

# Trendy v měření

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Regional Sales Manager EE&Russia/CIS

March 16, 2017



We are  
the global  
network test,  
data and  
analytics  
experts.

90%+

of leading service  
providers choose us

1500+

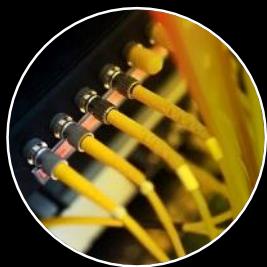
employees in  
25 countries and  
clients in 120 countries

30+

years of leadership

# Intelligence

Fiber



High speed



Cloud



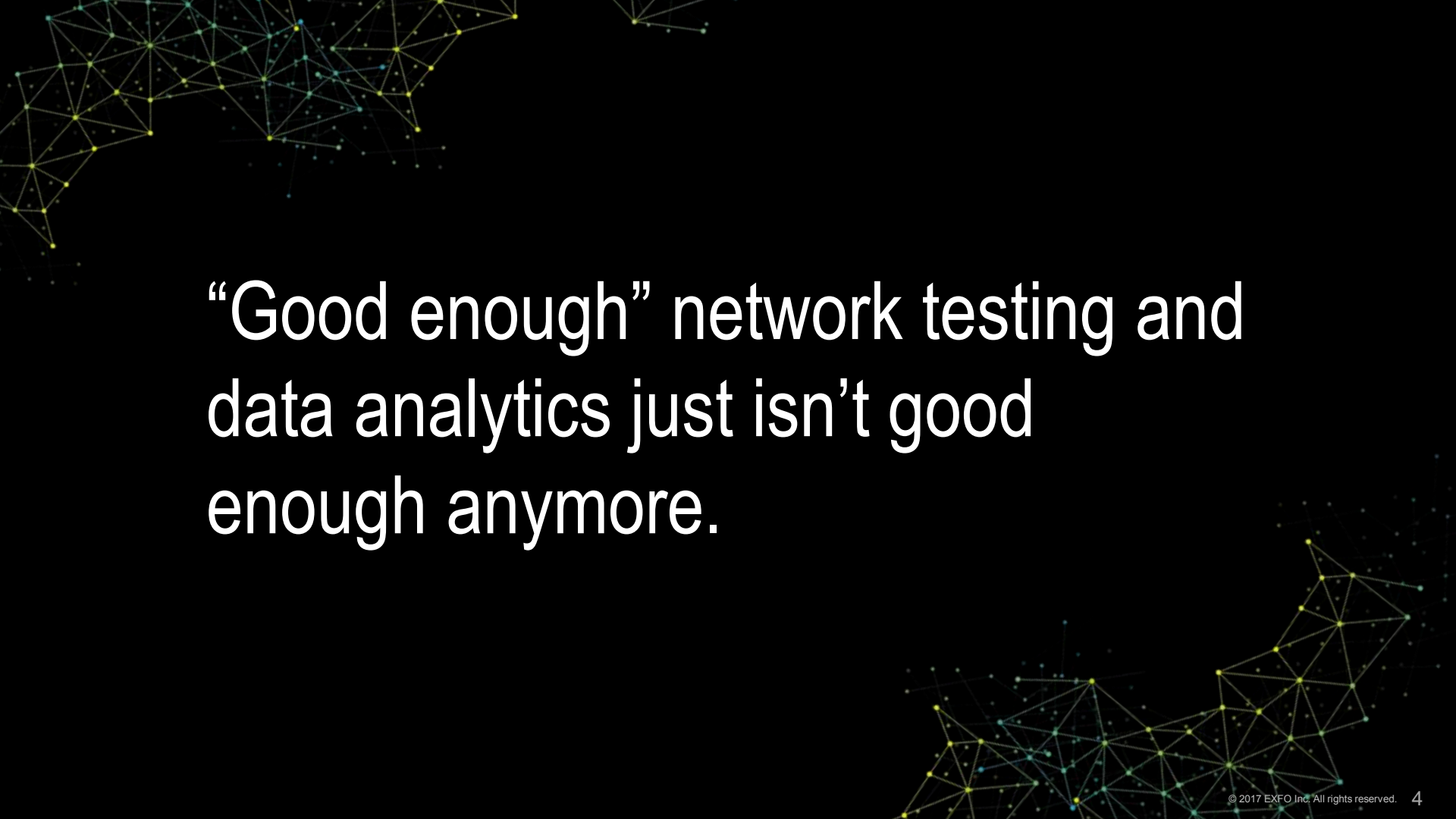
5G, IoT, NFV



Analytics

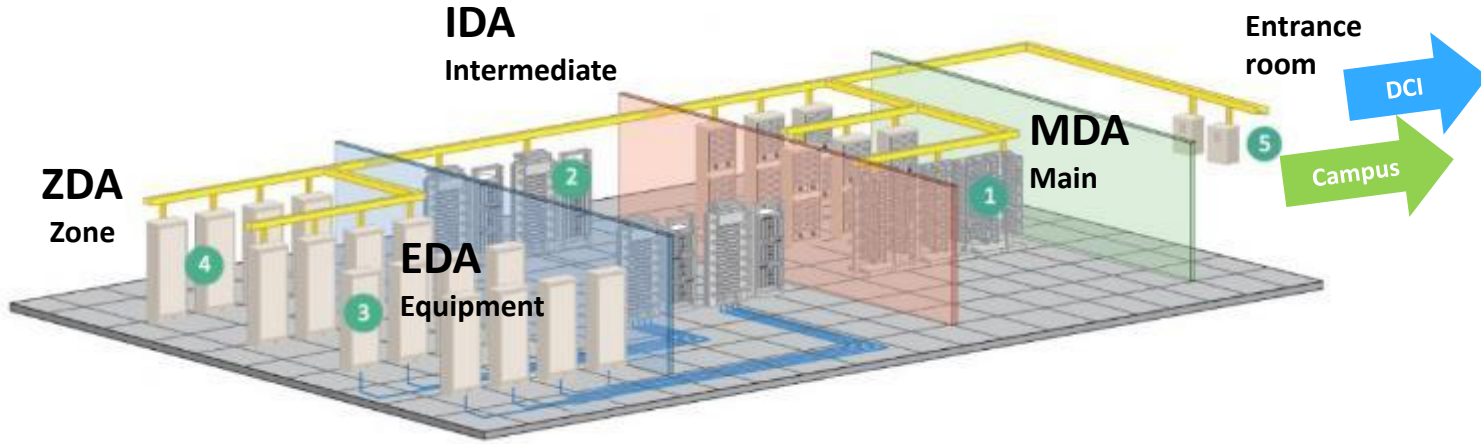


Partnering with you to make your whole network smarter. Our test orchestration and real-time 3D analytics solutions help you adapt, transform, accelerate and excel.

A network diagram background consisting of a complex web of interconnected nodes and lines. The nodes are represented by small dots in yellow, blue, and green, and the lines are thin, light-colored lines connecting these nodes. The network is dense and irregular, with many small clusters and long, thin connections. The overall appearance is that of a data network or a complex system.

“Good enough” network testing and data analytics just isn’t good enough anymore.

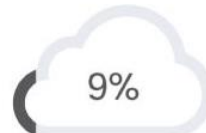
# How fast your Data center needs to scale?



**DC global traffic – 5 ZB 2016/ 10.4 ZB 2019**



Between DC & users



Between Data Center



Within the DC

# Testing: Construction, Maintenance & Upgrades

## ANSI/TIA-568.3-D (07-2016: Circulating for Default

Ballot)

### Optical Fiber Cabling and Components Standard

#### Tier 1

each optical fiber link is measured for its **attenuation with an OLTS**. Fiber length verification may be obtained from cable sheath markings or via the OLTS. **Polarity** can be verified with the OLTS while performing attenuation tests. A visible light source, such as a VFL, can also be used to verify polarity.

#### Tier 2 (Optional)

Tier 2 testing supplements Tier 1 testing with the **addition of an OTDR trace** of the cabling link. **The OTDR trace characterizes elements along a fiber link**, including fiber segment length, attenuation uniformity and attenuation rate, connector location and insertion loss, splice location and splice loss, and other power loss events such as a sharp bend that may have been incurred during cable installation.

## ISO-IEC 11801: 2010 (Ed. 2.2)

### Generic cabling for customer premises

Table B.2 – Test regime for reference conformance and installation conformance – Optical fibre cabling

Transmission parameter	Reference conformance testing	Installation conformance testing
Attenuation	N	N
Propagation delay <sup>a</sup>	I	I
Polarity	N	N
Length	I	I
Connector return loss <sup>b</sup>	N	N

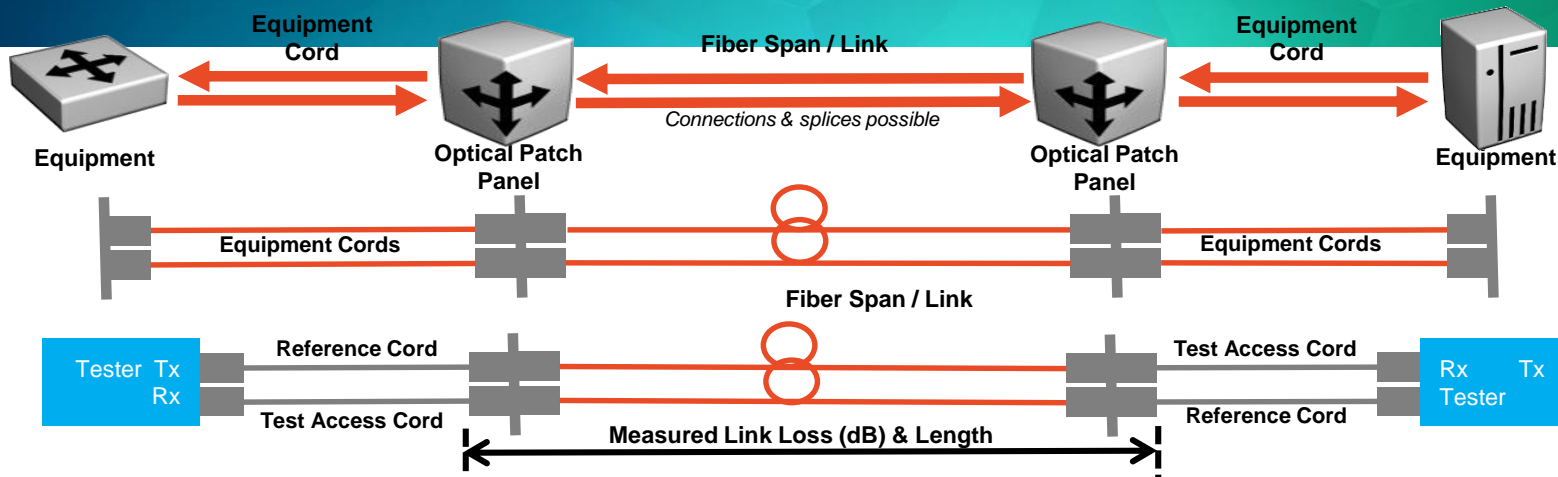
where

- I = Informative (optional) testing.
- N = Normative (100 %) testing.**

<sup>a</sup> Propagation delay is not a pass/fail criterion.

<sup>b</sup> This is a requirement for connecting hardware return loss (see Clause 10).

# Tier 1 Certification Testing Review



- Test loss to pass/fail to maximum link loss budget
- Applies to any point-to-point or passive link
- Link Loss (dB), Length & Polarity check using Tier 1 test set
- Test procedure applies to both multimode and single mode testing
- All test access and reference cords must be reference-grade

**Two very important things to remember**

1.

**IBYC**




2. Reference prior to testing

Tester Tx  
Rx

Reference Cords

Rx Tx  
Tester

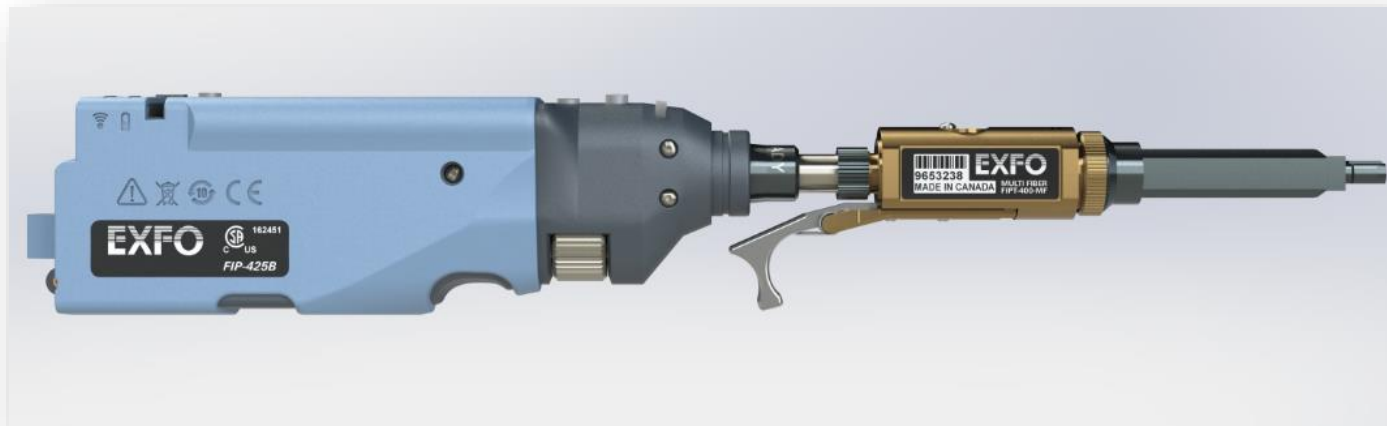
# IBYC EXFO

						
Feature	EXFO FIP-400	EXFO FIP-410B	EXFO FIP-420B	EXFO FIP-430B	EXFO FIP-425B	EXFO FIP-435B
Connectivity	Analog cable	Digital USB	Digital USB	Digital USB	WiFi	WiFi
Compatibility	FTB PC via USB adapter FOT-930	FTB, MaxTester, PC, IQS	FTB, MaxTester, PC, IQS	FTB, MaxTester, PC, IQS	FTB, MaxTester, PC, Android, IOS	FTB, MaxTester, PC, Android, IOS
Analysis	Phase OUT soon	NO	YES	YES	YES	YES
Auto center	NO	NO	YES	YES	YES	YES
P/F indicator	NO	NO	YES	YES	YES	YES
Auto focus	NO	NO	NO	YES	NO	YES



# NEW « FIPT-400-MF » SCANLESS TIP

- › Long Reach for recessed panels
- › Fits in dense panels
- › Extremely easy to use
- › Error free, no risk of skipping a fiber
- › At least 5 times faster than current tips
- › No scanning knobs: Uses a trigger



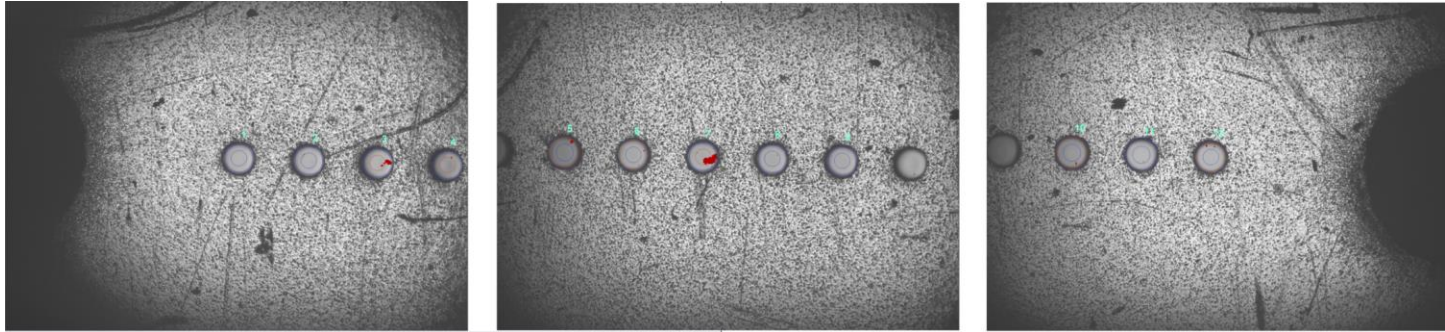
# Tip design

Versatile solution with interchangeable Nozzles:

MPO/UPC, MPO/APC, Optitip MT (male/female) and even Q-ODC-12 (male/female)



- 3 captures for up to 2 rows
- Compatible with 12 or 16 fiber rows
- **From 32 captures to 3**



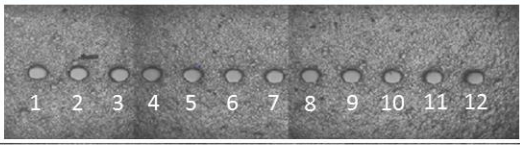
- Each capture will take 3-5 seconds
- Total capture+ analysis target 30 seconds for 12 fibers

# REPORTING

Instant Ferule view:  
Fibers numbered in  
the GUI & Report

### ConnectorMax2 Report

**Overview**



**General information**

Filename:	cab1_Fiber.pdf	Inspection date:	2/17/2016 10:33 AM
Analysis version:	1.8.0.0	Analysis date:	2/17/2016 10:33 AM
Job ID:		Customer:	
Company:		Frame:	

**Locations**

	Location A	Location B
Operator		
Platform S/N	893330 Se	

**FIP Information**

Info.	Value
Model	FIP-435B
Serial number	808559
Firmware version	6.2.0.9

**Identifiers**

Cable ID	Fiber ID	Location A	Location B	Connector ID
cab1	Fiber1 to Fiber4			

**Test Parameters**

Configuration:	IEC SM MF UPC ORL $\geq$ 45 dB (61300-3-35, 1.0) (Standard)		
Connector type:	Multiple fiber	Cladding diameter:	125 $\mu$ m
Fiber type:	Singlemode	Polishing type:	Ultra-polished physical contact
Number of fibers:	4	Analysis mode:	Outside plant

**Results Summary**

Fiber1 (Focus level: Good)

Zones	Criteria ( $\mu$ m)	Thresholds	Count
A - Ferret 0-65 $\mu$ m ✔	0 $\leq$ size < $\infty$	Scratches 0	0
	0 $\leq$ size < 3	Any	0
	3 $\leq$ size < $\infty$	0	0
B - Galvo 65-115 $\mu$ m ✘	0 $\leq$ size < $\infty$	Defects 0	1
	0 $\leq$ size < 3	Any	0
	3 $\leq$ size < $\infty$	0	0

Fiber2 (Focus level: Good)

Zones	Criteria ( $\mu$ m)	Thresholds	Count
A - Ferret 0-65 $\mu$ m ✔	0 $\leq$ size < $\infty$	Scratches 0	0
	0 $\leq$ size < 3	Any	0
	3 $\leq$ size < $\infty$	0	0
B - Galvo 65-115 $\mu$ m ✘	0 $\leq$ size < $\infty$	Defects 0	1
	0 $\leq$ size < 3	Any	0
	3 $\leq$ size < $\infty$	0	0

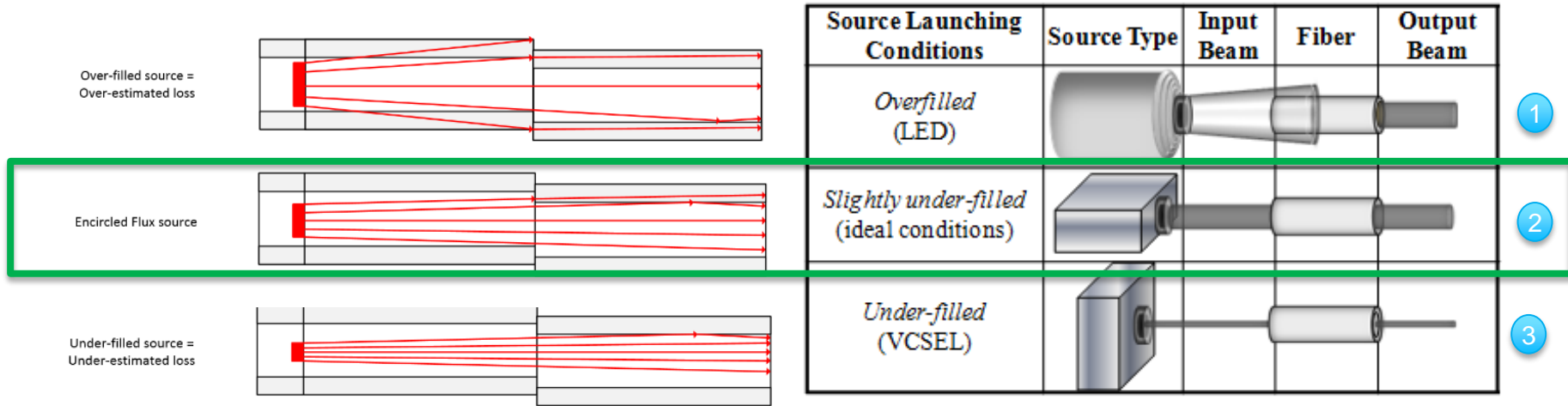
Fiber3 (Focus level: Good)



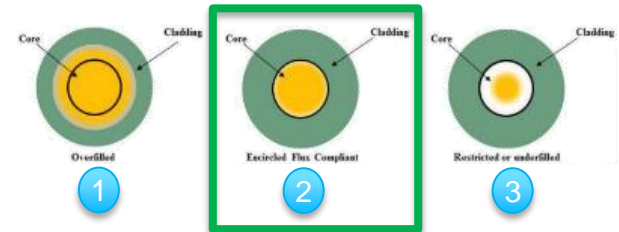
Global P/F Assesement

Detailed  
view for  
each fiber

# Encircled Flux Metric

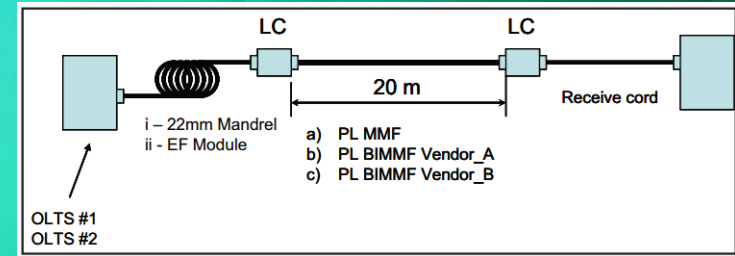
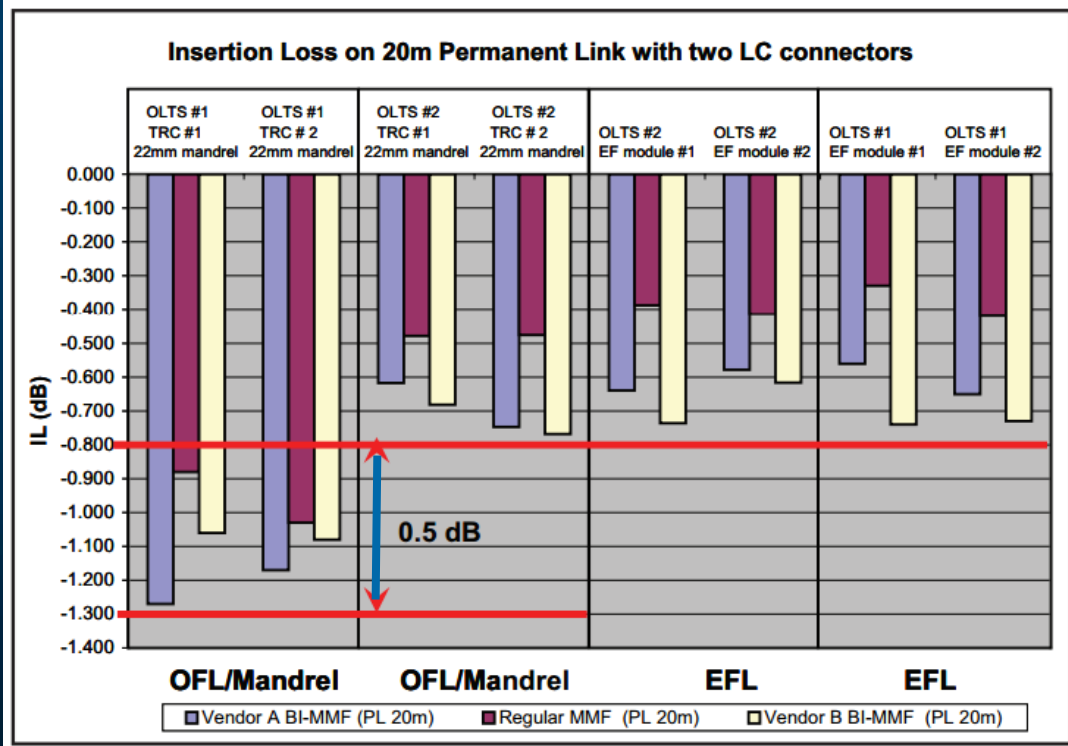


Use EF-compliant instrument and change the reference-grade test jumpers as recommended  
**REPEATABILITY, REPRODUCIBILITY and UNCERTAINTY**



Various source filling conditions

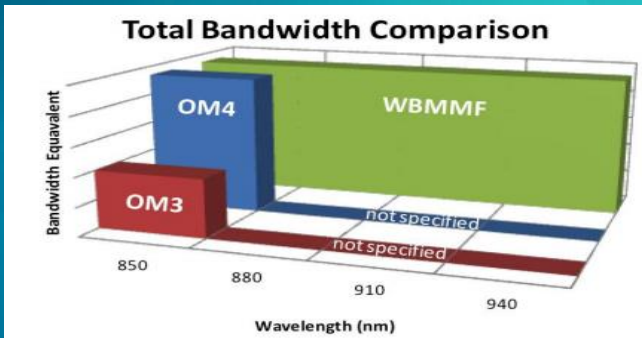
# Encircled Flux Metric vs Mandrel Wrap



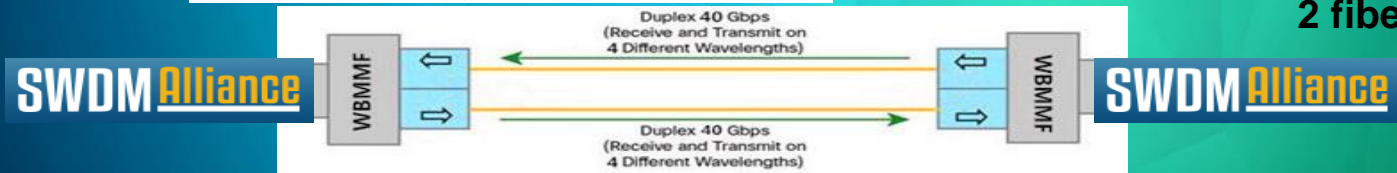
**OFL/Mandrel Wrap per TIA-426- 14-A, Method B**  
**Encircled Flux (EFL) TIA-426-14-B, Annex A**

Source: *Optical loss testing in the field is not as simple as it seems, Belden (2011)*

# Coming to the rescue: WBMMF (SWDM)



## Wideband Multimode Fiber (WBMMF)

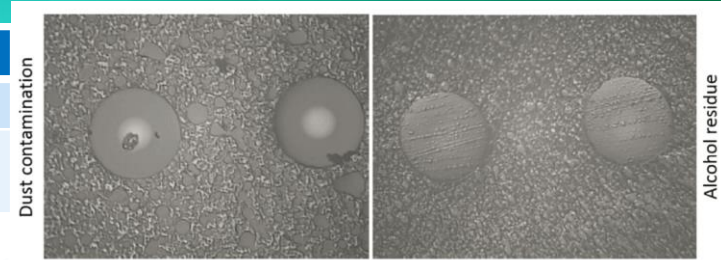


2 fibers at 850 nm  
880 nm  
910 nm  
940 nm

Test parameter	Test vendor advices
Attenuation	<b>Testing 850 nm worst case appears the best practice</b> 850 nm presents higher attenuation than 950 or 1300 nm
ORL / Reflectance	<b>VCSEL is more sensitive to ORL than LED</b> ORL is wavelength independent, not light source independent
Dispersion (Chromatic and Modal)	<b>Expect the smallest differential mode delay (DMD) specs possible for WBMMF</b> Unless stated otherwise by the fiber manufacturer, CD (chromatic) and modal dispersion shall be considered OK by design

# Return Loss: the elephant in the room?

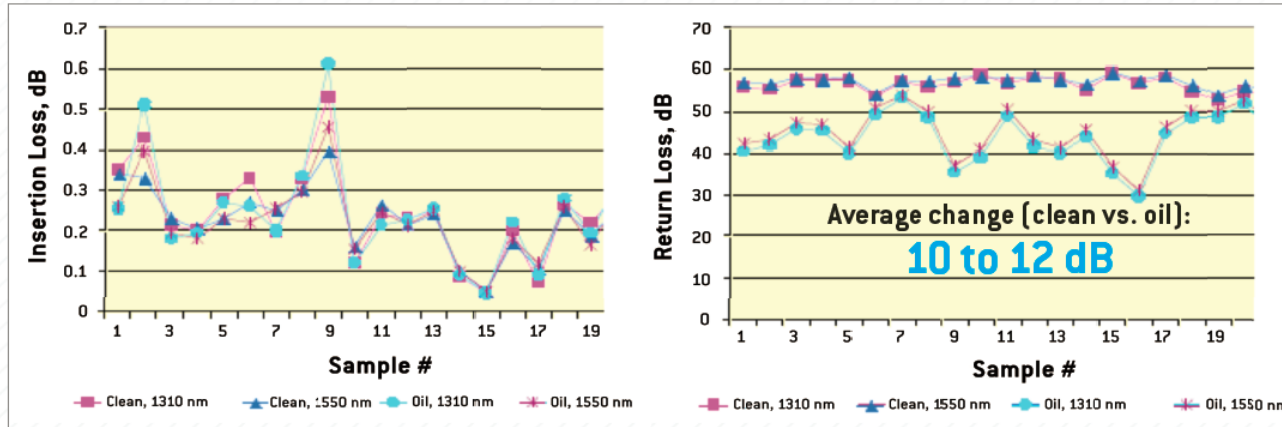
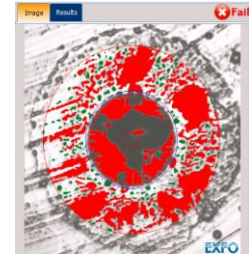
Reflectance	ISO/IEC 11801 (2010)	TIA-568.3-D (2013)	ISO-IEC 14763-3 (2014)*
MMF	20 dB	20 dB	35 dB
SMF	35 dB UPC	35dB UPC 55 dB analog video	45 dB UPC 60 dB APC



MPO connector

## Oil Contamination

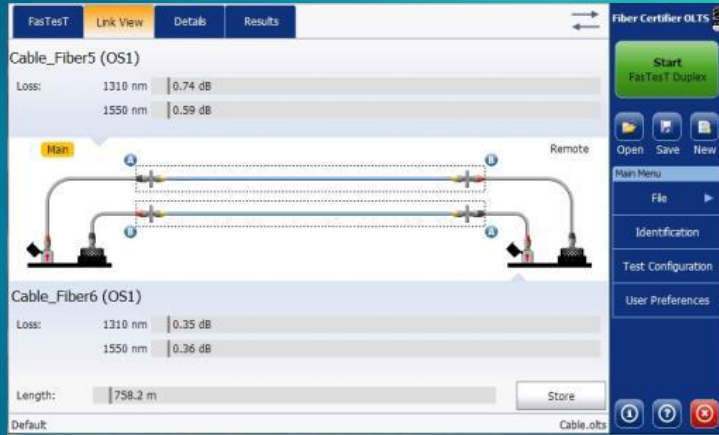
Oil contamination results in major changes to return loss (10 dB to 12 dB), but not insertion loss. However, contamination does lead to significant degradation of bit-error-rate test (BERT) performance.



Source: EXFO Application Note 327 – Touching on Failure: Sources of Fiber Optic Issues in the Data Center, December 2016

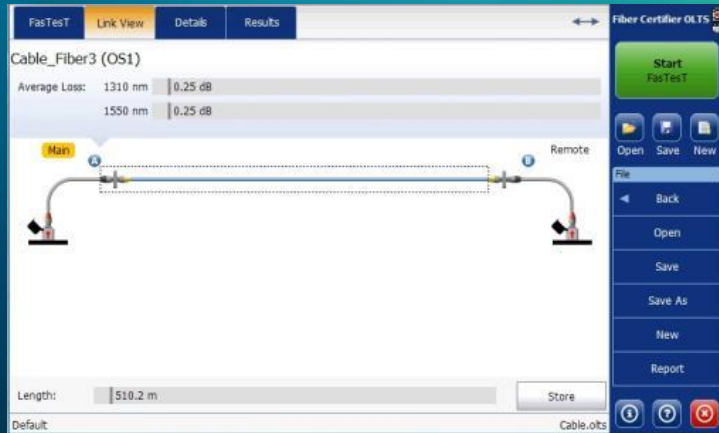


# Simplex vs. Duplex



## DUPLEX Testing

- Two fibers at a time
- FasTesT to Power Meter port
- Enterprise/DataCenter approved method
- Available in SM and MM



## SIMPLEX Testing

- One fiber at a time
- FasTesT to FasTesT port
- TelCo approved method
- Available in **SM ONLY**

# OLTS FTBx-94X



- Same model range as the MAX-94X
- Compatible with the FTB-2/FTB-2PRO platform
- Available in stand alone purchase or in TK-2x kits
- Target customers include
  - FTB-2 users
  - Looking for modularity
  - Looking for advanced optics, T/D and other applications



MaxTester  
94x OLTS

# MAX-945iCERT OLTS: Link Certif. & Screening

MAX-945iCERT-QUAD



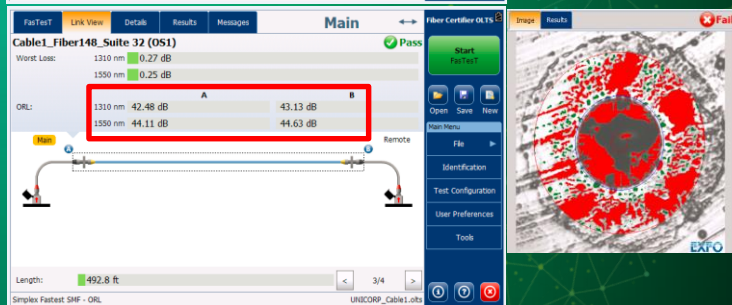
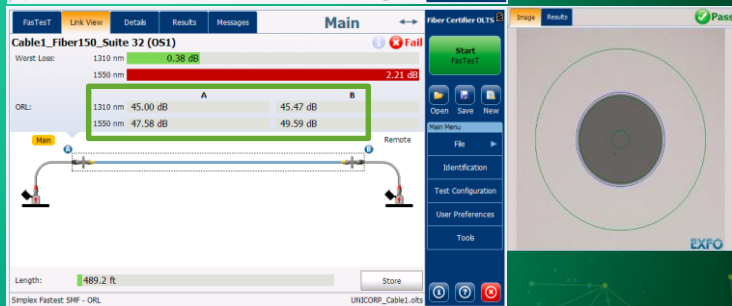
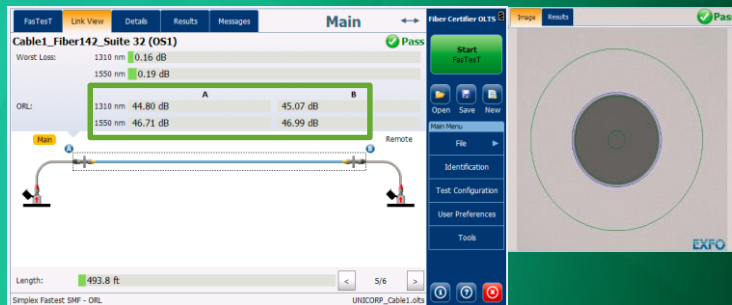
ORL

FasTest  
Simplex

MAX-945iCERT-V-QUAD

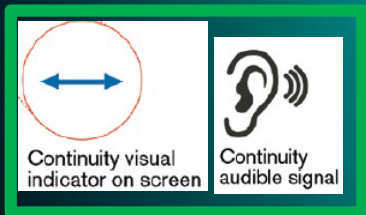
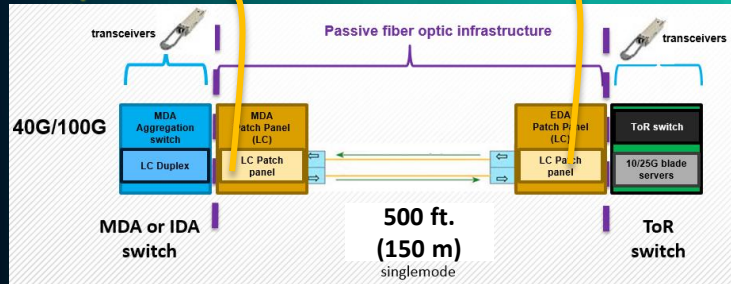


1- OLTS



1- OLTS  
2- iOLM

1- OLTS  
2- FIP  
3- iOLM



Success!



Certification of total loss budget (tier-1)

# Tier 2 Testing

**When** and why is it needed in the Enterprise?

**Primarily during maintenance** as a troubleshooting tool

- OTDRs see the link from beginning to end. It's the only optical test device that can determine if there is a problem with the physical infrastructure, the severity, and where the problem exists.

**Sometimes during construction and link acceptance**

- When network won't turn up initially – troubleshooting cause and location
- Complex networks
  - Lots of connectors or splices
  - Higher speeds more sensitive to loss budget limits and reflections
- Wide Area Networks (longer with many splices and higher speeds)
- Required by customer Service Level Agreement (SLA) as more complete documentation.

# Tier 2 Certification

## Newer test views simplify testing

intelligent Optical Link Mapper (0) Fail

Source iOLM Link View Elements Info Summary

Start Optimode

Open Save Config

Menu Test Config

Back Home

Select...

Manage...

Pos. -39.2 -36.1 0.0 30.3 62.4 94.2 m

Len. 3.2 36.1 30.3 32.1 31.7 m

iOLM		1310 nm	1550 nm
Link loss:		1.517 dB	1.103 dB
Link ORL:		52.49 dB	54.29 dB

Type	Pos. (m)	Loss (dB)		Reflectance (dB)	
		1310 nm	1550 nm	1310 nm	1550 nm
+	0.0	0.447	0.403	-76.5	-73.9

MPO Reference Verification [Fast Short Link] Filename: 23\_1550

### OTDR versus iOLM

**OTDR**

- Proper setup?
- Multiple shots may be required.
- Must have interpretation expertise.

**iOLM**

- Dynamic multiplexed acquisitions
- Intelligent trace analysis
- Collapse all results into a single link view
- Display clear Pass/Fail with comprehensive diagnosis

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Results Identification Summary Thresholds

**iOLM Config**

Results	Test Parameters	Test Settings	Link Definition
	OptiMode: None	IOR (850 nm): 1,490000	Fiber type
	iCert: No	Backscatter (850 nm): -66,30 dB	Number of connections: ---
		IOR (1550 nm): 1,468325	Number of splices: ---
		Backscatter (1550 nm): -81,87 dB	No custom element: 0
		Core size: 9 µm	Splitter ratio stage 1: None
		Method: Standard	Splitter ratio stage 2: None
			Splitter ratio stage 3: None

SOR Custom Pulse Editor

Pulse: 20 µs

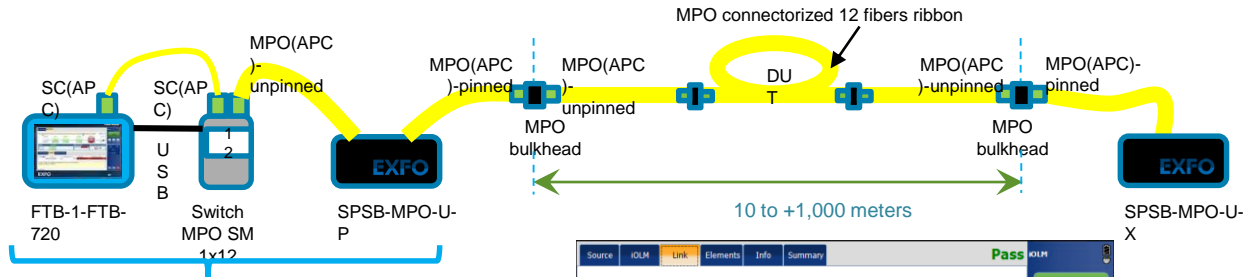
Acquisition time: 50 s

Note: This function allows you to specify a pulse width in your iOLM configurations. This pulse width will be applied when exporting files to the OTDR Before (sor) format in the iOLM application.

OK Cancel

SOR Pulse Editor...  Use 2-N Splitter Custom Elements...

# OTDR-iOLM – MPO TEST KIT SM 1X12



SPSB-MF (MTP) SWITCH-MF (MTP) FTB-1V2-730-SM

#	Filename	Link Length (km)	Link Loss (dB)	Link ORL (dB)
1	6_1550_01.iolm	0.0228	1.691	58.60
2	6_1550_02.iolm	0.0222	1.447	58.17
3	6_1550_03.iolm	0.0241	1.086	58.47
4	6_1550_04.iolm	0.0228	1.135	57.95
5	6_1550_05.iolm	0.0247	0.851	59.11
6	6_1550_06.iolm	0.0247	1.160	57.63
7	6_1550_07.iolm	0.0234	0.598	58.68
8	6_1550_08.iolm	0.0241	1.363	57.97
9	6_1550_09.iolm	0.0234	1.620	57.43
10	6_1550_10.iolm	0.0183	0.733	57.55
11	6_1550_11.iolm	0.0234	1.029	57.40
12	6_1550_12.iolm	0.0247	1.178	58.29

- ❑ **Test in sequence individual fibers of MPO connectorized cable**, inside or outside the data center.
- ❑ **Leverage the power of iOLM / OTDR** and locate precisely faults and connectors' reflectance
- ❑ *Multimode MPO Switch 1x12 on the roadmap*

intelligent Optical Link Mapper (0)

Source iOLM Link View Elements Info Summary Fail

Launch cable calibration: **Within thresholds**

#	Filename	Link Length (m)	Link Loss (dB)		Link ORL (dB)	Worst value
			1310 nm	1550 nm		
1	23_1550 + 1310_01.iolm	62.1	1.073	1.032	51.87	✓
2	23_1550 + 1310_02.iolm	62.1	0.911	0.957	51.83	✓
3	23_1550 + 1310_03.iolm	62.1	0.766	0.816	51.78	✓
4	23_1550 + 1310_04.iolm	62.1	0.627	0.663	51.72	✓
5	23_1550 + 1310_05.iolm	62.1	0.656	0.785	51.77	✓
6	23_1550 + 1310_06.iolm	62.1	0.905	0.620	51.79	✓
7	23_1550 + 1310_07.iolm	62.1	0.536	0.384	51.79	✓
8	23_1550 + 1310_08.iolm	62.1	0.515	0.361	51.71	✓
9	23_1550 + 1310_09.iolm	62.1	0.842	0.599	51.74	✓
10	23_1550 + 1310_10.iolm	62.1	0.829	0.524	51.64	✓
11	23_1550 + 1310_11.iolm	62.4	1.517	1.103	52.49	✓
12	23_1550 + 1310_12.iolm	62.1	1.626	1.418	52.22	✗

Start Optimize

Open Save Config.

... Menu | Test Config.

Back Home

Select...

Manage...

Link Length  
 Total link loss  
 Link ORL  
 Individual connection  
 Insertion Loss  
 Individual connection Return  
 Loss  
 Pass/Fail diagnostic

✓ 11
✗ 1

MPO Reference Verification [Fast Short Link]

intelligent Optical Link Mapper (0)

Source iOLM Link View Elements Info Summary Fail

62.4 m

Type	Pos. (m)	Loss (dB)	Reflectance (dB)
	-39.2	-0.035	0.001
	-36.1	2.411	3.063
	0.0	0.447	0.403
	30.3	0.370	0.169
	62.4	0.688	0.530
	94.2	---	---

Type	Pos. (m)	Loss (dB)		Reflectance (dB)	
		1310 nm	1550 nm	1310 nm	1550 nm
	0.0	0.447	0.403	-76.5	-73.9

iOLM		1310 nm	1550 nm
Link loss:		1.517 dB	1.103 dB
Link ORL:		52.49 dB	54.29 dB

MPO Reference Verification [Fast Short Link]

Filename: 23\_1550 + 1310\_11.iolm

Start Optimize

Open Save Config.

... Menu | Test Config.

Back Home

Select...

Manage...

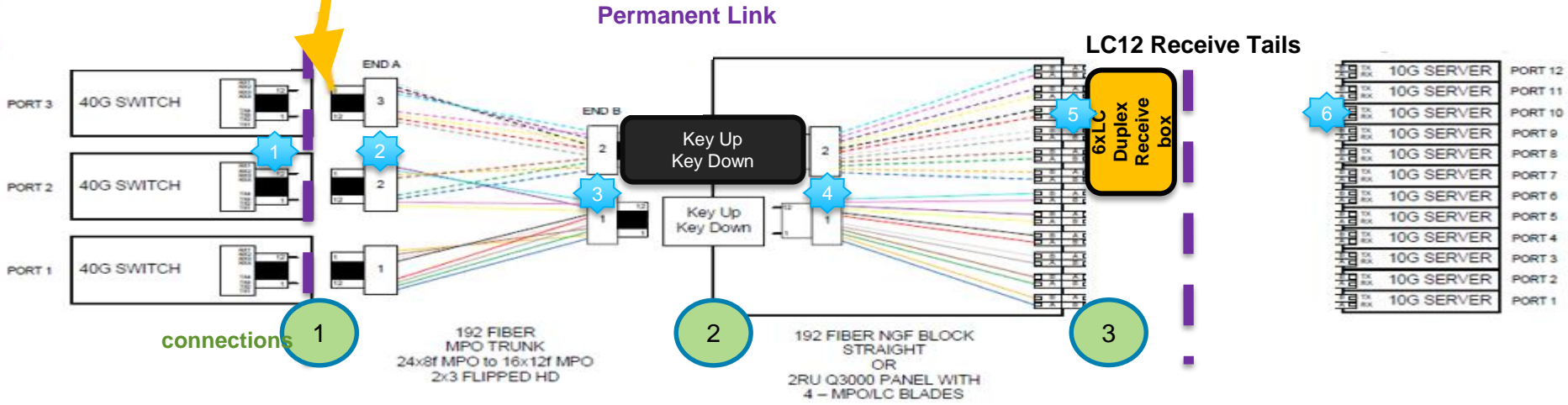
Info Help Fail

# MTP/MPO12-LC Link Measurement

MPO12 Launch Leads



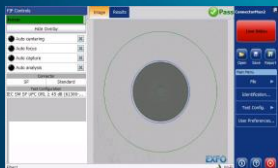
FIP test points



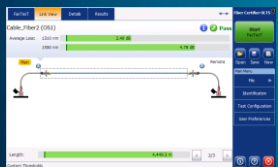


# Main application

## OLTS & OTDR/iOLM for Construction/Maintenance



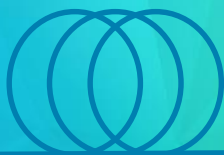
Connector Inspection



OLTS



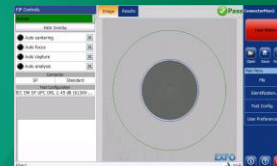
MaxTester  
94x OLTS



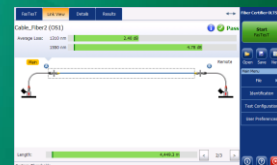
Link under test



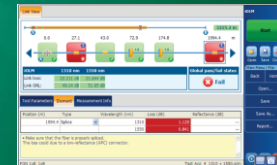
TK-1v2 Combo



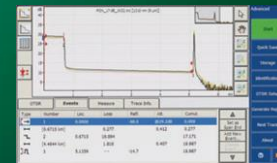
Connector Inspection



FasTesT OLTS



iOLM



OTDR

# FTB-2: Multilayer testing

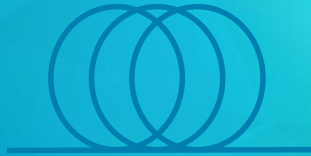
Physical, Optical, Transport, etc.



Connector Inspection



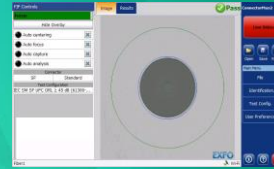
MaxTester  
94x OLTS



Link



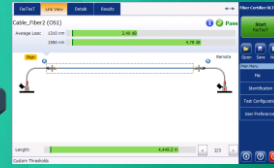
FTB-2 (PRO)



Connector Inspection



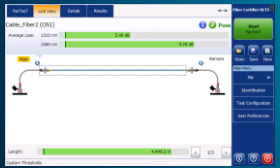
Optical Spectrum



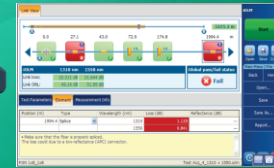
FasTesT OLTS



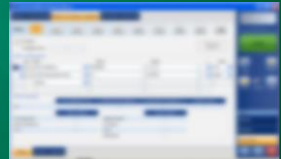
100G Analyzers



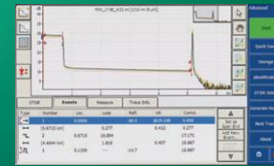
OLTS



iOLM



Future modules...



OTDR

# Factors affecting uncertainty (instruments)

Light Source / Power Meter (OLTS)	OTDR
<ul style="list-style-type: none"> <li>Source drift after referencing</li> <li>Reference test jumpers conditions</li> <li>LSPM vs OLTS (coupler PDL)</li> <li><b><i>Respect calibration period and change your test jumpers...</i></b></li> </ul>	<ul style="list-style-type: none"> <li>Ideal LSPM vs OTDR (same for SM, slight difference for MM)</li> <li>OTDR loss linearity (vs loss uncertainty)</li> <li>Launch vs receive fiber geometry (different backscattering ratio)</li> <li>Noise on trace (vs pulse, vs averaging time)</li> <li>Trace recovery (vs reflectance, vs length of receive fiber)</li> <li>Echos</li> <li>Trace analysis/ event detection robustness</li> </ul>

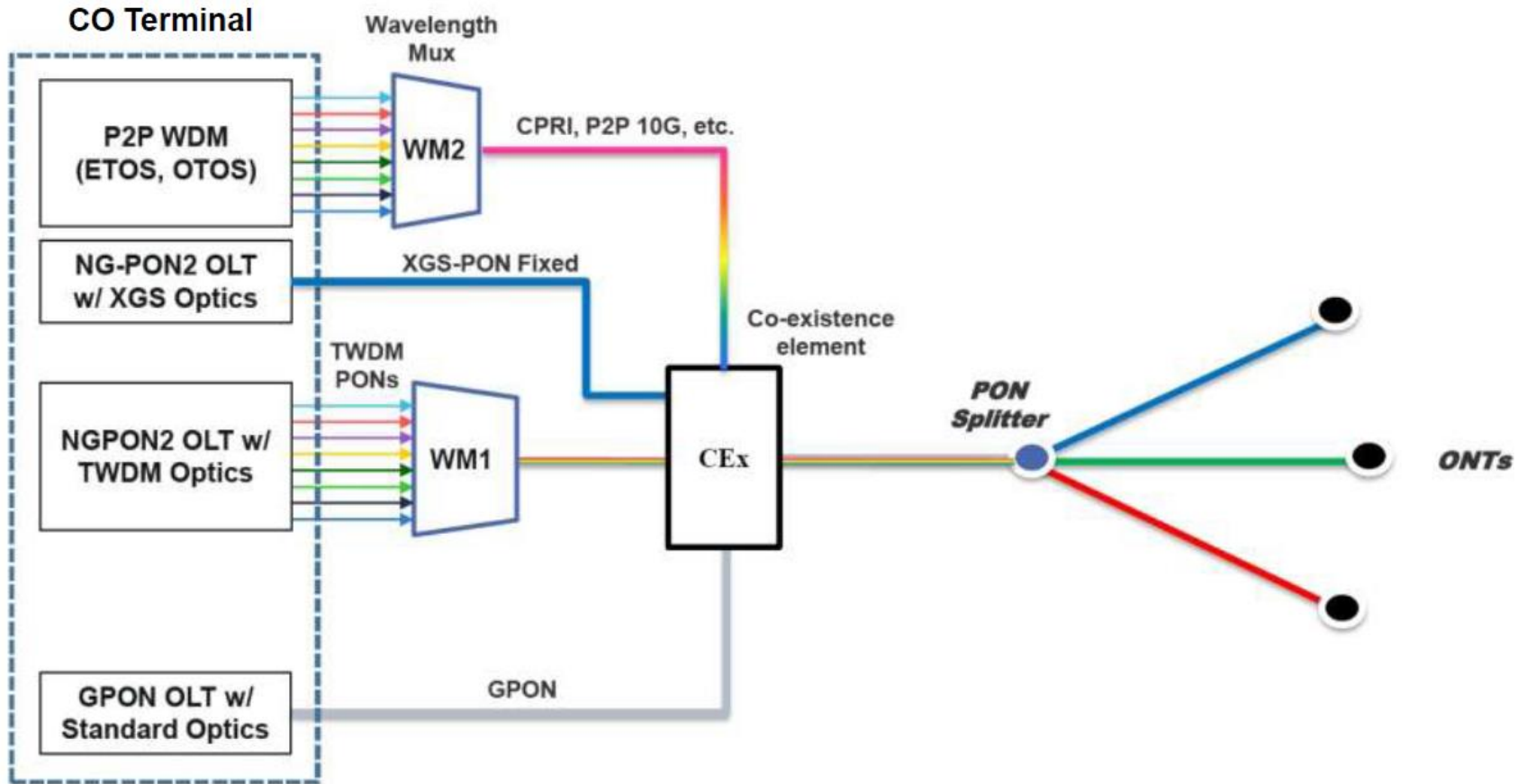
The example below is given for a MM loss measurement using a 1-cord reference, at **850 nm** for a link of **300 m** with a total loss of **1.6 dB**

Uncertainty contributor	Value	Comment
Light source instability	+/- 0.05 dB	Typical instability of a light source as per IEC 61282-14
Light source wavelength	Spectral loss dependence for <b>300 m</b> at 850 nm +/- 30 nm	Light source wavelength tolerance specified as per ISO/IEC-14763-3 (2014)
MM Launch condition	+/- 10 % X <b>1.6 dB</b> (850 nm)	For Encircled Flux compliant source
Mating reproducibility	+/- 0.1 dB	As per IEC 61282-14
Reference connector repeatability	+/- 0.05 dB	As per IEC 61282-14

All contributors are added in a statistical way, with a weight that is dependent on the type of uncertainties, to calculate the total uncertainty. In the example above, the total uncertainty is:

**Uncertainty = +/- 0.27 dB (850 nm).**

# How to apply it to Generic PON architecture

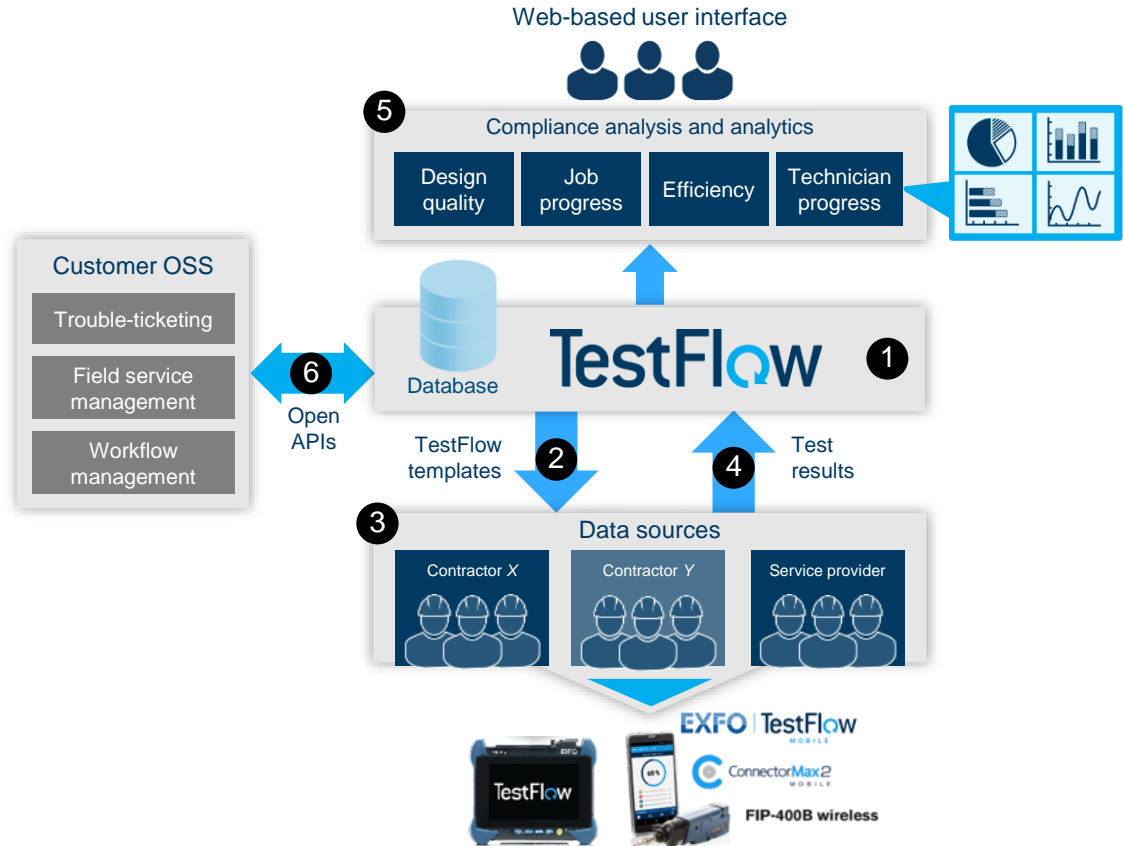


	OSI Model	TCP/IP	Protocol	Test Application	EXFO Tool
<b>Host Layers</b>	<b>Application Layer</b>	<b>Application Layer</b>	<b>DNS, DHCP, FTP, HTTP, SIP ...</b>	<b>Speedtest (Ookla)</b>	<b>Ookla, Verifiers</b>
	<b>Presentation Layer</b>		<b>MPEG, JPEG, TIFF ...</b>		
	<b>Session Layer</b>		<b>PAP, SQL, ...</b>		
	<b>Transport Layer</b>	<b>Transport Layer</b>	<b>TCP, UDP</b>	<b>RFC6349 (TCP/IP throughput, MTU, RTD)</b>	
<b>Media Layers</b>	<b>Network Layer</b>	<b>Internet Layer</b>	<b>IP, ICMP, IGMP, IPv4, IPv6, ...</b>	<b>RFC2544, SAM (Y.1564), OAM (802.1ag, 802.3ah, Y.1731), SyncE G.8262, PTP 1588v2, Rf over CPRI</b>	<b>FTB-870-880-8880-88x00 , BV-3100</b>
	<b>Data Link Layer</b>		<b>Ethernet, ATM, PPP, MPLS, CPRI, OBSAI ...</b>		
	<b>Physical Layer</b>	<b>Link Layer</b>	<b>Media (Fiber, Copper... ) Technology (DSL, WiFi, PON, WDM...) Modulation (DMT, OFDM, TDMA, QAM, PAM)</b>	<b>Copper or Fiber qualification (level, loss, reflectance, ...), Upstream, Downstream, ...</b>	<b>PPM-350, MAX-600(G), MAX-94x, MAX-700, FTB-55/57/5800, FTB-5200, FG-750</b>

# Link Layer trend: Large-scale FTTH deployment

## Key operational efficiency enabler

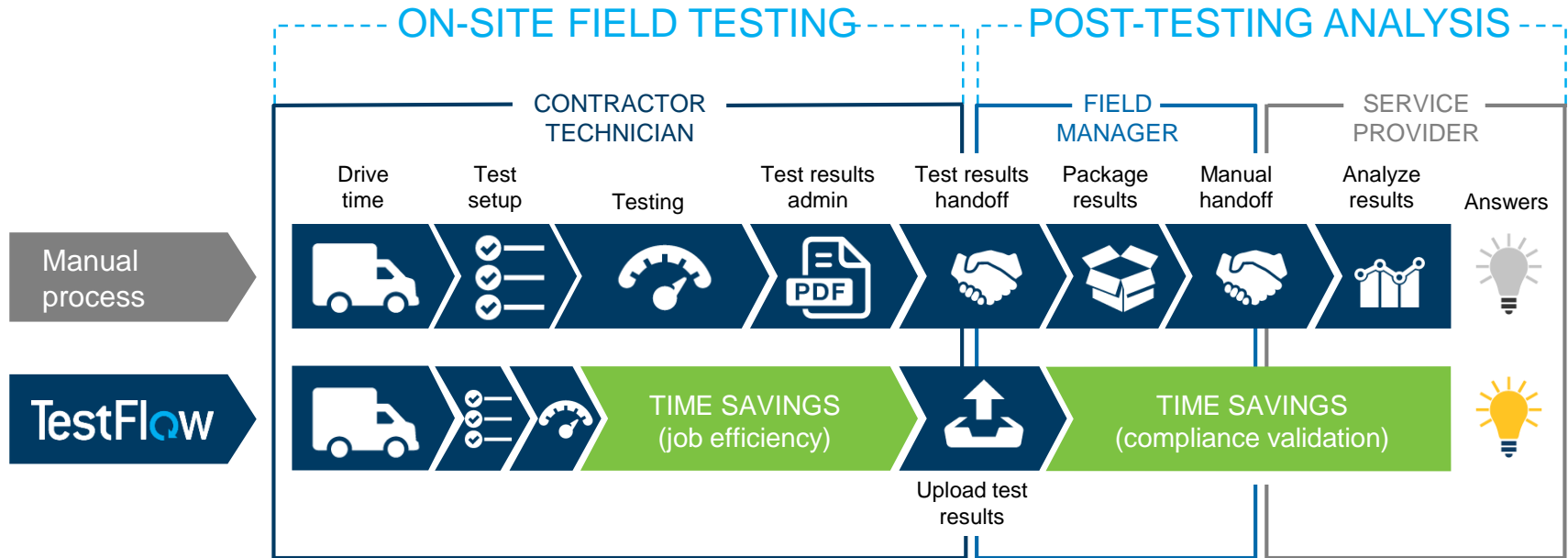
- 1 Create and load intelligent digitized MOP templates onto TestFlow server.
- 2 Distribute templates to test units from TestFlow server.
- 3 Modify and run test sequences (template instances) on test units without the need of other applications or manuals.
- 4 Automatically log test results and upload test-result files to centralized TestFlow server for results-to-metrics processing.
- 5 Analyze key testing metrics from centralized TestFlow database and verify compliance with network design standards.
- 6 Integrate TestFlow server with back-office systems using open application programming interfaces (APIs).



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# Link Layer trend Contractor process conformance

Reducing OPEX and improving performance



# Link Layer trend SmartR—makes copper testing a whole lot easier



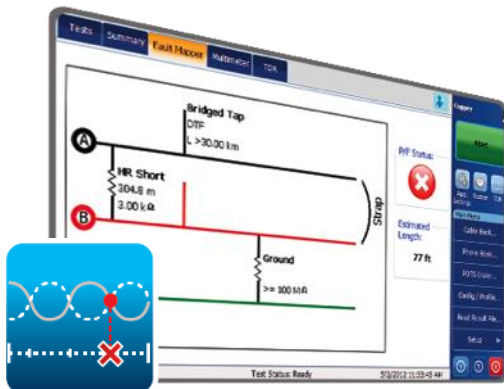
Available for  
MaxTester 600 Series



## Pair detective

Optimized fault identification through automated analysis

Guidance on probable issues for faster and comprehensive interpretation



## FaultMapper

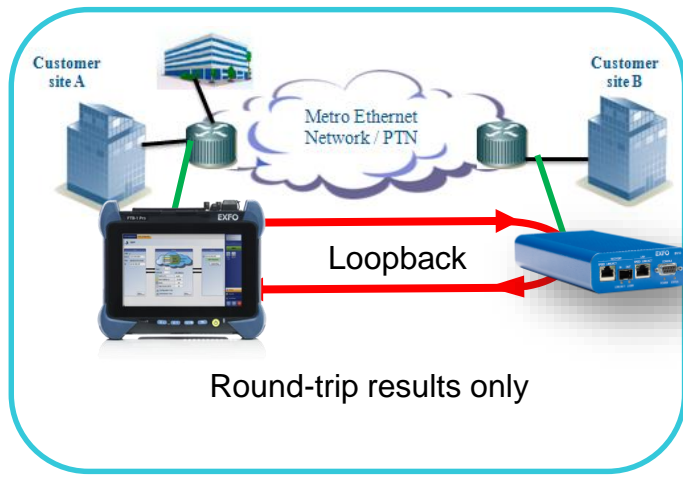
Automated copper pair analysis with fault location

Intuitive schematic/graphical presentation of the copper loop



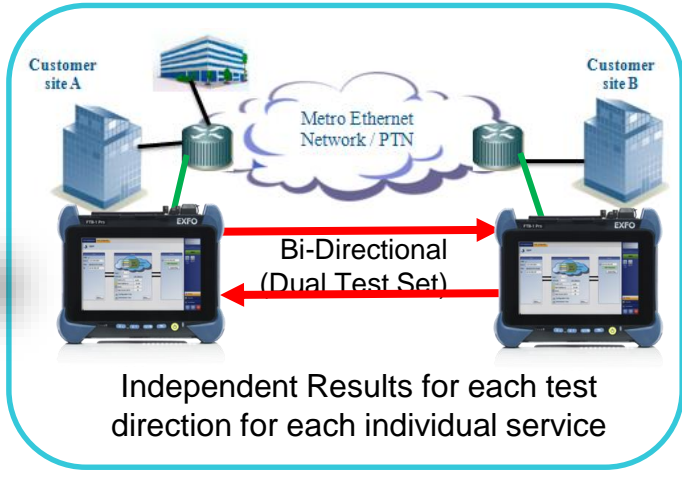
# Internet/Transport Layer trend: Manual Testing Issues with proper testing

Asymmetrical traffic –Need for Dual-Test-Set (aka bi-directional test )



Round-trip results only

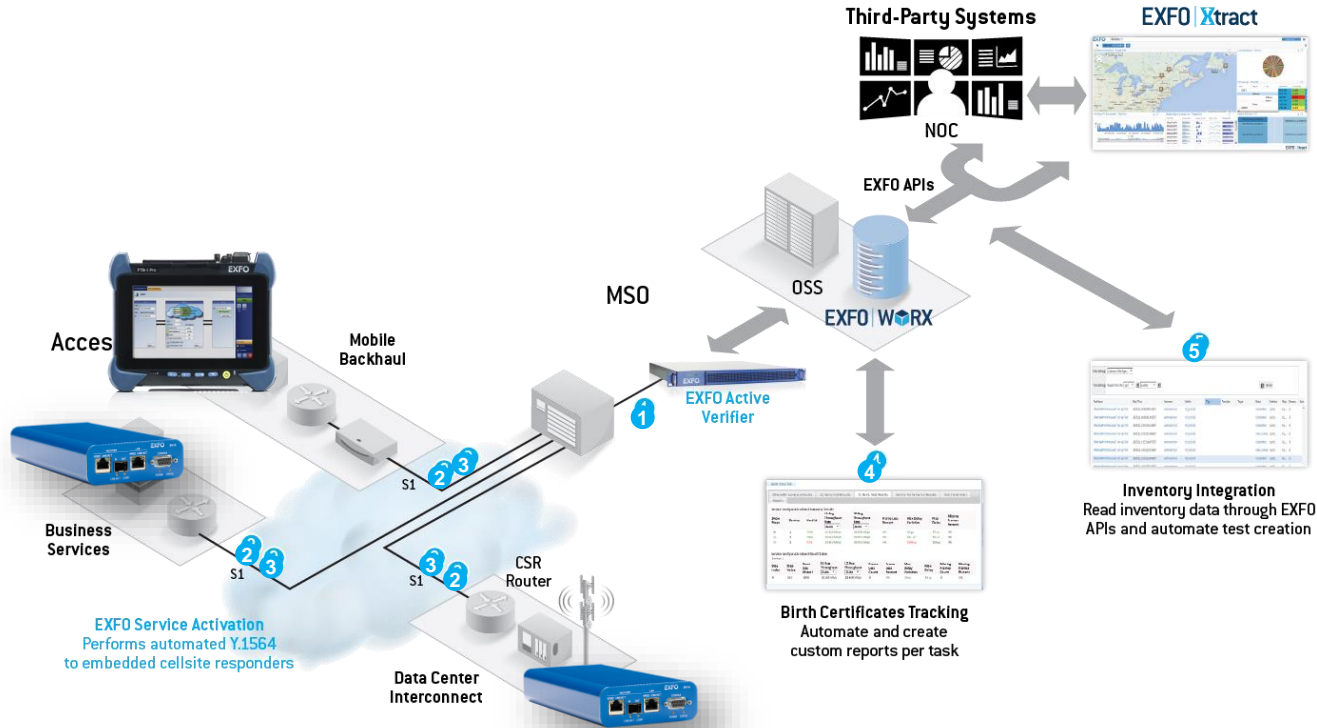
Test Setup 1



Independent Results for each test direction for each individual service

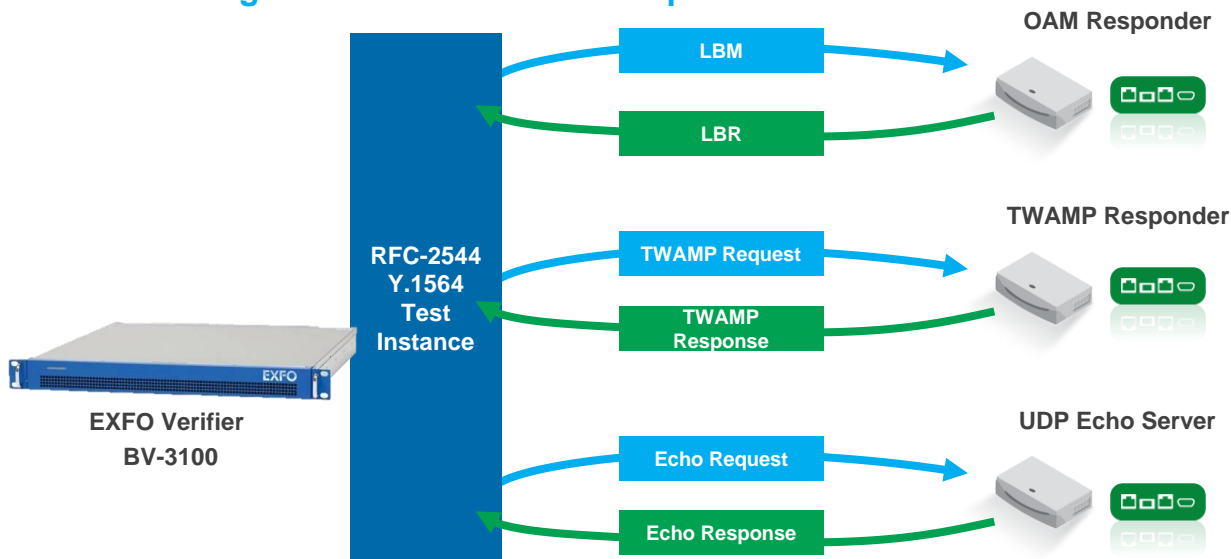
Test Setup 2

# Internet/Transport Layer trend: Centralized Activation



# Internet/Transport Layer trend:—“No Truck-Roll” Activation

## Using OAM/TWAMP/Echo Encapsulation

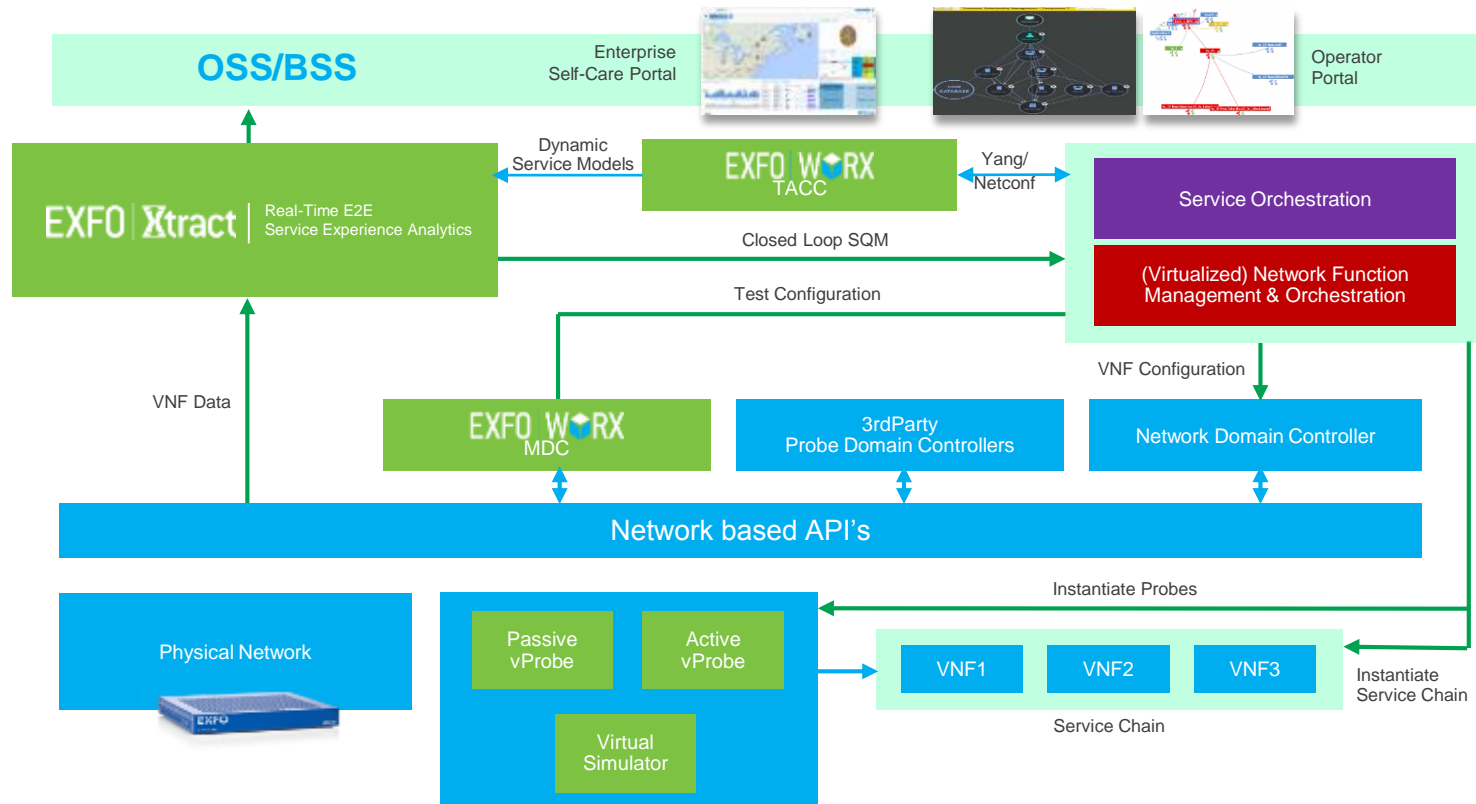


### No-truck-roll activation:

- Leverage standards-based activation to perform turn-up
- Same test/methodologies—just the test packet
- Tested with various NID Vendors, such as RAD, ADVA, TelcoSystems, etc.
- Significantly reduce costs when possible

Note: OAM responder can be software or hardware based. However software-based responder may have performance limitations at high throughput.

# Application Layer EXFO's NFV/SDN Architecture



# DCI Optical Testing/ Physical Layer Requirements

Same guidelines as for telco deployments apply. Some tests are only relevant in certain conditions.

Potential issues	What to test?	Test instrument	When to test?
Dirty and damaged connectors	Connector endface cleanliness	Inspection probe	Always
Broken fiber, dirty connectors, macrobends	OTDR	OTDR/iOLM	Always
Chromatic dispersion	Chromatic dispersion	CD tester	Only links of more than 70-80 km
Polarization mode dispersion	PMD	PMD tester	Only links of more than 10-20 km
Wavelength drift	Channel central wavelength	Optical Spectrum Analyzer	Always
Power drift	Channel power	Optical Spectrum Analyzer	Always
Defective (noisy) amplifiers/ROADMs	Optical Signal-to-Noise Ratio	Optical Spectrum Analyzer	Only when networks include amplifiers/ROADMs

