# *Field Testing and Troubleshooting of PON LAN Networks.*

## *Best practices and initial guidance from IEC 61280-4-3*

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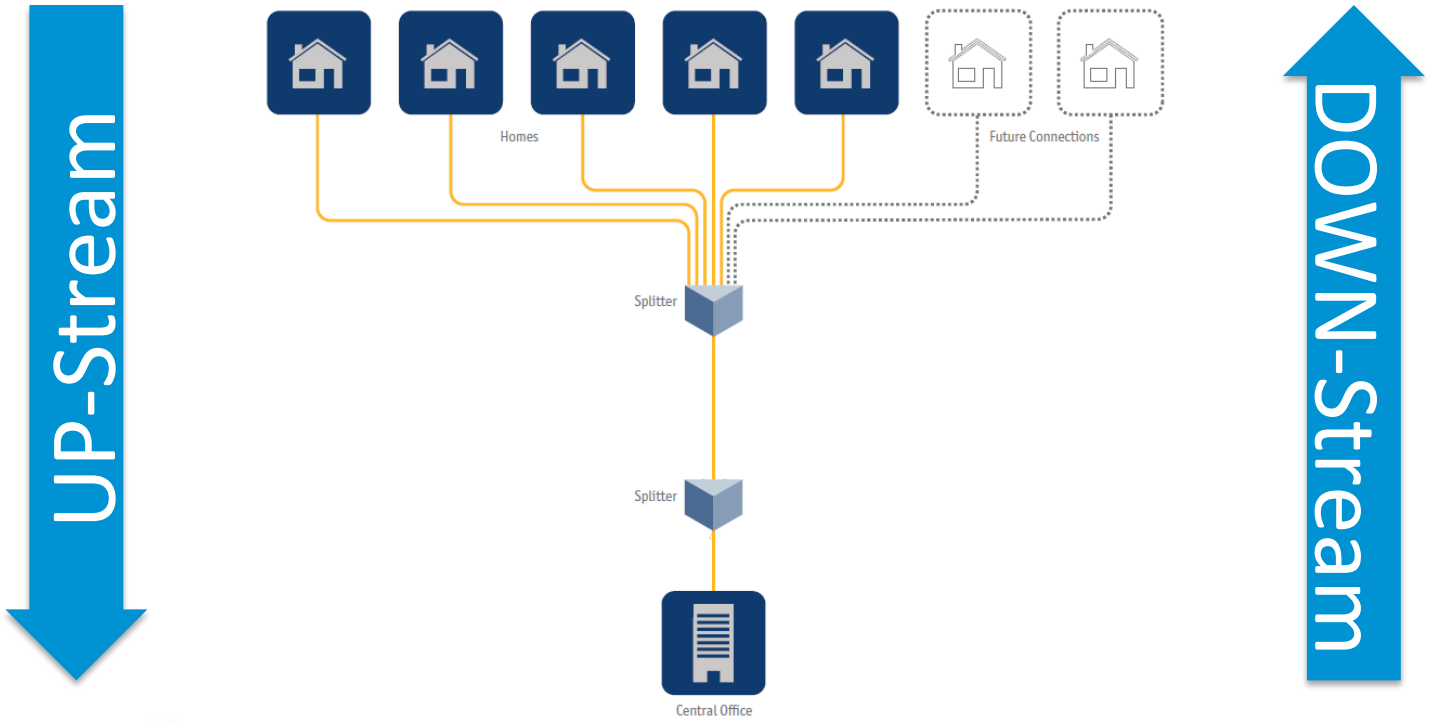
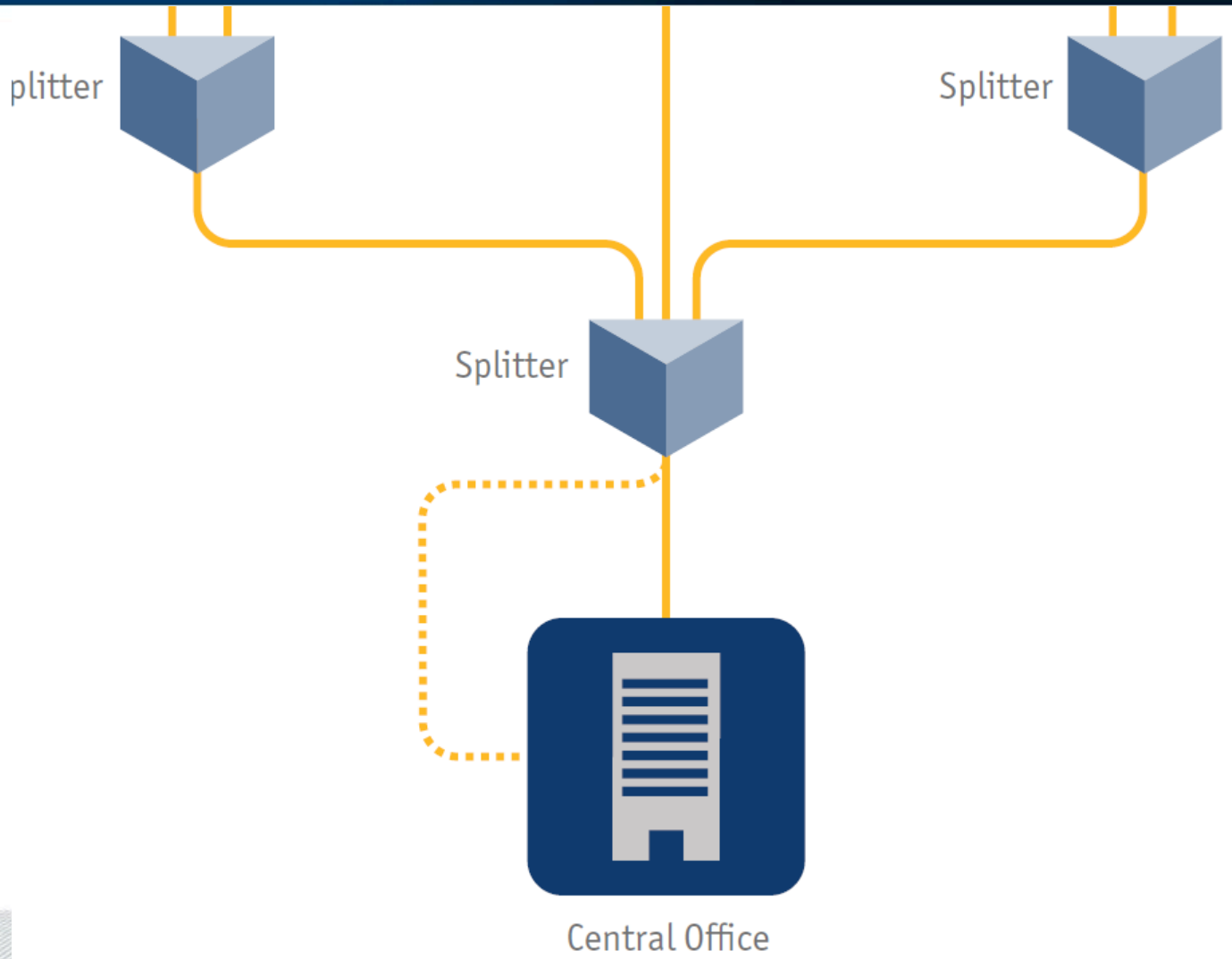
# Agenda

- PON basics
  - Wavelengths
  - Architecture
    - Splitters
- Fiber Optic Testing Compared: Data Center, Telco, PON
- Guidelines for Certification
- Troubleshooting
  - OTDR
  - Power Meter
- Document Results

# ‘basic’ PON architecture




plitter
Splitter
Splitter
Central Office

# *"Flavors" of Passive Optical Networks*

- E-PON and G-PON – most common today
- 10G or XG-PON, NG-PON, NG-PON2
- TBD-PON
- FTTx
- PON-LAN
- We don't care what you put on the road – we want to make sure the road is in good shape to support today's applications
  - Loss Budgets, Distances, Reflectance limits may be tighter with future versions

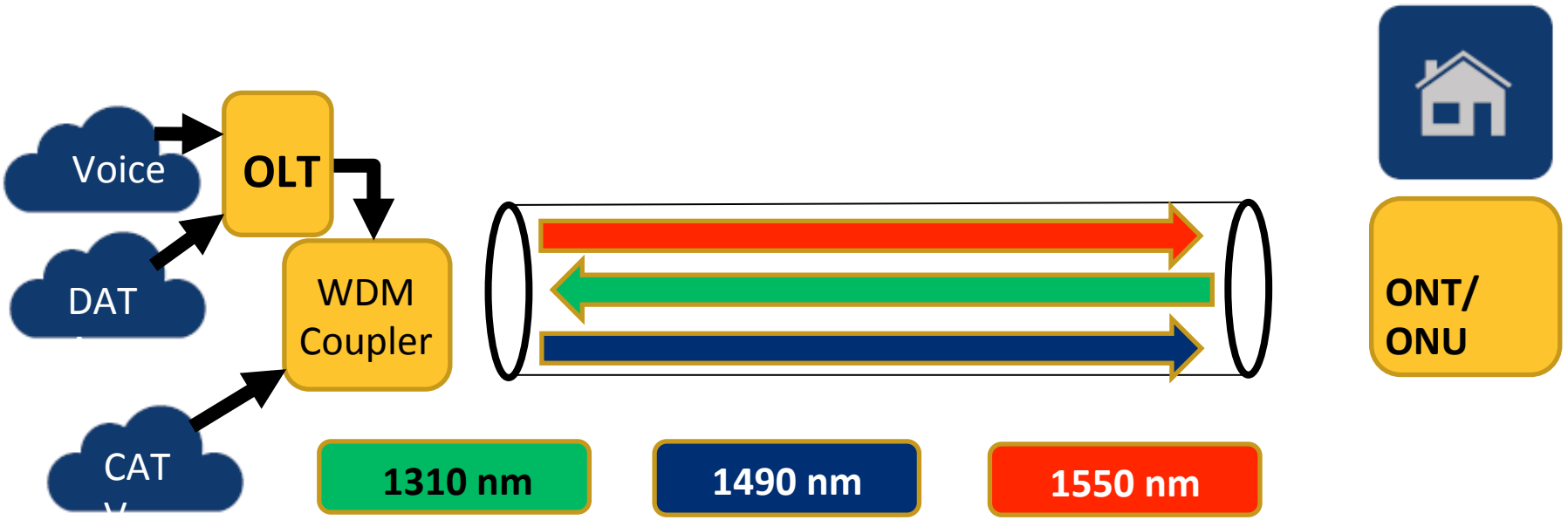
# Basic PON LAN Layout

Fiber Concentration Point (FC/ FCP)

Fiber Distribution Terminal (FDT)

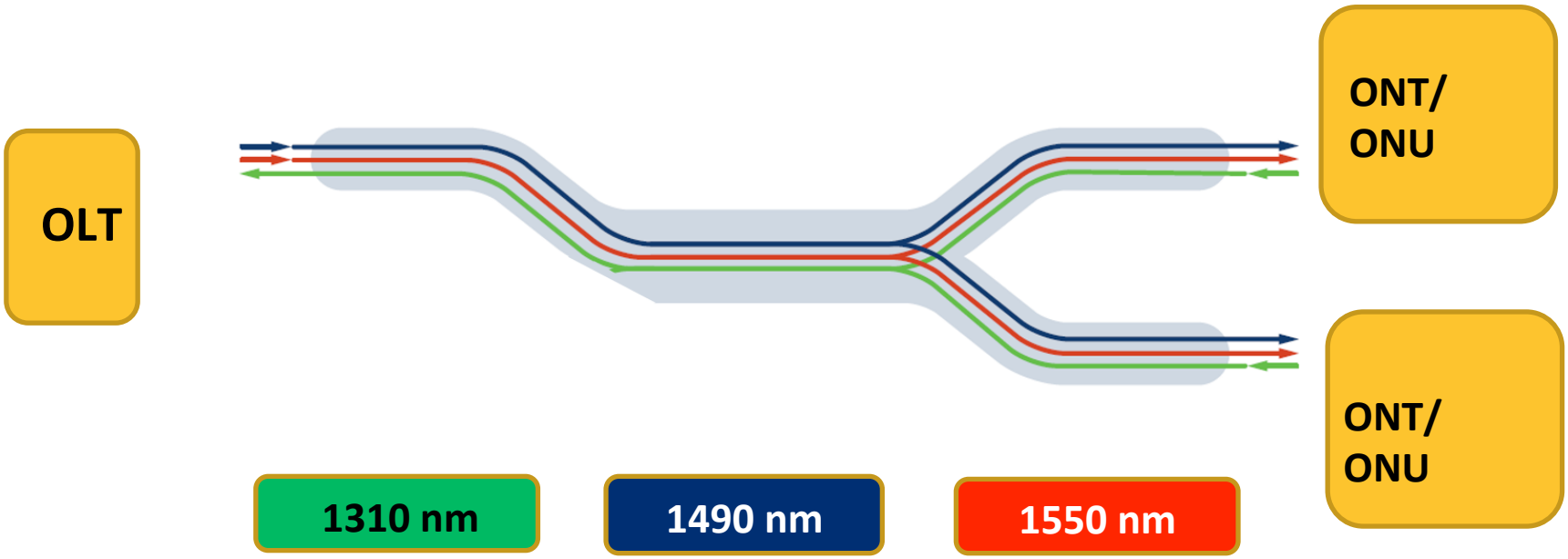
Fiber Distribution Hub (FDH)
DataCenter/MDF Single Administration Point

# Multiple Wavelengths λ One Fiber



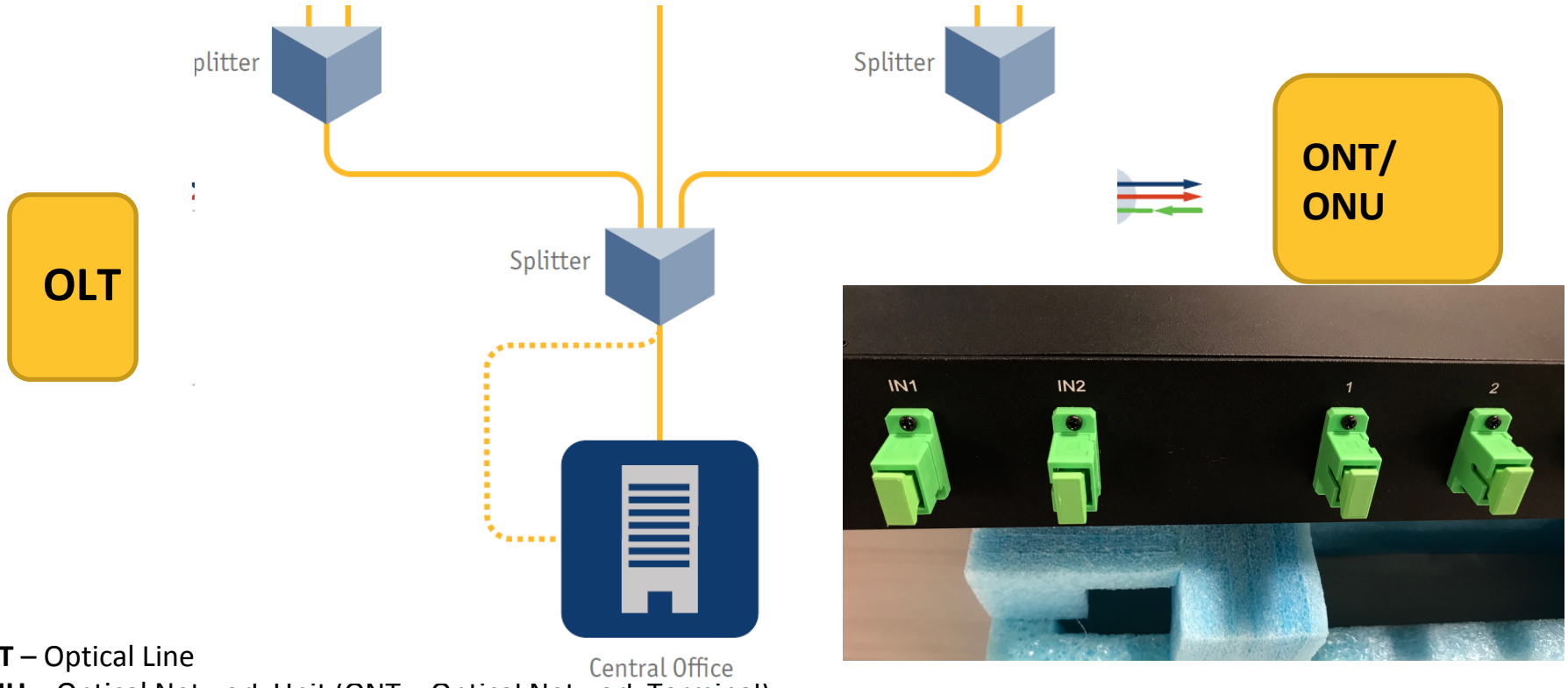

**OLT** – Optical Line Terminal
**ONU** – Optical Network Unit (ONT – Optical Network Terminal)

# Multiple Wavelengths λ One Fiber - Split




**OLT** – Optical Line Terminal
**ONU** – Optical Network Unit (ONT – Optical Network Terminal)

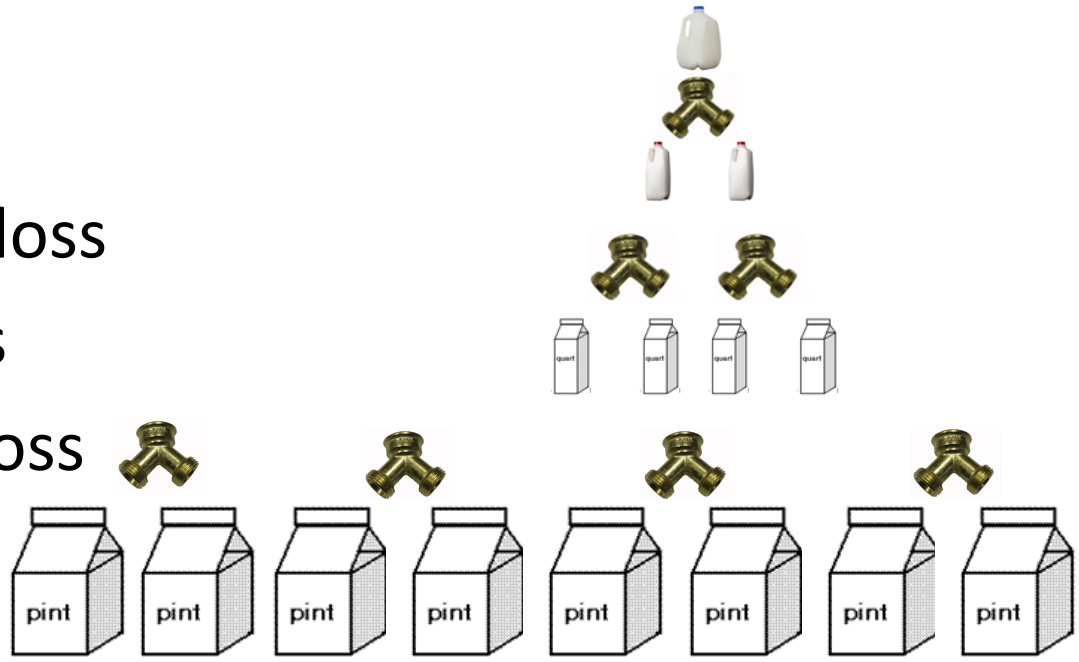
# *Multiple Wavelengths λ One Fiber – Redundancy*



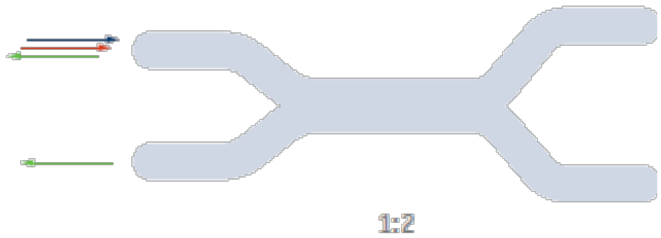

**OLT** – Optical Line
**ONU** – Optical Network Unit (ONT – Optical Network Terminal)

# *As you increase the split, you attenuate the light that is coming out of a splitter*

- A 1 X 2 = 3.5 dB of loss
- 1 X 4 = 7 dB of loss
- 1 X 8 = 10.5 dB of loss



# *Loss Budget per Split per TIA-568 Annex D*




Maximum permitted loss 3.9 dB

# *Test of PON Networks*

# *Fiber Testing Applications Compared*
## *Data Center*

- Multiple connections supporting
  - "Zoned" Data Centers
  - Spine – Leaf Architecture
  - *Ultra Low Loss c*omponents
- Short over all distance
- Very low loss budgets
  - Even lower budget per segment … often < 1dB / segment

# Fiber Testing Applications Compared
## Data Center Testing

- Testing is typically performed per segment
  - Testing Errors are often systematic and will accumulate for the final channel

**Best Practices:**

- Basic/Tier-1 Testing with a LSPM
  - 1 Jumper Reference
  - EF Launch Conditions for Multi Mode
  - Use of TRC (Test Reference Cords)
- Extended/Tier-2 Testing an OTDR is complimentary
  - More detailed but less accurate
  - Bi-Directional testing for evaluation of components is essential
  - Use of Launch & Tail Fiber essential

# *Fiber Testing compared*

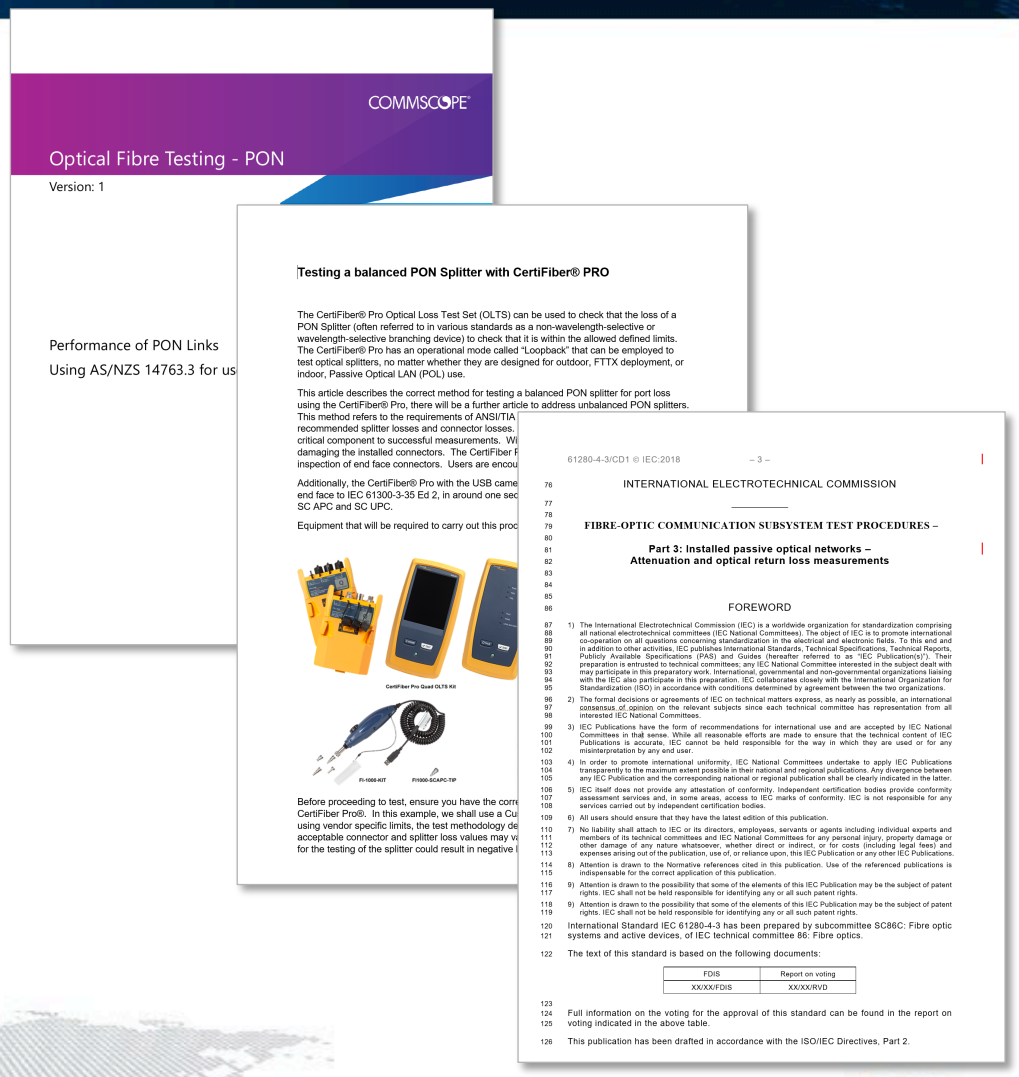
| Application | Distance | Overall Loss dominate by | Typical provisioning | Use of TRCs | Bi-Di Testing | Use Launch & Tail Fiber |
|---|---|---|---|---|---|---|
| Data Center | short | Connections | Segments | ✹ | ✹ 1) | ✹ |
| Telco (Long Haul) | long | Fiber | End To End | ⭘ | ○ | ⭘ |
| PONs | medium | Splitter | End To End | ⭘ | n/a | ⭘ |

Note 1) Essential for Pass/Fail on component level

○…Not Essential ⭘…Beneficial ⭘…Recommended ✹…Essential

# Guidance for Testing

- Manufacturers from PON-Lan Systems
- Test Equipment Manufacturers
- IEC 61280-4-3 (Committee Draft)



# *Guidance for Testing will come from IEC 61280-4-3*

- Title:
  FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –
  Part 3: Installed passive optical networks – Attenuation and optical return loss measurements
- Status:
  First Committee Draft

# *IEC 61280-4-3 Testing Methods*

Four Methods Defined

1. LSPM – One Cord Method
2. OTDR – In Band (…Out Of Service)
3. OTDR – Out Of Band (… In Service)
4. Equipment Source & PON PM

**RTM**
Recommended Test Method

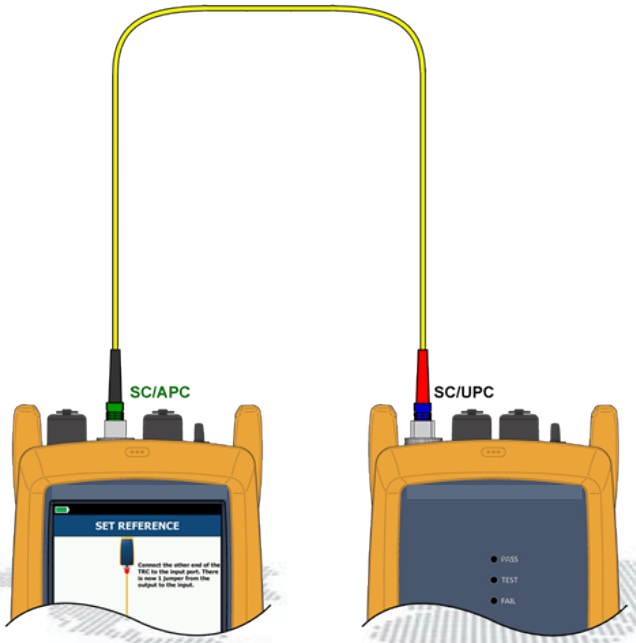
**ATM**
Alternative Test Method

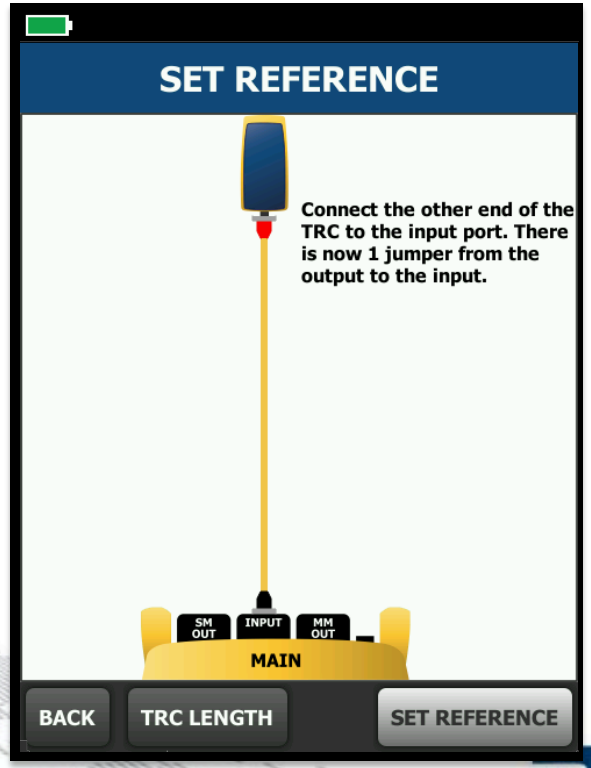
# *IEC 61280-4-3*
# *Testing Method*

# (1) LSPM – One Cord Method

# *Single fiber testing – setting a reference*

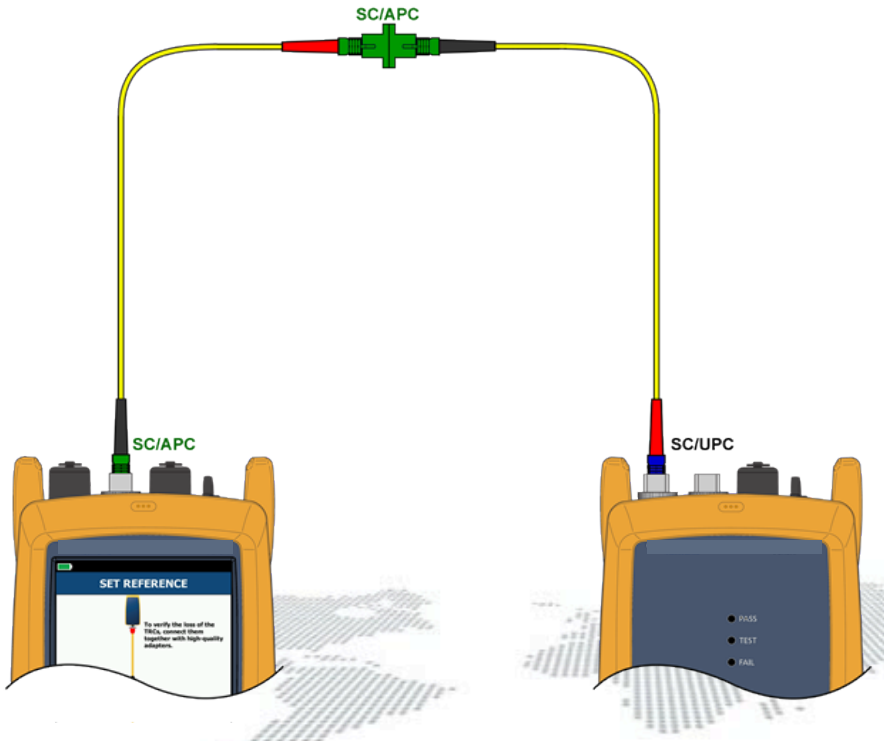
- Connect the MAIN and SOURCE units together
  - **One Jumper Reference**
  - **Must have input port that is the same as the connector to be tested**

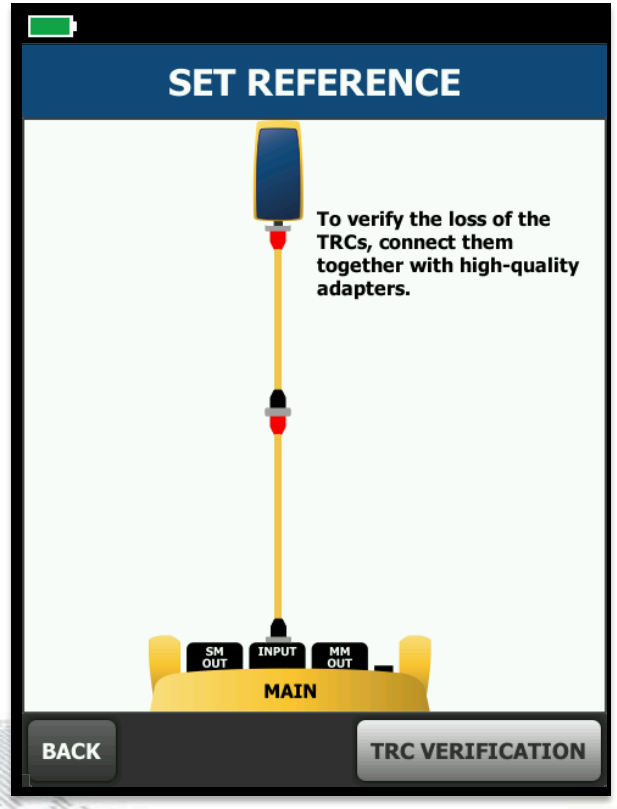


# *Single fiber testing – setting a reference*

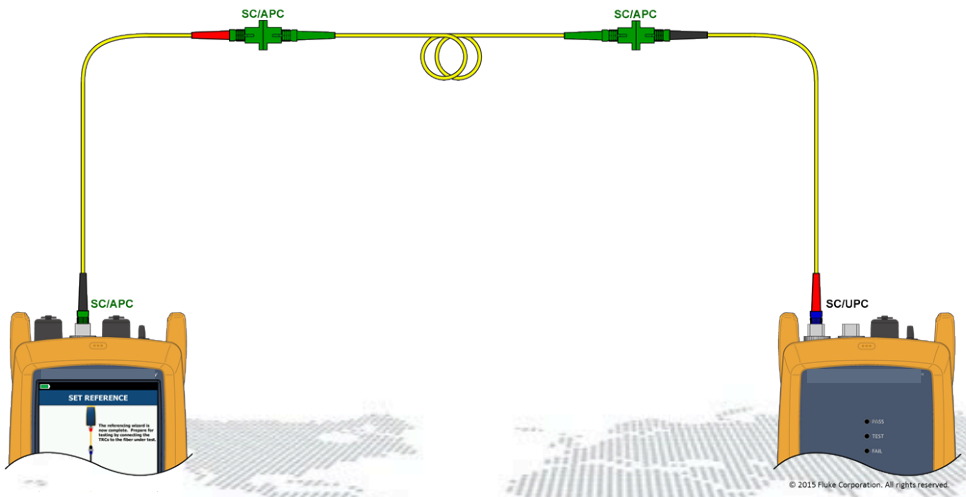
- After the reference is set, verify the condition of the other Test Reference cord
- Save this in your test results!

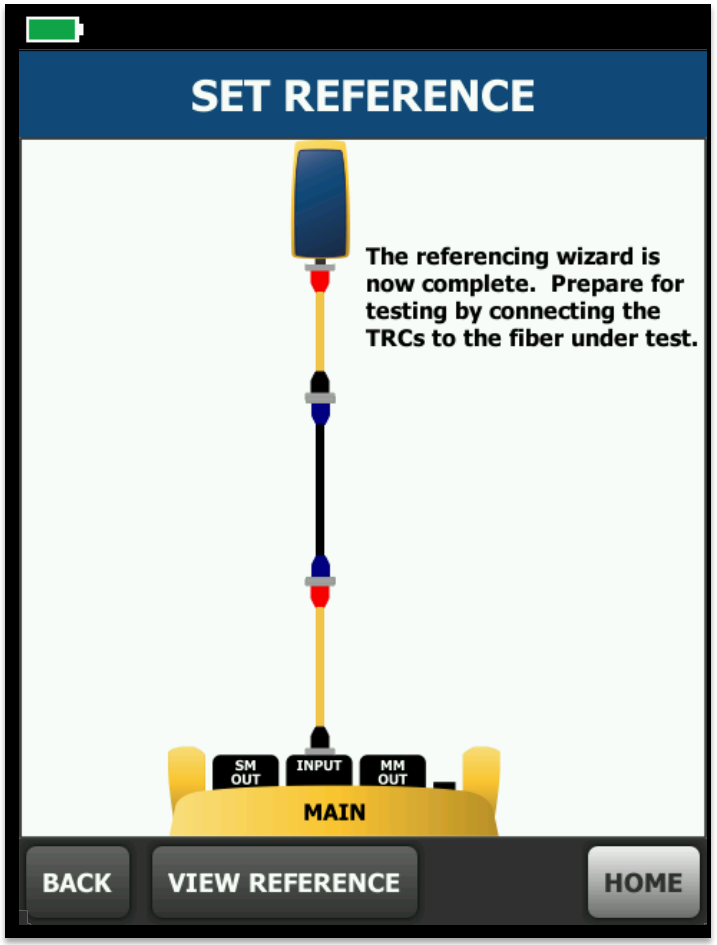


# *Single fiber testing – setting a reference*

- Connect to the link you wish to test



# Sample Test Results

**Cable ID: HGI ROOM 204**
Date / Time: 12/29/2017 09:28:09 AM
Cable Type: OS2 Singlemode

n = 1.4670 (1310 nm)
n = 1.4680 (1550 nm)

**Test Summary: PASS**
Backscatter Coefficient: -79.5dB (1310 nm)
Backscatter Coefficient: -82.0dB (1550 nm)

**Loss (R->M)**
**PASS**
Date / Time: 12/29/2017 09:28:09 AM
Test Limit: *4 PORT & 8 PORT*
Operator: Jim
certifiber pro (17455007 v5.3 build 20171229
Module: CFP-QUAD(2427616)

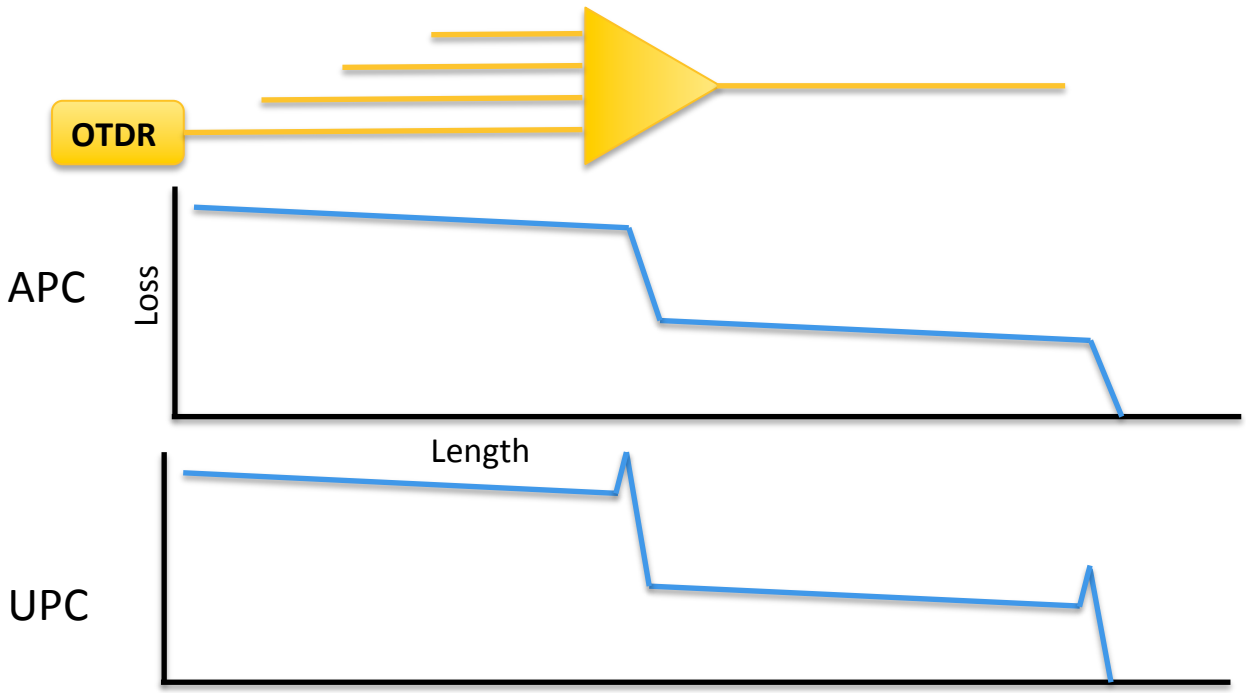
| | 1310 nm | 1550 nm |
|---|---|---|
| Result | PASS | PASS |
| Loss (dB) | 18.34 | 17.47 |
| Limit (dB) | 20.50 | 20.50 |
| Margin (dB) | 2.16 | 3.03 |
| Reference (dBm) | -2.66 | -2.73 |

Connector Type: LC
Patch Length1 (m): 2.0
Reference Date: 12/29/2017 09:08:10 AM
1 Jumper

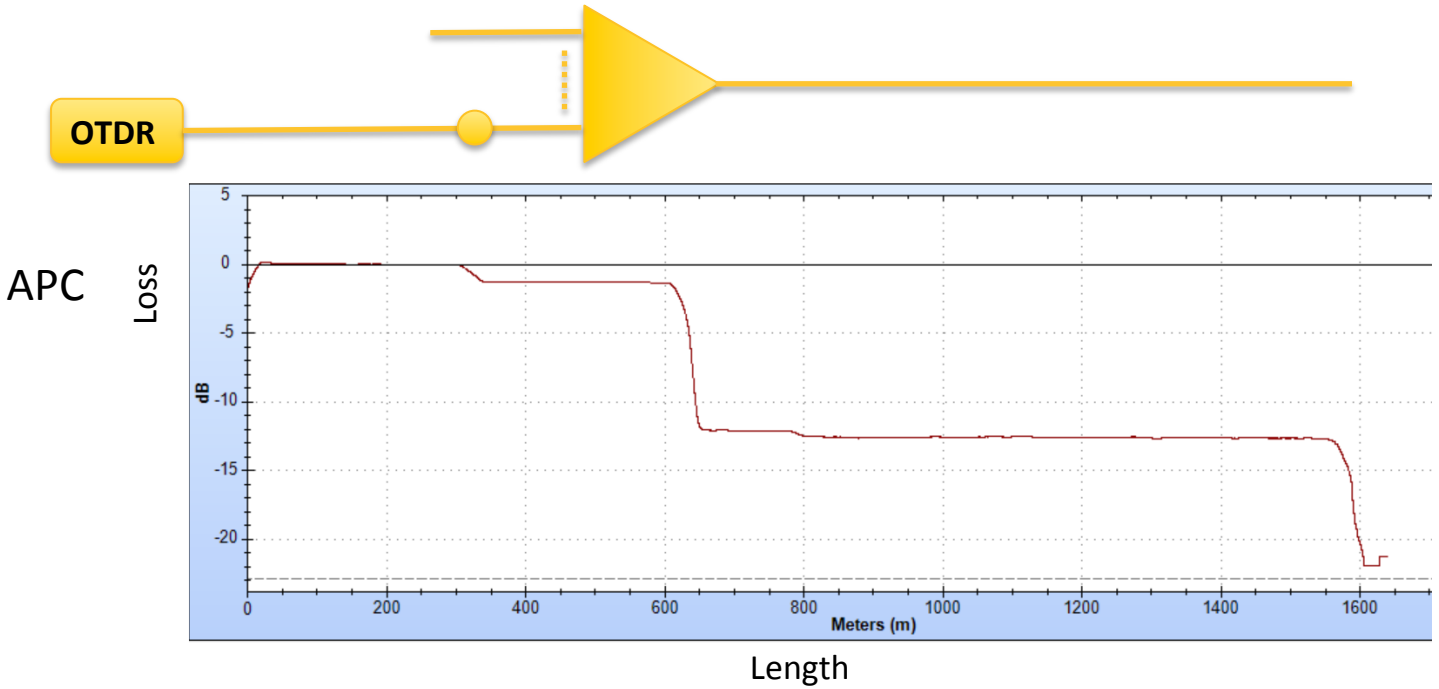
# *IEC 61280-4-3*
# *Testing Method*

# (2) OTDR (In-Band ... Out Of Service)

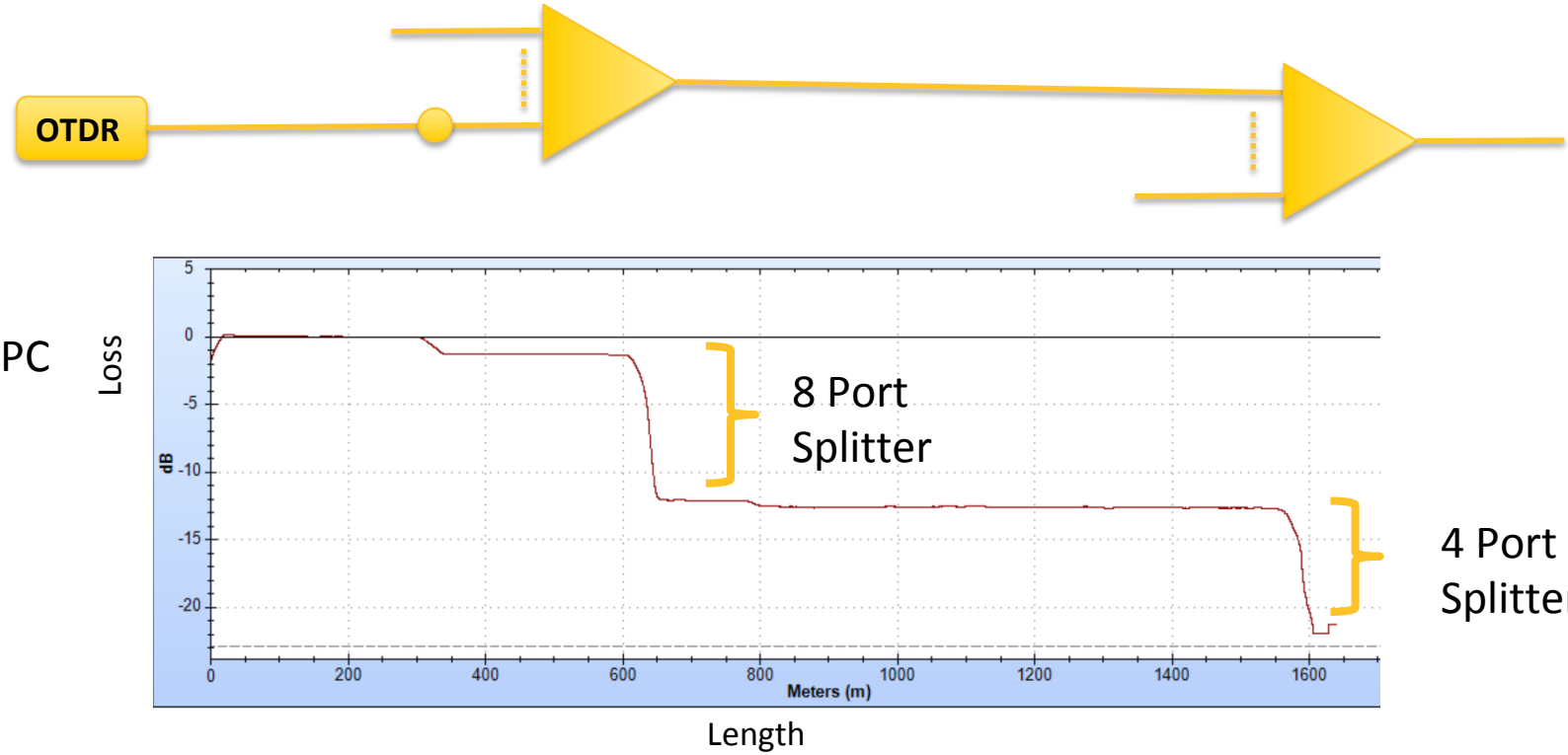
# *Upstream OTDR Testing*



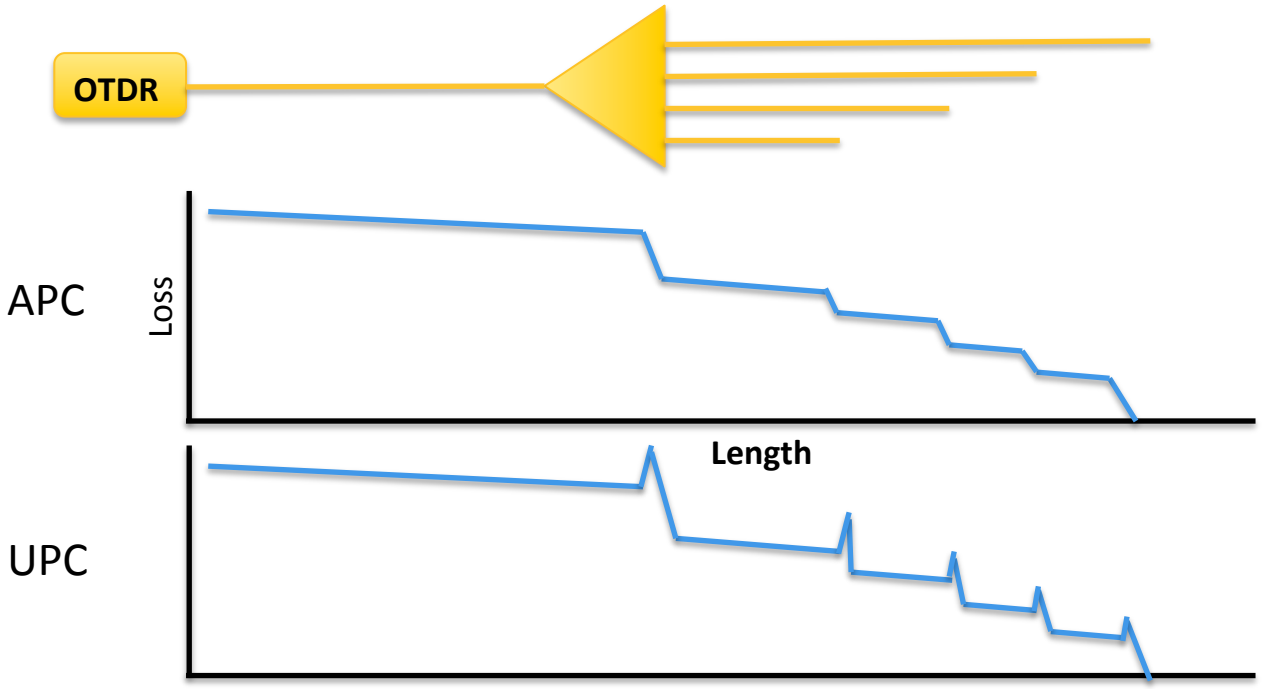
# Upstream OTDR Testing



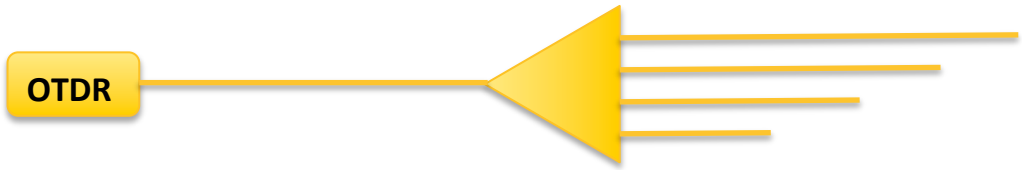
# Upstream OTDR Testing



# Downstream Testing

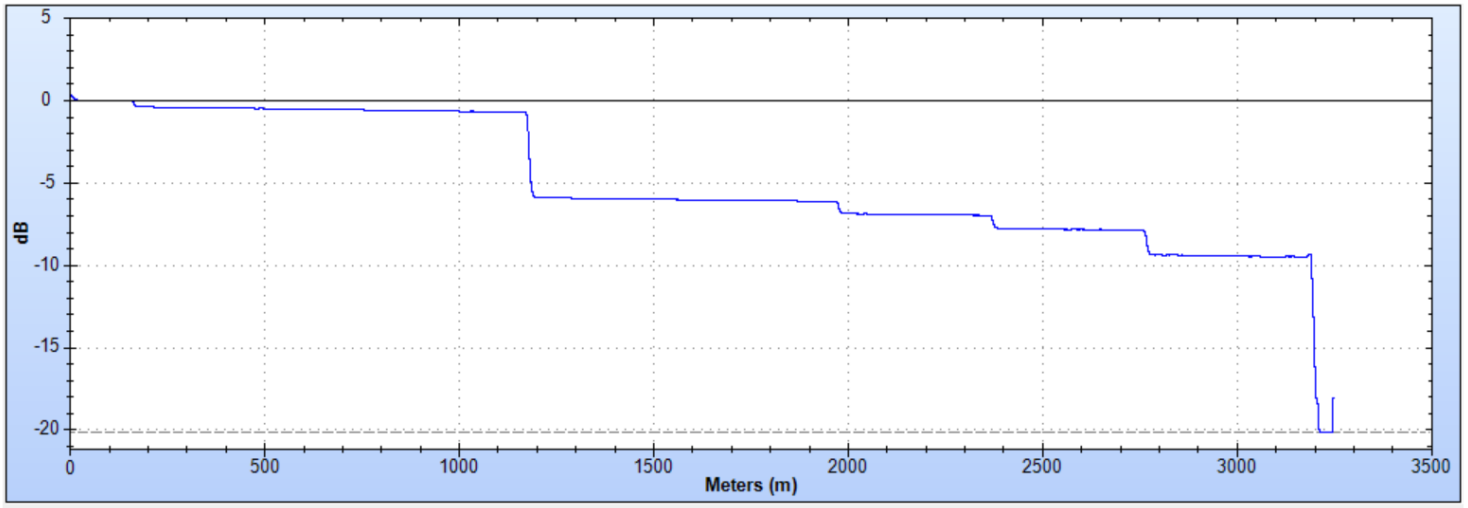


# Downstream Testing



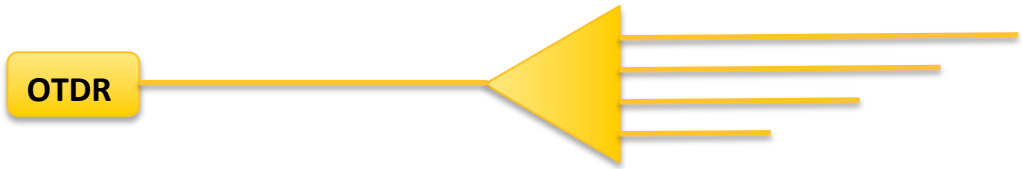

APC

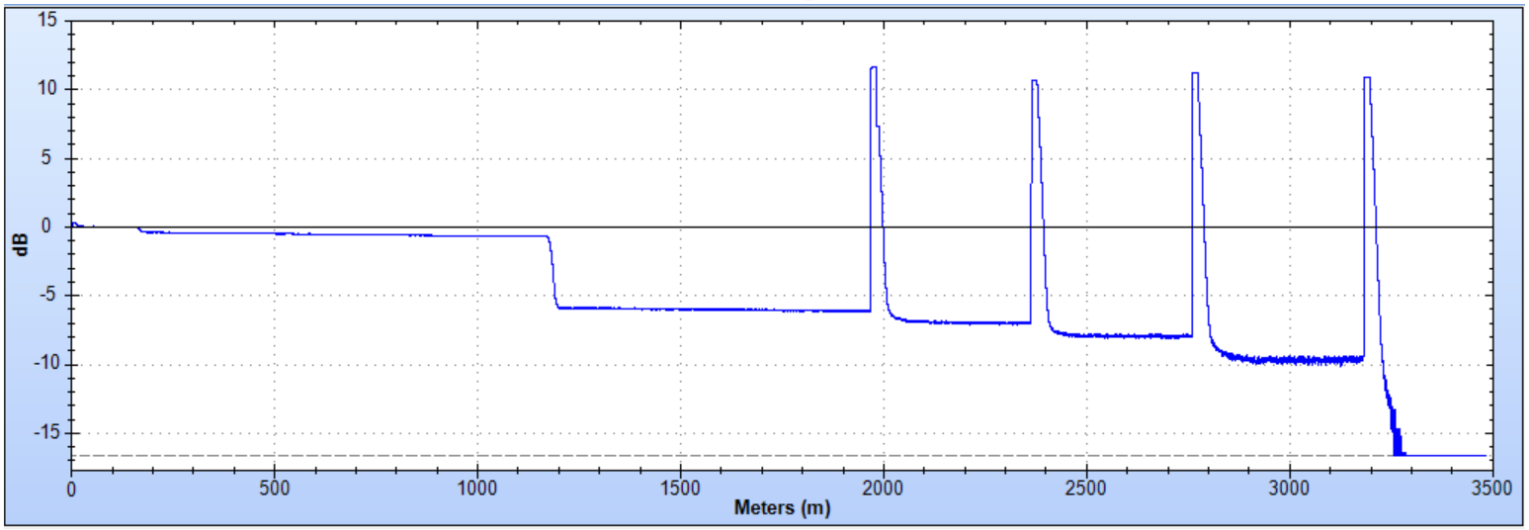
Loss



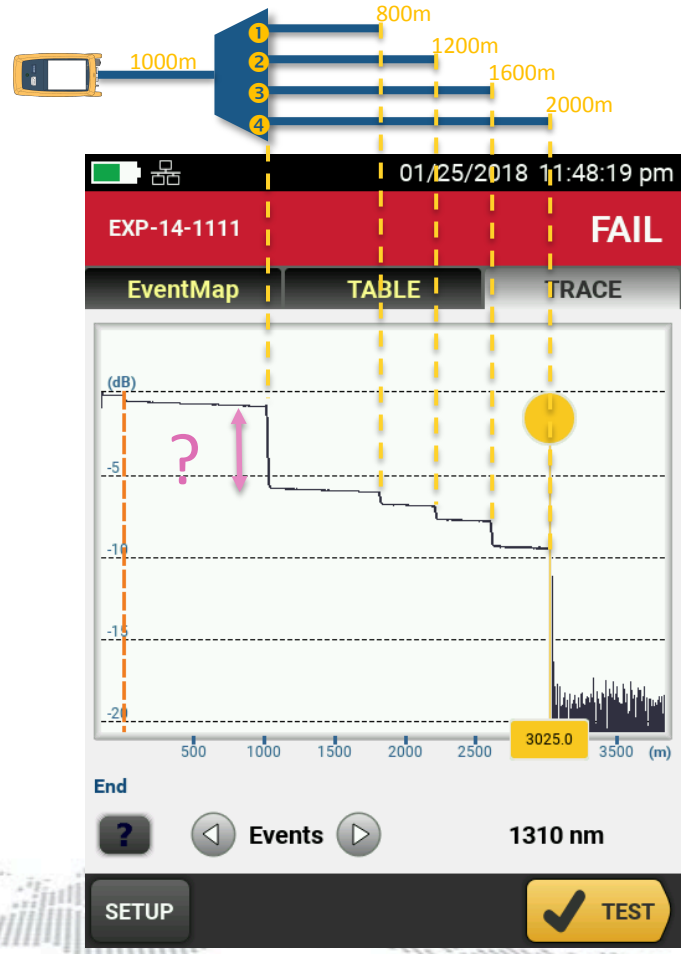

**Length**

# Downstream Testing



# Downstream Testing:
# Is it feasible ?

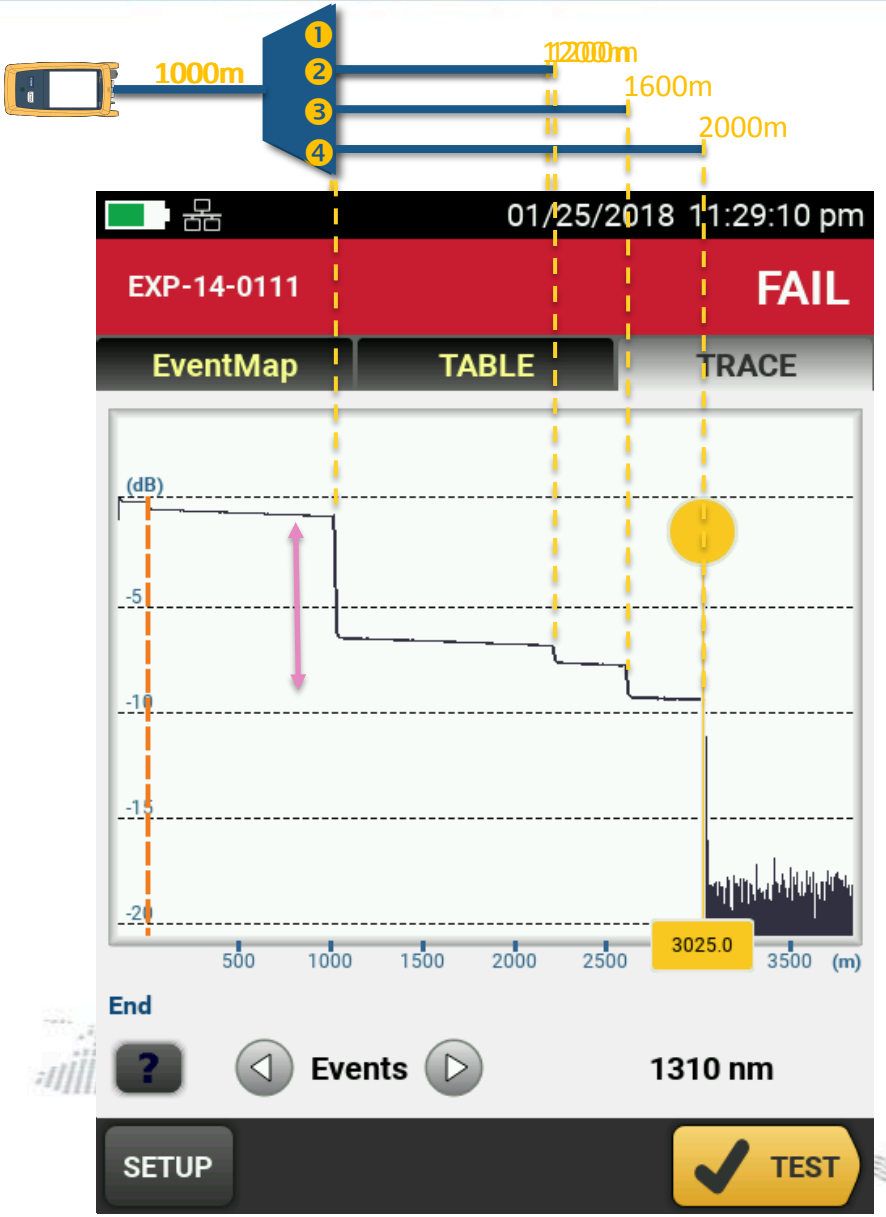


# Downstream Testing: Testing Splitter (1)

## Is it feasible ?

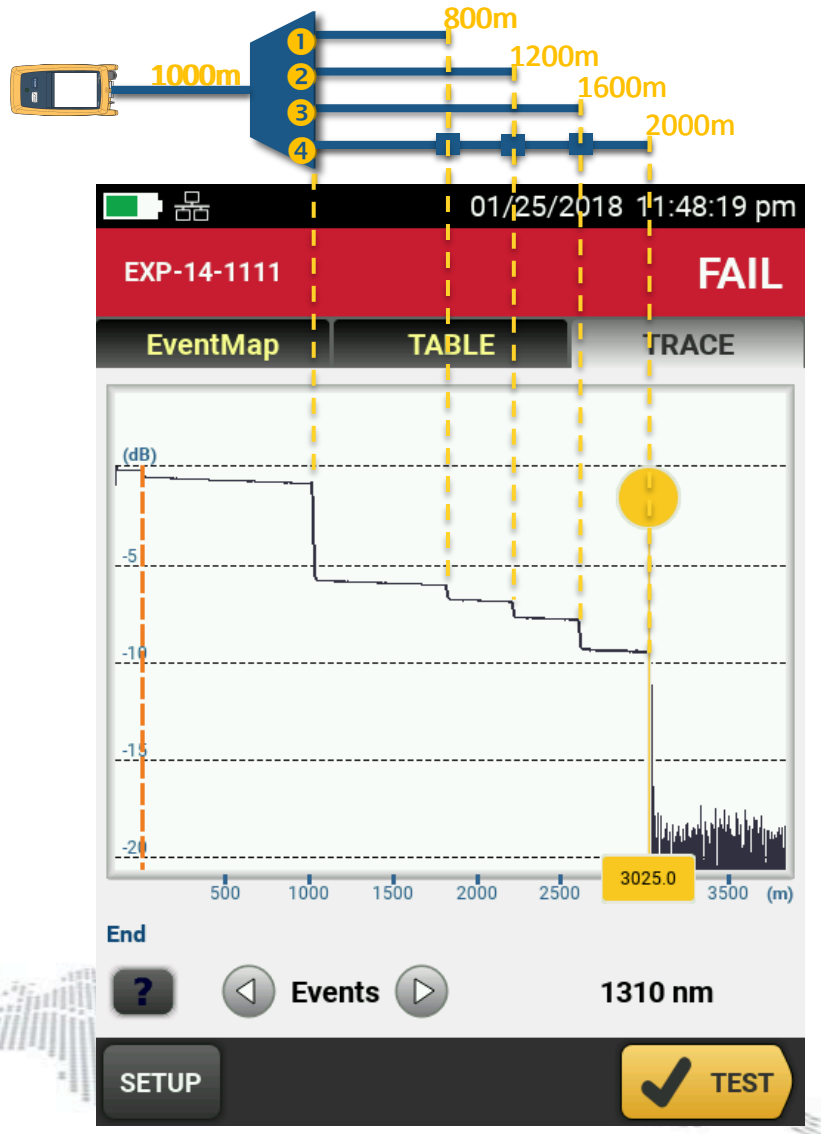
# Downstream Testing: Testing Splitter (2)

## Is it feasible ?



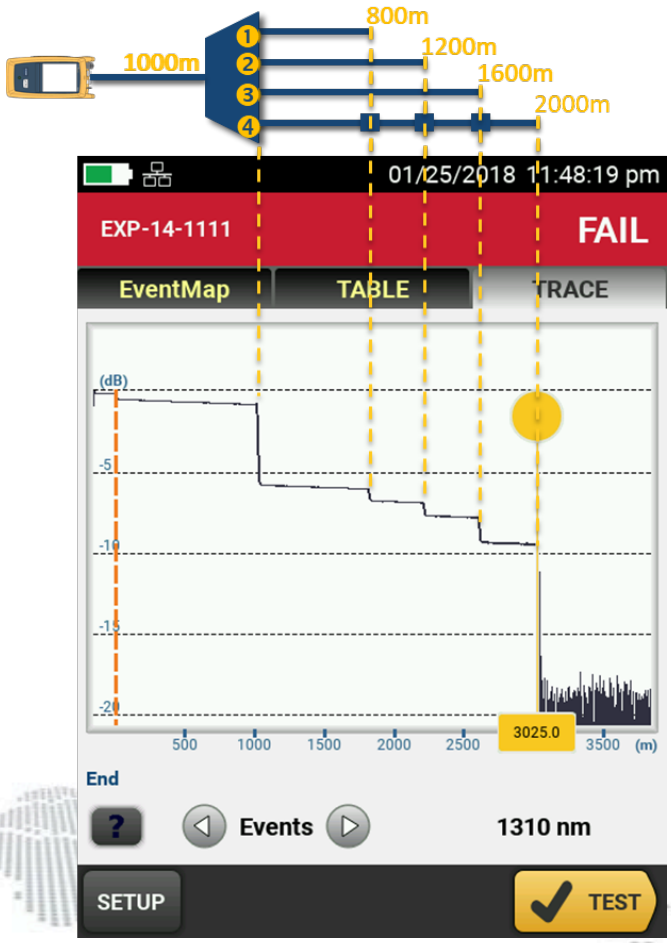
# Downstream Testing: Testing Splitter (3)

## Is it feasible ?

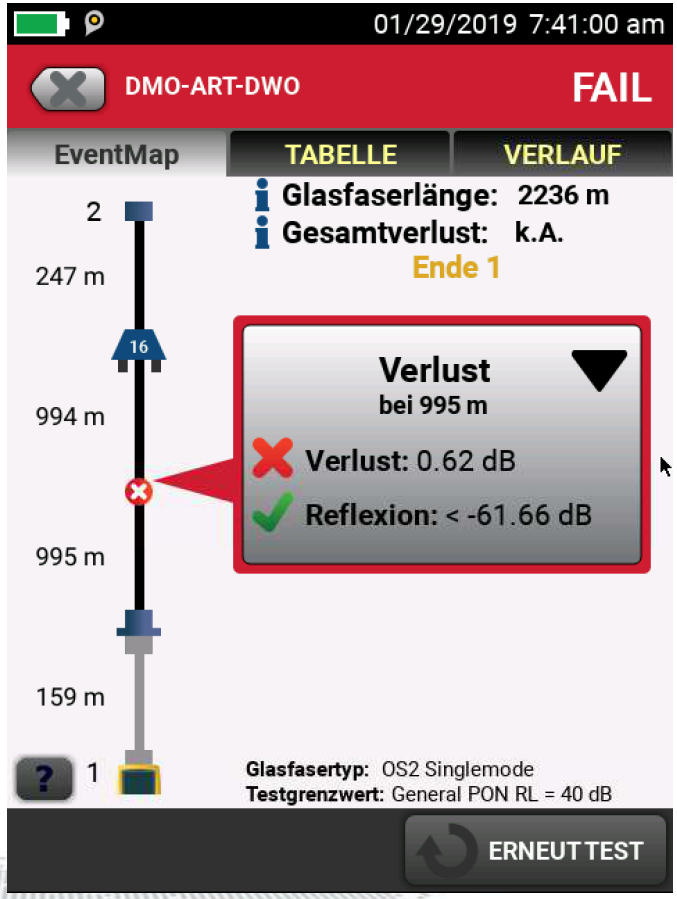


# Downstream Testing: Testing Splitter
## Is it feasible ?

## Only in a few exceptions



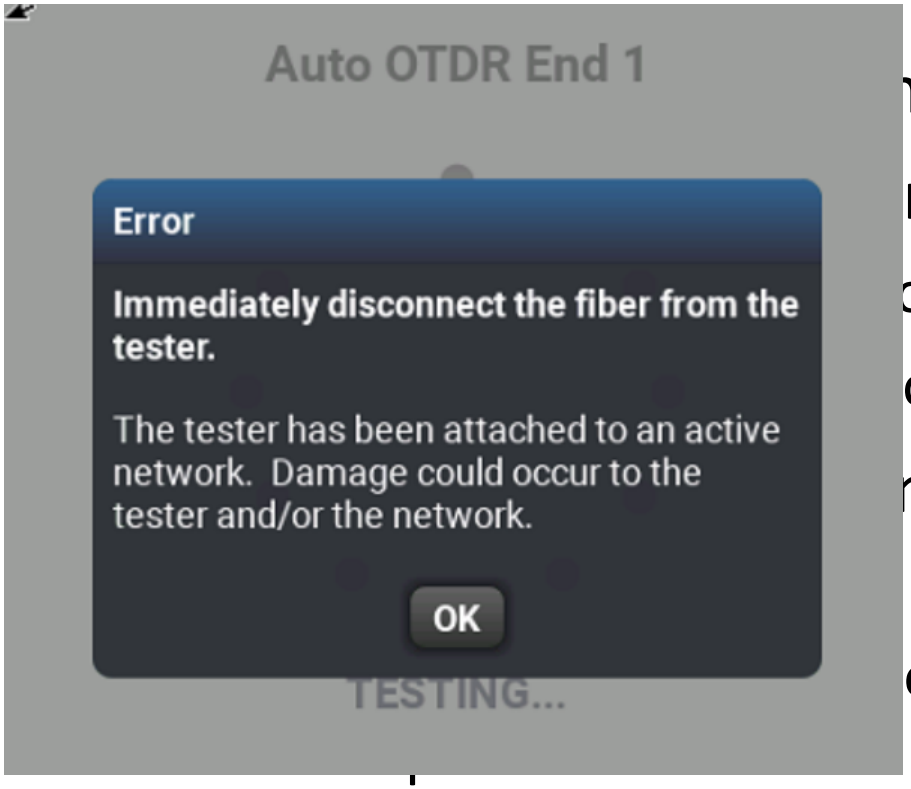
# OTDRs: Can help with the interpretation

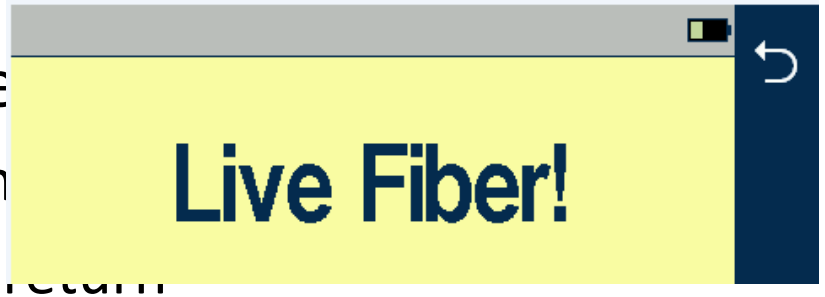


# *IEC 61280-4-3*
# *Testing Method*

# (3) OTDR (In-Band ... Out Of Service)

# Troubleshooting a live network with an OTDR

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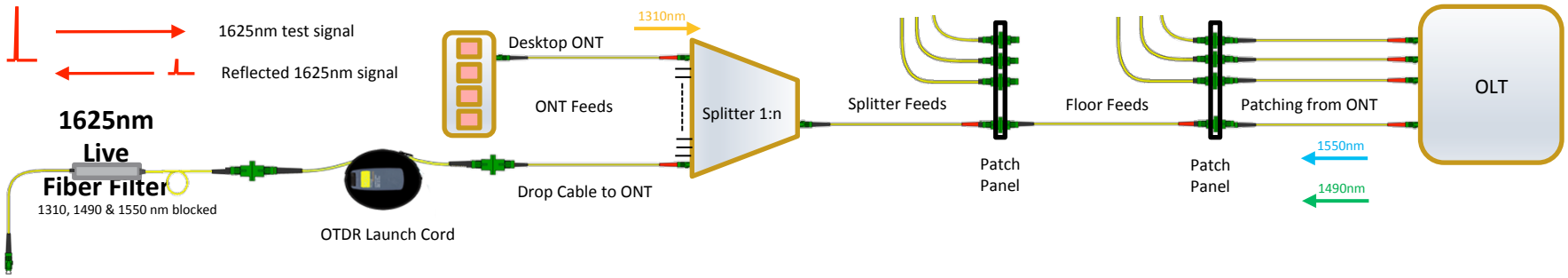
nsmitting on the fiber?

om OTDR transmitted pulse

- Unplug from OLT (and run)
- Unused wavelength – 1625 nm or 1650 nm

# Filtered test configuration for a PO-LAN



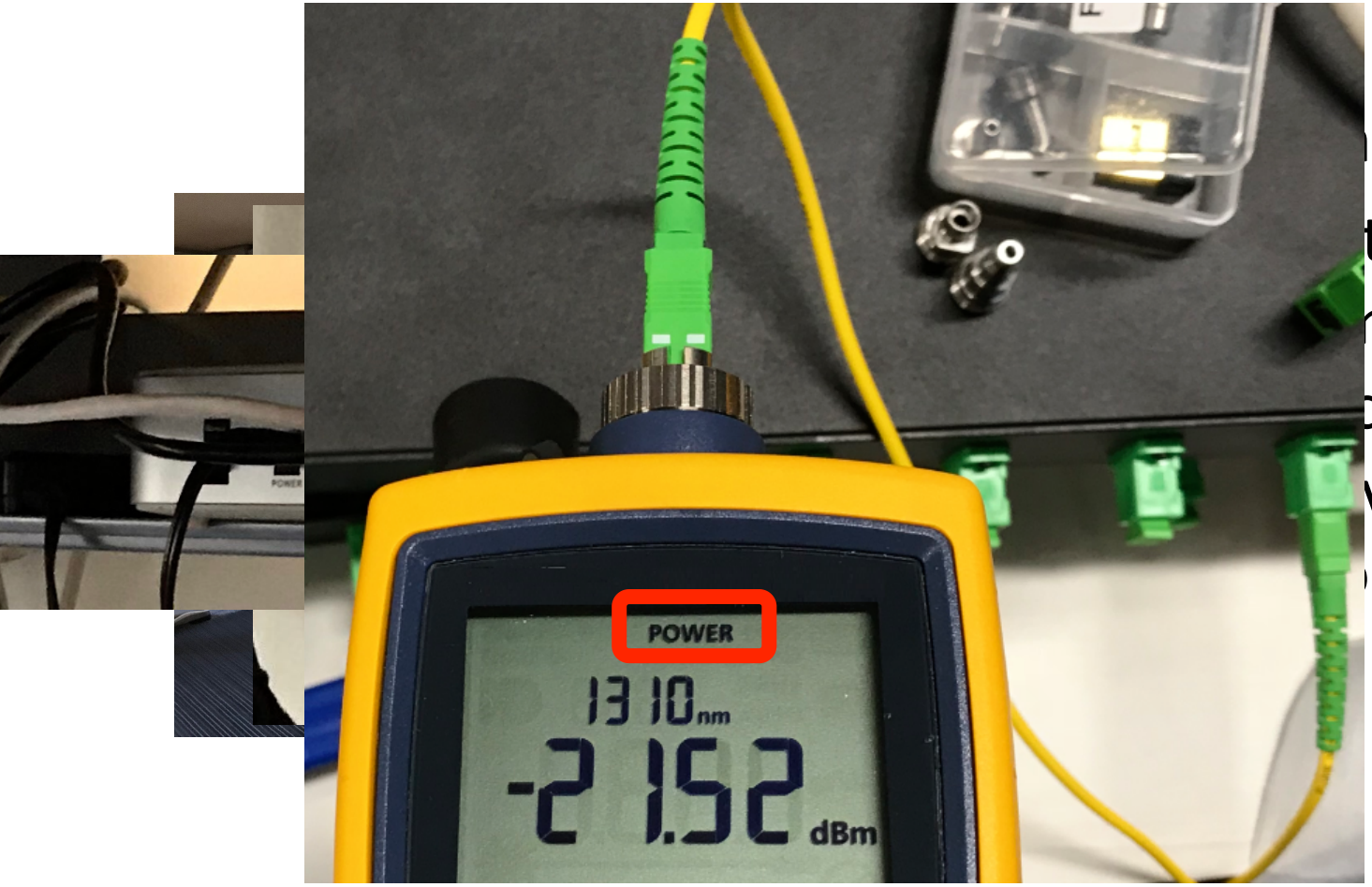

**OTDR**

- When troubleshooting a connectivity issue you need to be able to connect into a live system with an OTDR to troubleshoot without disturbing the system and without the POLAN signals interfering with the OTDRs measurements.
  - A 1625nm **Live Fiber Filter** allows the OTDR to use an out of band 1625nm test wavelength to meet this purpose.
    - 1625nm will not interfere with the active POLAN signals
    - The filter blocks the 1310nm, 1490nm and 1550nm wavelengths from entering the OTDR port, preventing them from interfering with the measurement

# *IEC 61280-4-3*
# *Testing Method*

# (4) Equipment Source & PON PM

# *Example of PON to the desk*




gle fiber

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copper

vity to phone,

p, local WAP,

# *In Conclusion*

- PO-LAN is a valid alternative to pure copper networks
- Many niche markets are appearing
  - Hospitals
  - Hotels
  - Government
- Follow best practices for loss testing
  - One Jumper reference, accurate loss budget
- OTDRs can be used for Troubleshooting
  - Clean the fibers before you connect them!

***Thank You for Your Attention !***

***Questions ?***

***END***