LEVERAGING HIGH-FIBER COUNT DOCUMENTATION TO AUTOMATE TIER 1-2 TESTING AND REPORTING

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CABLING Installation & Maintenance

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Table of contents

1. Fiber and connector basics
2. Inspection
3. Tier 1 OLTS testing
4. MPO Polarity validation
5. Tier 2 End-to-end certification
6. OLTS and OTDR pros and cons
7. Automation and Reporting
8. Recap

Standards

ANSI/TIA 568.3: OPTICAL FIBER CABLING AND COMPONENTS STANDARD

This American standard covers premise optical fiber cabling, components and test procedures. It specifies cable, connectors, connecting hardware, patch cords and test and measurement. Tier 1 and tier 2 fiber cabling certification and inspection is described alongside recommended test equipment.

ISO/IEC 11801-5: GENERIC CABLING FOR CUSTOMER PREMISES PART 5: DATA CENTERS

This international standard specifies generic cabling within and to the computer room spaces of data center premises, or computer room spaces within other types of building. Additionally, those premises can include office spaces (for which generic cabling is specified in ISO/IEC 11801-2) or industrial spaces (for which generic cabling is specified in ISO/IEC 11801-3).

ANSI/TIA 942: TELECOMMUNICATIONS INFRASTRUCTURE STANDARD FOR DATA CENTERS

The American standard specifies minimum requirements and guidelines for the design and installation of a data center or computer room. It provides a comprehensive understanding of power systems, mechanical systems, architecture, security, cabling systems and network design.

ANSI/BISCI 002: DATA CENTER DESIGN AND IMPLEMENTATION BEST PRACTICES

This American standard features 17 chapters and 9 appendices spread over 550 pages. It covers design methodology and site selection right the way through to network maintenance. The content can be applied to modular, containerized, edge and hyperscale data centers.

Abstract

While multi-fiber connectors are gaining in popularity, they also come with their share of challenges. Especially in a data center context. Ensuring link performance and getting it right the first time is critical.

This session will cover what you need to do to ensure the quality of your links.

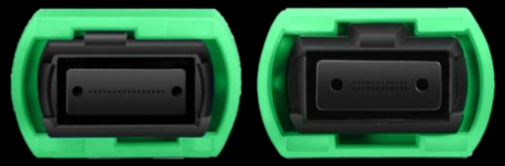
Things are getting tight.

- MPO, MMC, SN-MT, and VSFF connectors support ultra-dense patch panels
- One cable may support thousands of services—testing must be precise and complete
- MPO, MMC, SN-MT, and VSFF connectors support ultra-dense patch panels
- One cable may support thousands of services—testing must be precise and complete

Base 8/12
MPO/MTP® -8/12

1U Rack Density

12 fibers/connector = 864 fibers per 1 RU



Base 16/24 Fiber
MPO/MTP® -24

24 fibers/connector = 1,728 fibers per 1 RU

Base 16/24
MMC-16/24

24 fibers/connector = 6,336 fibers per 1 RU

Source: BICSI Seminar: Changes in structure cabling influenced by AI deployments – USConec & EXFO

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Fiber and Connetor Basics

Color Coding

Connectors

Multimode

- UPC (flat connectors)
- Connector outer housing is aqua blue (OM3)
- Other connector housing color exist depending on the fiber type

Singlemode

- APC (angled connectors)
- Connector outer housing is green or yellow

Multimode = aqua blue

Multimode fiber type	Colors
OM1	
OM2	
OM3	
OM4	
OM5	

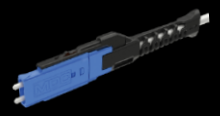
Singlemode = Yellow

OPTICAL FIBER CONNECTIVITY

Duplex

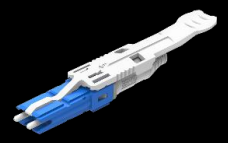
LC
- Lucent connector
- 1.25 mm ferrule
- Also available in simplex

MDC
- VSFF
- 1.25 mm ferrule
- Native duplex



SN
- VSFF
- 1.25 mm ferrule
- Native duplex

CS
- VSFF
- 1.25 mm ferrule
- Native duplex



Base-8/12

MPO-8
- Multi-fiber push on
- Single row 8 fibers
- Alignment pins

MPO-12
- Multi-fiber push on
- Single row 12 fibers
- Alignment pins

MMC-12
- VSFF
- Single row 12 fibers
- Alignment pins

Base-16

MPO-16
- Multi-fiber push on
- Single row 16 fibers
- Alignment pins

SN-MT-16
- VSFF
- Single row 16 fibers
- Alignment pins

MMC-16
- VSFF
- Single row 16 fibers
- Alignment pins

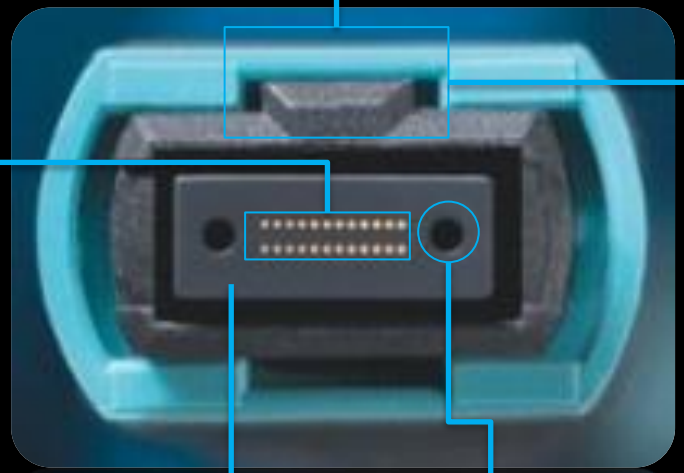
Base-24

MPO-24
- Multi-fiber push on
- Double row 12 fibers
- Alignment pins

SN-MT-24
- VSFF
- Double row 12 fibers
- Alignment pins

MMC-24
- VSFF
- Double row 12 fibers
- Alignment pins

MPO Connector



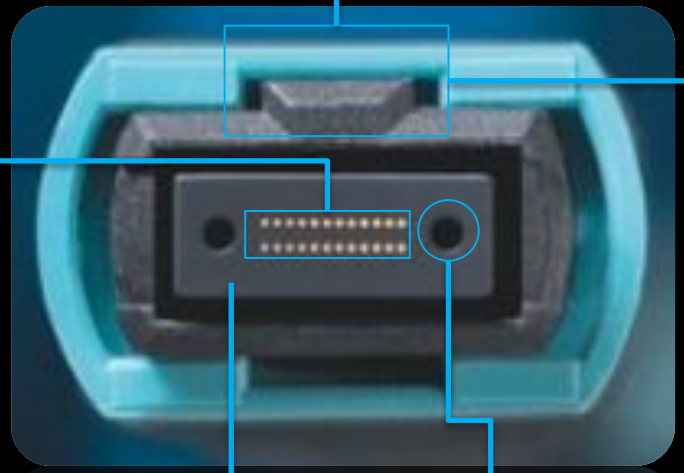
MPO 8, 12 & 24 connectors

Key is centered

MPO 16 & 32 connectors

Key is on the side

MPO Connector



MPO 8, 12 & 24 connectors

Key is centered

MPO 16 & 32 connectors

Key is on the side

Migration to Parellel Optics

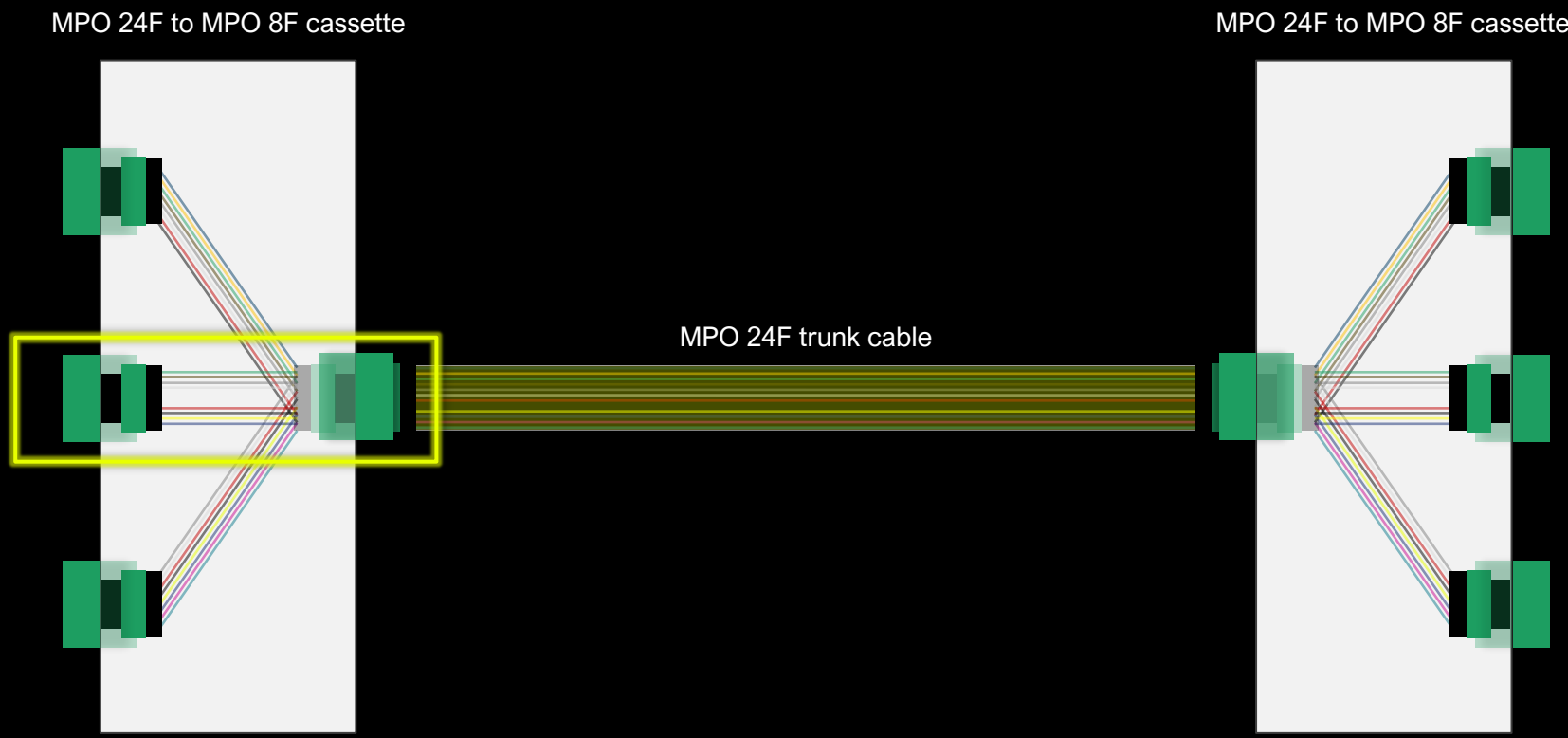
High Parallel Speed Optics

Name	Standard	Release	Form Factor	Wavelengths (nm)	Transmission Type	Fiber Type	Max Distance (m)	Max Loss (dB)	Fiber Count	Connector Type
100GBASE-SR2	IEEE 802.3cd	2018	QSFP56	850	Parallel	OM3	70	1.8	4	MF Base-4
100GBASE-SR2	IEEE 802.3cd	2018	QSFP56	850	Parallel	OM4	100	1.9	4	MF Base-4
100GBASE-PSM4	PSM4 MSA	2015	QSFP28	1310	Parallel	OS2	500	3.5	8	MF Base-8
200GBASE-DR4	IEEE 802.3bs	2017	QSFP56	1310	Parallel	OS2	500	3	8	MF Base-8
200GBASE-SR4	IEEE 802.3cd	2018	QSFP56	850	Parallel	OM3	70	1.8	8	MF Base-8
200GBASE-SR4	IEEE 802.3cd	2018	QSFP56	850	Parallel	OM4	100	1.9	8	MF Base-8
400GBASE-DR4	IEEE 802.3bs	2017	QSFP-DD	1310	Parallel	OS2	500	3	8	MF Base-8
400GBASE-SR8	IEEE 802.3cm	2020	QSFP-DD	850	Parallel	OM3	70	1.8	16	MF Base-16
400GBASE-SR8	IEEE 802.3cm	2020	QSFP-DD	850	Parallel	OM4	100	1.9	16	MF Base-16
800GBASE-DR8	IEEE 802.3df	2024	OSFP/QSFP-DD800	1310	Parallel	OS2	500	3	16	MF Base-16
800GBASE-DR8-2	IEEE 802.3df	2024	OSFP/QSFP-DD800	1310	Parallel	OS2	2000	3.5	16	MF Base-16
800GBASE-SR8	IEEE 802.3df	2024	OSFP/QSFP-DD800	850	Parallel	OM3	70	1.7	16	MPO-16
800GBASE-SR8	IEEE 802.3df	2024	OSFP/QSFP-DD800	850	Parallel	OM4	100	1.8	16	MF Base-16
800GBASE-VR8	IEEE 802.3df	2024	OSFP/QSFP-DD800	850	Parallel	OM3	30	1.6	16	MF Base-16
800GBASE-VR8	IEEE 802.3df	2024	OSFP/QSFP-DD800	850	Parallel	OM4	50	1.7	16	MF Base-16
1.6TBASE-DR8 (future)	IEEE 802.3dj (draft)	2025	OSFP-XD	1310	Parallel	OS2	500	3.5	16–32	MF Base-16/32

Migration to parallel optics

Migration to parallel optics

Migration to parallel optics



Fiber Inspection

Why is inspecting multi-fiber connectors even more important?

#1

cause of network failures is contaminated connectors

80%

of networks have connector issues

Disposing and replacing MPO jump cables is expensive

Multi-fiber connectors have greater impact as a single bad connector impacts multiple links

Cleaning an MPO connector when not needed can make it worse

BER, performance and reliability of networks are directly impacted by bad connectors

High speed networks are more sensitive to contamination

Inspecting guarantees quality and avoids plug and pray

What is a Fiber Inspection Probe ?

FIP = Fiber Inspection Probe
Also called Fiber Inspection Scope

FIP-500 Probe

Definition:
A FIP is a specialized microscope that :

1. Takes a picture of the small connector end-face,
2. Locates and measures all defect and scratches found on the connector end-face
3. Applies industry standard thresholds
4. Gives a clear Pass/Fail status on the quality of the connector end-face

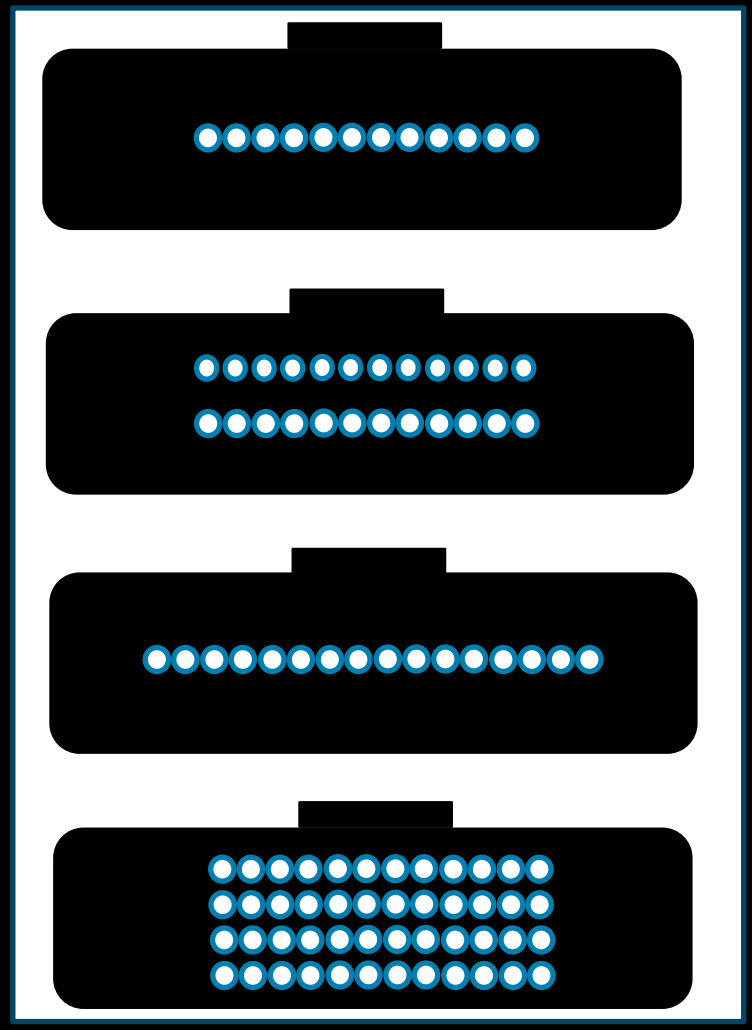
MPO Inspection results

MPO connectors

- Come in various fiber configurations
- Various fiber count in rows: 8, 12, 16, etc
- Single or multiple rows: 1, 2, 4

Multiplies the occurrence of damaged or dirty fibers

Multiplies possibilities of a failing link/channel



Connector Inspection

1

LC

CS

SN

MDC

2

MPO-8/12

3

MPO-16

SN-MT

MMC

4

MPO-24

SN-MT

MMC

Tier 1 Testing
OLTS

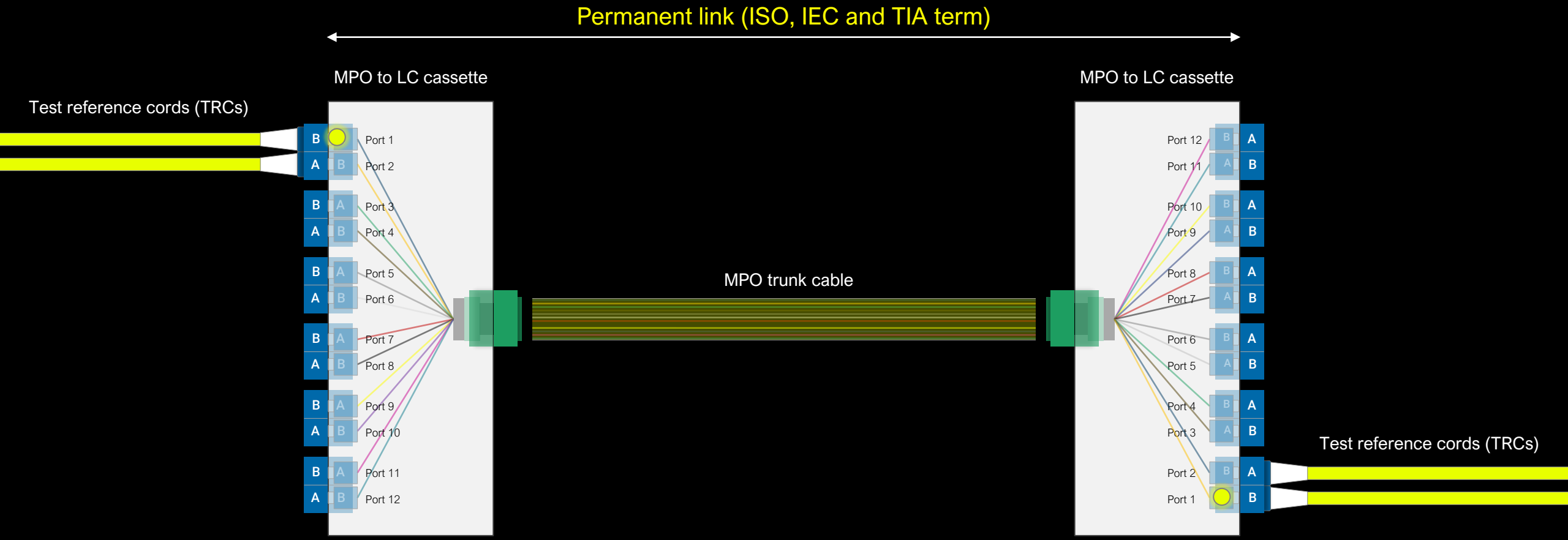
Tier-1 testing definition

TIA-568 : Optical Fiber Cabling and Components Standard

- Testing installed optical fiber cabling for attenuation with an optical loss test set (OLTS), as described in cabling standards, and verifying the cabling length and polarity constitutes Tier 1 testing.
- An OLTS includes an optical power meter to measure received optical power and a light source that closely resembles a system transmitter (e.g., an LED for multimode optical links, a laser for single-mode optical links). An OLTS may be a single instrument or separable optical power meter and light source.

PXM-LXM MF OLTS

Tier 1 certification testing on LC ports



Tier 1 certification testing on LC

Fiber type

Cabling standard

Link details

CONNECTORS, SPLICES

Source: ANSI/TIA (2016) TIA-568.3 Optical fiber cabling and components standard

Tier 1 certification testing on LC

SET REFERENCE
USING
1 CORD RTM

STEP 1

STEP 2

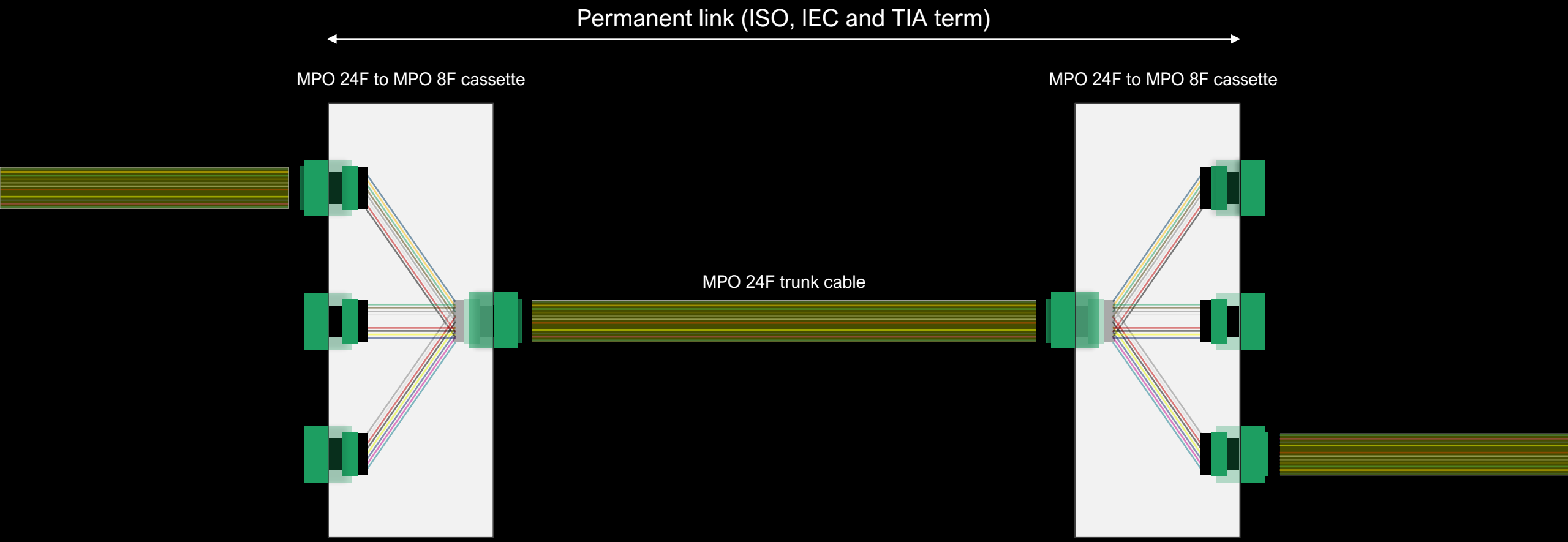
Tier 1 certification testing on LC

LOW LOSS

PASS

WILL SUPPORT
HIGH SPEED
100/200/400G

Tier 1 certification testing on MPO 8/12F

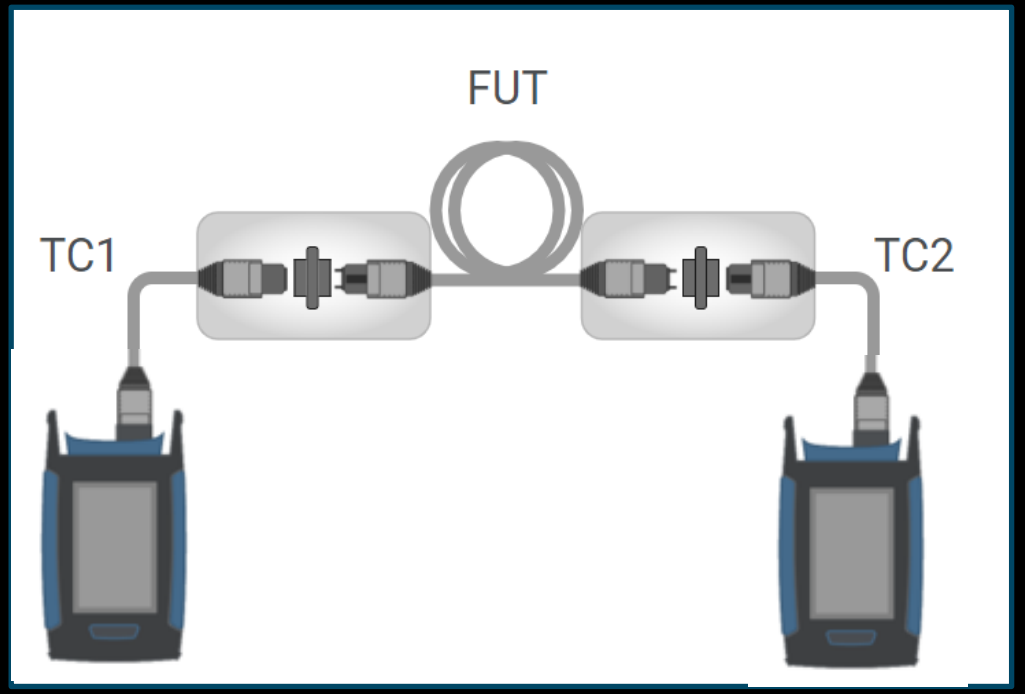


Tier 1 certification testing on Multi-Fiber

MPO power meter and light source for Tier-1 testing

Testing with a MPO power meter and light source provides:

1. Insertion loss per channel
2. Continuity validation
3. Polarity type confirmation
4. Fiber length



MPO Light Source MPO power meter

MPO Polarity Validation

30%

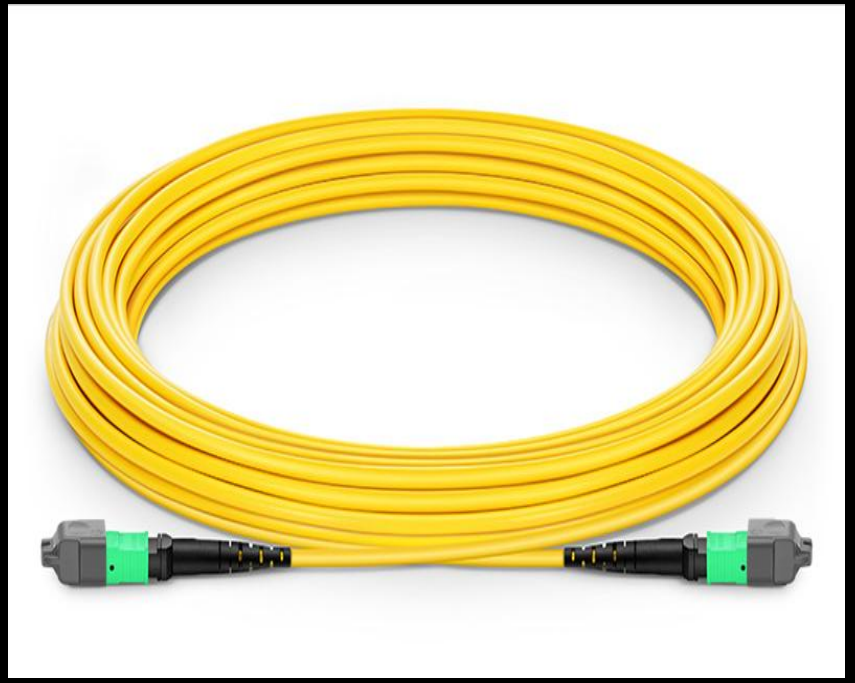
of MPO-cable users report that determining polarity type is confusing

- Navigating MPO waters: 2018 survey

Polarity validation

Considerations

- Polarity type refers to different possible fiber paths within multifiber cables
- Critical to ensure proper connectivity
- Polarity validation can change within the optical path
- Good practice: validate MPO jumper polarity as well as the fiber link itself



Regardless of polarity type, they may all look the same !

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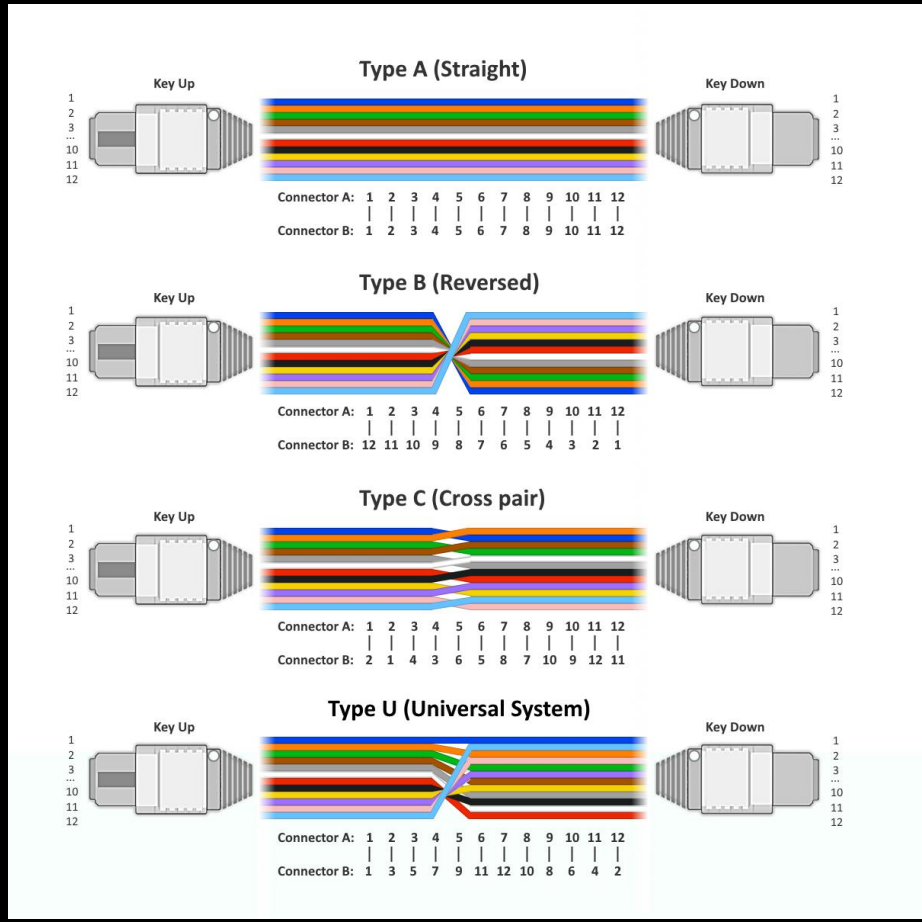
Polarity validation

Polarity is often referred to as “mapping” or “routing”

Types found in the industry:

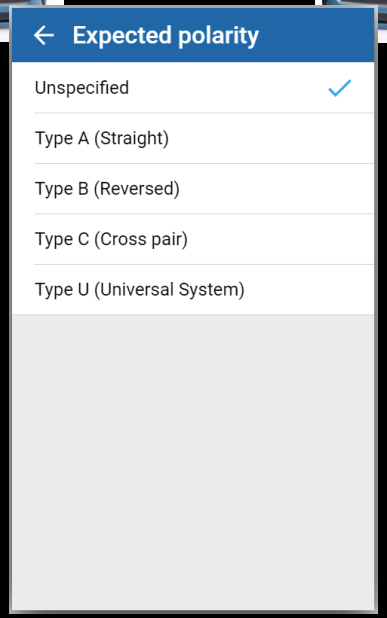
- Type A (straight Through)
- Type B (Reversed or Rollover)
- Type C (Twited Pair, Reversed Pair, Crossover)
- Type U (universal system)

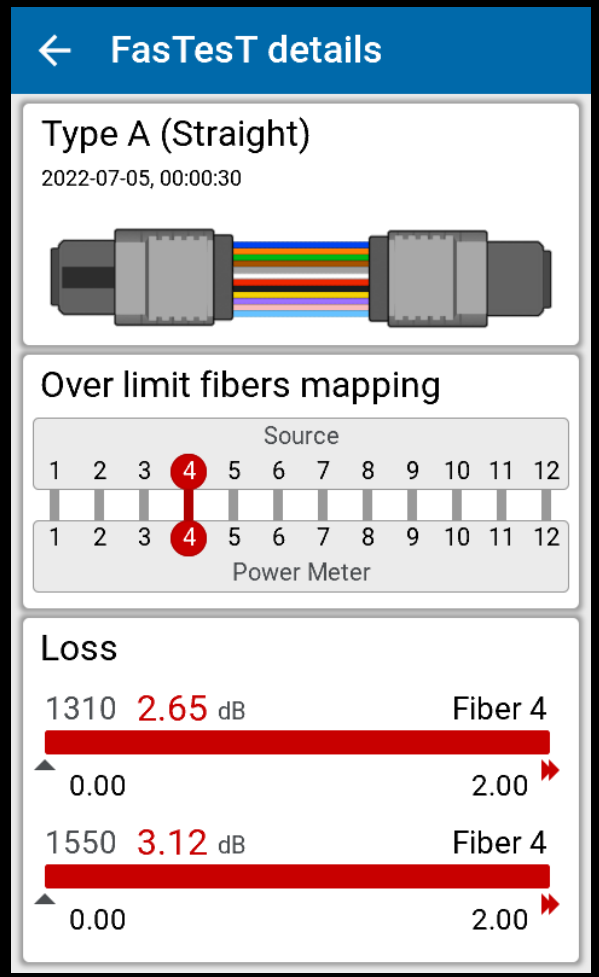


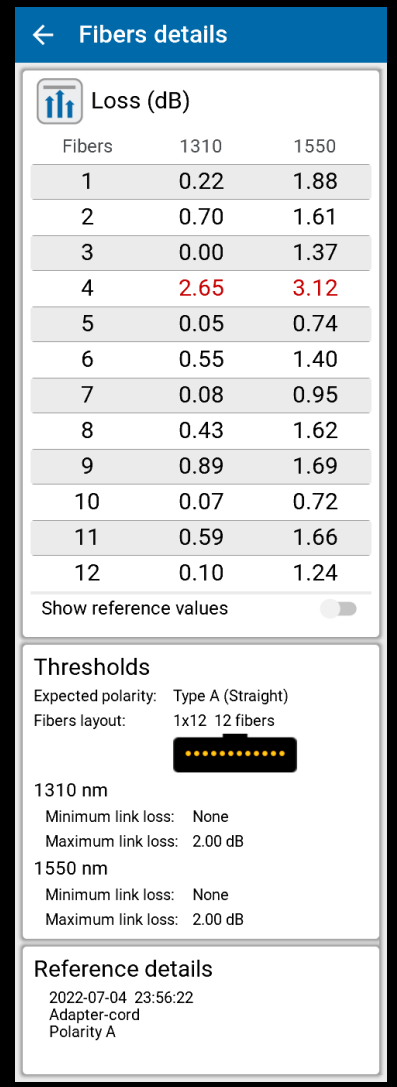
Polarity validation

- Fiber 1 is usually aligned with the dotted side of the connector.
- Will also determine the “key up” and “key down” type

Polarity validation

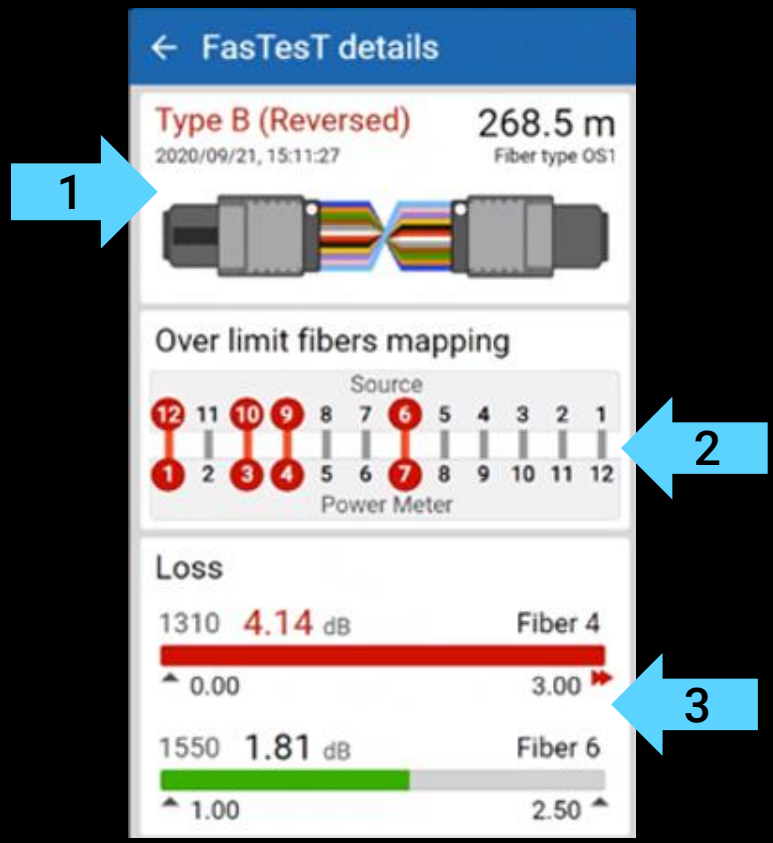




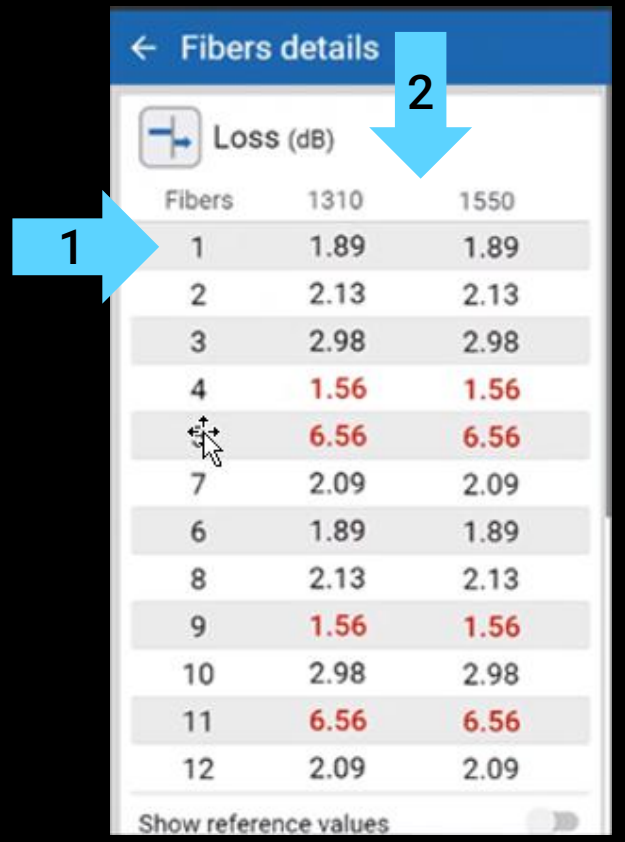


MPO OLTS test results example

1. P/F global status
2. Worst fiber loss
3. Length
4. 12-Fiber bar graph



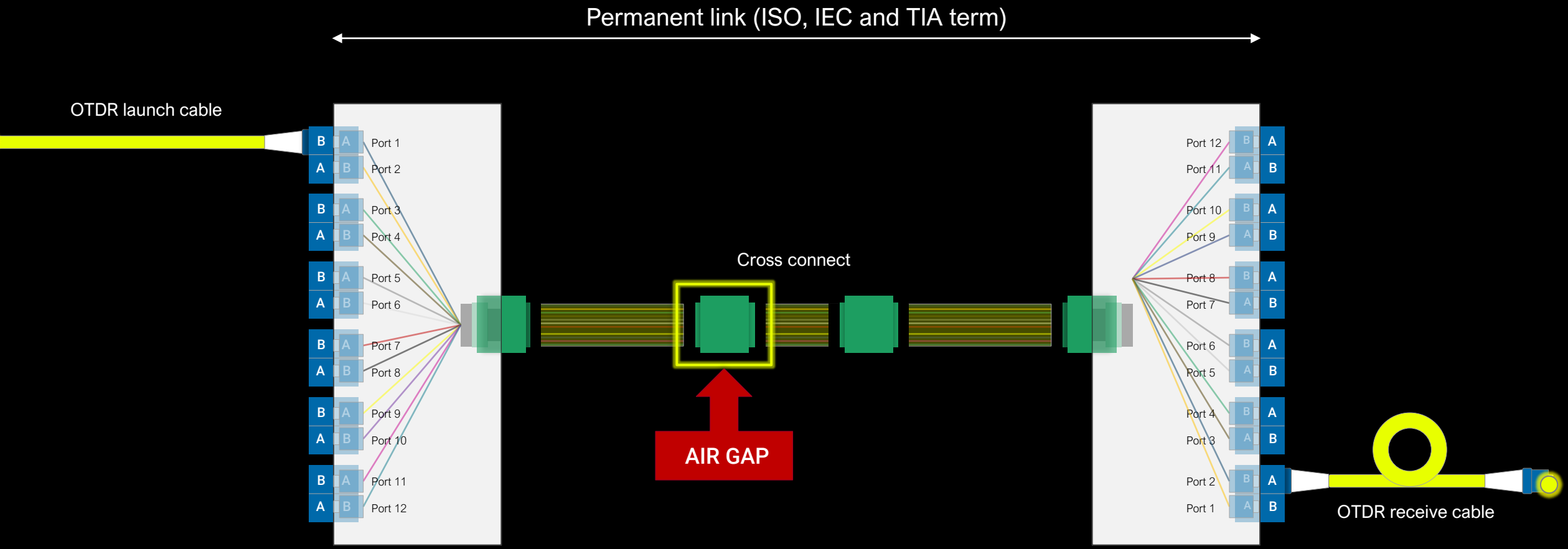
1. Polarity validation
2. Fiber mapping
3. Loss thresholds



1. Individual fiber results
2. Loss/lambda/fiber

Tier 2 Testing
OTDR

Troubleshooting using an OTDR



Troubleshooting using an OTDR

FAILURE

IN CROSS CONNECTION

Troubleshooting using an OTDR

HIGH REFLECTANCE

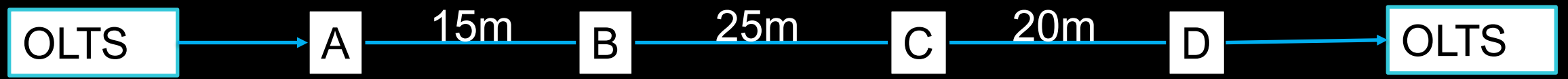
Troubleshooting using an OTDR

GOOD REFLECTANCE

BOTH CONNECTIONS VISIBLE

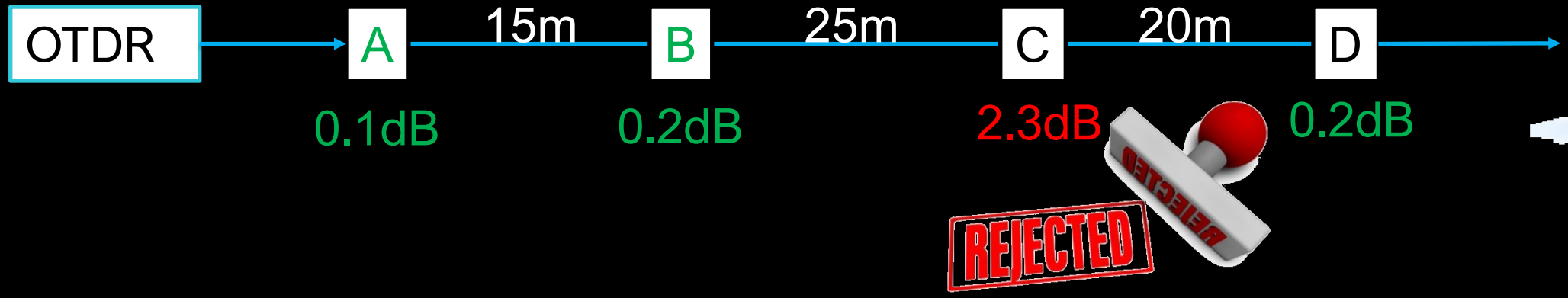
Self-reflections on the “certification” concept

Let’s assume a link with 4 connections (3 segments)



Total loss tolerance: 4 connections (0.75dBx4) + 60m x 1dB/Km = 3.06dB

OLTS E2E loss measured: 2.9dB



Tier 1
vs
Tier 2

OLTS pros/cons

Strengths

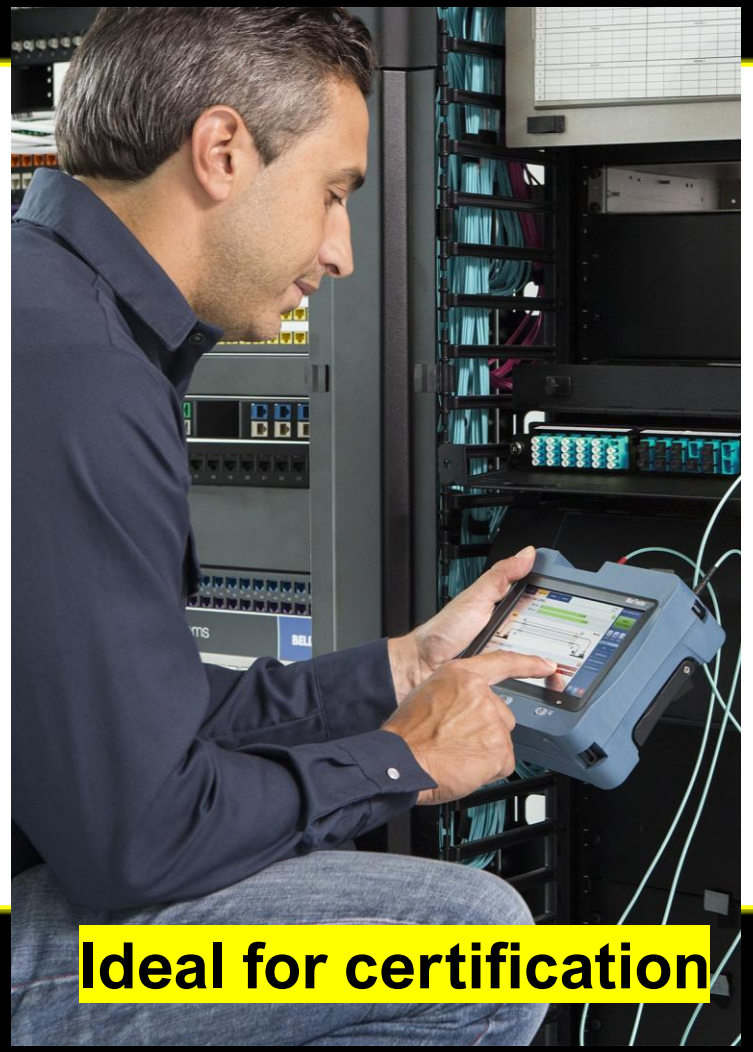
Automated IL+ORL+Length

Very fast

Reference validation

E2E Loss measurement + Polarity + continuity

Bidirectional or unidirectional



Weaknesses

- Needs referencing
- Cannot pinpoint faults
- No distributed loss

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OTDR/iOLM pros/cons

Strengths

No reference

Accurate (E2E and events)

Distributed loss measurement

Mapping of event

Full automation via iOLM

E2E loss measurement + continuity using LF and RF

Bidir or unidirectional

Weaknesses

- Test time longer than OLTS
- Not Tier 1
- Traditional OTDR complexity

Ideal for characterization and Tier 2 certification

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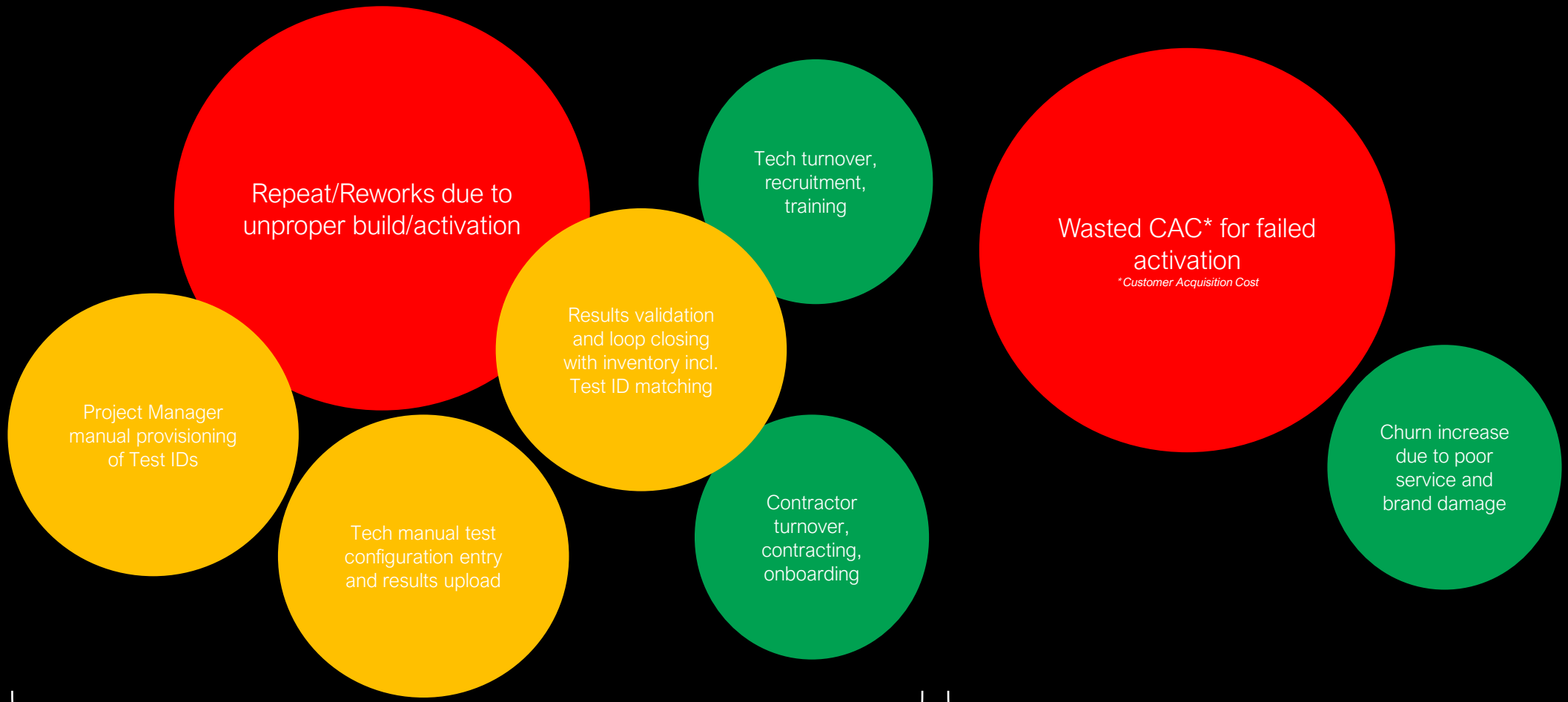
Test Automation

Network lifecycle testing – Potential Savings



Field Challenges

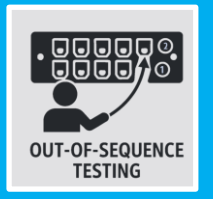
Non-standard MOPs and inconsistent procedures

Manual data transfers (USB, SD cards, screenshots)

Delays in approval, reporting, and payments

Point-to-Multipoint testing: multiple far-end test points

Out-of-sequence testing: flexibility to skip test points



Congested close-out packages: allot of data, hard to interpret

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Scaling -Traditional Method

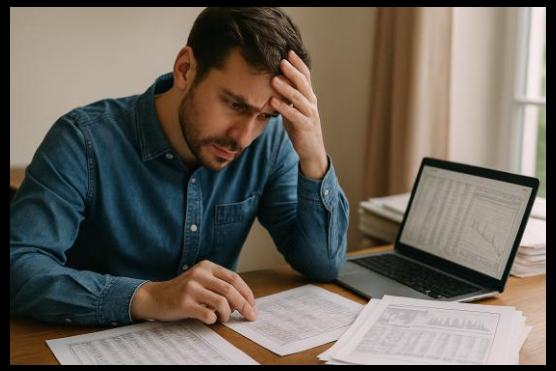
Manual processes involve Excel, paper, email chains, and USB transfers.

Naming conventions and test parameters must be entered by hand — and often re-entered.

Common issues: test result mismatches, delayed approvals, and time-consuming rework.

Sorting, validating, and digesting large trace datasets is time-consuming

Human error in test data saving or location labeling causes rework and confusion



Revisit - Data Analysis and Reporting

As fiber networks scale to accommodate the demands of AI, 5G, and FTTH, traditional manual methods for processing and reporting test data are increasingly inadequate. Utilizing advanced reporting and analysis tools to revisit your manual test results methodology is a critical stop-gap on the road to full test automation and reporting.

Challenges with Manual Methods:

- **Time-Consuming Processes:** Manually handling large volumes of test data is labor-intensive and prone to delays.
- **Error-Prone Data Handling:** Human errors in naming conventions, labeling, and data entry can lead to significant issues in network performance and reliability.
- **Inefficient Report Generation:** Creating close-out packages using spreadsheets or paper-based methods is cumbersome and slows down project completion.

Advantages of Advanced Reporting and Analysis:

- **Automated Batch Processing:** Quickly process and analyze multiple test results simultaneously, reducing manual workload.
- **Customizable Reporting:** Generate tailored reports in various formats (PDF, Excel) to meet specific project needs.
- **Error Detection and Validation:** Built-in tools automatically identify and flag inconsistencies or errors in test data.

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Examples of Custom Close Out Packages

Customizing test reports enable you to create targeted deliverables for customer facing and internal use.

Detailed

Analysis

EXFO **Fail Report**

A: GDYAZ1MN
B: PHXAZ1MN

Failed Connector Loss

Fiber ID	Wavelength (nm)	Direction	Distance from A: (km)	Loss (dB)
102	1550	Average	1.0260	0.531

Failed Splice Loss

Fiber ID	Wavelength (nm)	Direction	Distance from A: (km)	Loss (dB)
99	1550	Average	54.1161	0.156
103	1550	Average	71.6188	0.164
104	1550	Average	71.6648	0.233
105	1550	Average	71.6341	0.259
106	1550	Average	71.6494	0.364
107	1550	Average	71.6392	0.243
108	1550	Average	71.6443	0.256

Failed Reflection

Fiber ID	Wavelength (nm)	Direction	Distance from A: (km)	Reflectance (dB)
97	1550	A->B	1.0260	-45.8
98	1550	A->B	1.0260	-45.2
99	1550	A->B	1.0260	-45.8
100	1550	A->B	1.0260	-45.9
101	1550	A->B	1.0260	-45.9
102	1550	A->B	1.0260	-45.8
103	1550	A->B	1.0260	-45.9
104	1550	A->B	1.0260	-45.9
105	1550	A->B	1.0260	-45.9
106	1550	A->B	1.0260	-45.9
107	1550	A->B	1.0260	-45.9
108	1550	A->B	1.0260	-45.8

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Automation

"Manual reporting doesn’t scale — but our networks do. Let automation do the heavy lifting."

What Automation and Advanced Reporting Unlocks :

✓ **Accuracy** — Lock-in correct test parameters and naming via job presets.
✓ **Compliance** — Ensure everything meets SOW/SLA requirements before the tech leaves the site.
✓ **Consolidation** — Merge multiple test types into unified packages.
✓ **Scalability** — Bulk job creation and auto-validation cut job setup from hours to minutes.
✓ **Efficiency** — Auto-process, validate, and generate close-out packages in minutes minutes.

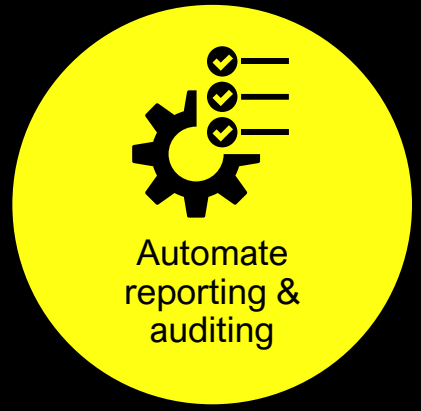
Field test management solution

EXFO | EXchange

Create & assign jobs to field techs

Pre-defined & controlled info

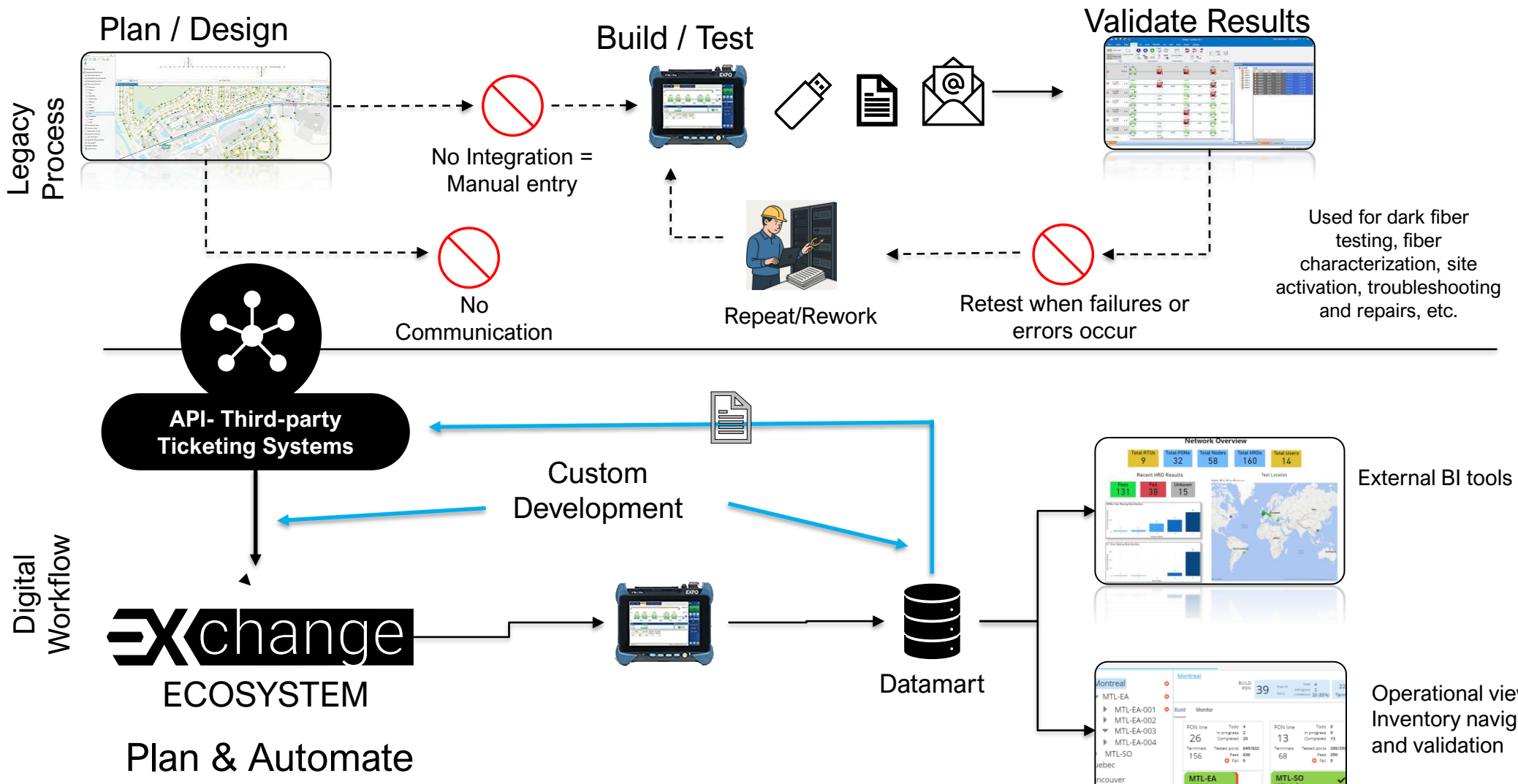
Real-time & centralized upload



Online reporting & progress view

Comprehensive analytics & BI

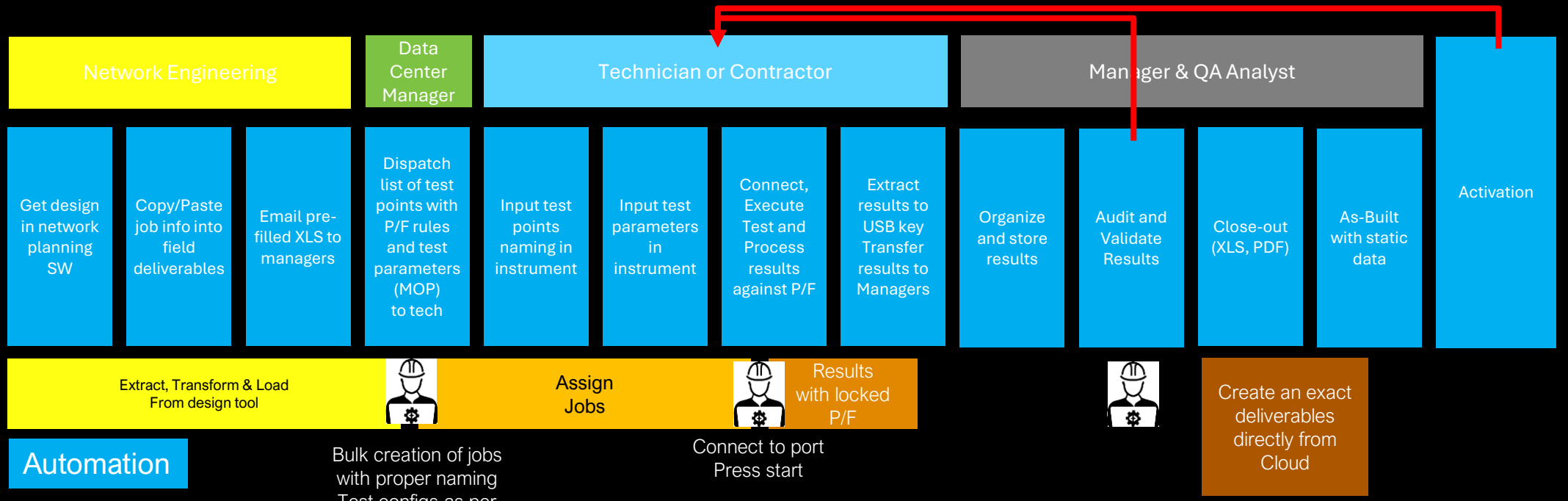
Automation Ecosystem



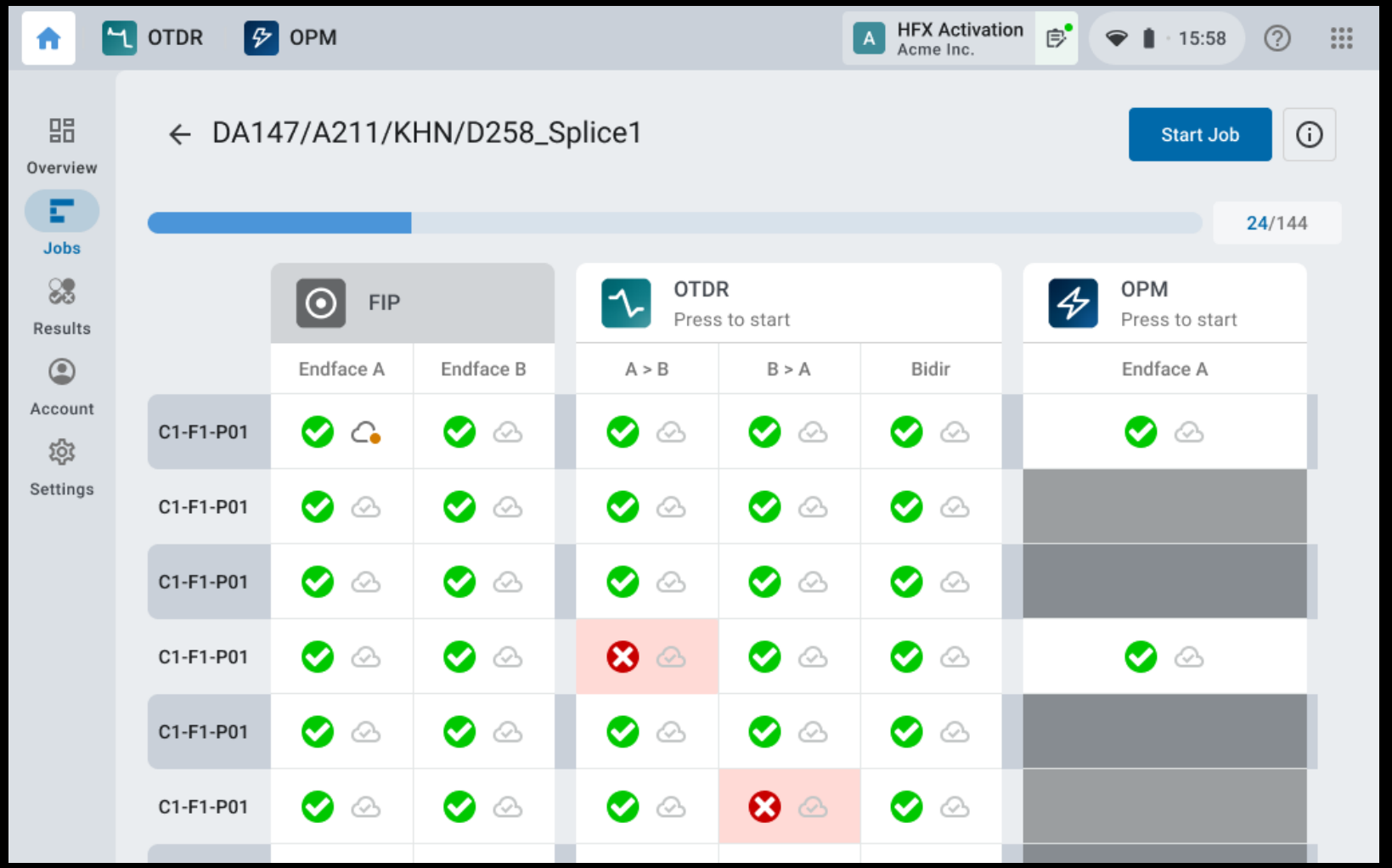
EXFO

ElectroRent EXFO

Use Case Process

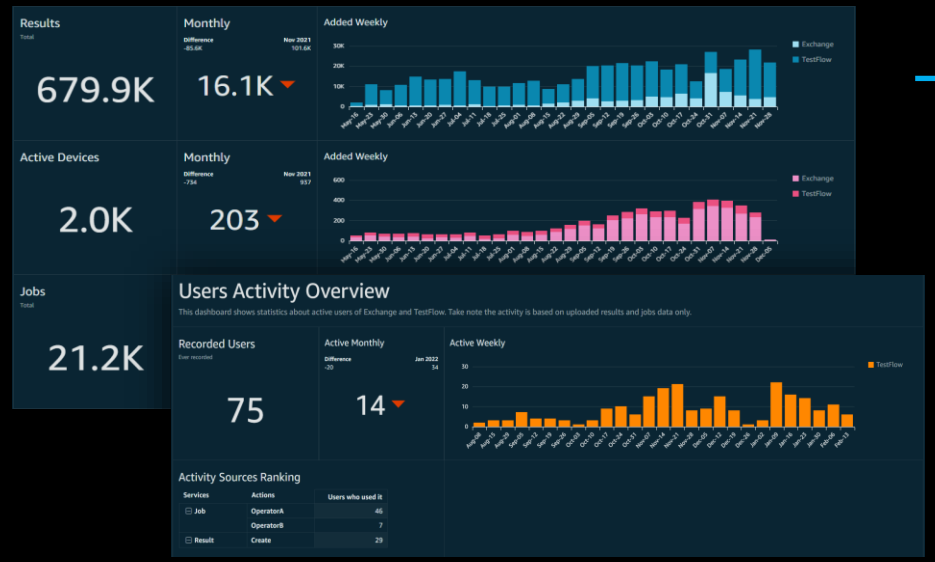


Digitized MOP



Analytics and insights ready for BI tools

EXFO | EXchange



Pipeline

Customer datamart

tableau

snowflake

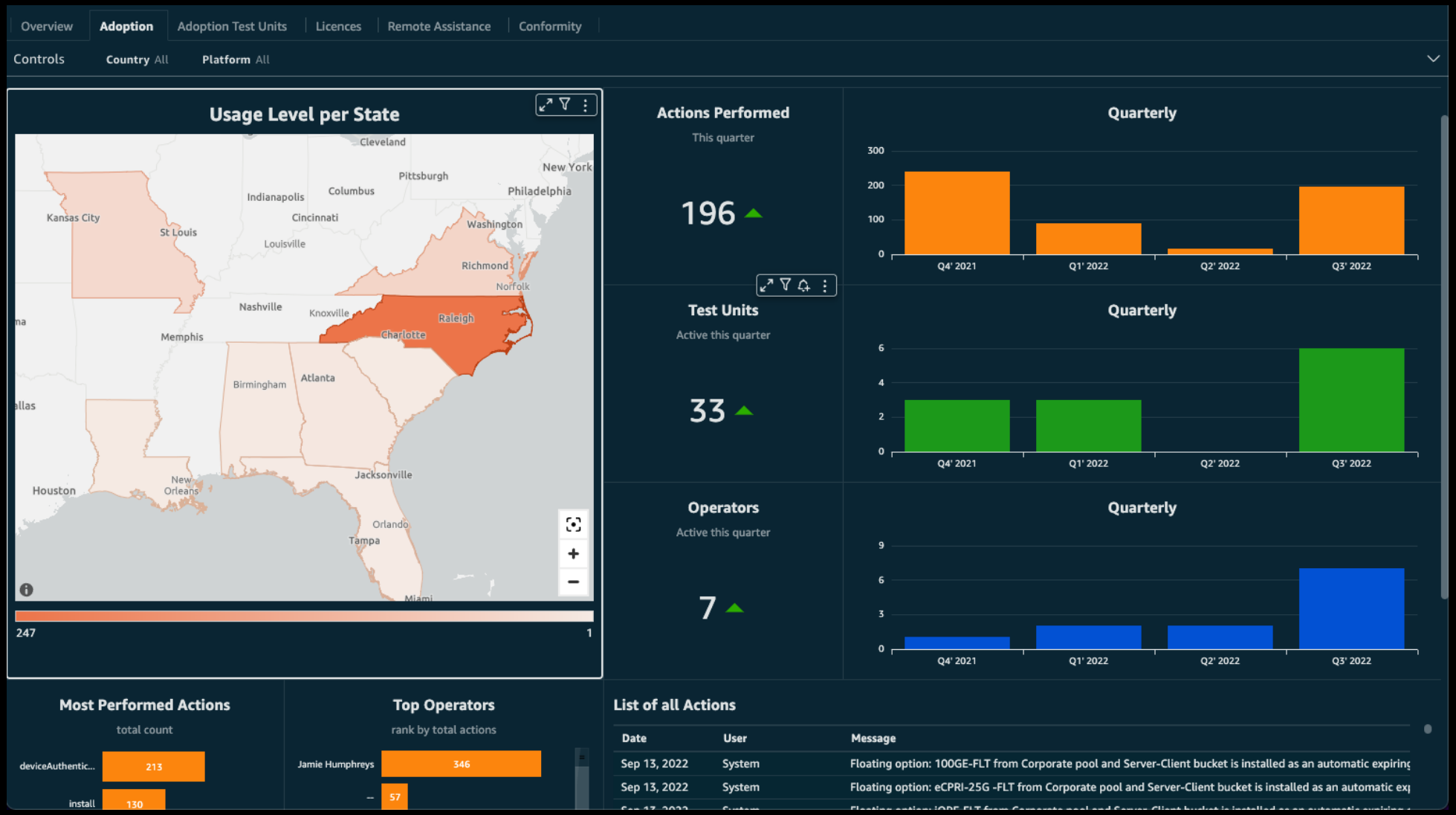
MicroStrategy

Power BI

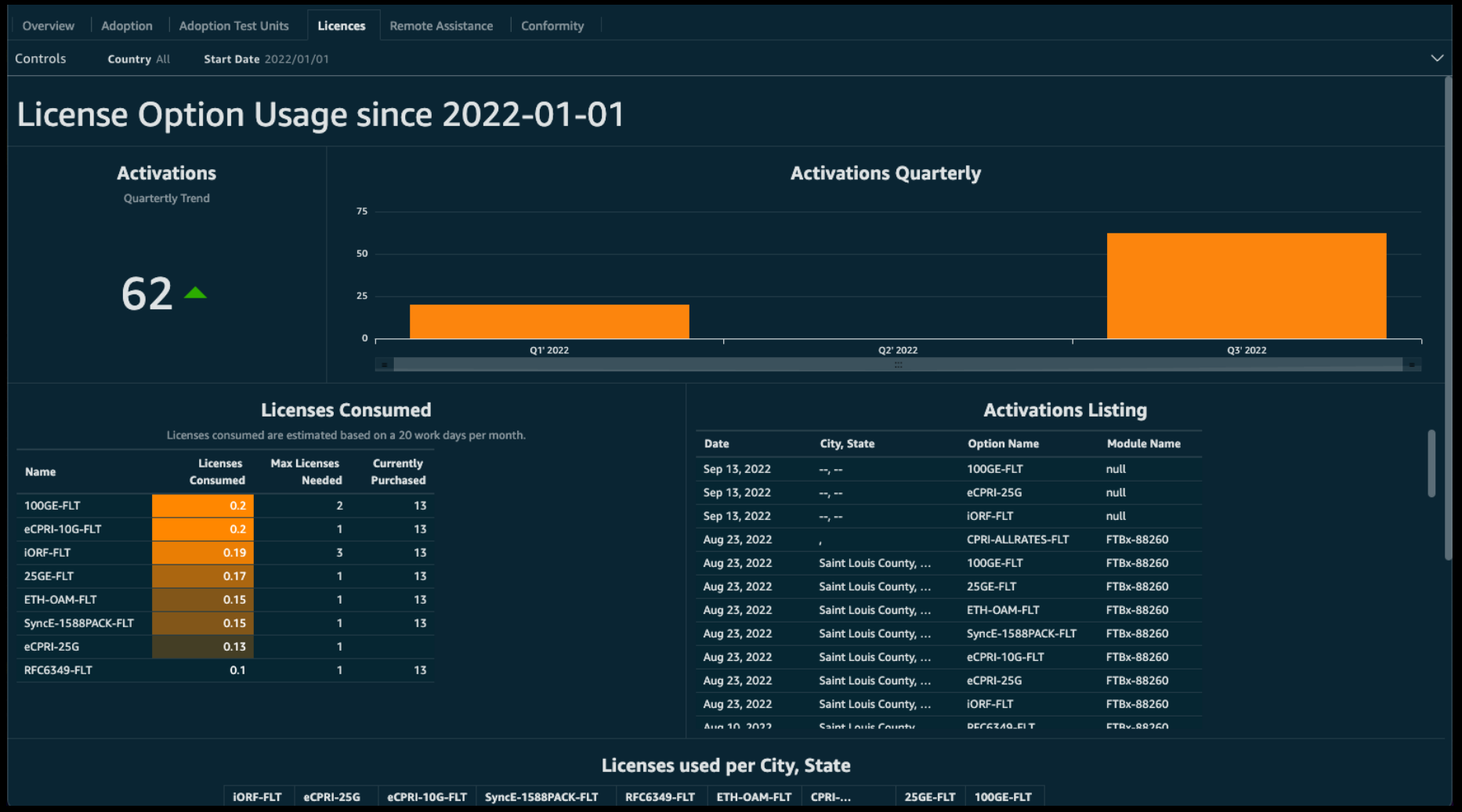
Qlik

ElectroRent EXFO

Analytics - Filtering



Manage Fleet - Inventory



Easy close out package
Cloud, Mobile & FR3

- ✓ Validate compliance
- ✓ Analyze measurements
- ✓ Edit traces
- ✓ Documentation
- ✓ Combine different types of jobs
- ✓ Generate report

- ✓ Auto-documentation
- ✓ Duplicated files detection
- ✓ Template mode
- ✓ Batch process
- ✓ Auto-validation

Key functionalities from FastReporter

Automated test results acceptance process for faster test acceptance

Recap

PXM/LXM *PRO*

DUPLEX AND MULTI-FIBER OLTS

THE FASTEST

Measure loss, length, and polarity on **duplex and multi-fiber** links at two wavelengths to industry standards

1-CORD REFERENCING

Unique patented Click-out design enables 1-cord referencing to accurately certify **LC, SN, MDC, MPO-8, MPO-12 and CommScope MTP** cabling systems

LOWER COST OF OWNERSHIP

Click out connector design, 3-year warranty and calibration keeps testers in the field not the factory

FIRST-TIME-RIGHT POLARITY

Only tester on the market to detect duplex and base-8/12 polarity issues hidden in trunk cabling

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FIP-500

Fiber Inspection Probe

Accurate & repeatable

High Resolution duel detectors, improved field of view, with no compromise to image quality.

Zero-Button Automation

Auto: Focus, Center, capture and analysis. Detects new fiber on insert for a zero button experience.

Large Capacitive Screen

Bright backlit 2.4 inch color touchscreen for easy navigation at your finger tips.

Fast tip swap

Automatic threshold adjustment using smart RF tip scan. Quick change from Single Fiber to MultiFiber inspection

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Physical-layer field testing

Optical fiber multimeters

OLTS and fiber certifiers

OTDR and iOLM

Optical spectrum analyzers (OSA)

Dispersion

TestFlow
FastReporter

Automation and reporting

Fiber inspection

Multifiber MPO/MTP®

Light sources, power meters and VFL

xDSL/Copper

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Thank You for Attending!

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