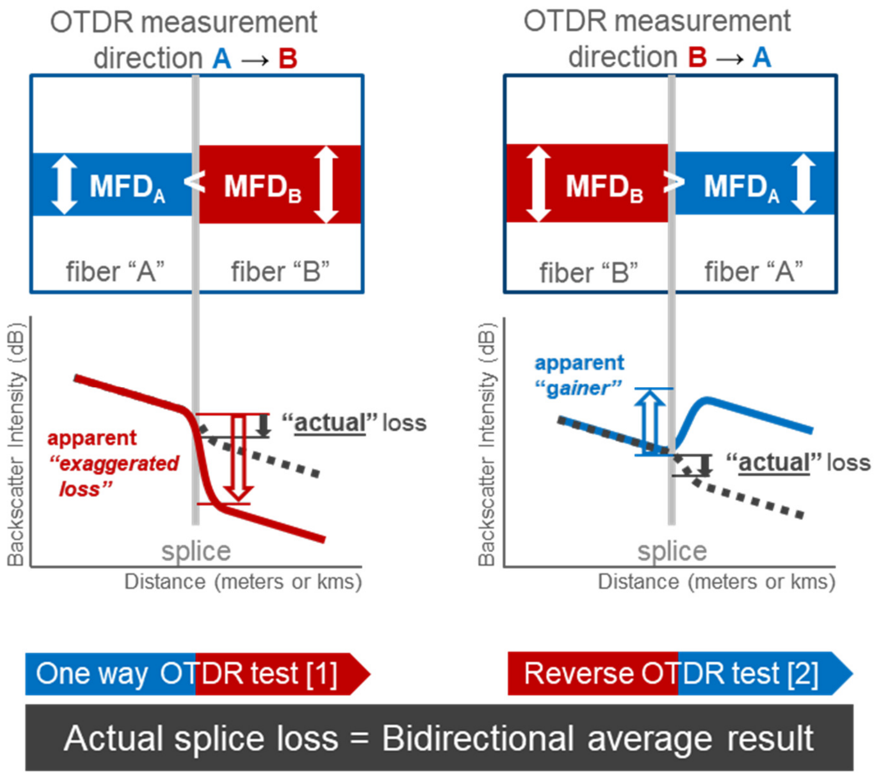
In fibre design there are trade-offs to be had between:

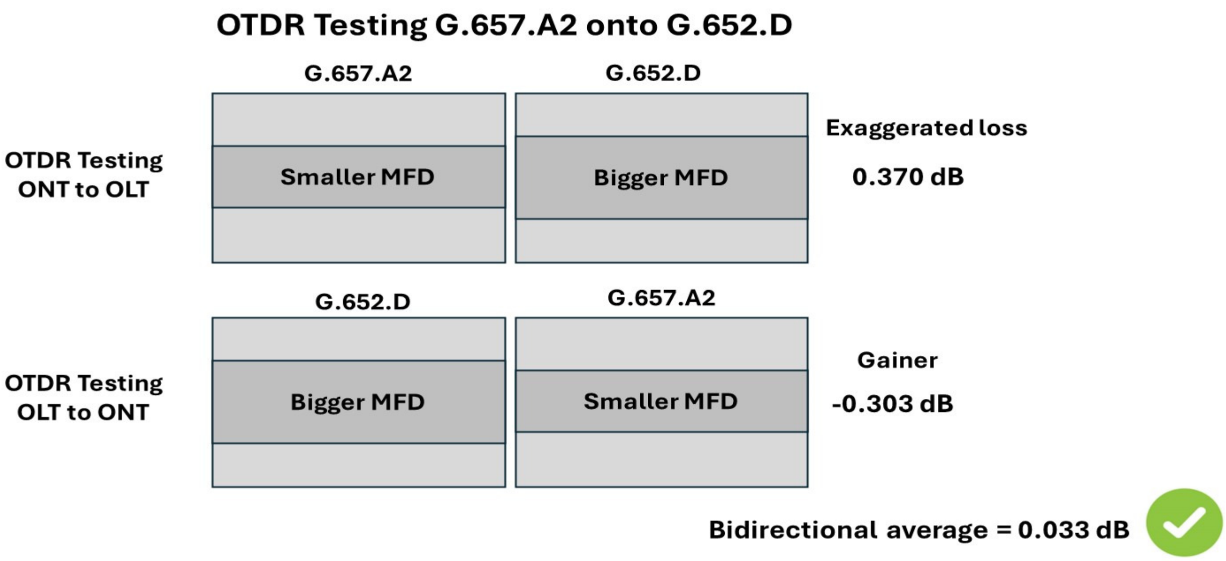
1. Bend performance
2. Mode Field Diameter (MFD)
3. Attenuation

All things being equal, a low MFD fibre will have better bend performance but higher attenuation. this is the only way to make a fibre that has the bend performance that complies with the G.657.A specification.

There is a strong preference for a 9.2 um MFD. Most of the outside plant (OSP) is on this base. A change to the 9.2 um MFD can create problems with installation and test because, whilst recommendations state that testing should be done using a bidirectional (2-way) OTDR test, which is not always practical or economical. On a one-way OTDR test a mismatch in MFD creates a fictitious "exaggerated loss and gainers" that creates ambiguity about what the actual splice loss of a connection or fusion splice is. This confusion can create delays and unnecessary rework, by the uninformed.

There have been some modifications to the G.657 specification that puts more stringent boundaries on a MFD to assure compatibility of bend insensitive fibre (BIF) with standard G.652 fibre. Furthermore, the ITU has studied the full set of transmission parameters for G.657A1 and A2 fibres and has stated that the products are fully compatible. That said, smaller MFD's have better macro bend performance and as a result the more bend insensitive G.657.A2 and G.657.B3 fibre on the market shows artefacts in one-way OTDR traces due to the MFD change, as shown in the images below.


OTDR measurement direction A → B
MFD_A < MFD_B
fiber "A"
fiber "B"
Backscatter Intensity (dB)
apparent "exaggerated loss"
"actual" loss
splice
Distance (meters or kms)
OTDR measurement direction B → A
MFD_B > MFD_A
fiber "B"
fiber "A"
Backscatter Intensity (dB)
apparent "gainer"
"actual" loss
splice
Distance (meters or kms)
One way OTDR test [1]
Reverse OTDR test [2]
Actual splice loss = Bidirectional average result

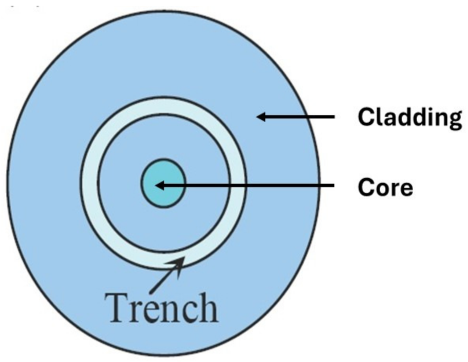

OTDR Testing G.657.A2 onto G.652.D
G.657.A2
G.652.D
OTDR Testing ONT to OLT
Smaller MFD
Bigger MFD
Exaggerated loss
0.370 dB
G.652.D
G.657.A2
OTDR Testing OLT to ONT
Bigger MFD
Smaller MFD
Gainer
-0.303 dB
Bidirectional average = 0.033 dB

G.657's low-index trench.

This nano-engineered low-index area goes by several names i.e. trench, ring or mesh.

As for the index profiles, the G.657.B3 fibres tend to have the most complex profiles with deeper lower index of refraction trenches and other features. Most G.657.A1/A2 fibres are closer to a matched clad with a small lower index of refraction trench added to the design.

The "trench" is a nano-engineered low refractive area, which greatly assists with trapping the light when a bend is applied.



In conclusion, the industry is moving towards G.657.A1 fibre, no doubt. But I do not think that we will see a wholesale move towards G.657.A2.

As mentioned, it is best using a G.657.A fibre because of its superior bend performance. That bend performance is helpful to avoid bend losses in the network - but also helps support the use of high-density cable formats that retain their low loss. High density cable formats basically mean more fibre in the same space - a criterion that is vital for many fibre network owners today.

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