TESTING – HIGH SPEED FIBER LINKS

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Agenda

- Intro to FOTC
- Basic/Tier 1 Fiber Certification
- Tier-2 OTDR testing & troubleshooting
- Multi-Fiber Connectors Inspection and Cleaning
- Using Cloud Based Services to Improve Results and Workflow Management

Fiber Optics Technology Consortium

Overview:

- Part of the Telecommunications Industry Association (www.tiaonline.org)Until 2013, we had been known as the Fiber Optics LAN Section (FOLS). Our new name was chosen to reflect our expanding charter.
- Formed 23 years ago
- Mission: to educate users about the benefits of deploying fiber in customer-owned networks
- FOTC provides vendor-neutral information

Fiber Optics Technology Consortium

Current Members

- AFL
- CommScope
- Corning
- EXFO
- Fluke Networks
- General Cable
- OFS

Current Members

- Legrand
- Panduit
- Sumitomo Electric Lightwave
- Superior Essex
- The Siemon Company
- Viavi

Fiber Optics Technology Consortium

- Maintain a website with Fiber FAQs, White Papers and other resources – www.tiafotc.org.
- Developed and maintain a free Cost Model that allows users to compare installed first costs of several architectures.
- Host a webinar series throughout the year with all webinars available on demand.
- Speak at industry conferences like BICSI
- Contribute to industry publications – Like BICSI News.
- Conduct market research – like the surveys today

Fiber Optics Technology Consortium

- Recent Webinars Available on Demand
  - Keeping up with High Speed Migration in the Data Center
  - Data Center Design, Planning & Upcoming Changes to TIA-942
  - Best Practices for Achieving Tier 1 Fiber Certification

- Visit www.tiafotc.org or our channel on BrightTalk

- Webinars are eligible for CEC credit for up to two years after they are first broadcast. Email liz@goldsmithpr.com if you have completed a webinar and want to receive your CEC.

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Basic/Tier 1 Fiber Certification

Tyler Vander Ploeg, RCDD
Fiber Solutions Marketing Manager
Viavi Solutions
Las Vegas, NV, September 24, 2017

Agenda

- Standards and Basics
  - Relevant standards
  - Links and channels
  - dB vs. dBm
- Loss/Length Certification
  - Leading causes of inconsistent results
  - End-face condition
  - Multimode launch condition
  - Test reference cords
  - Reference methods
- Conclusion/Q&A

Standards and Basics

A Brief Note on Standards

So many standards! Which one's should I follow?

ISO 11801

TIA-526-14

TIA-568.3

TIA-526-7

ISO/IEC

ANSI

ISO 14763-3

BS EN

IEC 24764

IEC 61280-4-2

IEC 61280-4-1

AS/NZS

Relevant IEC Technical Committees

ISO/IEC JTC 1/SC 25 Interconnection of information technology equipment

WG 3
Customer Premises Cabling

Standardization of characteristics of cabling systems for customer premises including test procedures and planning and installation guides

SC 86C Fibre optic systems and active devices

WG 1
Fibre optic communications systems and sub-systems

1. To define specification parameters, test procedures and design methodology for the physical layer of fibre optic communications systems and sub-systems.

2. To prepare Generic, Sectional and Blank Detail Specifications for fibre optic communications sub-systems.

3. To prepare test procedures measuring the parameters associated with the specification of fibre optic communications sub-systems.

Relevant IEC Standards

SC 25 WG 3

ISO 11801

Information technology - Generic cabling for customer premises

ISO 14763-3

Information technology - Implementation and operation of customer premises cabling - Part 3: Testing of optical fibre cabling

SC 86C WG 1
Test Procedures

IEC 61280-4-1

Installed cable plant - Multimode attenuation measurement

IEC 61280-4-2

Installed cable plant - Single-mode attenuation and optical return loss measurement

IEC 61280-1-4

General communication subsystems - Light source encircled flux measurement method

IEC 61300-3-35

Visual inspection of fibre optic connectors and fibre-stub transceivers

Relevant TIA Technical Committees

ADVANCING GLOBAL COMMUNICATIONS

TR-42.11 Optical Systems (568)

Mission & Scope

The TR-42.11 Subcommittee on Fiber Optic Systems develops and maintains standards, specifications and related documents for the performance, design, characterization, and description of optical fiber subsystems, systems and networks across all applications.

Relevant TIA Standards

- **568.3-D – Optical fiber cabling and component standard**
  - Updated to revision "D" in October 2016
  - Transmission performance and test requirements in Clause 7
  - Annex E (informative) provided guidelines for field testing
- **ANSI/TIA-526-14-C-2015**
  - Test procedures for installed multimode fiber cable plant
  - Released in April 2015
  - Adaptation of IEC 61280-4-1 Ed. 2.0
  - Encircled Flux for 850nm/50 micron
- **ANSI/TIA-526-7-A**
  - Test procedure for installed single mode fiber cable plant
  - Released in July 2015
  - Adoption of IEC 61280-4-2 Ed 2.0

Tests Defined in Standards

- Both TIA and ISO/IEC standards specify to tiers of certification
  - Tier 1 (or basic): loss, length, and polarity
  - Tier 2 (or extended): Optical time domain reflectometer (OTDR)

- Tier 2 (extended) tests are an optional addition to tier 1 (basic) tests

- Fiber end-face inspection and certification is also a requirement to ensure pristine end-face condition PRIOR to mating

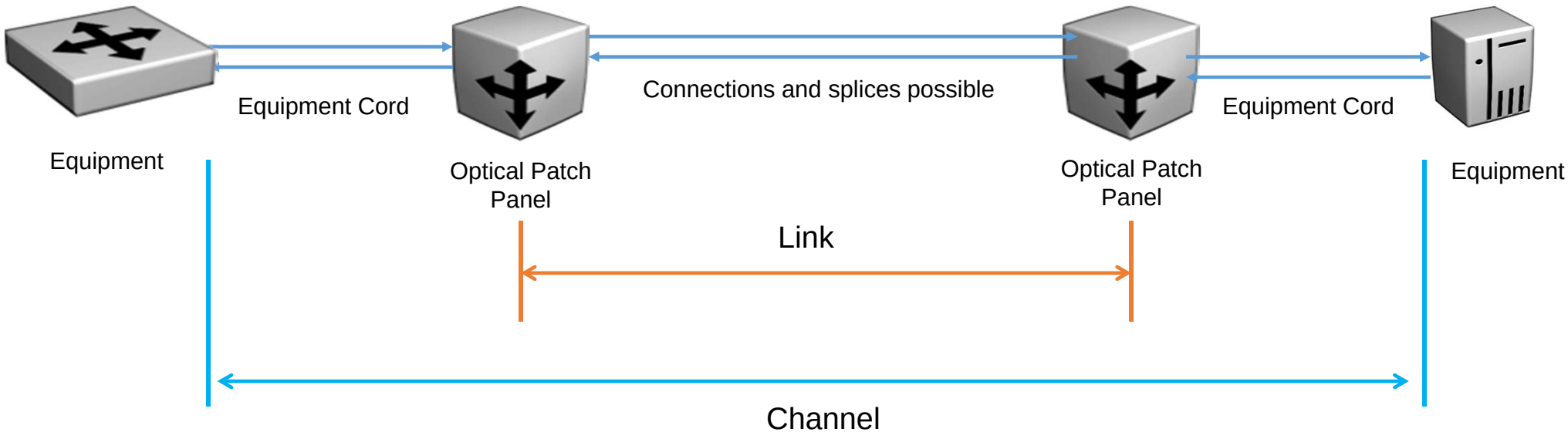
Testing to a specific Application

- Application is the protocol that will "ride" on the fiber (Typically Ethernet or Fiber Channel)
- Most Enterprise Optical Loss Test Sets will report "Compliant Networks" based on loss measurement
- Cautions!
  - Can "PASS" standards-based generic limit, but have too much loss for specific application
  - Most testing performed is on **links** – but applications run on **channels**
- If the Application to be carried on the fiber is known
  - …use Application (Network) limit on your test device

Compliant Networks

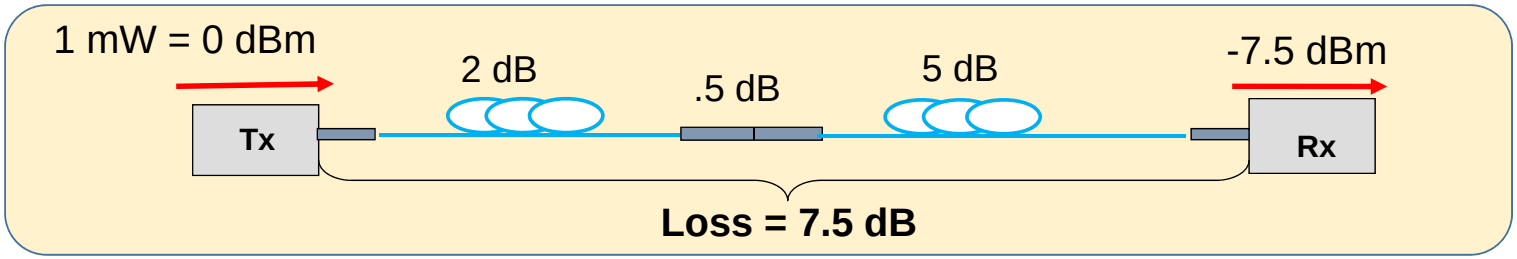
1000BASE-LX_MM	1000BASE-SX	100GBASE-ER4
100GBASE-LR4	100GBASE-SR4_OM3	100GBASE-SR4_OM4
10BASE-FB	10BASE-FL	10GBASE-LR/LW
10GBASE-LX4	10GBASE-SR/SW	40GBASE-SR4_OM3
40GBASE-SR4_OM4	1Gbps-FC_OM2_MM	1Gbps-FC_OM3_MM
2Gbps-FC_MM	2Gbps-FC_OM2_MM	2Gbps-FC_OM3_MM
4Gbps-FC_OM1_MM	4Gbps-FC_OM2_MM	4Gbps-FC_OM3_MM
8Gbps-FC_OM1_MM	8Gbps-FC_OM2_MM	8Gbps-FC_OM3_MM
ISO-14165-111_MM		

Channels and Links



dB vs. dBm

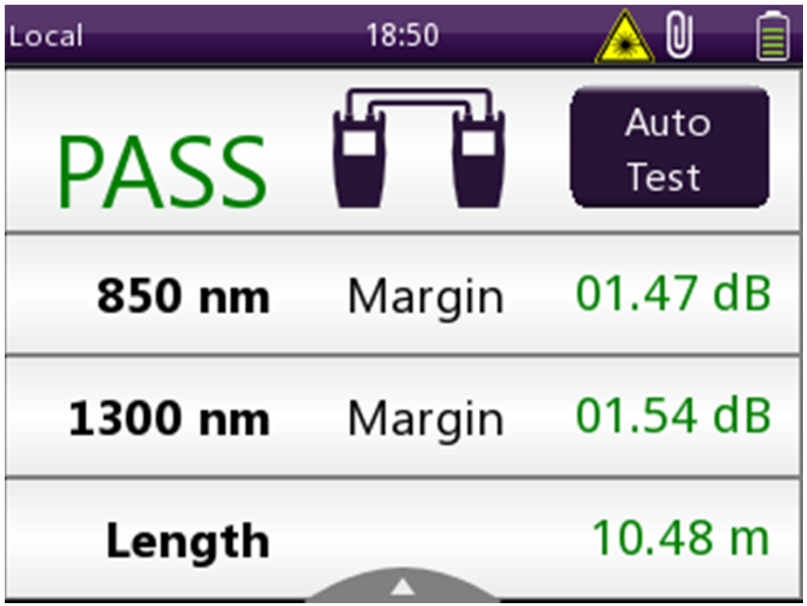
- **dBm** = an ABSOLUTE measurement of power (1mW = 0dBm)
- **dB** = a RELATIVE measurement
- **Loss** is a Reference Measurement (not an Absolute Measurement)
- First step in an accurate loss measurement is **performing a reference**!
- Purpose of a reference is to "**zero out**" any test cables and connectors



Loss/Length Certification

Loss/Length Certification

- Measure Length
- Measure Loss
- Check Polarity

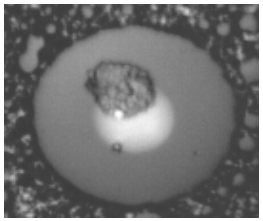


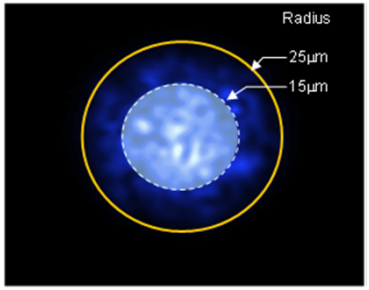
- Ensure Loss does not exceed a "limit" (AKA loss budget)

- Document results

Leading Causes of Inconsistent Results

1. Not following IEC 61300-3-35





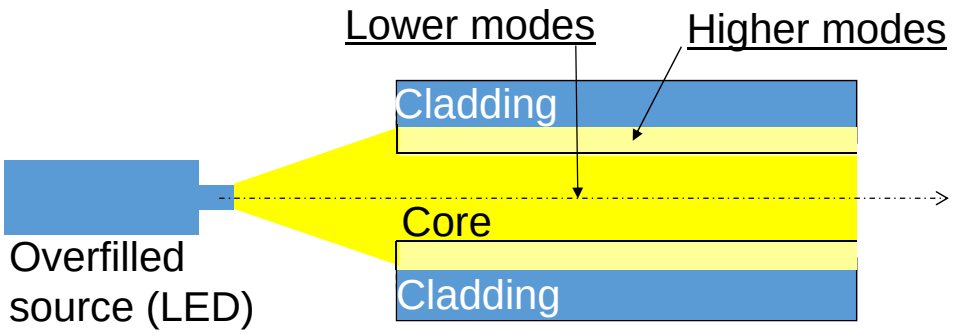
2. Multimode Transmitter Launch Condition

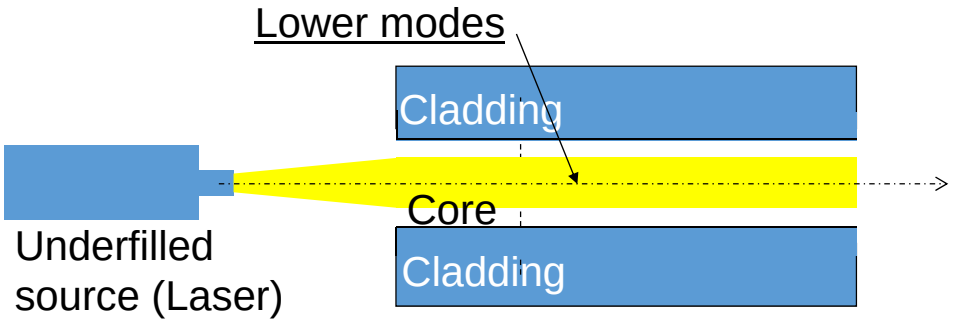
3. Not using Test Reference Cords (TRCs)

4. Errors with Referencing

Multimode Launch Conditions

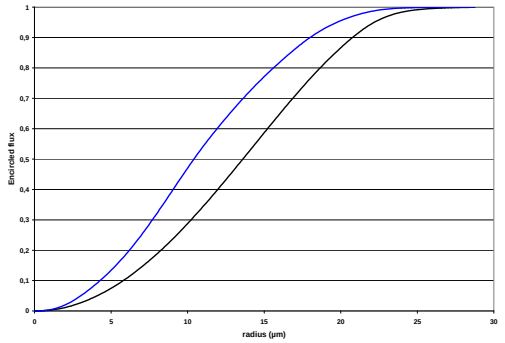
- Different multimode light sources = different modal power distributions (commonly referred to as launch conditions)
- Launch conditions directly impact link loss measurements accuracy
  - LED overfills a multimode fiber tending to overstate loss
  - Laser underfills a multimode fiber tending to understate loss

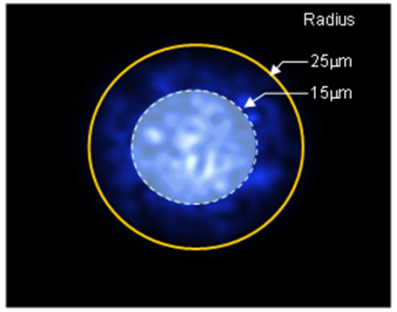




IEC 61280-4-1 sets standards for MM launch conditions

- Ratio between the transmitted power at a given radius of the fiber core and the total injected power
- Defined in IEC 61280-4-1 standard to characterize the launch conditions of MM test sources
- Is measured at the launch cord connector – NOT at the source output
- Replaces older “launch condition” requires such as Coupled Power Ratio (CPR)
- Can be achieved by using a universal or matched modal controller





MM Launch Condition

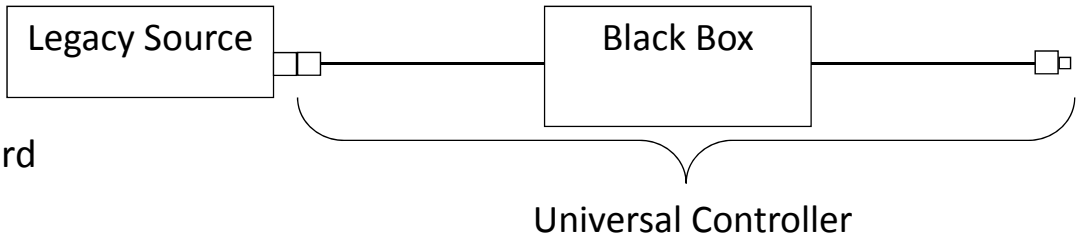
Launch modal conditions for testing multimode optical fibre cabling

The launch modal condition at the point of measurement, at the output of launch cords, shall meet the requirements of IEC 62614 and IEC 61280-4-1. The launch modal condition at the point of measurement, the light emitted by the core of the reference connector may be achieved in several ways.

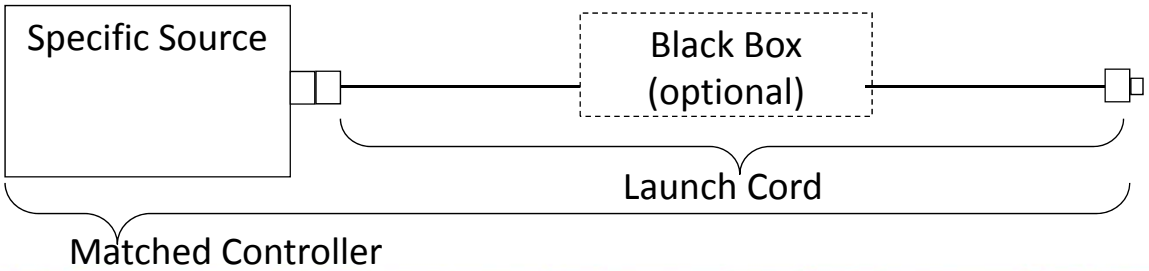
Source: IEC 14763-3

Universal and Matched Controllers

- **Universal Controller**
  - For legacy sources
  - Adds a "black box" to the output of the legacy source



- **Matched Controller**
  - Specific source matched with specific launch cord
  - Launch cord may have additional conditioning



Test Reference Cords (TRCs)

- Use high performance (reference grade) connectors
  - Optimal optical and geometrical characteristics
    - Numerical aperture (NA)
    - Core/ferrule concentricity
- When mated with other TRCs produce near zero loss
- Minimizes uncertainty
- Called for in various standards for loss measurements of installed fiber cabling

> The connector or adapter terminating the launch cord shall be compatible with the cabling and the termination should be of reference grade to minimize the uncertainty of measurement results.

Source: IEC 61280-4-2

Losses associated with mating of TRCs

Table G.1 – Expected loss for examples (see NOTE 1)

Termination 1	Termination 2	Attenuation requirement
SM reference grade	SM reference grade	≤0,2 dB
SM reference grade	SM standard grade	≤0,5 dB
SM standard grade	SM standard grade	≤0,75 dB
NOTE 1 Table G.1 shows the required performance of standard and reference grade SC connectors in accordance with IEC 60874-14-2. These values are found in other, but not all, performance standards for connecting hardware. NOTE 2 Current studies by JWG8 of IEC SC86A and SC86B on reference grade terminations may produce values for other connector styles.		

Source: IEC 61280-4-2

Table F.1 – Expected loss for examples (Note 1)

Termination 1	Termination 2	Attenuation requirement
MM Reference grade	MM reference grade	≤ 0,1 dB
MM Reference grade	MM standard grade	≤ 0,3 dB
MM standard grade	MM standard grade	≤ 0,5 dB (note 2)
NOTE 1 Table F.1 shows the required performance of standard and reference grade terminations in accordance with IEC 60874-19-1. These values are found in other, but not all, performance standards for connecting hardware. NOTE 2 97 % of individual connections are required meet this attenuation limit. As a minimum of two connections are present within installed cabling, a value of 0,5dB is quoted on a statistical basis.		

Source: IEC 61280-4-1

Correct Steps for Referencing

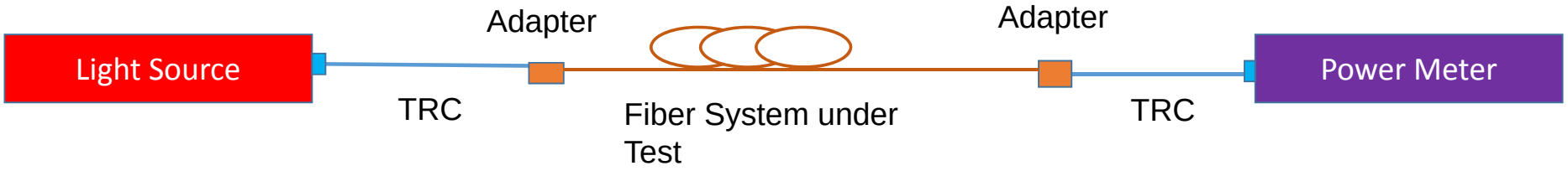
- Turn units on and let sources warm up for 5 min
- Select and configure appropriate limit
- Set reference method on device
- Connect devices together according to reference method selected (+ Inspect)
- Perform reference
- Verify reference (+ Inspect)
- Test (+ Inspect)

Setting Reference – Three options:

- 1 Cord Reference

- Connect the OLTS together w/TRC – reference power meter (set to 0dB)

- Disconnect the fiber at the power meter. Connect a TRC to the power meter. Connect to the fiber system under test



OLTS = Optical Loss Test Set. Typically has Light Source and Power Meter at both ends. Simplex shown for clarity.

Setting Reference – Three options:

- 2 Cord Reference

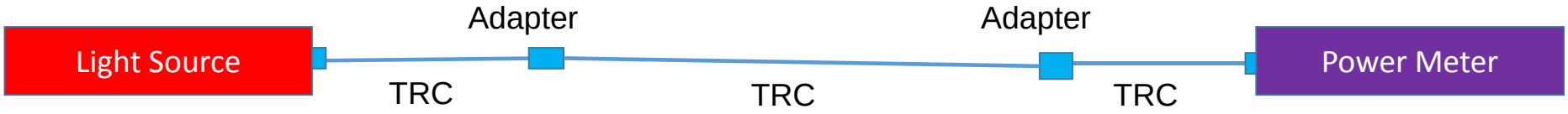
- Connect the OLTS together using two TRCs and an adapter – reference power meter (set to 0dB)

- Disconnect the fibers at the adapter and connect the system to be tested.

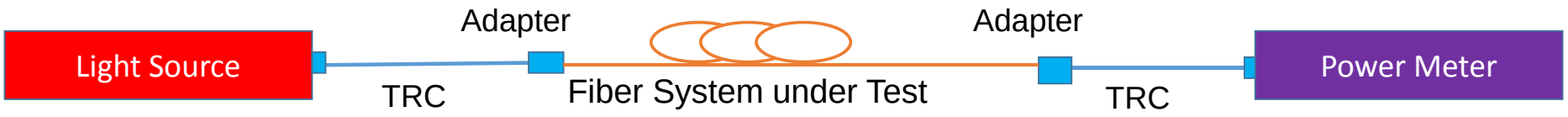
Setting Reference – Three options:

- 3 Cord Reference

- Connect the OLTS together with two TRCs, two adapters AND a third TRC – reference power meter (set to 0dB)

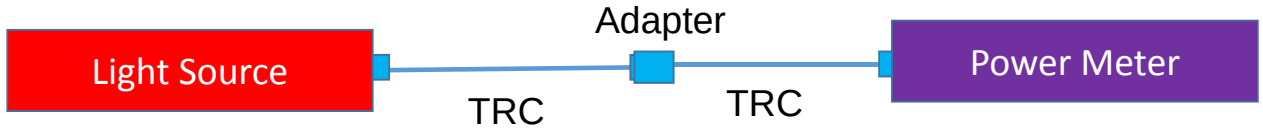


- Disconnect the fibers at the adapters, remove the third TRC and connect to the system to be tested.



Reference Verification

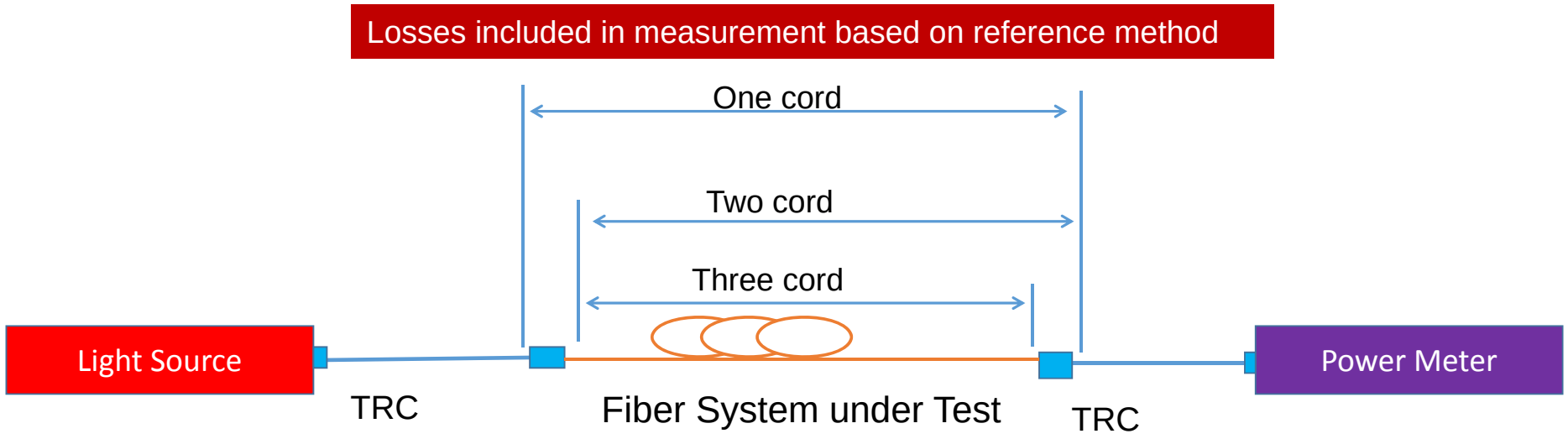
- Connect test cords together and measure loss



- Ensure no “gainers”
  - Negative loss on most loss test sets
- Ensure loss does not exceed the values for TRC-TRC connections
  - Multimode ≤ 0.1 dB
  - Single mode ≤ 0.2 dB
- Save result for proof of good reference

Summary of Reference Methods

- Difference is the number of bulkhead (coupler) connections included in the loss measurement.
- Use the method recommended by your local standards OR by your vendor!
- For link testing, 1 cord method is universally recommended



One-Cord Reference Method

The one-cord reference method measurement includes the attenuation of both connections to the cabling under test. It is the RTM for measurement of installed cabling plant of configuration A (see 4.2).

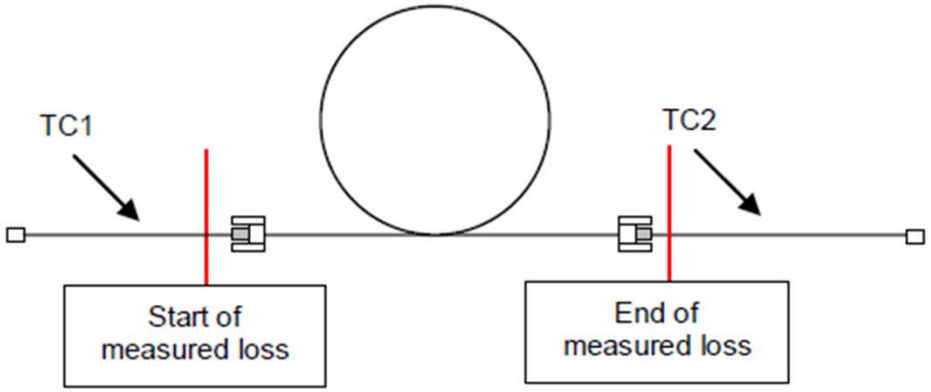


Figure 3 – Configuration A – Start and end of measured losses in reference test method

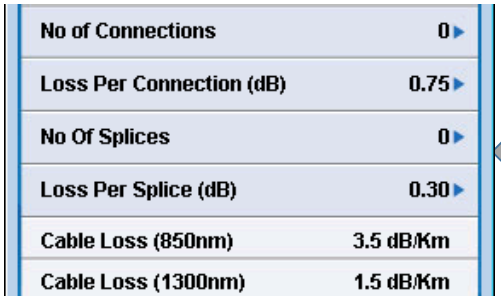
NOTE 1 Figure 3 is an example of cabling in configuration A with test cords TC1 and TC 2 attached, illustrating the start and end point of the measured losses when the reference test method is used (the one-cord reference method as detailed in Annex A).

Source: IEC 61280-4-2

Loss Limits

- Acceptable loss limit is based on several factors:
  - Number of connections
  - Number of splices
  - Loss per Km (at specific wavelengths)

- Maximum **allowable** losses
  - Loss per connection = 0.75 dB
  - Loss per splice= 0.3dB
  - Loss per Km (slope)
    - 850nm = 3.5 dB
    - 1300nm = 1.5 dB
    - 1310 nm = 1.0 dB
    - 1550 nm = 1.0 dB



For Tier 1 Certification the user must tell the OLTS how many connections and splices are in the fiber system under test

Calculating Standards-Based Limits

Link Attenuation Allowance *(dB) = Cabled Fiber Attenuation Allowance (dB) + Connections Attenuation Allowance (dB) + Fiber Splices Attenuation Allowance (dB) + Test Cord Attenuation Allowance (dB)*

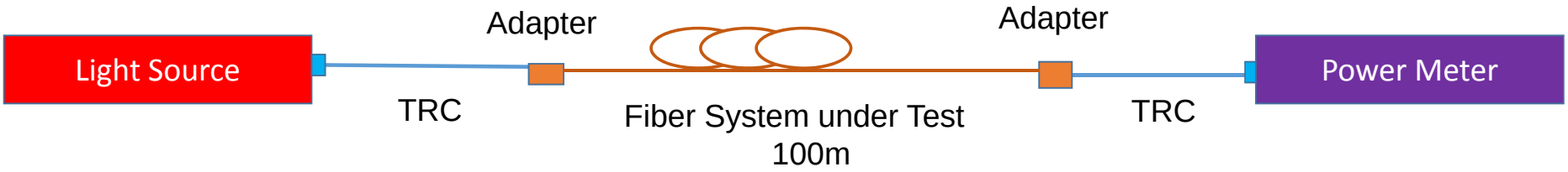
Where:

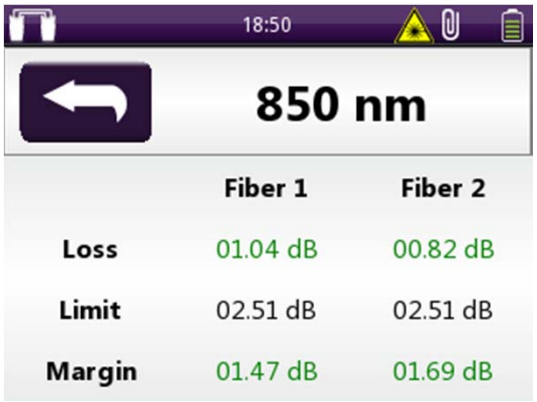
- *Cabled Fiber Attenuation Allowance (dB) = Maximum Cabled Fiber Attenuation Coefficient (dB/km) × Length (km)*
- *Connections Attenuation Allowance (dB) = Number of Connections within the link × Connection Loss Allowance (dB/connection)*

Note: The number of connections within the link excludes the connections on the ends of the link to the test cords that are accounted for subsequently as Test Cord Attenuation Allowance.

- *Fiber Splices Attenuation Allowance (dB) = Number of Splices × Fiber Splice Loss Allowance (dB/splice)*
- *Test Cord Attenuation Allowance for one-cord reference method = 2 × Test Cord Loss Allowance*
- *Test Cord Attenuation Allowance for two-cord reference method = 1 × Test Cord Loss Allowance*
- *Test Cord Attenuation Allowance for three-cord reference method = 0 × Test Cord Loss Allowance*

Loss Limit Example





Limit is based on settings
Loss is measured
Margin in calculated

850 nm example:

- Cabled fiber attenuation allowance = 3.5dB/km (0.35dB)
- Test cord attenuation allowance = 0.3dB x 2 (0.6dB)
- If no connections or splices in system under test, loss budget = 0.95dB
- If two connections (0.75dB/connection) in system under test, loss budget = 2.45dB

Will My Application Actually Work?

- In this context, application is the protocol that will "ride" on the fiber.
  - Typically Ethernet or Fiber Channel
- What is the connection between the "limit" on the previous slide and what the application requires?
  - Very little…

Loss and Length Limits at 850nm

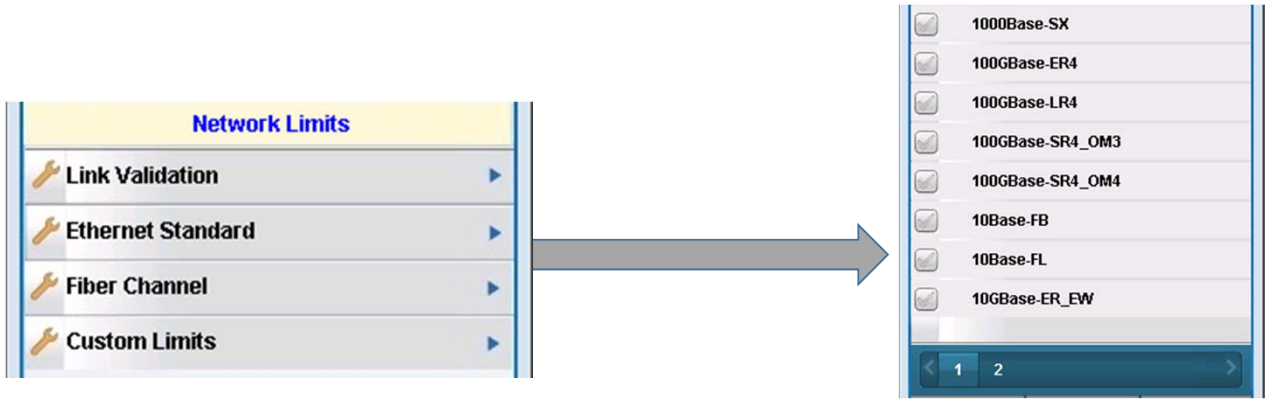
Cable Type	1GbE		10GbE		40 /100GbE	
	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)
OM3	4.5	1000	2.6	300	1.9	100
OM4	4.8	1100	3.1	1100	1.5	150

Compliant Networks

- Most Enterprise Optical Loss Test Sets will report “Compliant Networks” based on loss measurement
- **Cautions!**
  - Can “PASS” standards-based generic limit, but have too much loss for specific application
  - Most testing performed is on links – but applications run on channels
- **If the Application to be carried on the fiber is known**
  - Then use Application (Network) limit on your test device

Compliant Networks

1000BASE-LX_MM	1000BASE-SX	100GBASE-ER4
100GBASE-LR4	100GBASE-SR4_OM3	100GBASE-SR4_OM4
10BASE-FB	10BASE-FL	10GBASE-LR/LW
10GBASE-LX4	10GBASE-SR/SW	40GBASE-SR4_OM3
40GBASE-SR4_OM4	1Gbps-FC_OM2_MM	1Gbps-FC_OM3_MM
2Gbps-FC_MM	2Gbps-FC_OM2_MM	2Gbps-FC_OM3_MM
4Gbps-FC_OM1_MM	4Gbps-FC_OM2_MM	4Gbps-FC_OM3_MM
8Gbps-FC_OM1_MM	8Gbps-FC_OM2_MM	8Gbps-FC_OM3_MM
ISO-14165-111_MM		



Conclusion

- Ensure Your Results Are Accurate and Consistent
- Treat your test reference cords AND the fiber under test with respect – inspect and clean ALL fibers ALL the time
  - Inspect Before You Connect℠
  - IEC 61300-3-35 Certification
- Understand your multimode launch condition and have a plan to move to Encircled Flux
  - Standard modal power distribution = consistent loss results between testers
- Understand reference methods and their impact on limit, loss, and margin
  - Reference method chosen in tester setup is correct and matches actual physical setup
  - Verify and check the reference often
  - Use test reference cords
- Complement your loss/length certification with OTDR (Tier 2 Certification)

Thank-You!

Tyler Vander Ploeg, RCDD

Viavi Solutions

Tyler.VanderPloeg@ViaviSolutions.com

Tier-2 OTDR testing & troubleshooting

Jamie Humphreys,
Senior Technical Sales Specialist EXFO
Las Vegas, NV – September 24, 2017

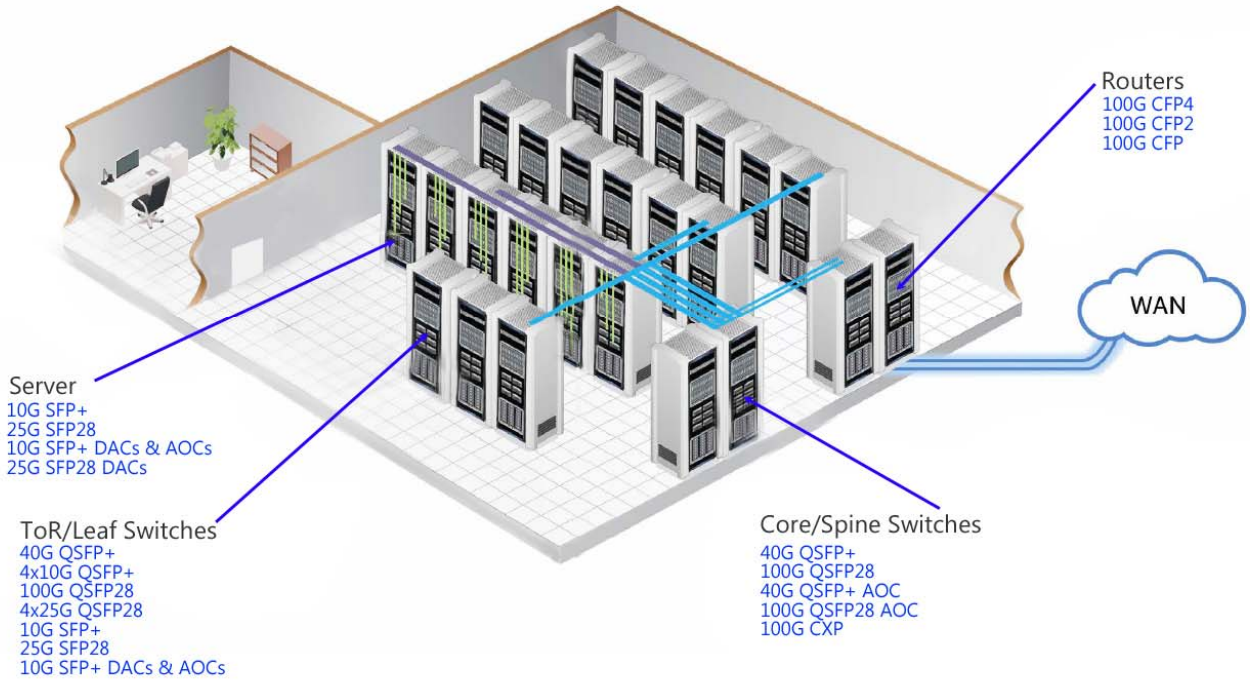
Data Center Evolution

Majority of Data Centers Today

- ✓ Mix of MM/SM Fiber
- ✓ Line Rates 10G-100G
- ✓ Legacy & New Optics

Migration of Data Centers

- ✓ HyperScale DC – 100% SM
- ✓ Line Rates 100G-400G-(Tbps?)
- ✓ New MM Optics- SWDM
- ✓ New MM OM5 Specification



Data Center Evolution

Application evolution over multimode and the impact of WBMMF on fiber plant

Transmission	40GbE Tx Rx	100GbE Tx Rx	400GbE Tx Rx
10G parallel lanes			N/A
25G parallel lanes	N/A		
10G or 25G with WDM and/or parallel lanes			

Note: Multiple lines represent parallel lanes and line with multiple colors represents WDM (multiple wavelengths within same lane).

Source: CablingInstall.com "Nomenclature for WBMMF decided: It's OM5 fiber" 12Oct2016

ANSI/TIA-492AAAE- Wide Band MMF
OM5- 50um MMF
Operating range 850nm to 953nm

SWDM Transceiver

Short Wave Division Multiplexing

- 40/100 Gigabit Serial
- 4 x Wavelength @ 10/25 Gbps
  - **850nm**
  - **880nm**
  - **910nm**
  - **940nm**

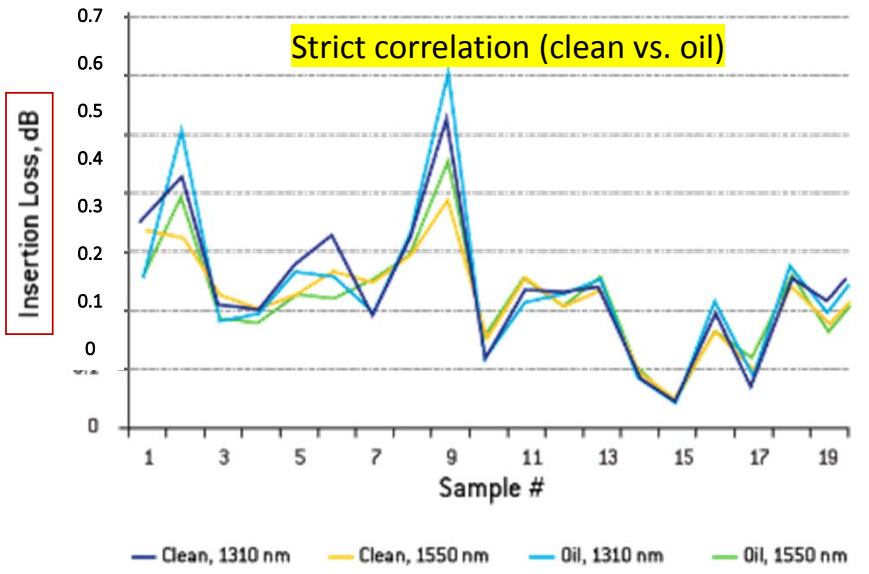
Note: 200Gbps and 400Gbps require a combination of WDM and parallel optic

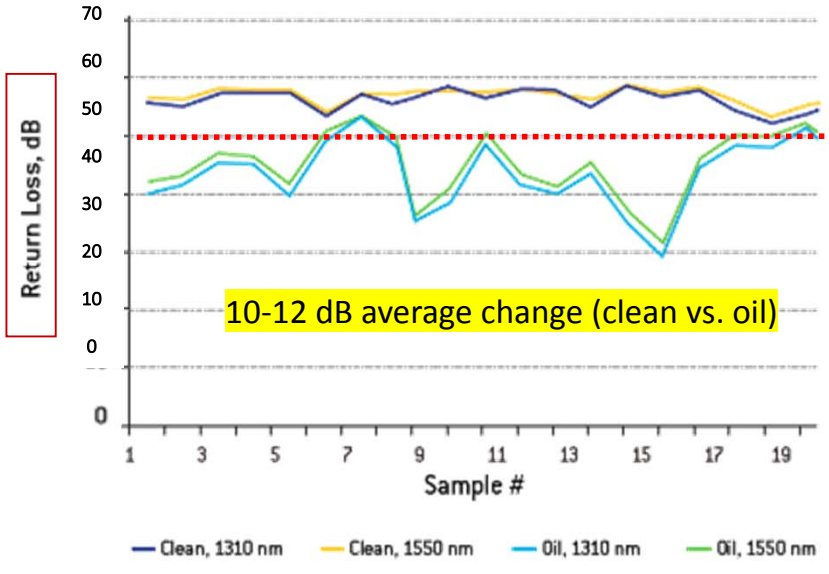
Reflectance : Growing Importance

Reflectance Thresholds:

Standards (TIA-568.3-D (2013, b.3), IEC-11801 (2010): SMF 35dB (MMF 20dB)

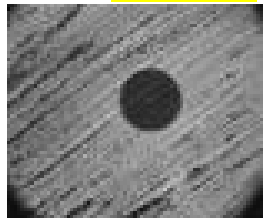
IEEE 802.3bs (200 – 400G): SMF -45 to -47dB for each discrete reflectance (4 connectors+) – *standard not yet ratified.*





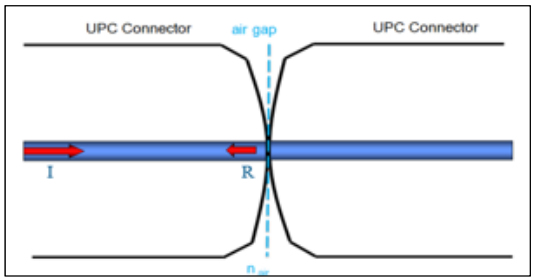
Typical Operator Requiremen

Finger oil

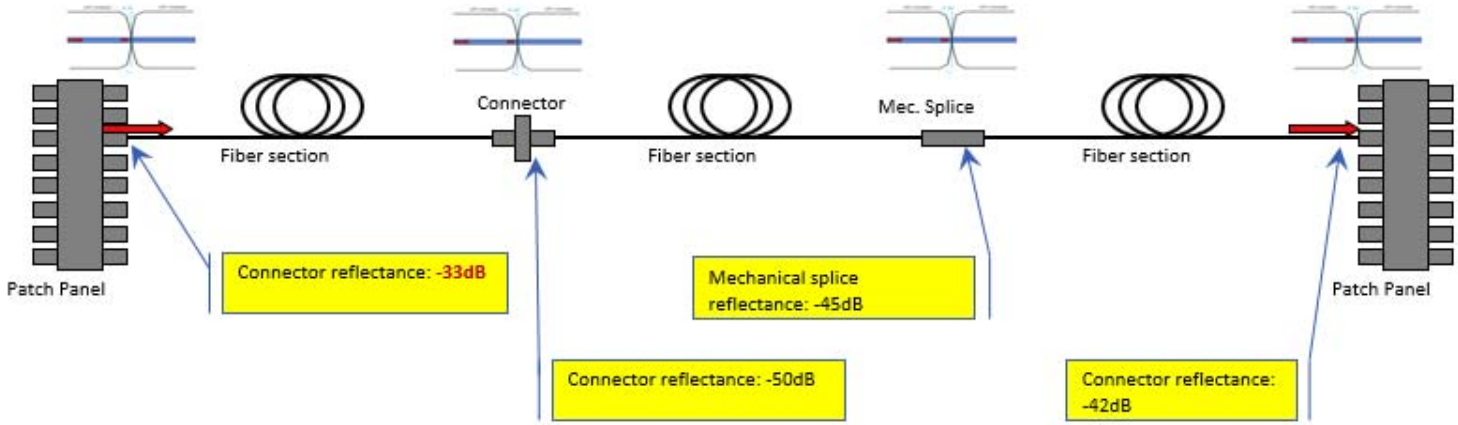


Reflectance

- **The amount of energy reflected back from specific points within the network**
- **Each reflectance point is independant (expressed as a negative value)**



The optical energy that is reflected back towards the source when significant change in the IOR occurs



Reflectance Tolerances

Rates	MMF Budget loss in dB @ 850 nm (Reach)	SMF Budget loss in dB @ 1310/1550 nm (Reach)	Connector Reflectance (dB) Standard	Connector Reflectance (dB) Customers
10GBASE *(IEEE 802.3ae 2002)*	**S- Serial (OM3/4)** 2.6 (300m)	**L- Serial (OS1-OS2)** 6.0 (10km)	-20 (MMF) -26 (SMF)	*No requirements*
40GBASE-SR4 100GBASE-SR10 40GBASE-LR4 100GBASE-LR4 *(IEEE 802.3bm – 2015)*	**SR4 / SR10** 1.9 (70m) (OM3) 1.5 (100m) (OM4)	**LR4 (OS1-OS2)** 6.7 (10km)	-20 (MMF) -26 (SMF) ***-35 dB*** ***TIA-568.3-D***	**-40 to -45 dB** (SMF / UPC polish) 4x25G lanes
New MSAs: 100G-PSM4 (4X25 MPO) 100G-CWDM4 (4x25 LC) 100G-SWDM4 (LC)	**OM5/SWDM4** 1,5 (100m)	**OS1-OS2** 3.3 dB (500m) 5.0 dB (2km)	-20 (MMF) -26 (SMF)	**-40 to -45 dB**

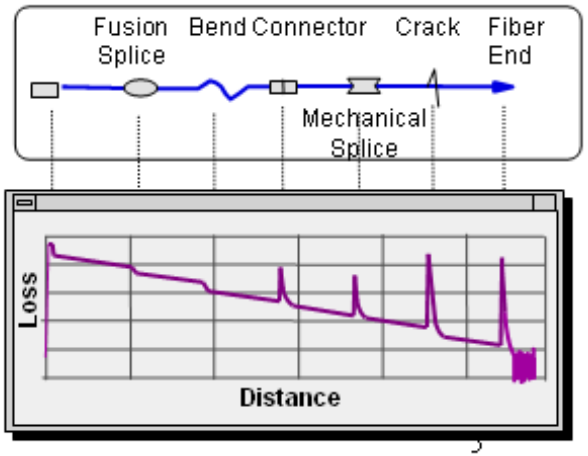
OTDR Basics-

An OTDR is an optical Sonar that can measure:

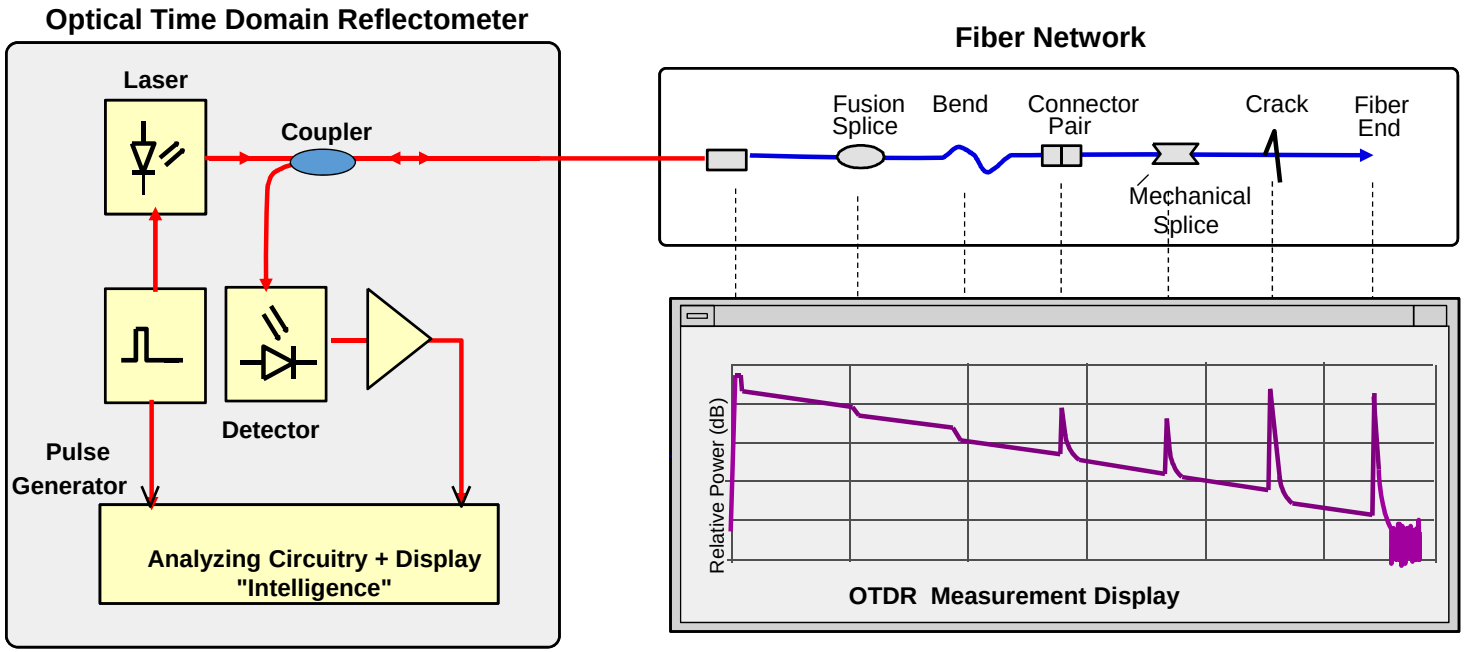
- Break points
- Splice and connector losses
- Point-to-point distances
- Total cable length
- Connector quality (return loss)
- Fiber attenuation

An OTDR is used for :

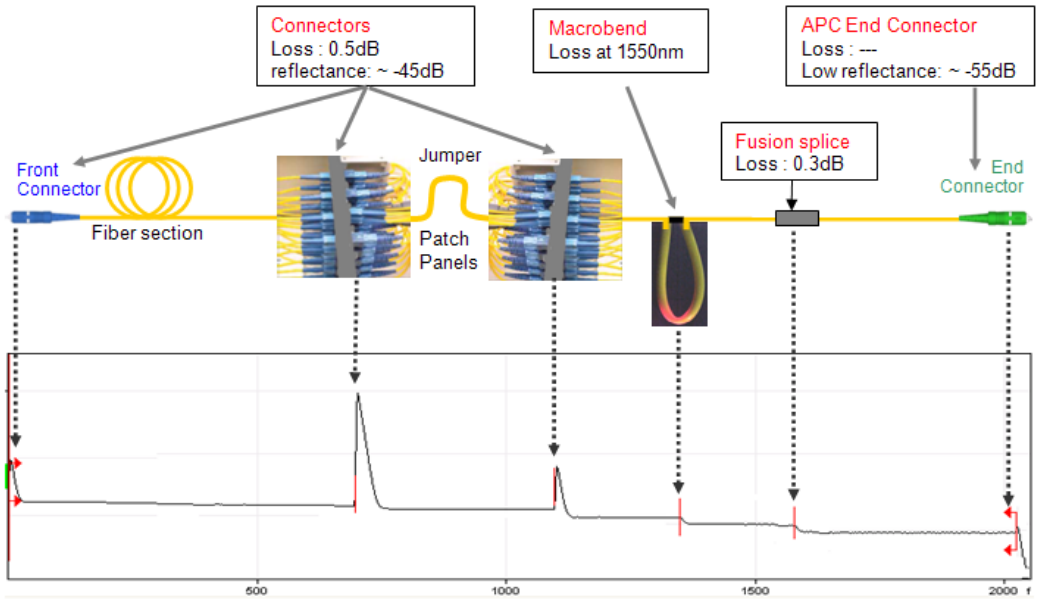
- Installation and commissioning
- Maintenance
- Emergency restoration
- Fiber identification
- Characterization



OTDR- Operation



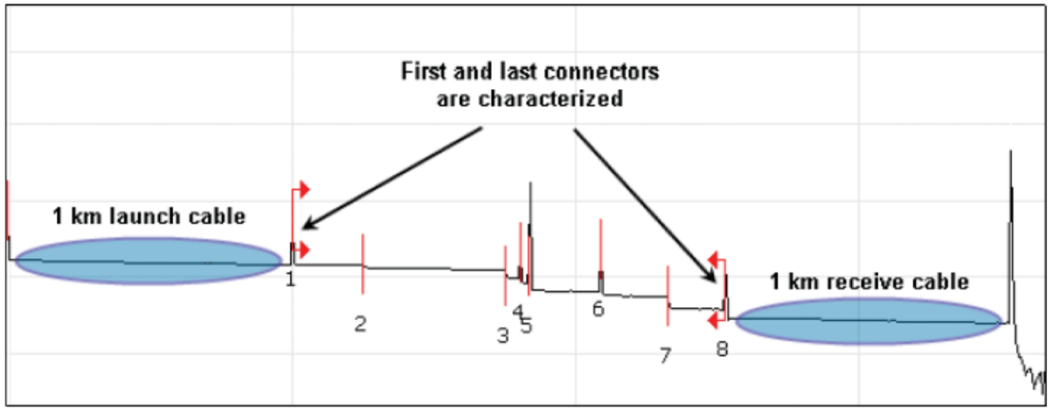
OTDR Basics- Attenuation & Reflective Events



Splices, macrobends, connectors, cracks, and components cause insertion loss that add to the total loss of fiber links. Connectors can cause reflectance as well as loss. OTDRs can be used to measure characteristics from these events.

OTDR Basics- Launch/Receive Cable

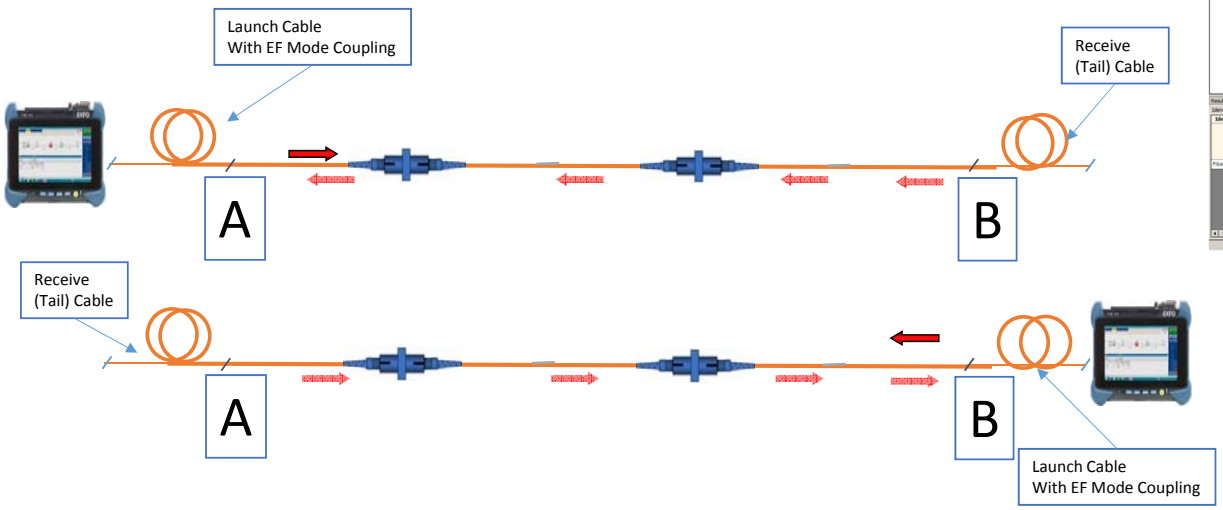
In order to properly measure the loss and refection of the first and the last connectors, launch and receive cables are required

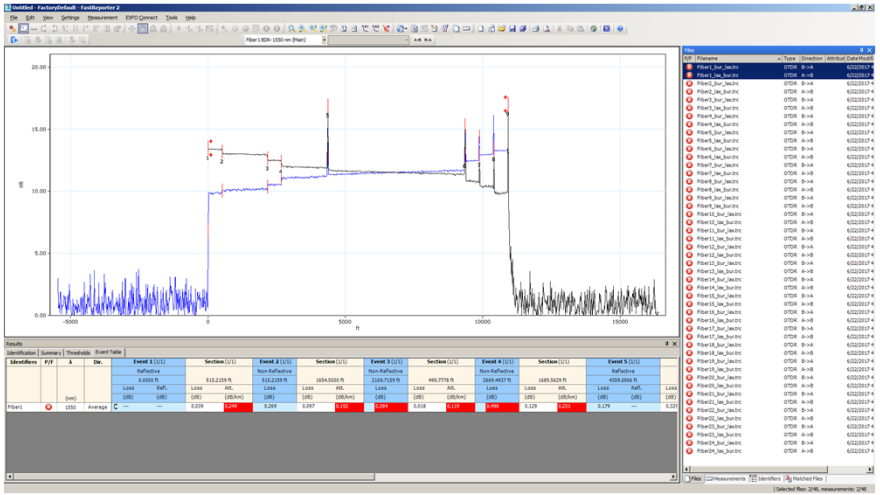


OTDR Basics- MMF Bi-Directional Testing

TIA-526-14B (and IEC 61280-4-1).

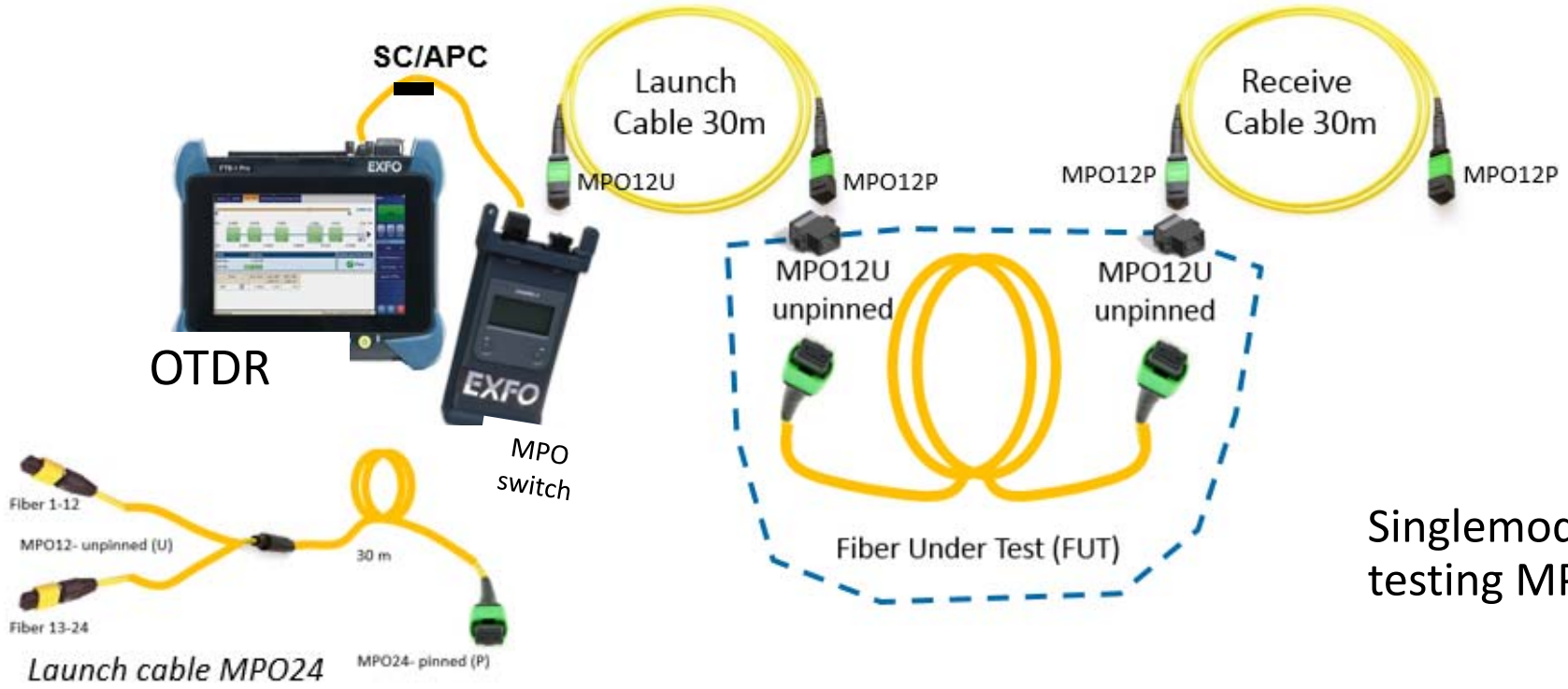
Bi-directional testing is required if the fibre characteristics of the test cords differ from those of the cable under test. If the launch cord and tail cord have identical scattering characteristics and it is only the total insertion loss of the link that is required to be measured, then it is sufficient to carry out OTDR testing in one direction only.





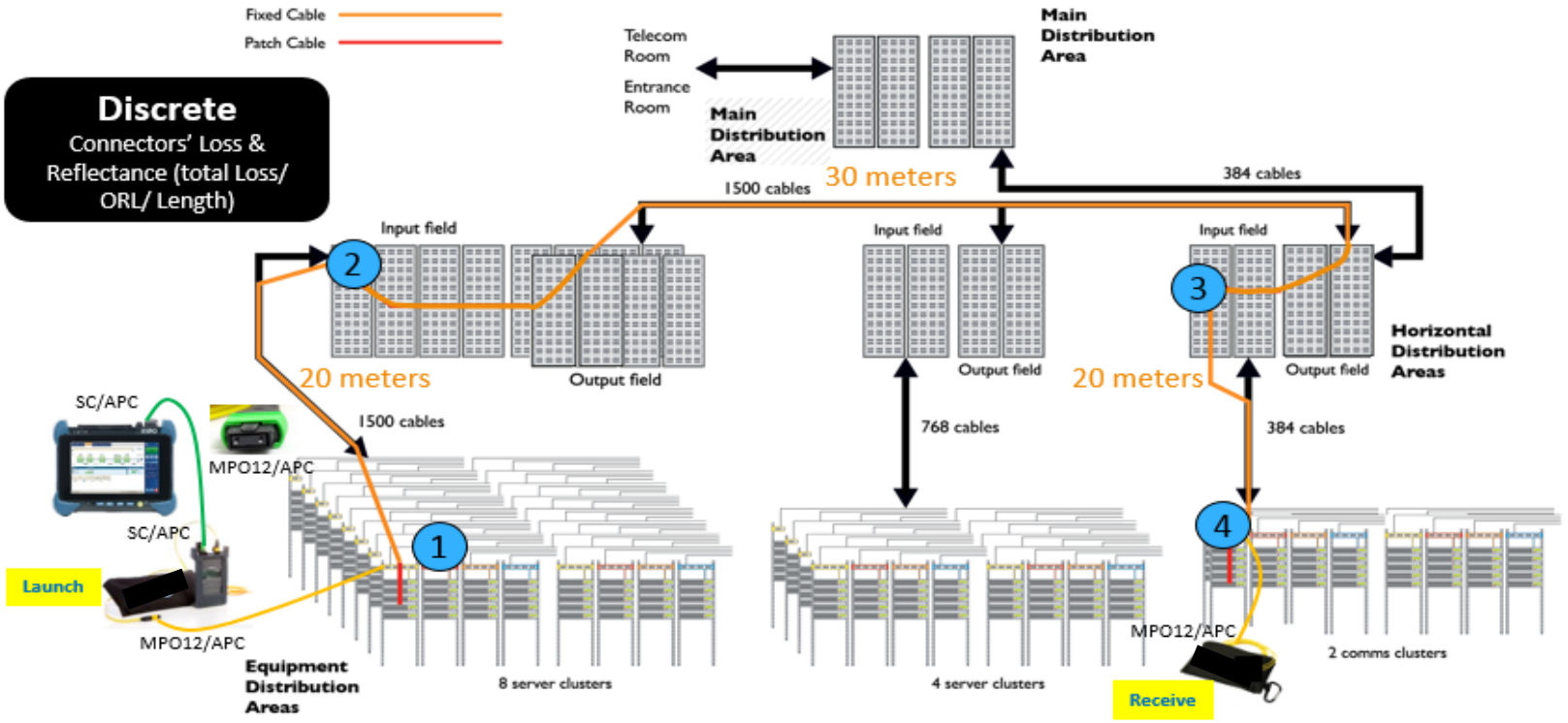
Post Analysis SoftwareAuto Average the A>B and B>A Traces

MPO-SMF OTDR/Switch Test Case



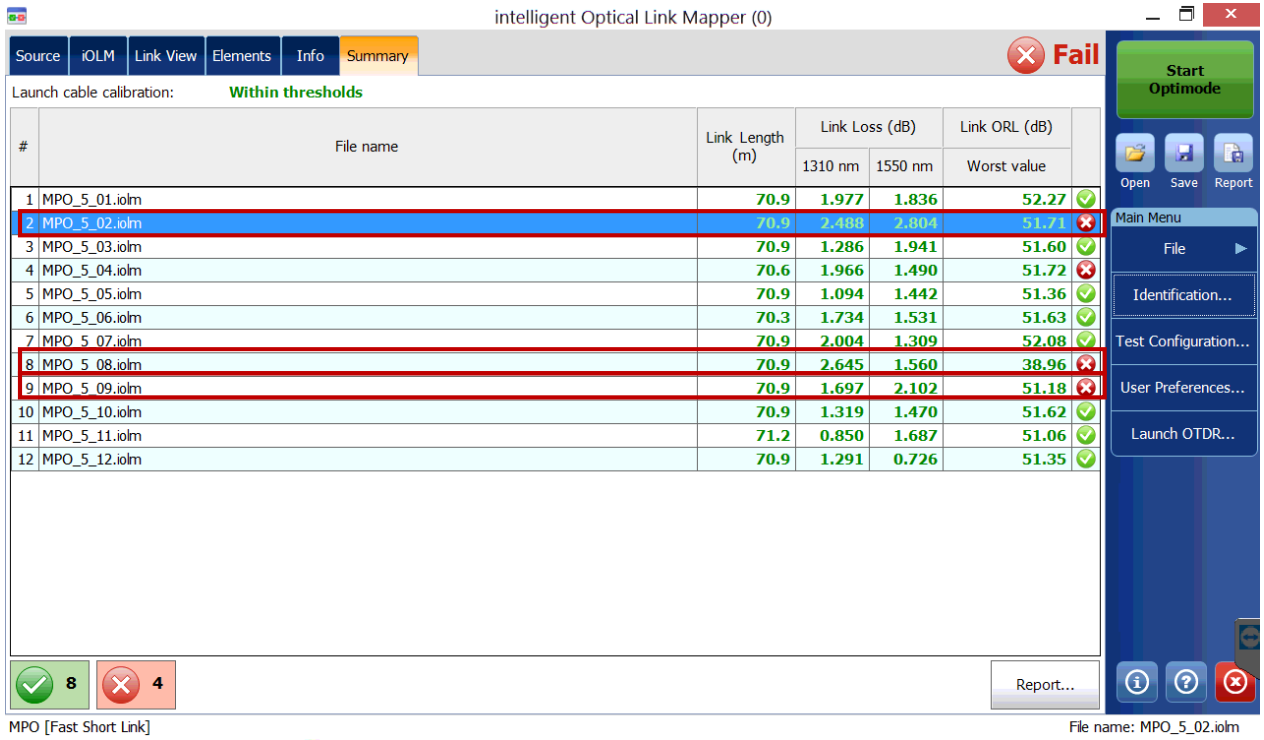
Singlemode fiber testing MPO12/24

MPO-SMF OTDR/Switch Test Case



MPO-SMF OTDR/Switch Test Case

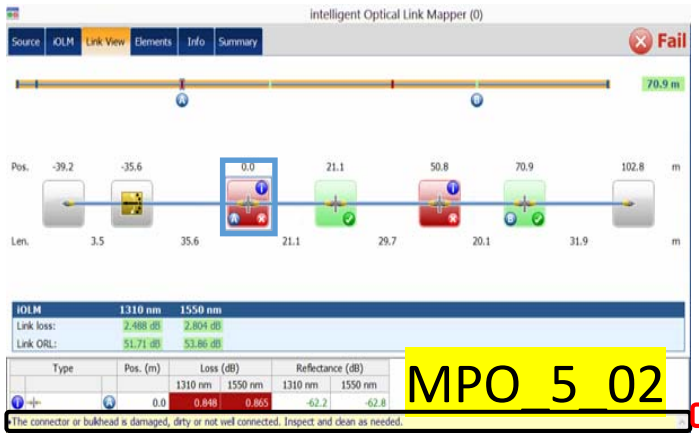
- Approximately 20 seconds per fiber (1310/ 1550nm)
- Fiber 8 has really bad ORL.
- Thresholds are at 0.75dB insertion loss per connector, 3.3dB budget loss for the link and -45dB reflectance

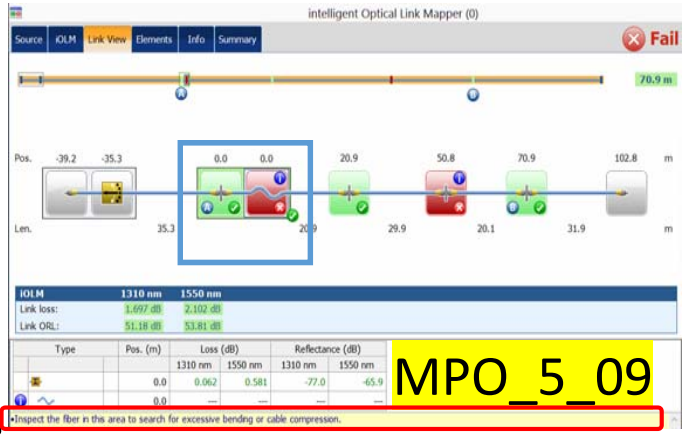


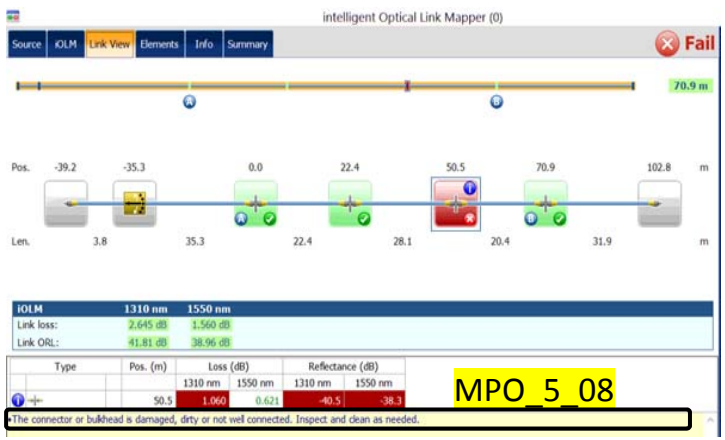
#	File name	Link Length (m)	Link Loss (dB) 1310 nm	Link Loss (dB) 1550 nm	Link ORL (dB) Worst value
1	MPO_5_01.iolm	70.9	1.977	1.836	52.27
2	MPO_5_02.iolm	70.9	2.488	2.804	51.71
3	MPO_5_03.iolm	70.9	1.286	1.941	51.60
4	MPO_5_04.iolm	70.6	1.966	1.490	51.72
5	MPO_5_05.iolm	70.9	1.094	1.442	51.36
6	MPO_5_06.iolm	70.3	1.734	1.531	51.63
7	MPO_5_07.iolm	70.9	2.004	1.309	52.08
8	MPO_5_08.iolm	70.9	2.645	1.560	38.96
9	MPO_5_09.iolm	70.9	1.697	2.102	51.18
10	MPO_5_10.iolm	70.9	1.319	1.470	51.62
11	MPO_5_11.iolm	71.2	0.850	1.687	51.06
12	MPO_5_12.iolm	70.9	1.291	0.726	51.35

8 4

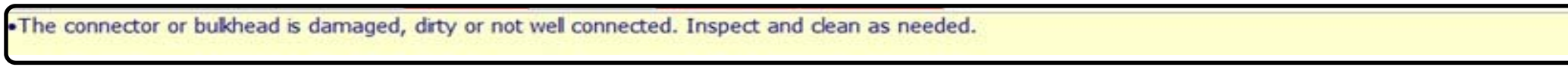
MPO-SMF OTDR/Switch Test Case

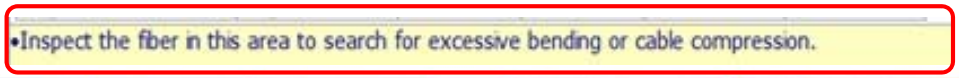




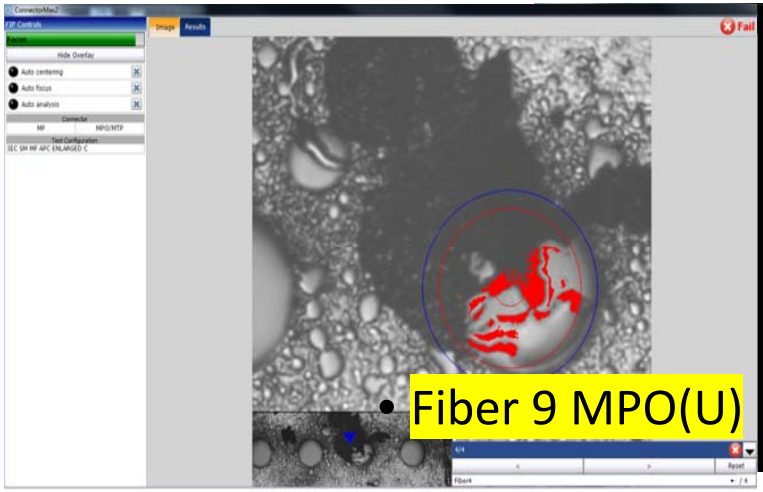


- For each fiber having issues, Link view shows which connector(s) will exceed thresholds for insertion loss or reflectance.

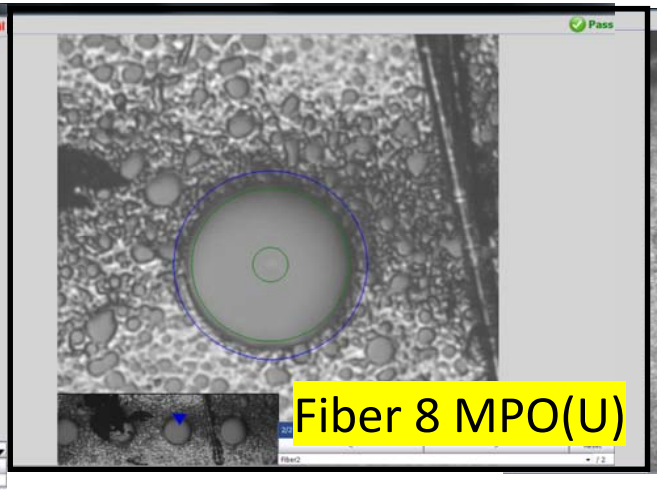




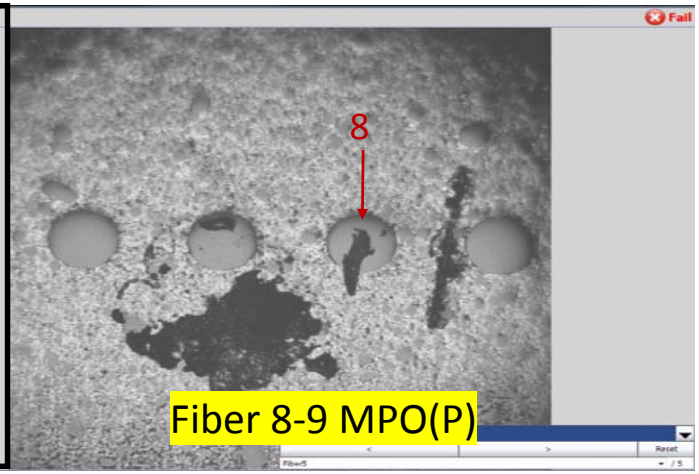
MPO-SMF OTDR/Switch Test Case



- Fiber 9 MPO(U)

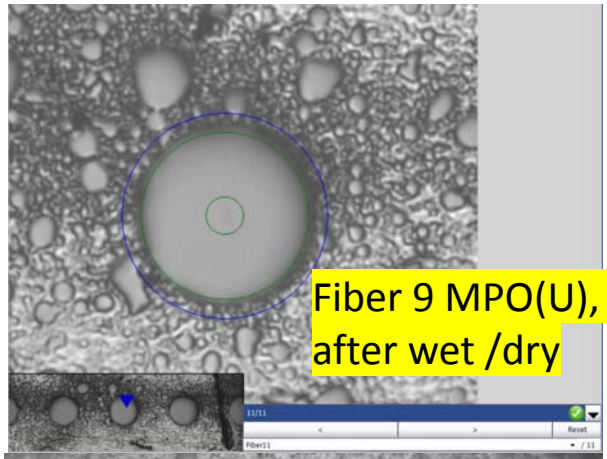


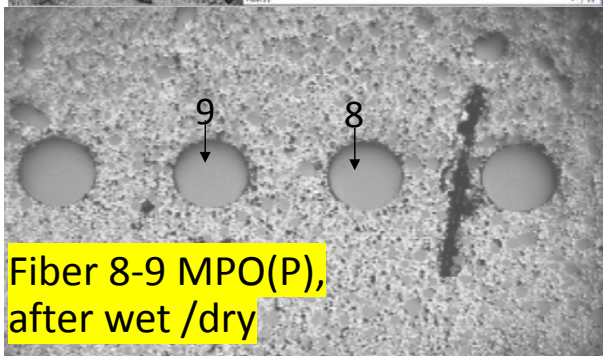
Fiber 8 MPO(U)



Fiber 8-9 MPO(P)

MPO-SMF OTDR/Switch Test Case





intelligent Optical Link Mapper (0)

Source | iOLM | Link View | Elements | Info | Summary — Pass

Launch cable calibration: **Within thresholds**

#	File name	Link Length (m)	Link Loss (dB) 1310 nm	Link Loss (dB) 1550 nm	Link ORL (dB) Worst value
1	MPO_5 T2_01.iolm	70.9	1.904	1.360	51.51
2	MPO_5 T2_02.iolm	70.9	1.582	1.847	51.54
3	MPO_5 T2_03.iolm	70.9	0.959	1.346	51.31
4	MPO_5 T2_04.iolm	70.9	1.623	1.274	51.58
5	MPO_5 T2_05.iolm	70.9	1.084	1.446	50.95
6	MPO_5 T2_06.iolm	70.6	2.038	0.969	51.91
7	MPO_5 T2_07.iolm	70.9	0.949	1.481	51.05
8	MPO_5 T2_08.iolm	70.9	1.744	1.497	51.53
9	MPO_5 T2_09.iolm	70.9	1.728	1.907	51.73
10	MPO_5 T2_10.iolm	70.9	1.191	1.583	51.14
11	MPO_5 T2_11.iolm	70.9	1.107	1.550	51.42
12	MPO_5 T2_12.iolm	70.9	0.841	0.731	51.09

Start Optimode | Open | Save | Report

Main Menu: File ▶ | Identification... | Test Configuration... | User Preferences... | Launch OTDR...

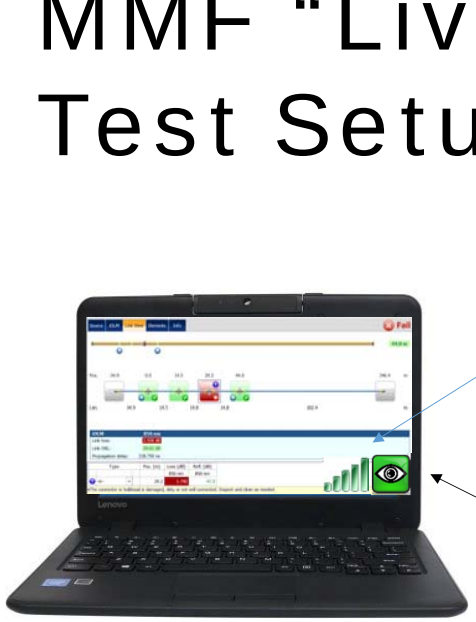
12 | 0

MPO [Fast Short Link]

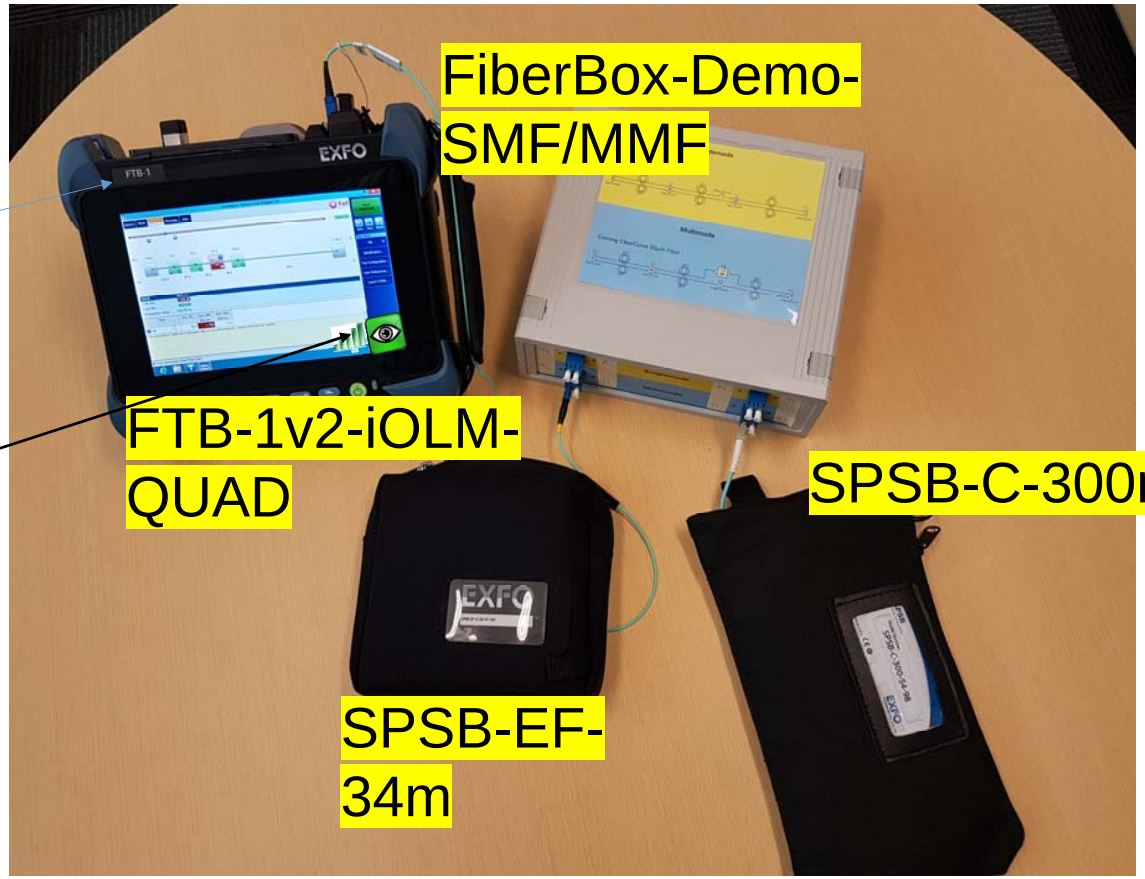
Source | iOLM | Link View | Elements | Info | Summary

Type	Pos. (m)	Loss (dB) 1310 nm	Loss (dB) 1550 nm	Reflectance (dB) 1310 nm	Reflectance (dB) 1550 nm
	-39.2	0.024	-0.033	-83.5	-83.3
	-35.3	2.056	1.917	-68.8	-59.6
A	0.0	0.271	0.159	-72.9	-76.5
	20.2	0.570	0.470	-65.8	-70.5
	50.0	0.577	0.057	-67.5	---
B	70.9	0.487	0.673	-73.6	-71.2
	102.8	---	---	-63.9	-64.9

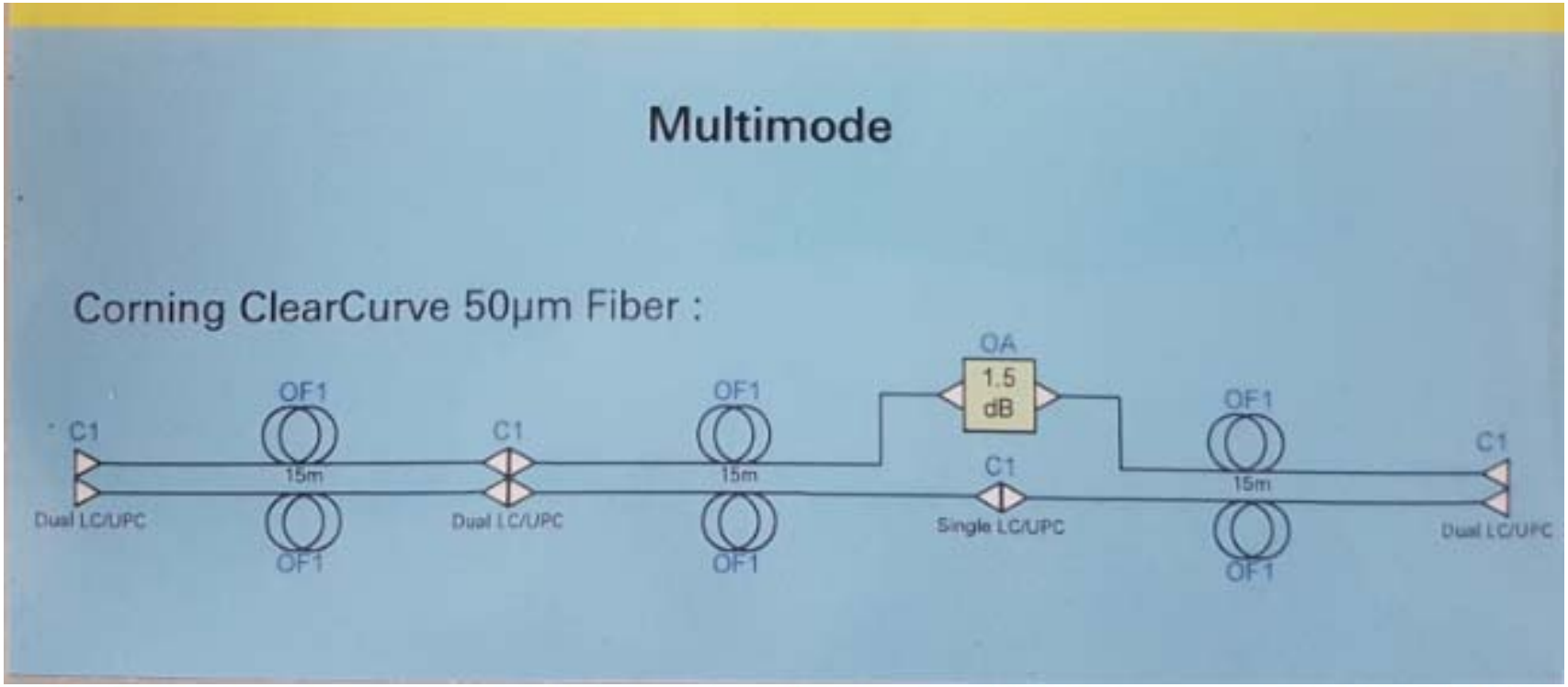
MMF "Live" Test Setup



VNC

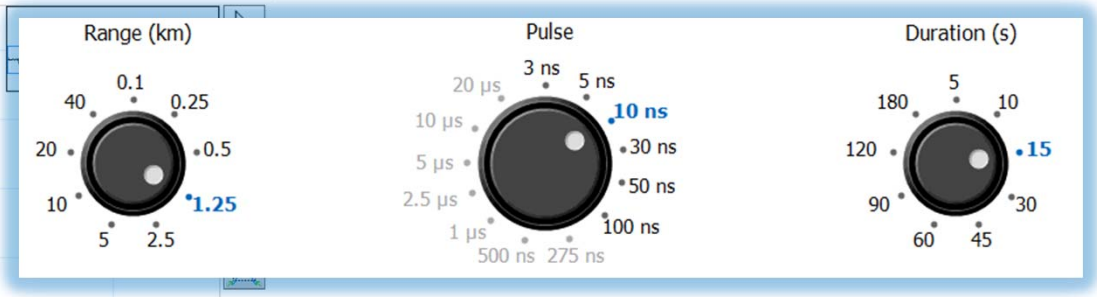


MMF Test Box



Back Up Slides Next 2 slides – Unhide if Trouble with “Live “

OTDR Trace- MMF Example

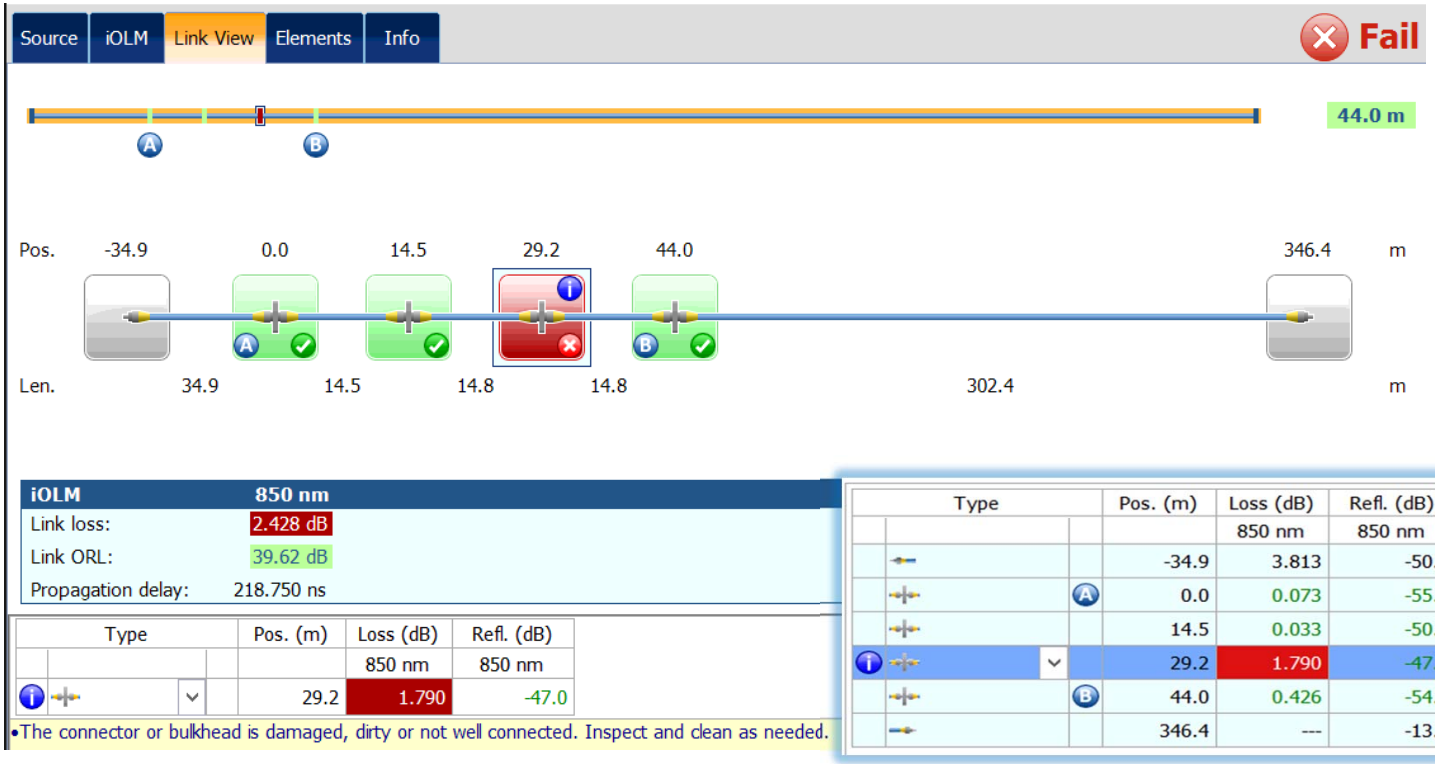


Is this accurate? Fault Location?

Did these setting produce the “cr

Was there a Launch / Receive ca

iOLM Trace- MMF Example



Insert Launch Measurement

Encircled Flux (EF) standard compliant (IEC 61280-4-1) 35m launch cable and standard 302m receive cable (OM3).

Thank-You!

Jamie Humphreys

EXFO

jamie.humphreys@exfo.com

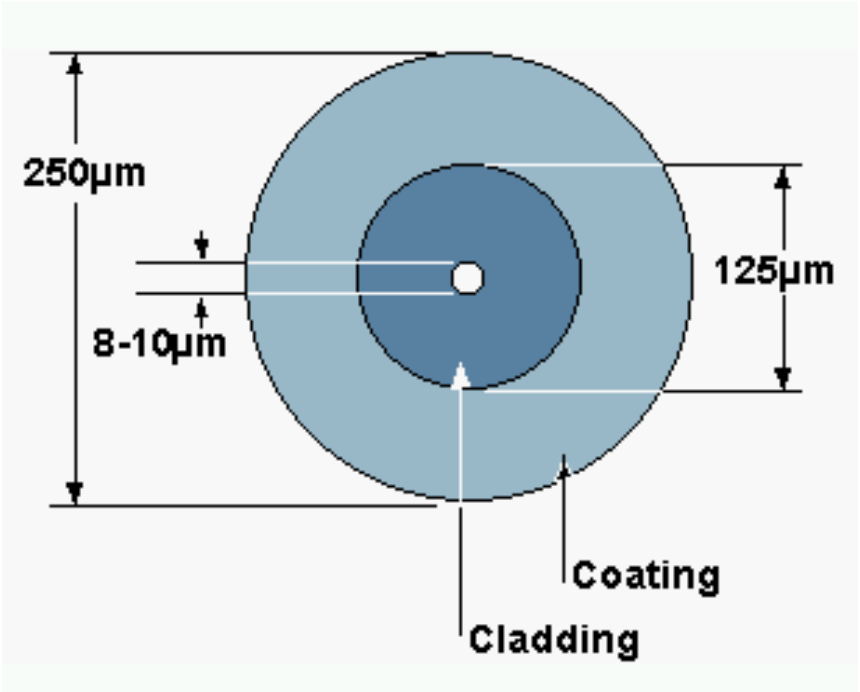
Multi-Fiber Connectors Inspection and Cleaning

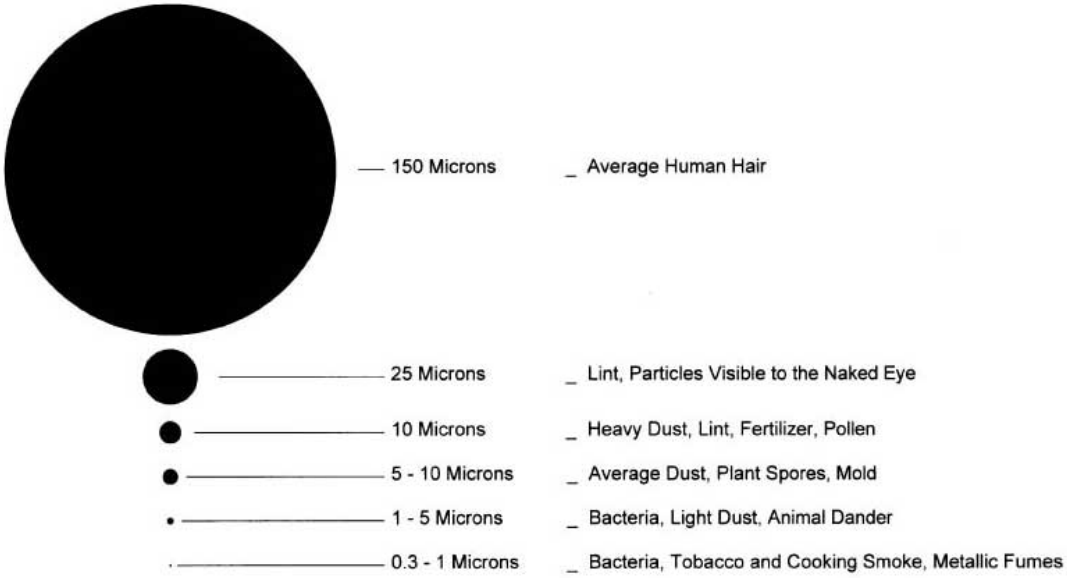
Rob Gilberti
Sr Product Marketing Manager AFL
Test and Inspection
Las Vegas, NV – September 24, 2017

What is so Important about Cleaning and Inspection?

- Connector contamination and damage is the leading root cause of fiber optic network failures.
- Lower loss budget requirements make cleaning even more important than before.
- Inspecting and cleaning before connecting saves troubleshooting costs, downtime and improves performance. Period!
- Dirt can be transferred from a contaminated connector to a clean connector (i.e. “cross-contamination”)
- All connectors --even brand new jumpers with a factory finish-- should be inspected prior to mating to prevent dirt moving from one connector to another

Contaminants and the Connector





What Happens to the fiber/connector?

- Dust and dirt can literally block the light
- Dirt and oils can cause light to refract and be lost at the connection
- Particles can prevent proper mating of connectors
- Dirt can damage connector end face when mating and cause permanent damage – cleaning will no longer help

Which of these are acceptable Cleaning Methods?

- Wipe on your sleeve
- Wipe on your skin
- Blow on the fiber end
- Rub with your finger
- Clean with water
- Clean with alcohol
- Clean with tissue/paper towel

NONE OF THESE!

What is Clean?

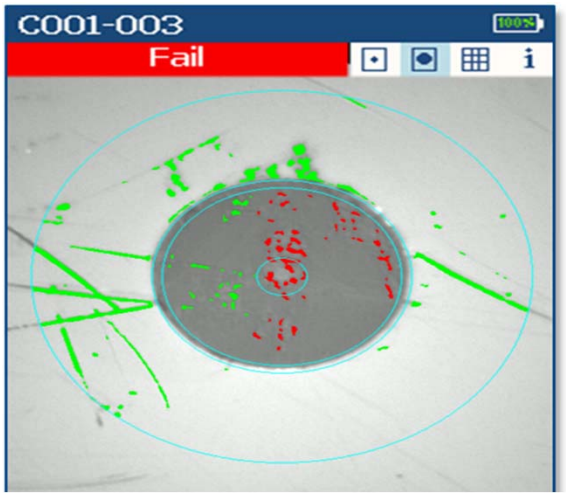
- Specifies pass/fail requirements for end-face quality before connection
- Telco Services have widely adopted - Enterprise and data centers have yet to follow
- Check *both* sides of the connection
- Always inspect the fiber first
- If dirty, clean and inspect again to verify the cleaning was effective
- Only when both connectors are clean can you proceed with connecting them

IEC Standard Definition - IEC 61300-3-35:2015

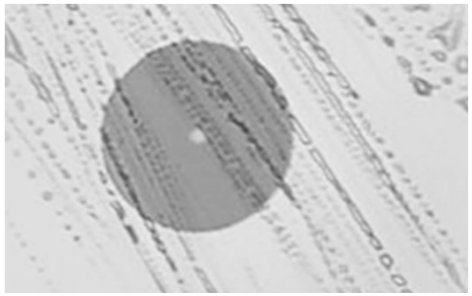
Table 4 – Visual requirements for multi-mode PC polished connectors

Zone[a]	Scratches (maximum number of a given dimension)	Defects (maximum number of a given dimension)
A: core 0 μm to 65 μm	No limit ≤ 3 μm None > 3 μm	4 ≤ 5 μm None > 5 μm
B: cladding 65 μm to 115 μm	No limit ≤ 5 μm None > 5 μm	No limit < 5μm 5 from 5 μm to 10 μm None > 10 μm
C: adhesive 115 μm to 135 μm	No limit	No limit
D: contact 135 μm to 250 μm	No limit	No limit < 20 μm 5 from 20 μm to 30 μm None > 30 μm
NOTE 1 There are no requirements for the area outside the contact. Cleaning loose debris beyond this region is recommended good practice. This is of particular concern for multiple-fibre rectangular-ferrule connectors. NOTE 2 For multiple-fibre rectangular-ferrule connectors, the criteria apply to all fibres in the array. NOTE 3 The zone size for multi-mode fibres has been set at 65 μm to accommodate both 50 μm and 62,5 μm core size fibres. This is done to simplify the grading process.		
[a] For multiple-fibre rectangular-ferrule connectors only, the requirements of Zone A and Zone B apply.		

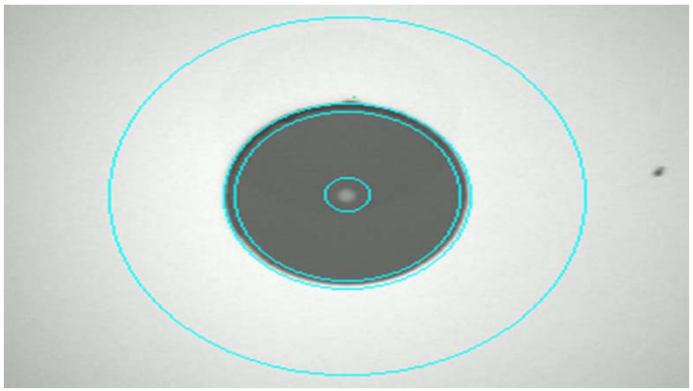
Examples



Scratched

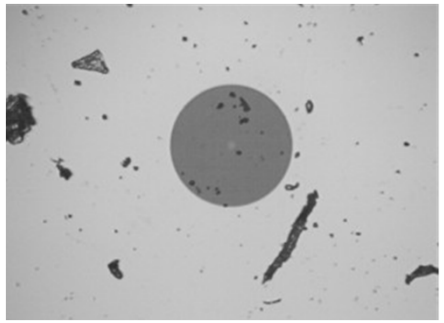


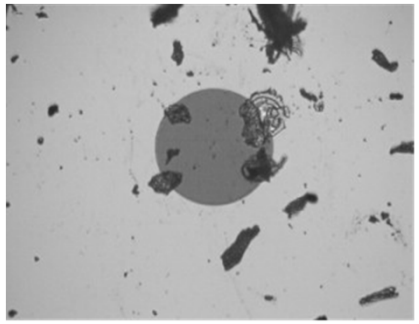
Residue

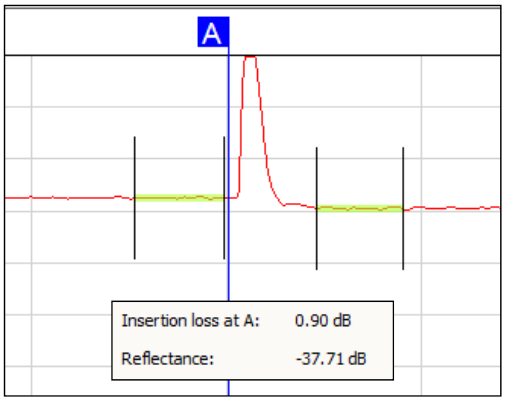


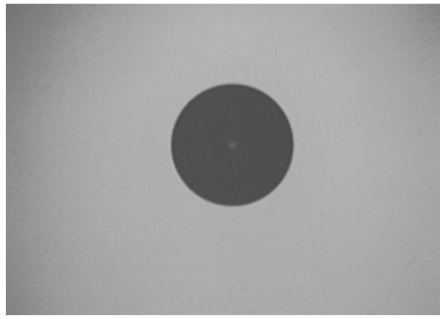
Clean

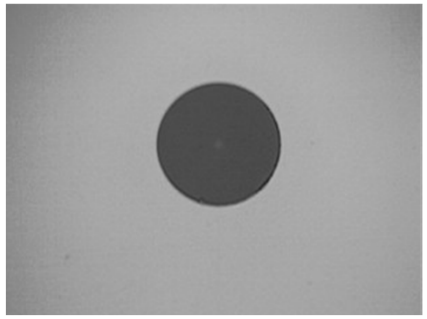
Clean connectors matter!

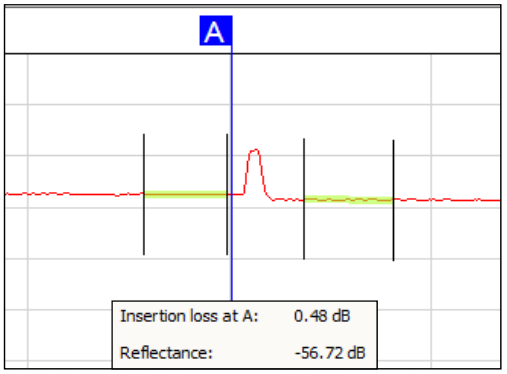






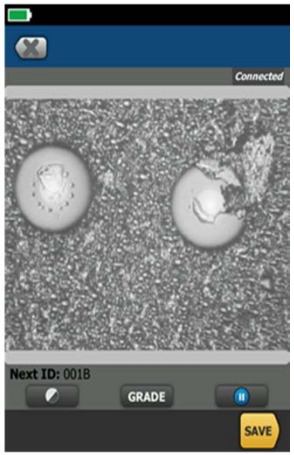






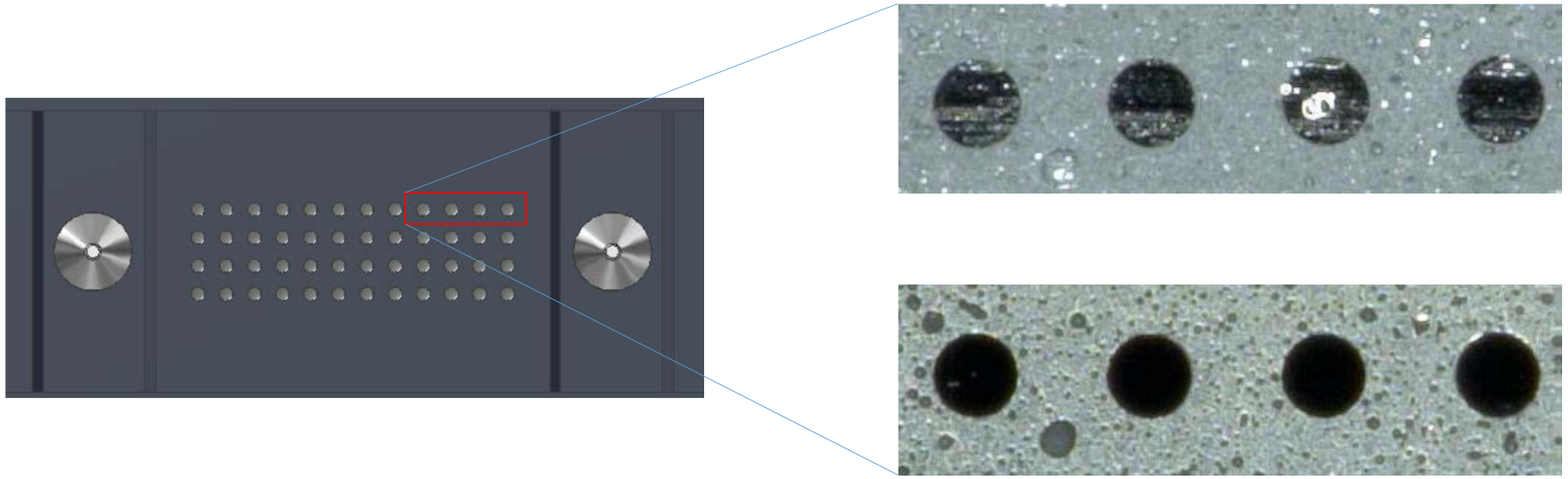
Inspection & cleaning

- You may have gotten away without it until now
- MPO/Multi-fiber will force you to rethink your inspection practices
- 40G/100G will require you to change



Example of a dirty MPO end face

Multi-Fiber Connectors - More fibers in same space



Inspecting Multi-Fiber Connectors

- For multi-fiber connectors the criteria applies to all fibers in the array

- It is especially important to clean loose contaminants beyond the contact point
  - Debris can migrate and the close spacing of the fibers increases the chances of contamination causing issues

Inspect…

- You need to inspect **all** end faces in the connector
  - Inspect the entire connector to determine need for cleaning
  - Inspecting first verifies pre-connectorized products have been supplied in good condition
  - Just because a connector comes from the factory with a protective cap does not ensure it is clean

Clean…

- You need to be able to clean **all** end faces quickly and efficiently
  - There are cleaners available today specifically designed for multi-fiber connectors
  - Dry cleaning is quite effective, but is not perfect
  - Use Mech Dry Cleaner for dust
  - Use Wet Clean for Oil/Grease (skin contact)
  - Repeat cleaning process until contamination removed

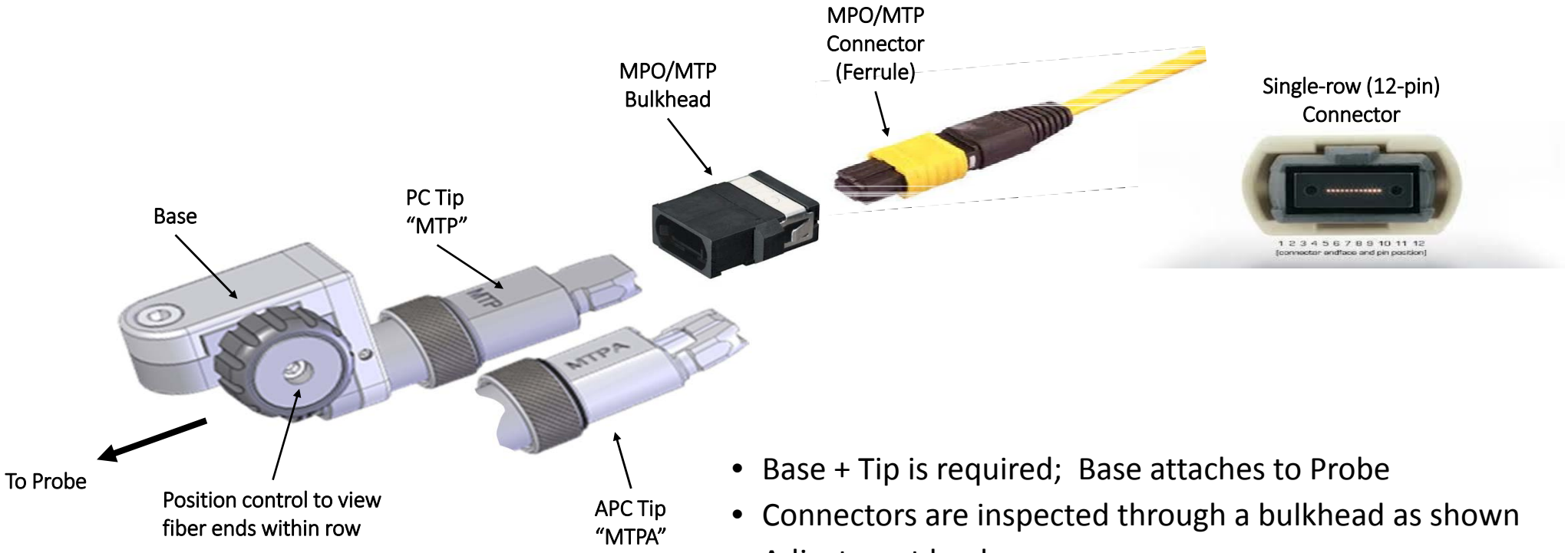
Inspect

- After cleaning you need to inspect **all** end faces in the connector again
  - If not clean… repeat the process and inspect again
  - Many customers now require proof of inspection to certify installations
  - Saves time and money in the long run

What Equipment Do I Need?

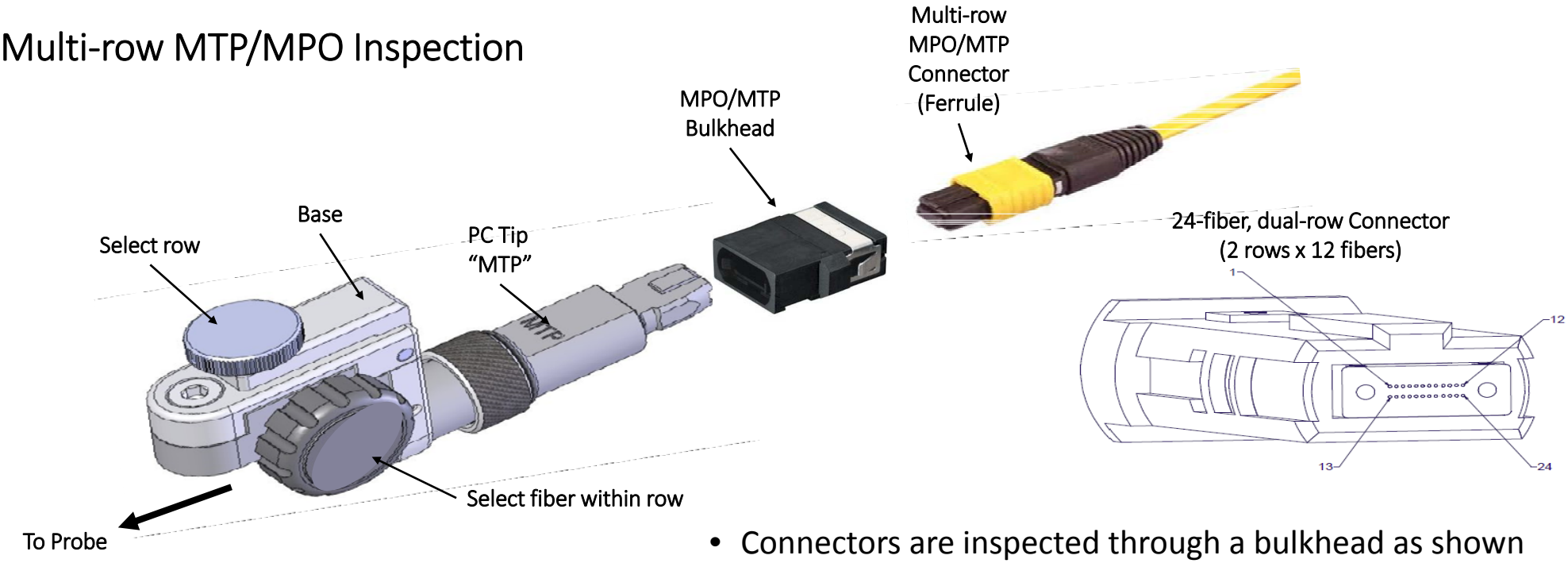
- A quality inspection microscope with appropriate connector tips
  - A scope or adapter specifically designed to inspect multi-fiber connectors.
  - Either pan and scan or wide field of view.
  - Stand-alone or connected to your other test equipment
- Cleaning supplies
  - Supplies specifically designed for multi-fiber connectors

Single-row MTP/MPO Inspection



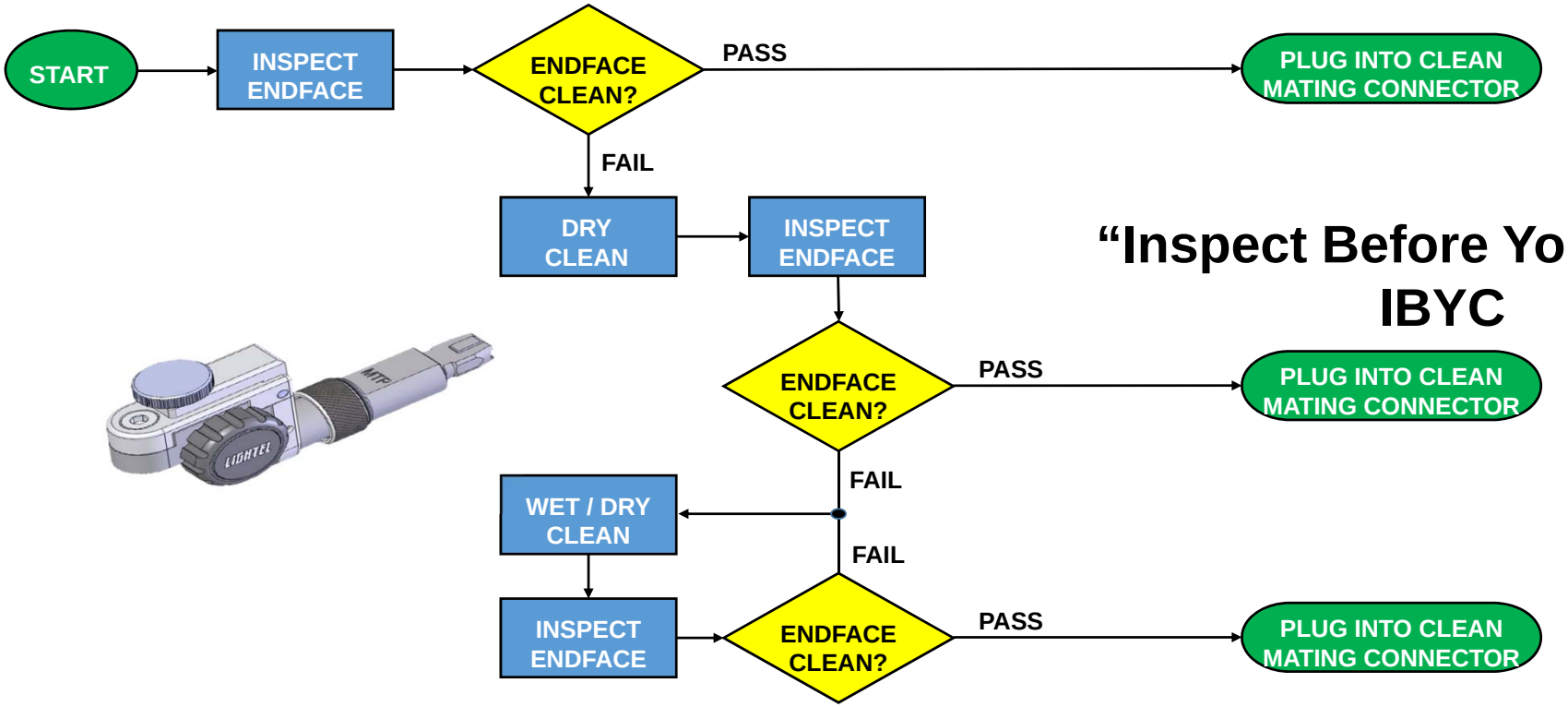
- Base + Tip is required; Base attaches to Probe
- Connectors are inspected through a bulkhead as shown
- Adjustment knob scans across row

Multi-row MTP/MPO Inspection



- Connectors are inspected through a bulkhead as shown
- One adjustment knob scans across row
- Second adjustment knob selects row (each row contains 12 fibers)

Cleaning & Inspection Best Practice



"Inspect Before You Clean"
IBYC

Tools and Methods Available Today

1 Stand-alone Connector Inspection

Handheld Probe

2 Equipment-paired connector inspection

Bluetooth transfers image & pass/fail results to TEST EQUIPMENT

Displays image and pass/fail results on Test Equipment

3 Connector inspection using Smart Device

Bluetooth transfers image & pass/fail results to Smart Device

4 Inspection reporting using SW Application

Creates Inspection reports

Integrates Inspection results into OTDR & OLTS reports

5 Inspection reporting using Cloud

Includes image & pass/fail results

Lessons learned from the field

- Contamination is #1 reason for troubleshooting optical networks
- Inspect through bulkhead, Inspect patchcords – if clean don't touch it!
- Connector dust caps are just that – caps with dust in them
- Contamination has significant Impact on High Data Rates – IL/RL
- Non-IPA solvent for effective, residual free cleaning – Alcohol not good enough

- Optical connector ferrule end-faces tend to become contaminated with skin oils, grease, salt, moisture, fingerprints, dust, lint, grime, flux residue, uncured epoxy

Summary/Conclusion

- Connector contamination and damage is the leading root cause of fiber optic network failures.
- Due to the number and spacing of fibers in a multi-fiber connector, the problem is multiplied.
- Proactive inspection and cleaning is not difficult and saves time and money
- Make Inspection and Cleaning part of your standard practice
- OPEX is name of game – long troubleshooting is deadly

Thank-You!

Rob Gilberti

AFL

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Using Cloud Based Services to Improve Results and Workflow Management

Jim Davis
Regional Marketing Engineer
Fluke Networks
Las Vegas, NV, September 24, 2017

Message of presentation, there is a new tool out there, use it

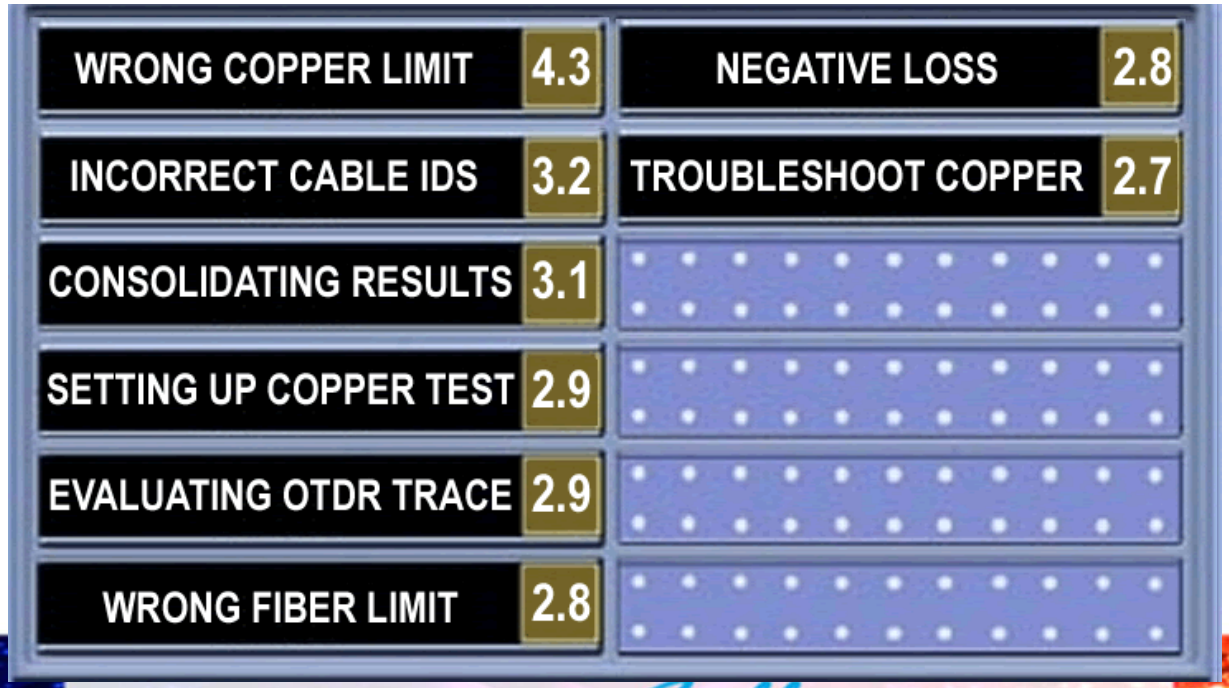
Agenda

- Results management challenges
- Cloud Based (SaaS) solutions
  - How they work
  - Implementation
  - Connection Options
- Changing the path of the elephant – Adoption Challenges

800+ Installers VOCs:

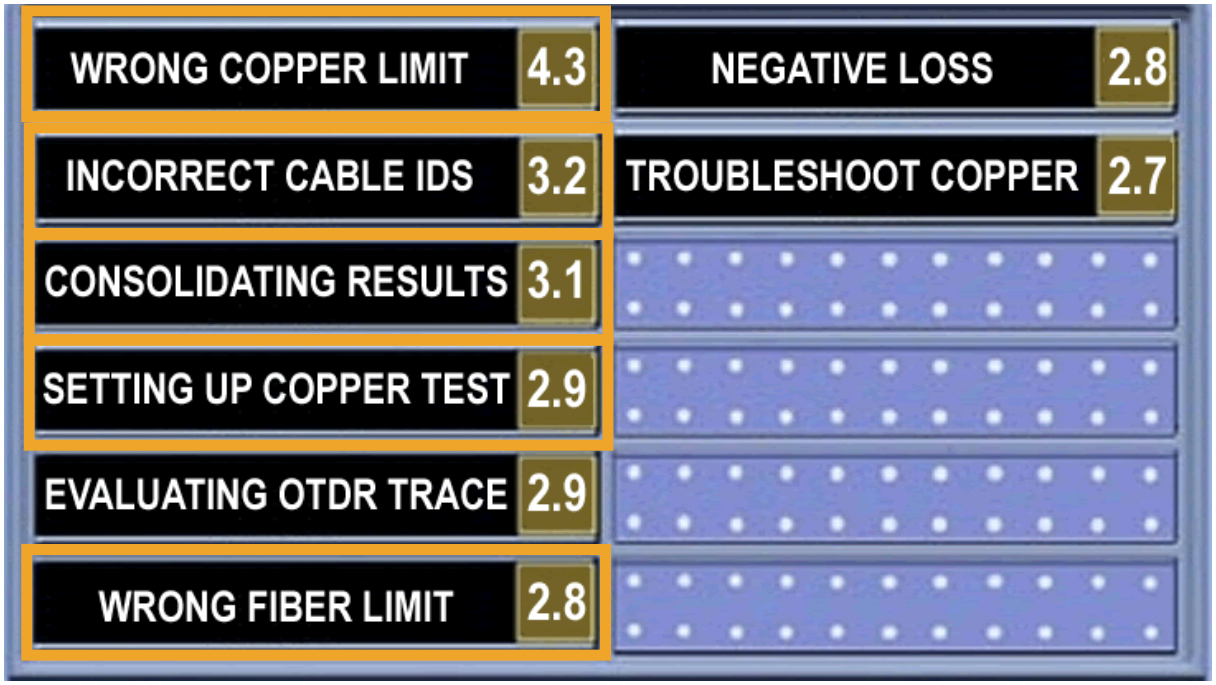
Top eight problems (hours wasted)

Average amongst all respondents in the previous 30 days



Top eight problems:

Wrong Configuration (Limit, IDs, Standard, …..)



Where the SaaS solution can help solve problems

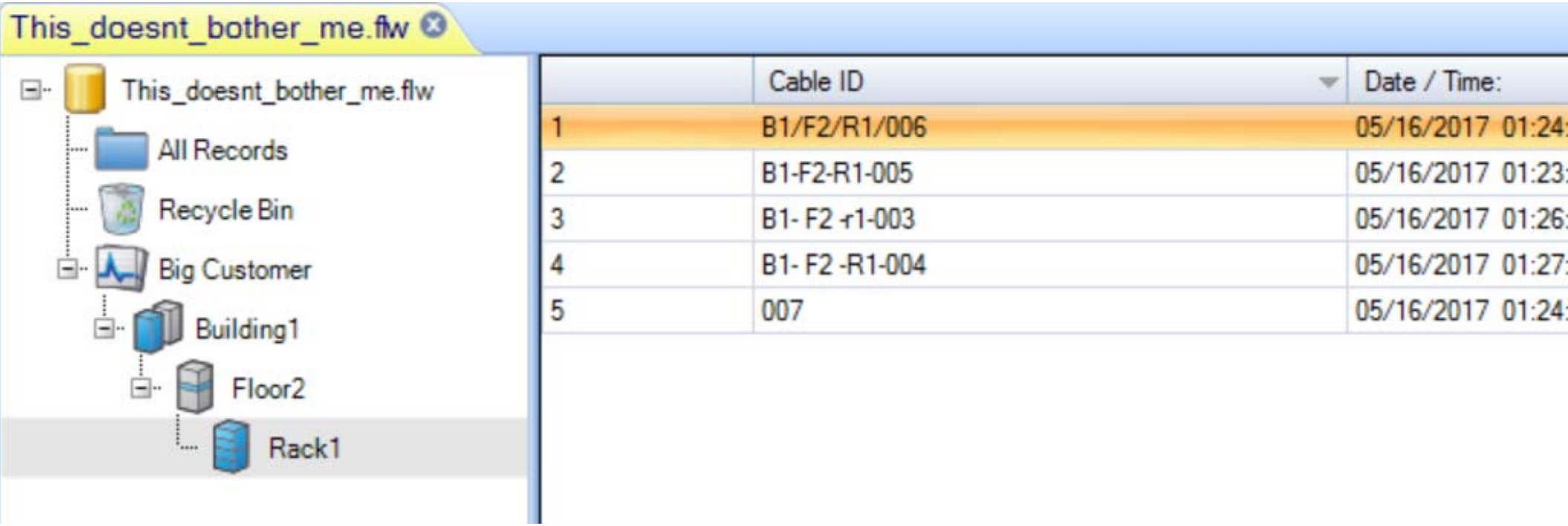
Let's look at the process – where does it leave us short- and X2 for big projects

- Tester Configured on-Site
- What are the customer/manufacturer's requirements?
- How is the tester configured?
  - What Test Limits?
  - What Cable ID's?
  - What Firmware does it have? What is the Calibration date and Period
- How are test results delivered?
  - When? Today, or in a week (month) when results downloaded
  - E-mail?
  - .pdf format?

Cloud Based Service…. Minimum Rollout
“USB Stick in the Cloud” Model
A Good Start!

Getting the results to the cloud is a good start, but there are drawbacks

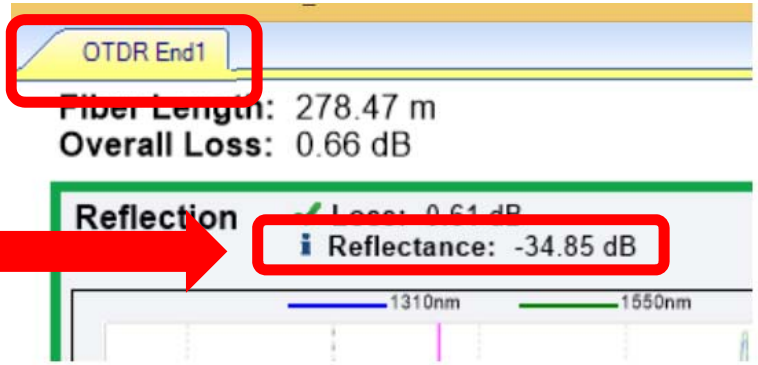
- When do they send the data? It is more valuable ‘fresh’
- What if they used the wrong Cable ID – still have to go back and edit



What if they test to the wrong limit in field

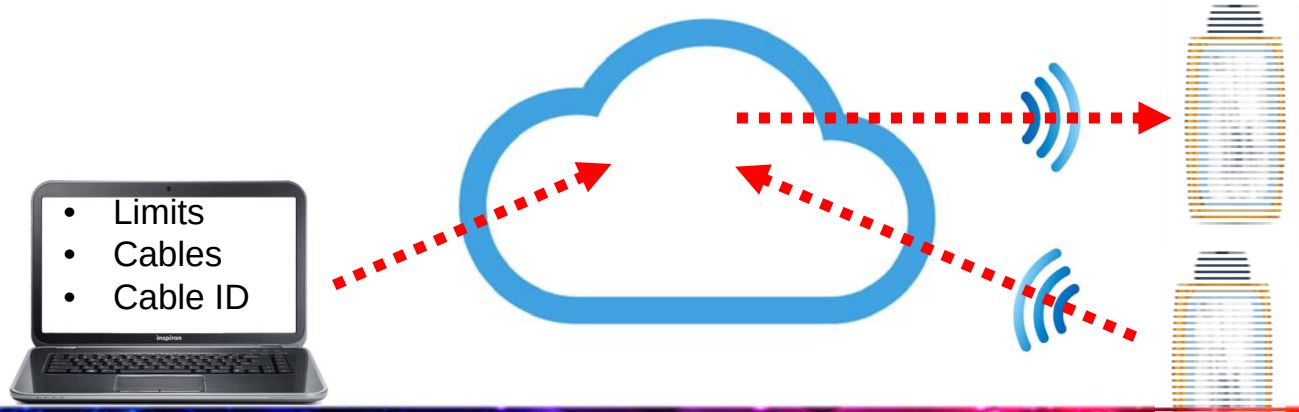
- The sooner you know, the sooner you can straighten them out
- Going back to the job site to re-certify can take a lot of time

2. OTDR testing
   a) All Tests shall be run bi-directionally ar
      loss values per
   b) Reflective events (connections) shall not exceed:
      1) 0.75 dB in optical loss when bi-directionally averaged
      2) -35 dB Reflectance or m
      3) -40 dB reflectance for UPC singlemode connections
      4) -55 dB reflectance for APC singlemode connections



A Better Way, Cloud Based Project Definition

- Limits, Cable Types, Cable ID are best known by the planner/project-manager
- With Fiber we don't want TIA or Application limits→ **Custom Limits**
- Which testers are going to do testing
  - Make configurations available to all testers



Pre-load your Cable IDs into the tester

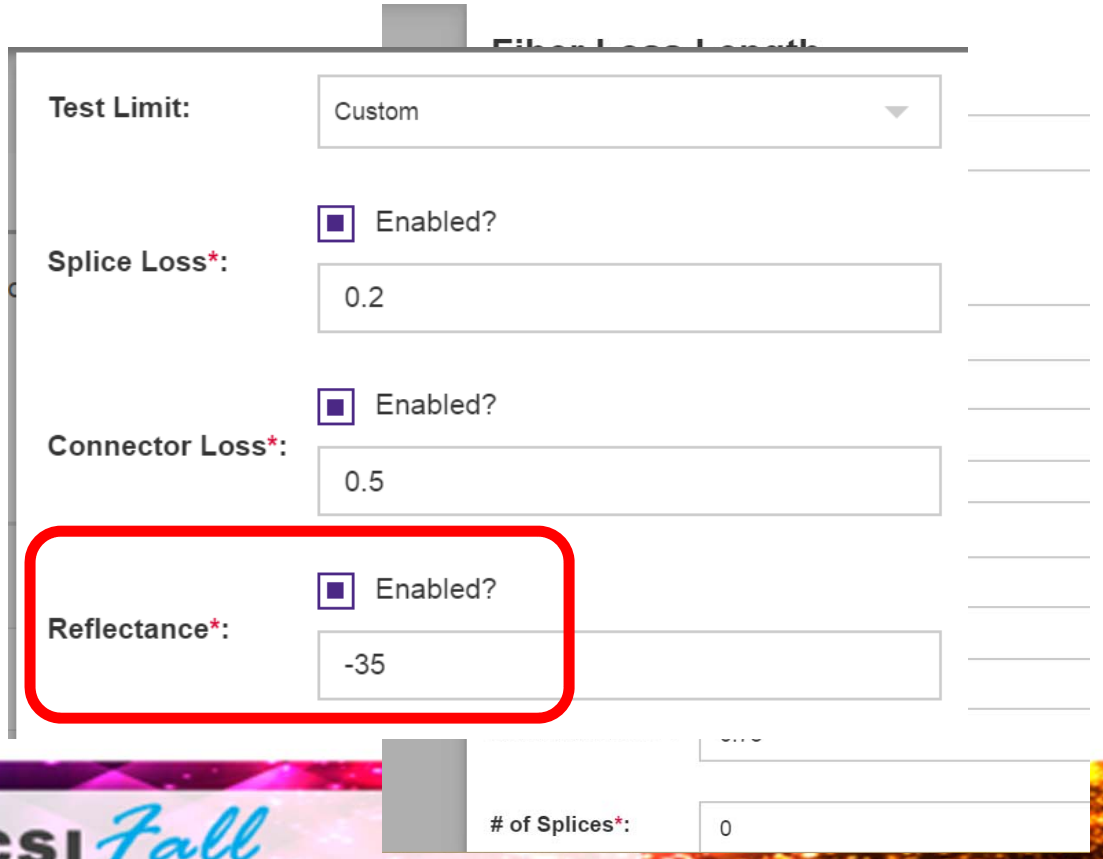
- What is the numbering scheme? TIA-606?
- How do you load the results into your tester?
- What are the rules for the Excel or CSV file for your tester
  - Know them, use this feature
- Save time in keying in Cable ID
- Save time in post processing
  - Select result => Right click => Properties => Edit

Project Building Blocks – Other Configuration Options

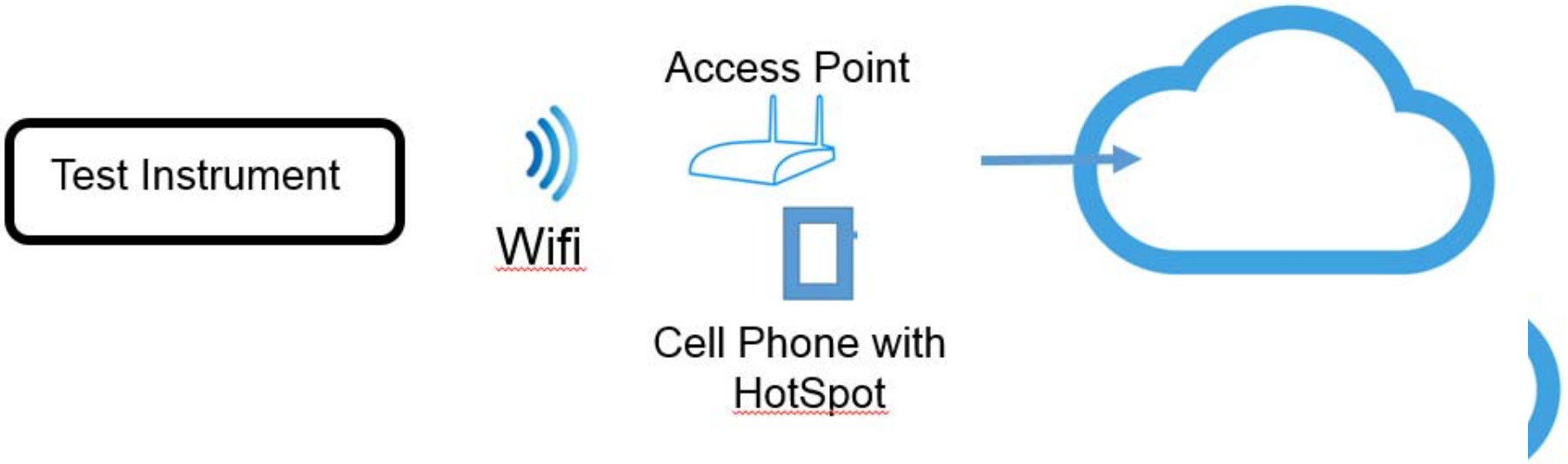
- Cable Type(s)
- Test Limit(s)
- Cable ID Lists(s)
- Test Regime
  - Copper
  - Fiber
    - BASIC – Tier I (LSPM)
    - EXTENDED – Tier II (OTDR)
    - End Face Grading

Application (IEEE) or Cabling Limit? Custom Limit?

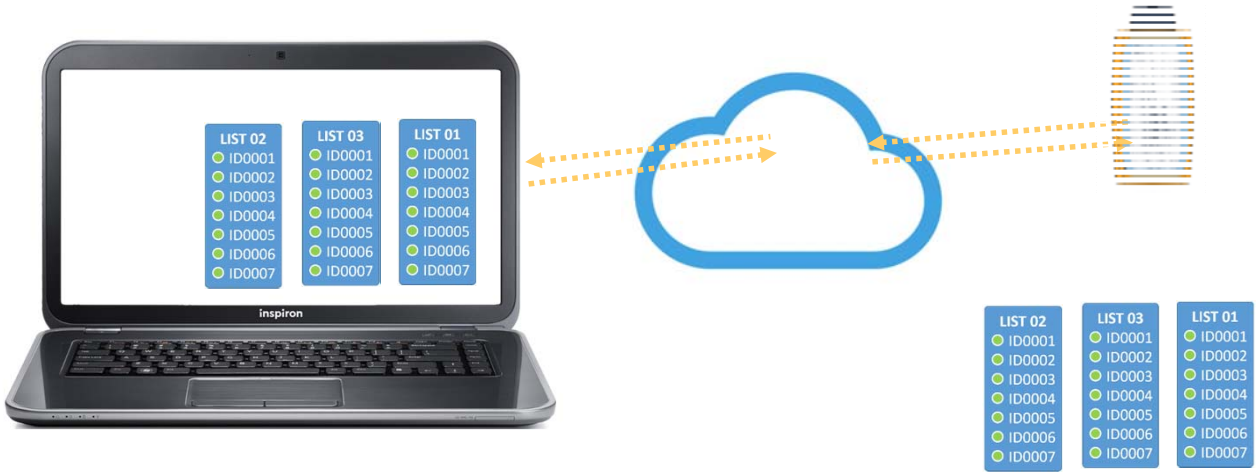
- Here is a custom Loss Length Limit
- And here is an OTDR example
- What Reflectance Value will you use?



How to Connect a Field Tester to the Cloud Service



Cloud Based Management …. Standard Rollout
PM defines entire Project in a SAAS



Visibility for ACE's & Manufacturers

- **Opportunities:**
- Are correct limits are use
- Is there a failing t trace?
- Is the refe tly? Is the value good?
- D ck show good cords ?
- rformance margin as expected ?
- hat is the progress, how many tests were run ?

Learn about it while there is still time for corrective actions !

Added bonus of Cloud service – Asset Management

- View of all testers
  - Firmware
  - Cal date
  - Location when last updated?

All Tools (349) | Tool Sets (41)

Status	Product Name	Serial Number	Project	Last Used	Synced By
✓		3583600	Portland	2 months ago	Jim Davis
✗					
✗		1989006	Brent Barr	14 days ago	Jim Davis
⚠		3190031	ExpoTIC	about 1 year ago	Jim Davis
✓		3184346	ExpoTIC	about 1 year ago	Jim Davis
✗		3133130	ExpoTIC	about 1 year ago	Jim Davis
⚠		3183381	ExpoTIC	about 1 year ago	Jim Davis
✓		3184390	ExpoTIC	about 1 year ago	Jim Davis
✓		2217224		about 2 years ago	Jim Davis
✓					

Cloud Based Solutions Challenges

- Projects are realized in Phases
- Projects are realized by multiple Teams
- Projects are realized by multiple companies (organizations)
  - Subcontractors
- All Participants will need access to Cloud Based Account
  - Permission Levels must be considered

Cloud Based Results Management Solutions offer efficiencies, but they have to be used

- Simple implementation – share results to all interested parties faster
- Better implementation – Send configurations to one or more testers
  - Especially for custom fiber limits
  - Sending Cable ID's is a great time saver
- Best Implementation – get teams to use system ☺
  - Future benefits will be developed for data that is available

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EXFO Connect

VIAVI

CERTiFi

LinkWare Live

In Conclusion

- The solutions have to be used
- Use model can be simple ‘Thumb Drive in the Cloud”
- Or more complex
  - Pre-load Cable ID’s and Test Configurations
  - Upload results frequently
- Keep your tester in the field
- Avoid Common problems
- Get paid faster – Send results today

Thank-You , Gracias, Obrigado!

Jim Davis

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