Importance of, and Challenges in Fibre Characterisation in modern networks

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50:50 Joint Venture between Liberty Global & Telefonica

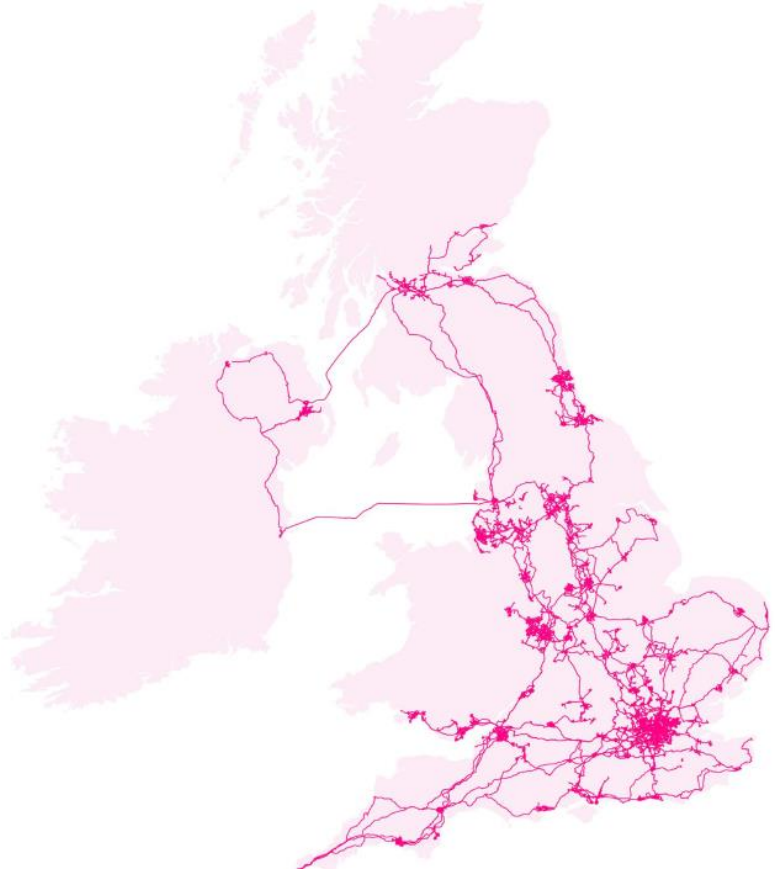
48m Customer connections

BUSINESS

186,000km
of fibre distance

336 VM PoPs

160+
connected data centres



- Ethernet Services (10G -100G)
- Dark Fibre

Why do we test?

Why do we test

Ensure link has been installed properly

No Damage, all elements within specification.

Certify that link is fit for use

System budgets (Loss, ORL, CD, PMD) are met.

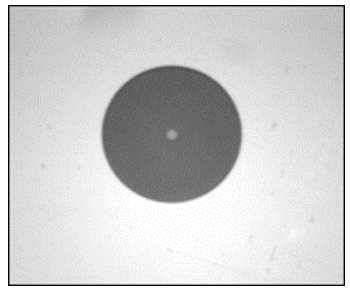
Series of measurements known as “Fiber Characterisation”, with specific requirements is recommended by the ITU-T SG15 in the G.650.3 Standard – Test Methods for Single-mode Fibre.

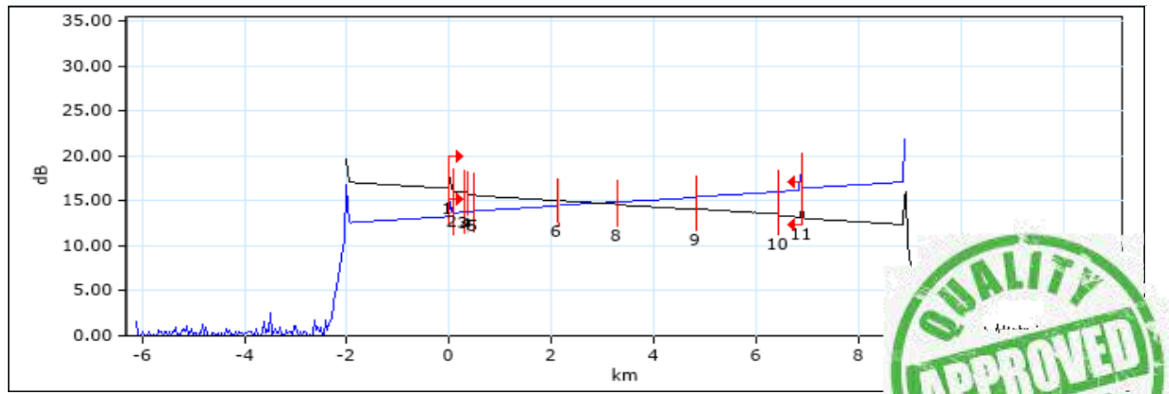
If these parameters are not met there can result in delays of delivery and potentially the inability to transmit at high speeds.

G.650.3 : What do we test?

The basic set of “Level 1” tests consists of:

- Connector Inspection
- Bi-Directional Loss (ILM)
- Bi-Directional OTDR





- At least 2 wavelengths
- Appropriate pulse width & average time
- Launch & receive cords

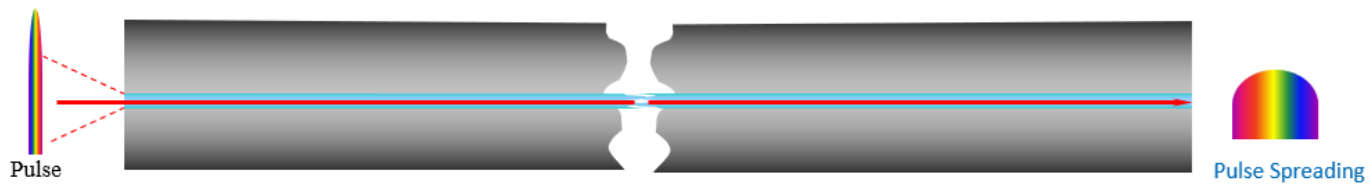
G.650.3 : What do we test?

An advanced set of “Level 2” tests consists of all tier 1 tests, plus:

- Optical Return Loss (ORL)
- Chromatic Dispersion (CD)
- Polarisation Mode Dispersion (PMD)

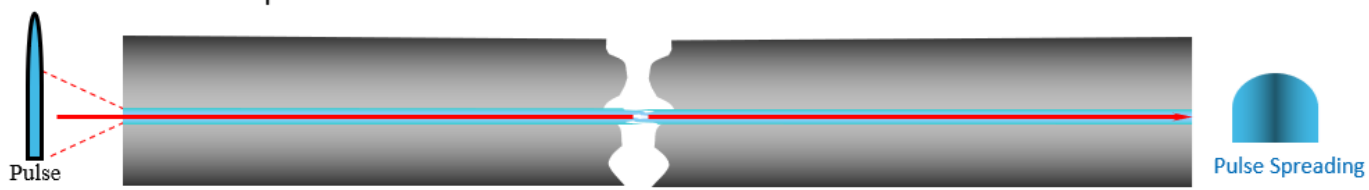
Chromatic Dispersion:

Different wavelengths travel at different velocities



Polarization mode dispersion:

Different polarization modes travel at different velocities

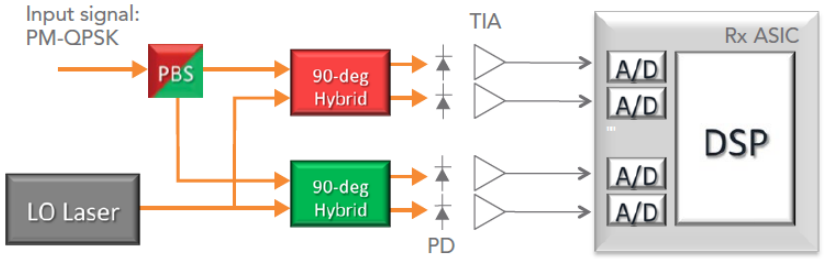


We now have Coherent systems - Is dispersion testing required in modern high speed networks?

Dispersion & Coherent Systems

- Direct detection (noncoherent): contains a photodiode for on-off keying signals

- Coherent detection



PBS: Polarization beam splitter
PD: Photodetector
TIA: Trans impedence amplifier
DSP: Digital signal processor
A/D: Analog to Digital Converter

Digital Signal Processing – greatly improved system tolerance to dispersion effects

Requirement for Dispersion testing

Still specify dispersion measurements for new core trunks.

- Ensure fibre complies to specification

Dark fibre customers specify dispersion measurements

- Seen as figure of merit for quality
- Ensure fibre can support future technologies

Challenges of volume roll out

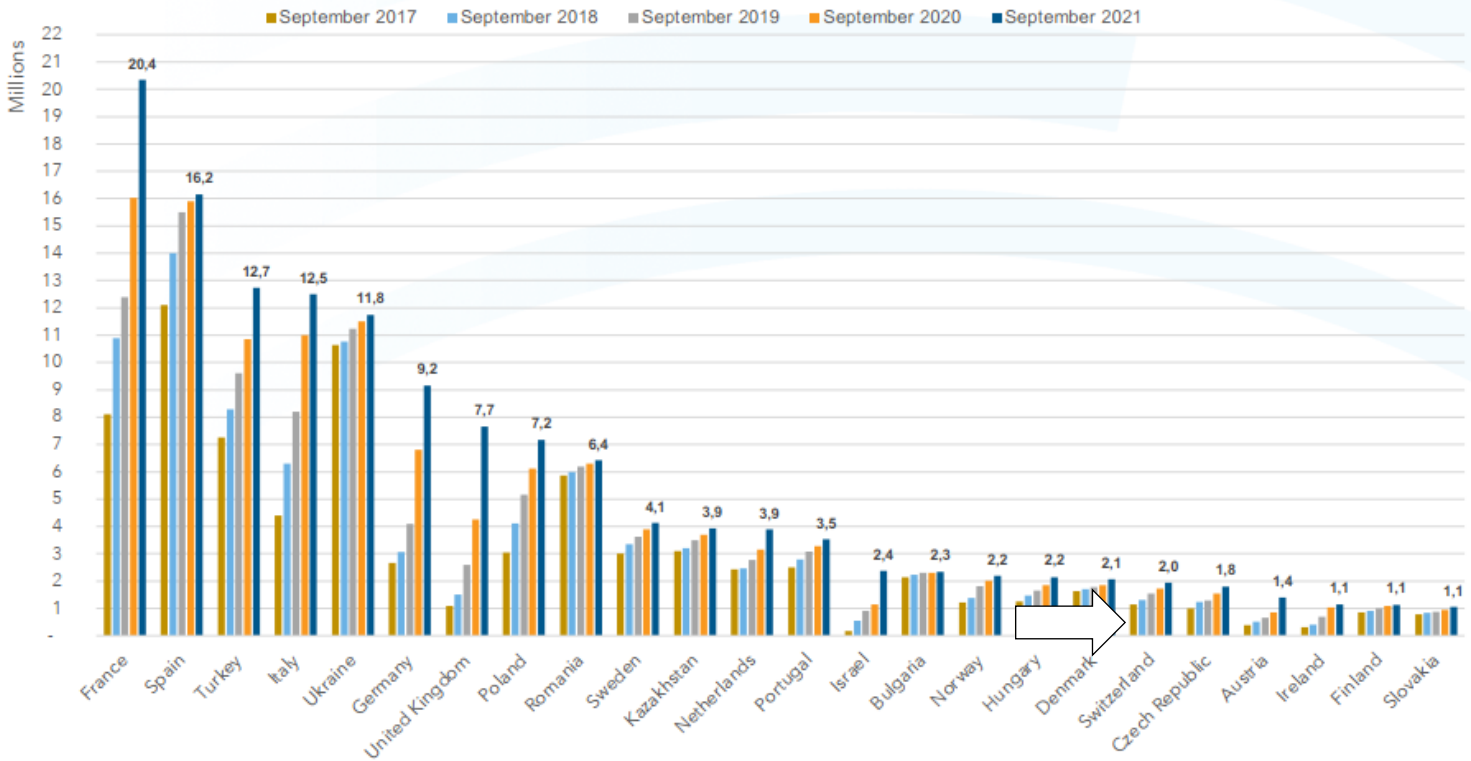
Challenge: Market Conditions

A great time for fibre deployment in the UK

FTTH/B Homes Passed - EU39 Ranking

EU27+UK ranking in terms of FTTH/B Homes passed over time (in million homes)

Data comparison between Sept. 2017 and Sept. 2021



5 fastest growing markets (in both volume and %)

Data from Sept. 2020 to Sept. 2021 (in terms of FTTH/B Homes Passed)

France **+4.3 M**	1	Belgium **+ 109%**
UK **+3.4M**	2	Israel **+ 107%**
Germany **+2.4M**	3	Greece **+ 90%**
Turkey **+1,8M**	4	Cyprus **+83%**
Italy **+ 1.5M**	5	UK **+ 80%**

***UK reached ~10.5M by March 2022**

With thanks to IDATE

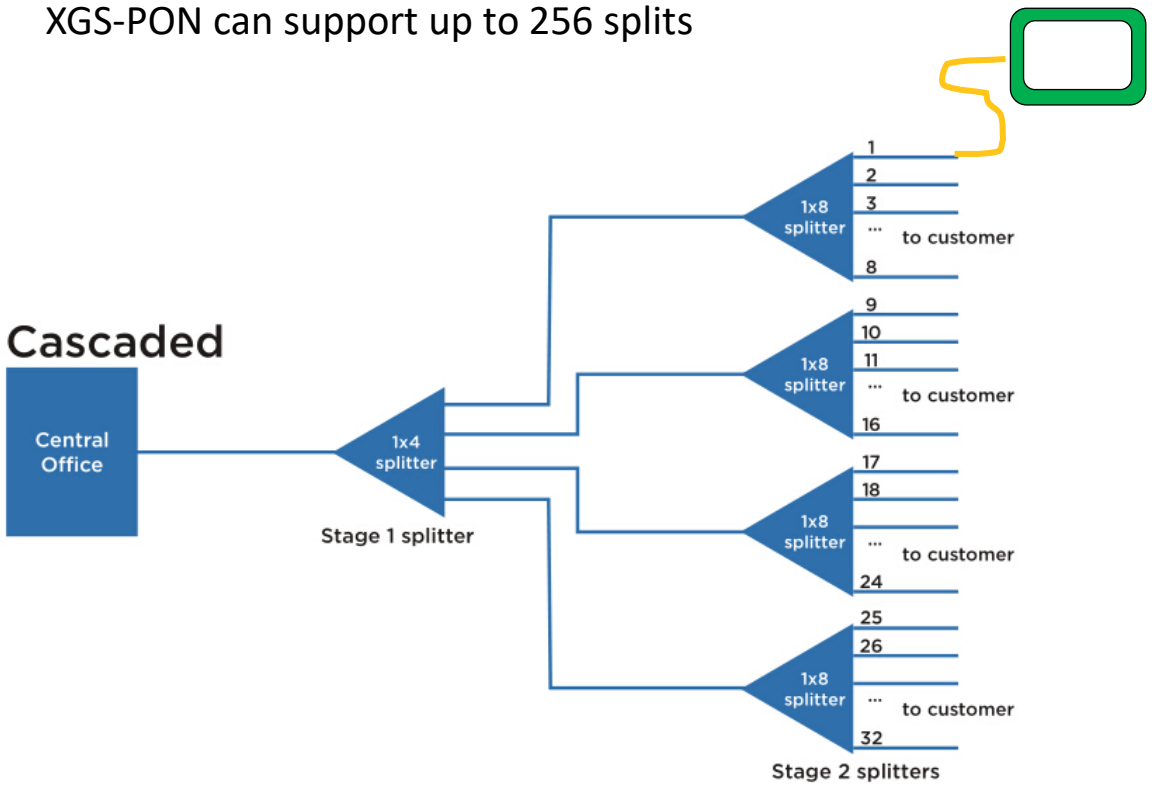
Source: IDATE for FTTH Council EUROPE

Full fibre for a digital and sustainable Europe

Challenge : Complex networks

G-PON, RFOG & XGS-PON networks being rollout

- XGS-PON can support up to 256 splits



Different network topologies

- cascaded splits, unbalanced splits

Only test upstream

- Unable to bi-directionally OTDR test

Large losses over a relatively short distance

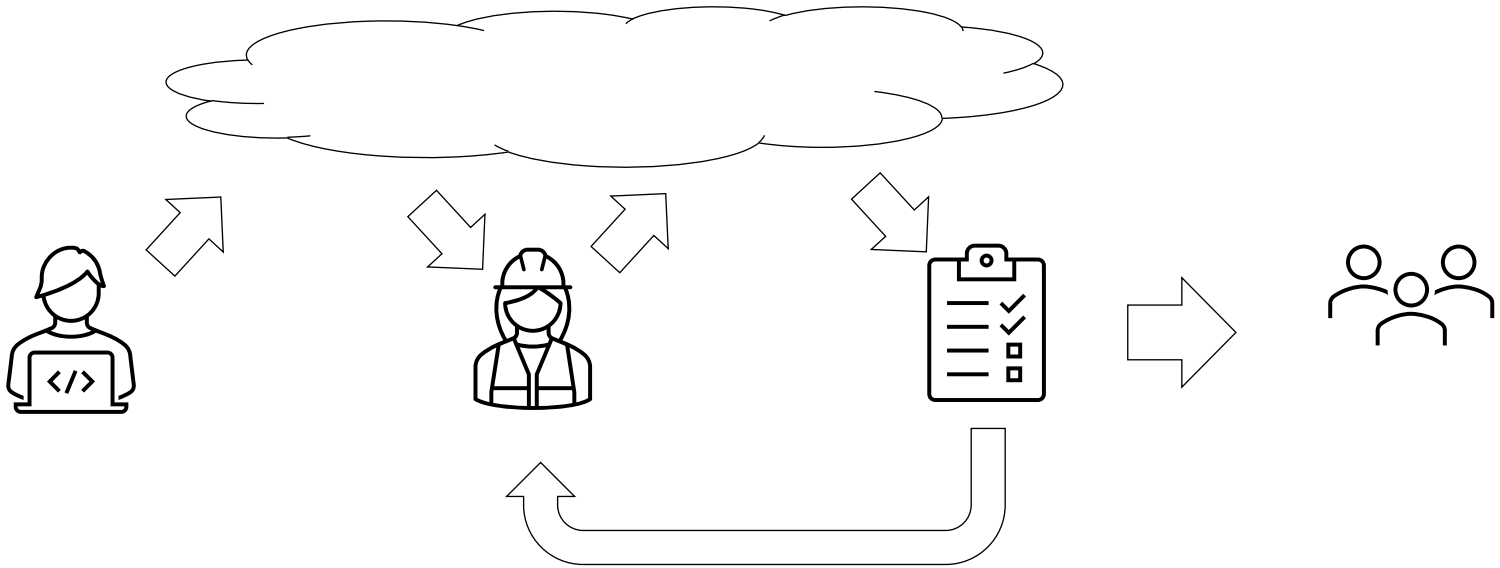
- makes characterising theses links increasingly difficult many events are being merged together

Still want to ensure these links are fit for purpose

Ways forward

Ways forward (i)

Smarter testers/Automation – Cloud based solutions



Benefits

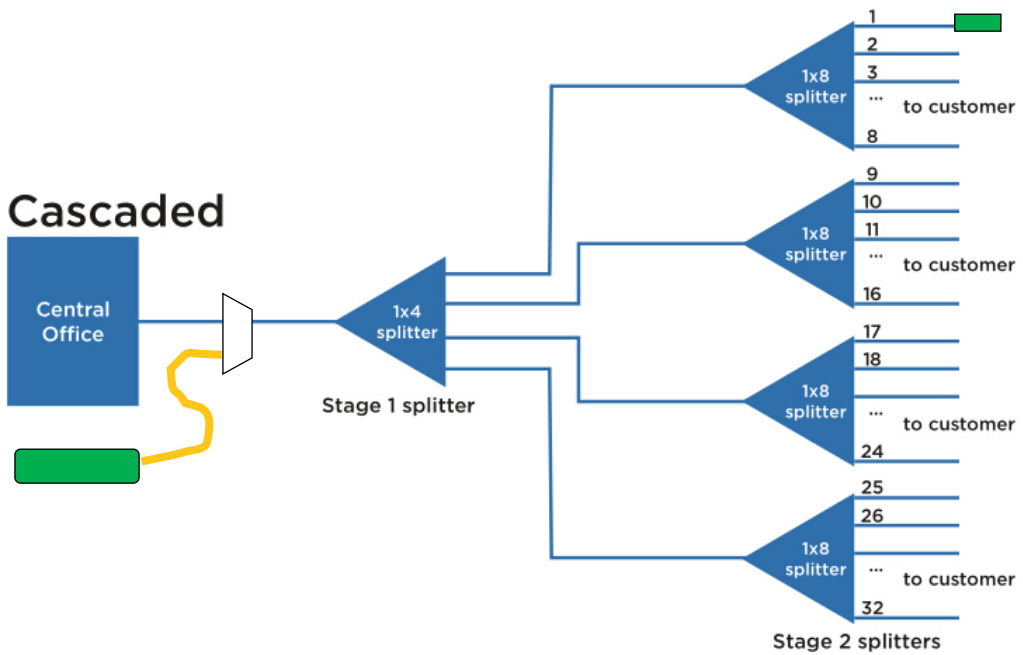
- Define & control testing parameters & pass/fail thresholds – Overcome some of the skills shortage
- Faster results back/Live analysis - reduction in truck rolls
- Cloud based results – faster delivery

Ways forward (ii)

Changing the way we test for volume roll out

Complex networks, analysing grouped events.

Measure loss (1650nm) downstream from centralised test head.



- Simple to use
- Fast test/ Fast results availability
- Reduction of test equipment in field
- Oversight of results – faster release

Summary

Fibre characterisation

- Access, Low speed — Level 1
- Core/Trunk — Level 1 & level 2

Challenges

- **Market conditions**
  - Automation, smarter testers
  - Help bridge the training/experience gap
  - Ensure network is tested correctly.
- **Volume roll out**
  - Potential move away from traditional testing to ‘just testing loss’

Thank you