Seminar – Complete FTTH testing solutions

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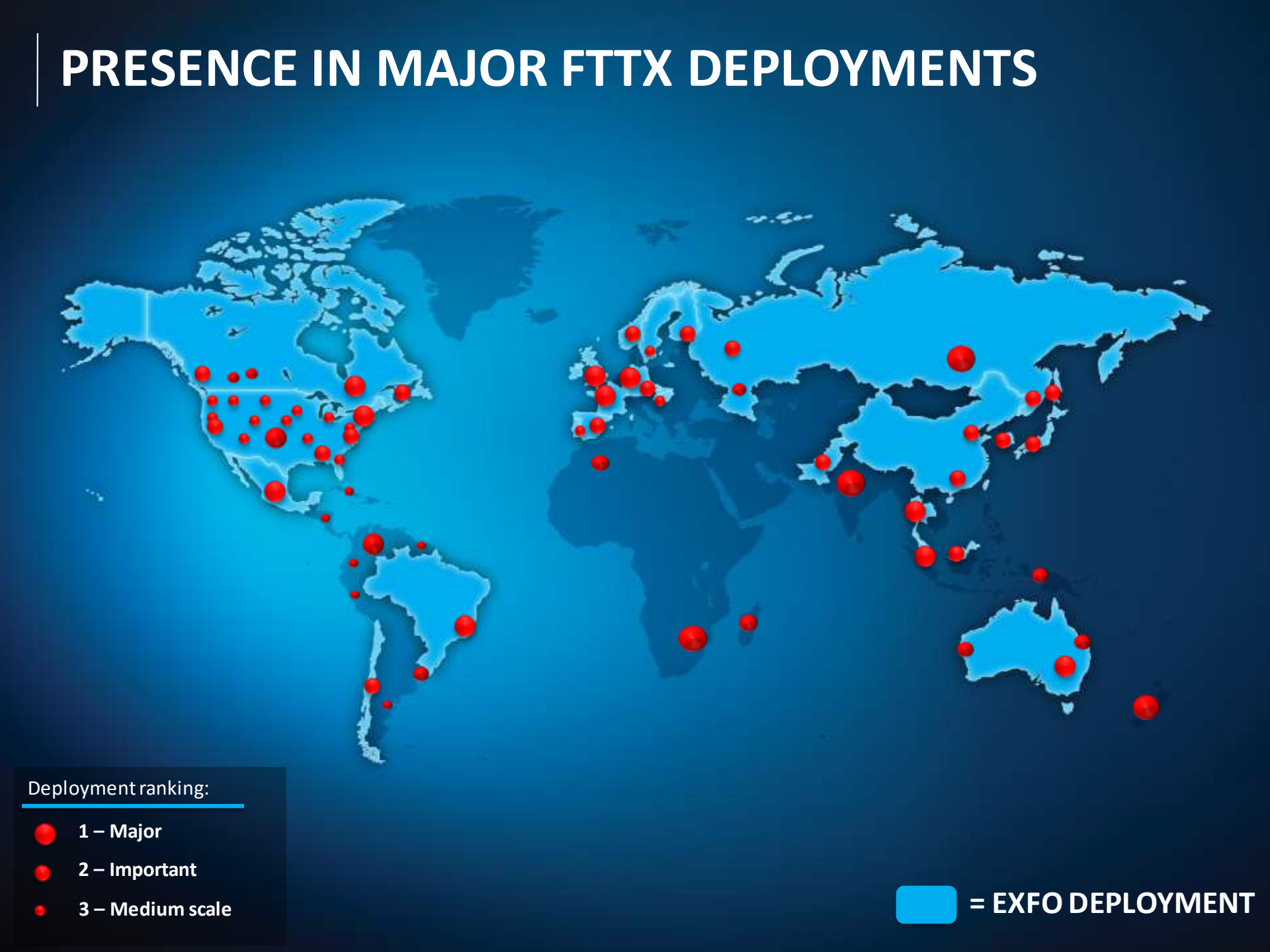
A STRATEGIC PARTNER IN FTTH

EXFO : Telecommunications test equipment manufacturer

No. 1 portable fiber testing OTDR manufacturer

- Present in **+80%** of world's major FTTH deployments
- **20 years** of OTDR expertise, with **the most recognized line of OTDRs** on the market
- OTDR : >45% market share and >125 000 units sold worldwide
- 6th generation of OTDR and iOLM is the future of fiber characterization

PRESENCE IN MAJOR FTTX DEPLOYMENTS



A FEW SUCCESS STORIES

- Verizon FiOS– USA
  - One of the first partner to deploy FTTH
  - Developed tools, process and products with them
- TM - Malaysia
  - FTTH test procedures and best practices
  - Optimized process with contractors
- Telmex FTTH – Mexico
  - Close support with trials, loaners, test procedures, ATP
  - Improved quality of their network, QoE

ETB – Colombia, Chorus – New Zeland, British Telecom – UK, etc…

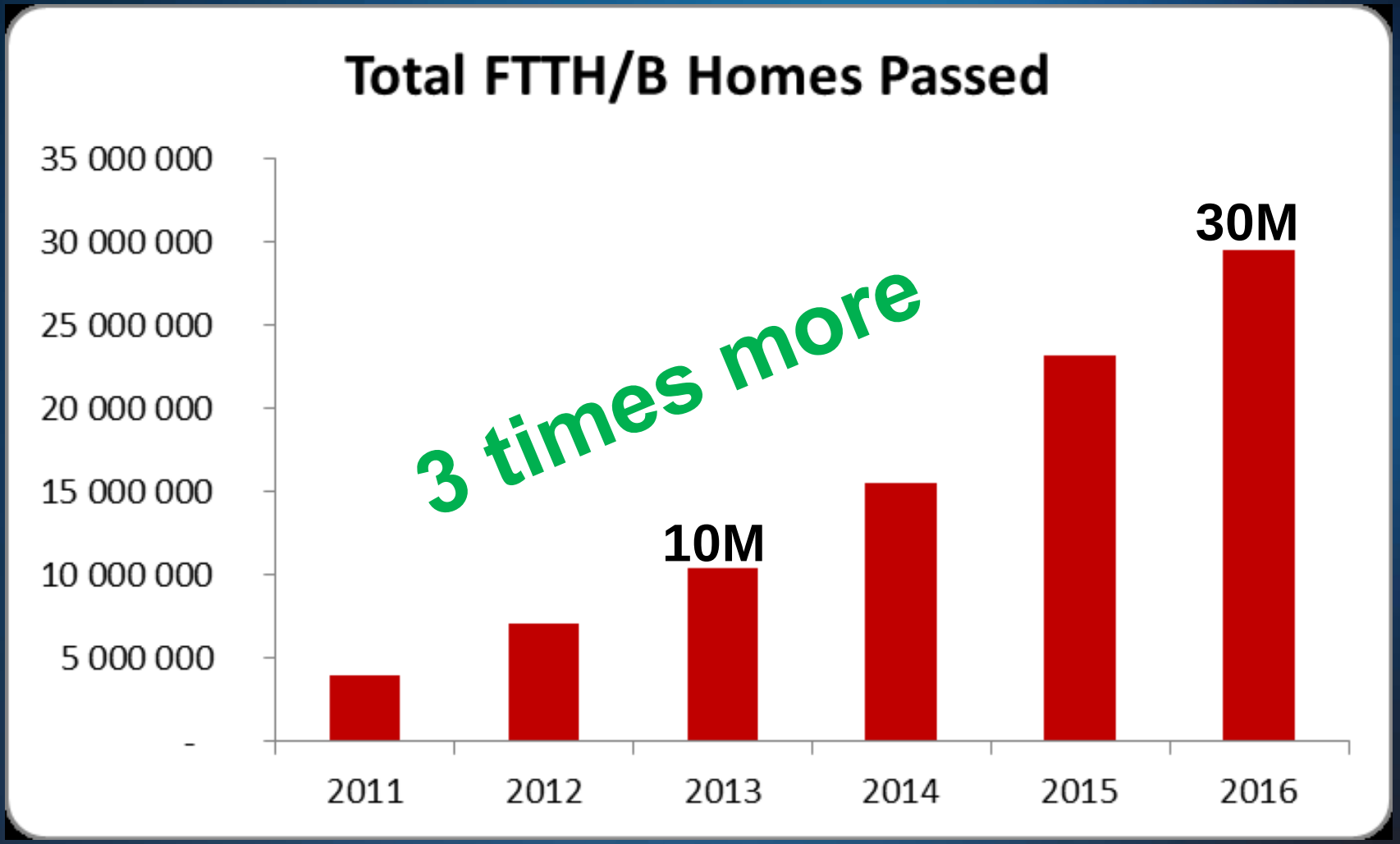
FTTH overview

FTTH HIGHLIGHTS

- +100M homes to connect by 2017
- 2014-2017 CARG +20% subscribers
- 5G$ in revenues for PON equipment
- Lots of investments planned in CALA/Asia FY14

Source : Infonetics 2013

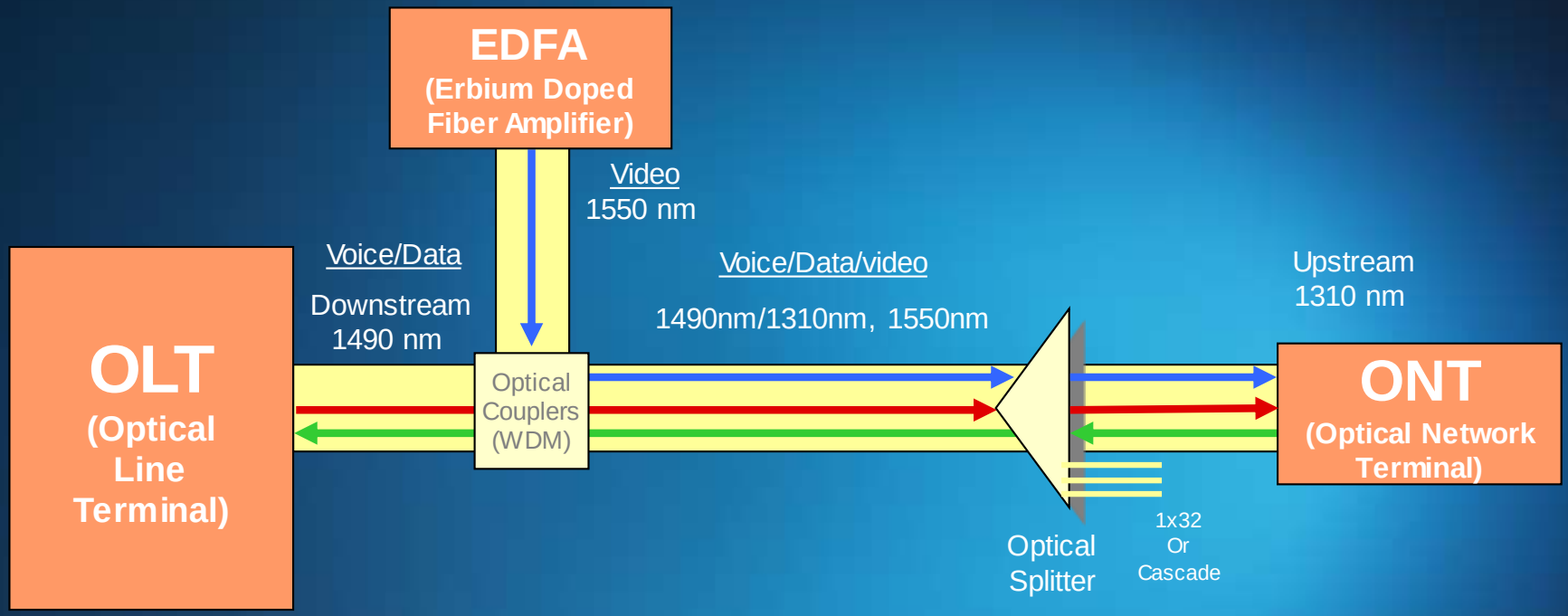
FTTH LATAM DEPLOYMENTS



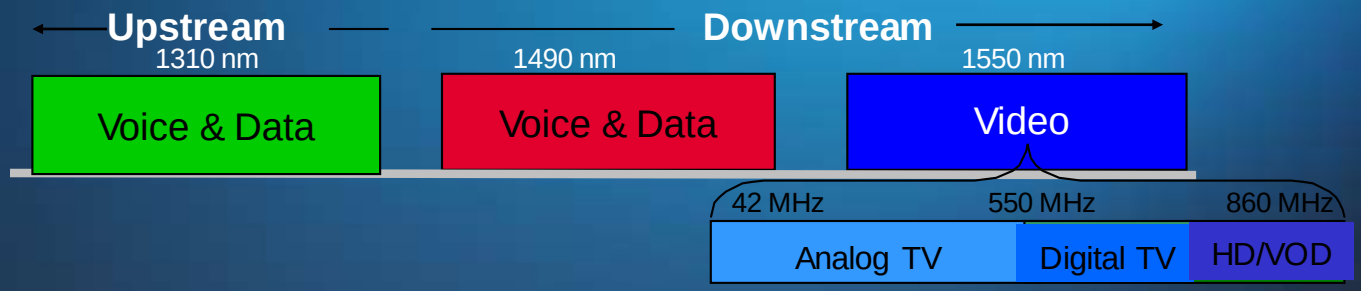
Source : Infonetics 2011

FTTH network topologies

Basic PON architecture

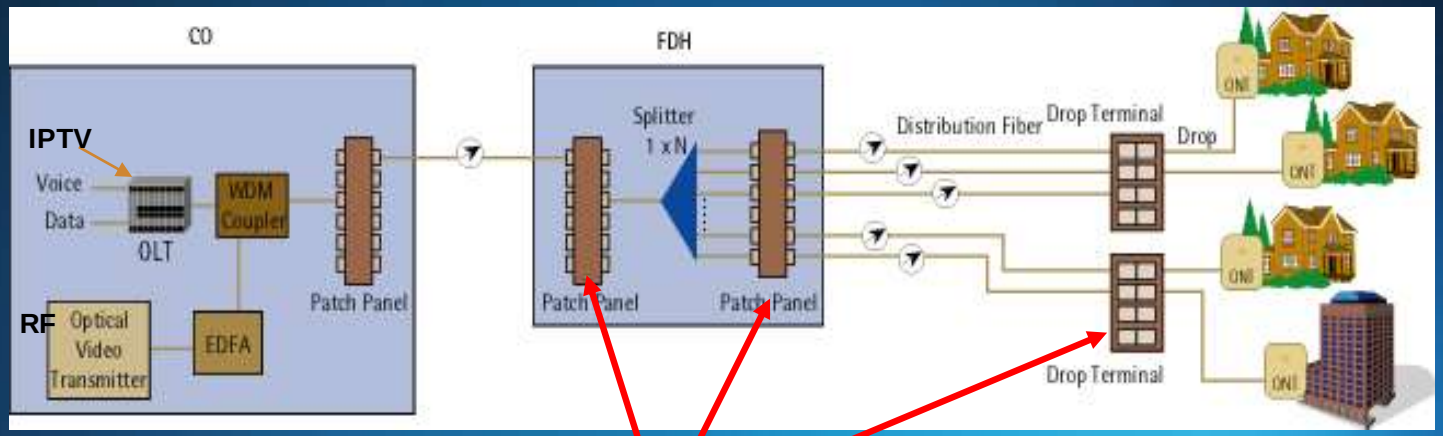


Anchos de banda y servicios



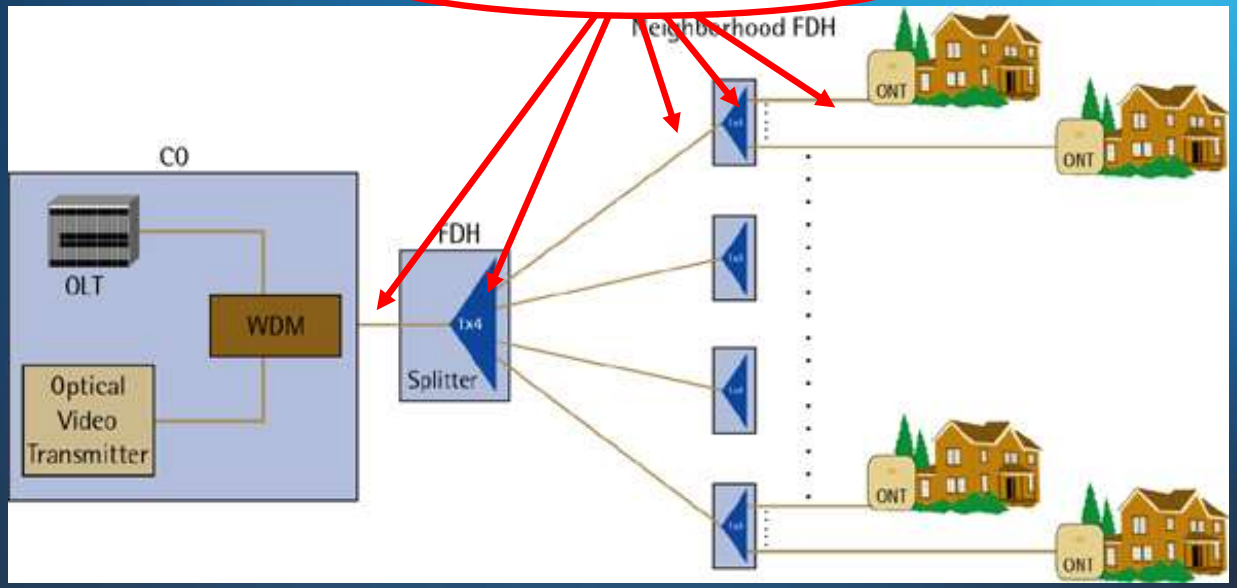
Typical topolgies:

1-stage splitter

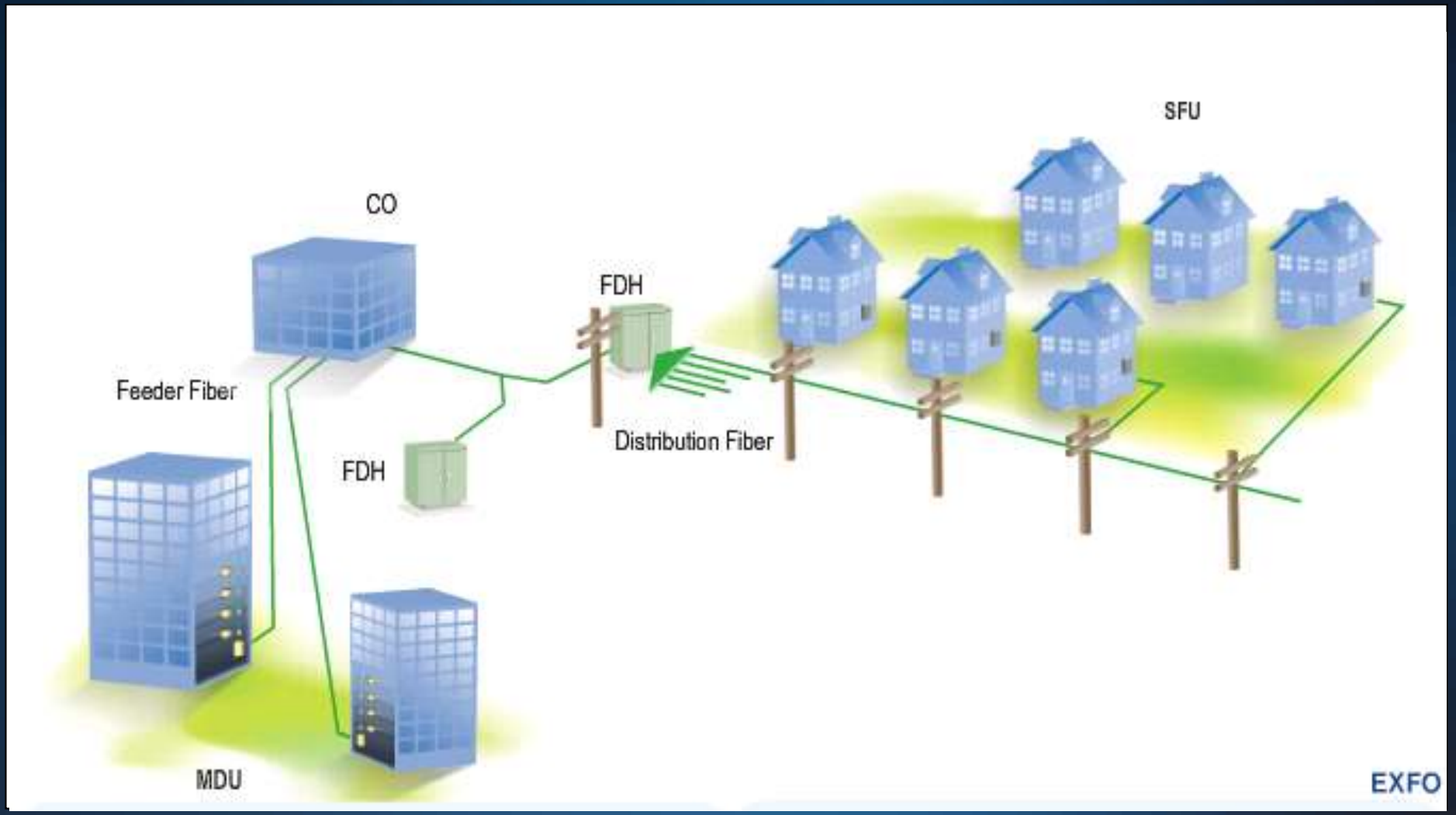


Connectors or splices

2-stage splitter



Typical topology -- FTTH / MDU



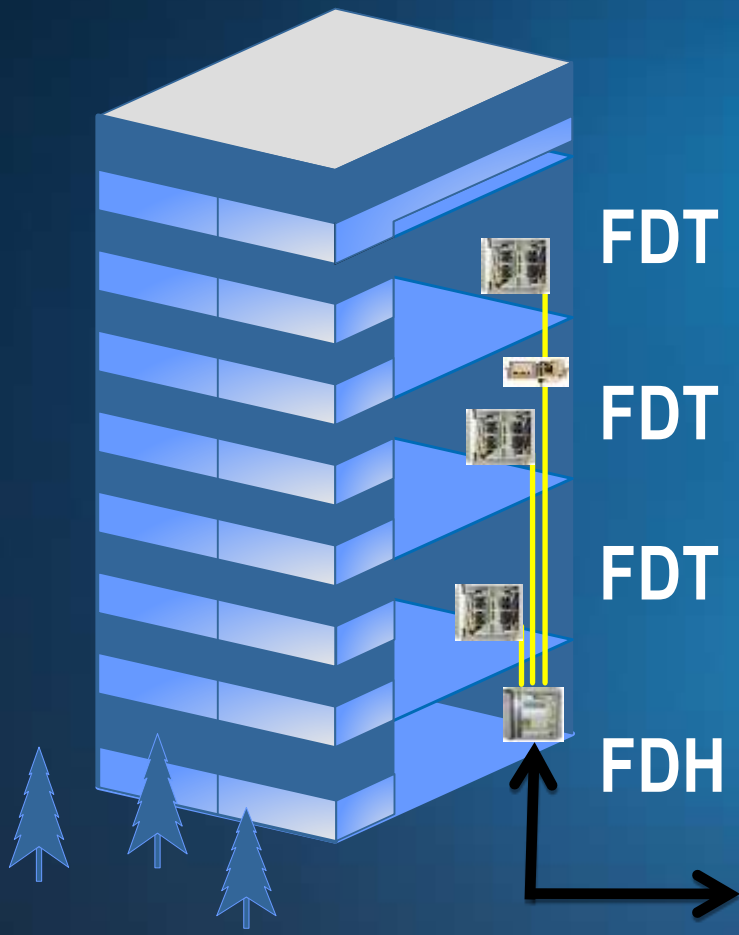
More information available on EXFO's Expertise Hub

New architecture trend: FTT-MDU

- Fast deployment - pre-engineered and connectorized solutions
- Fast ROI - accelerated construction schedule and take rate
- Seamless installs - New bend insensitive fiber (G657)
- Multi-fiber connections - MTP/MPO
- Interior components - Cabinets, Terminals, Fiber moldings

FTT-MDU - high-density reach

High/Medium-Rise MDU



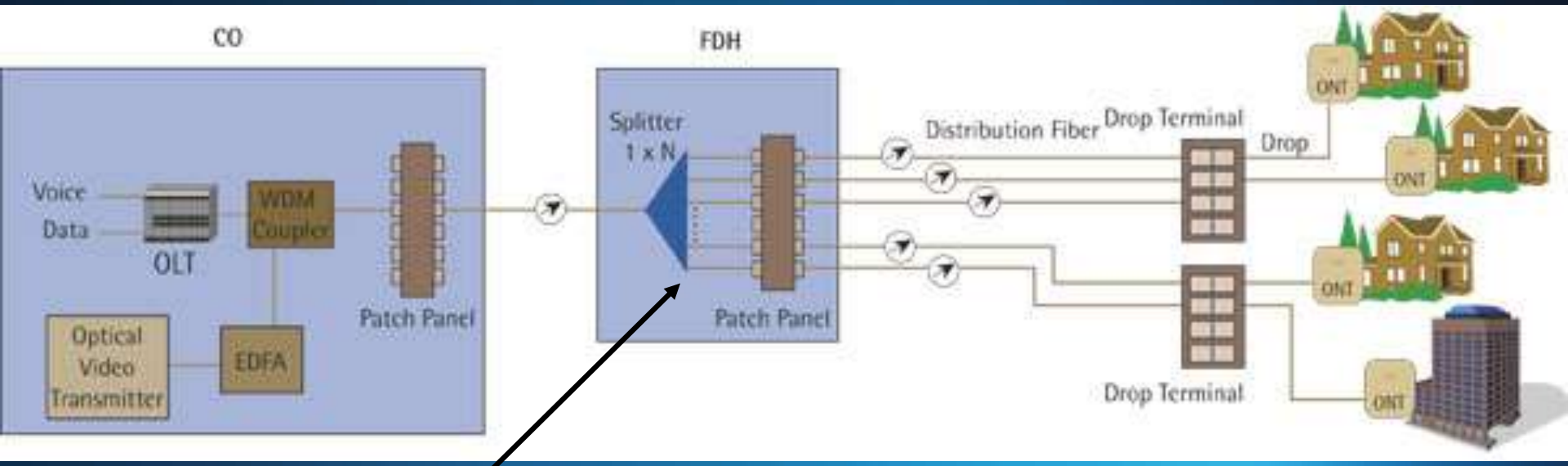
Fiber collector

Fiber Distribution Terminal
FDT

Riser Cable
Ribbon or multiple fiber

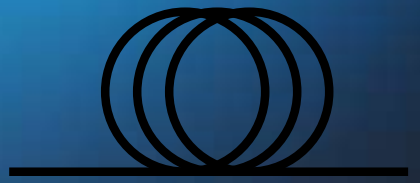
Fiber Distribution Hub
FDH

PON Split ratio and typical loss



Splitting Ratio	IL (dB)
1x2	3,6
1x4	7.7
1x8	10.8
1x16	14.5
1x32	18

≅ 0.3 – 0.5dB
Per connection

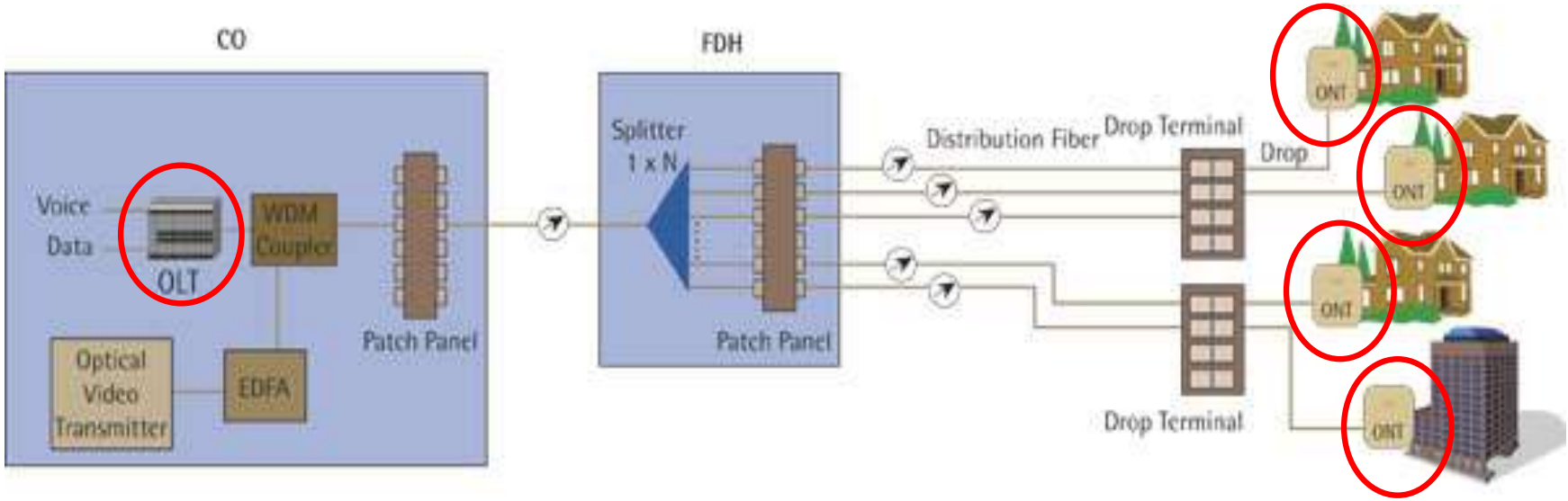


≅0.35dB/km 0.22dB/km
At 1310nm at 1550nm

FTTH PON—Active Equipment

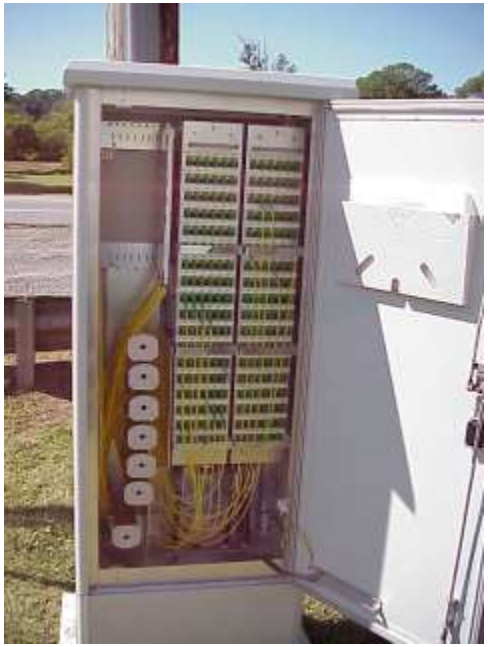
Optical line terminal (OLT)

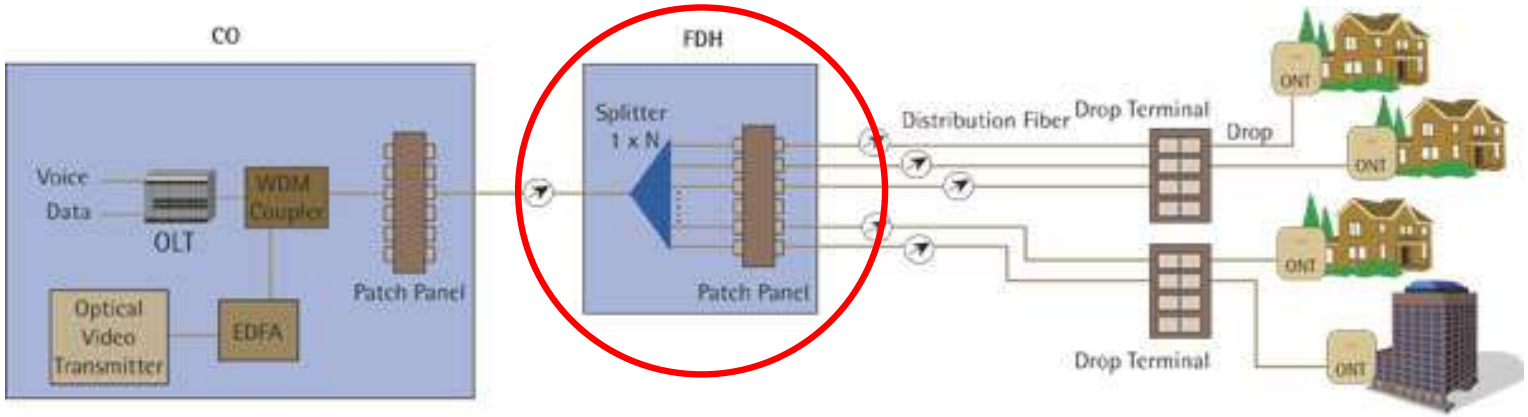
Optical network terminal (ONT)



FTTH PON - Passive Equipment

- FDH Enclosures:



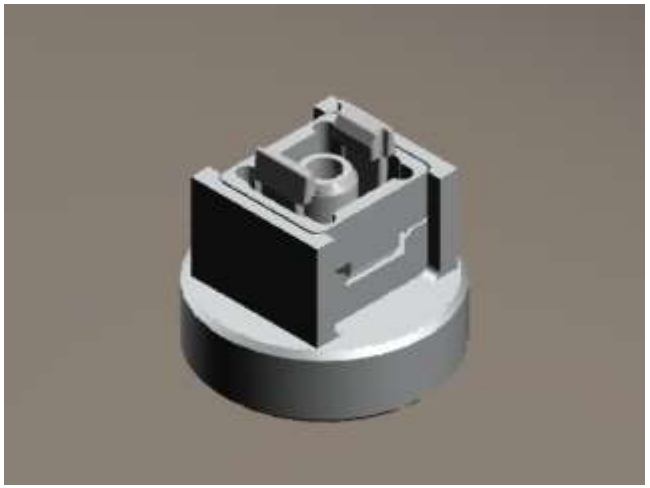


Special Connectors at Drops

- Rugged cables for last portion from drop to ONT will require special fiber optic adapters

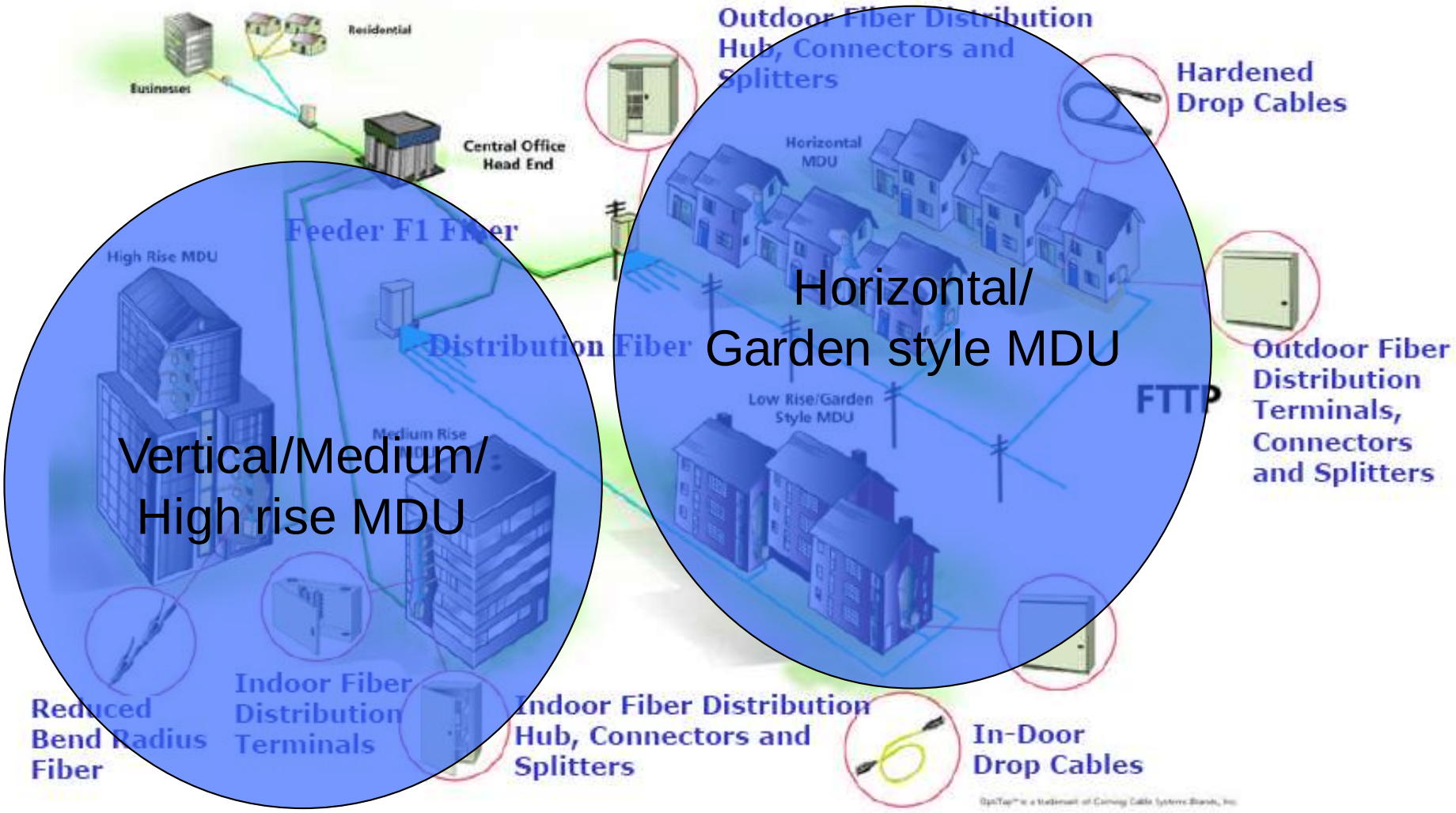
OptiFit Advantage Cable Assembly Drop Cable (Single-Fiber) | Photo CCA190

Example: Corning Optifit®



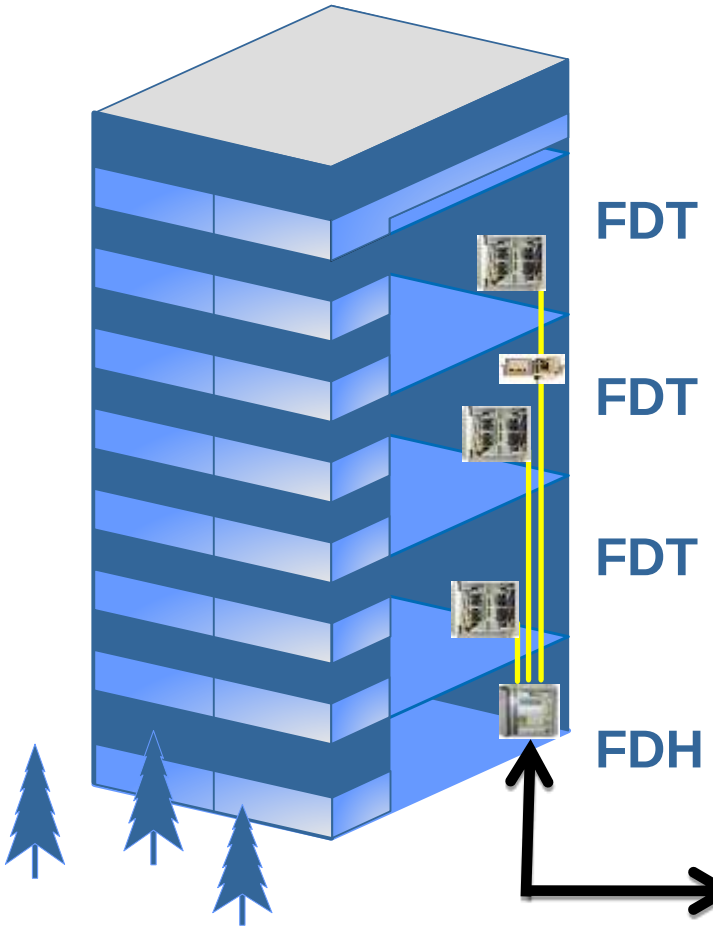
EXFO FTTH FOA

New architecture trend: MDU's



New architecture trend: MDU's – High density !

High/Medium-Rise MDU



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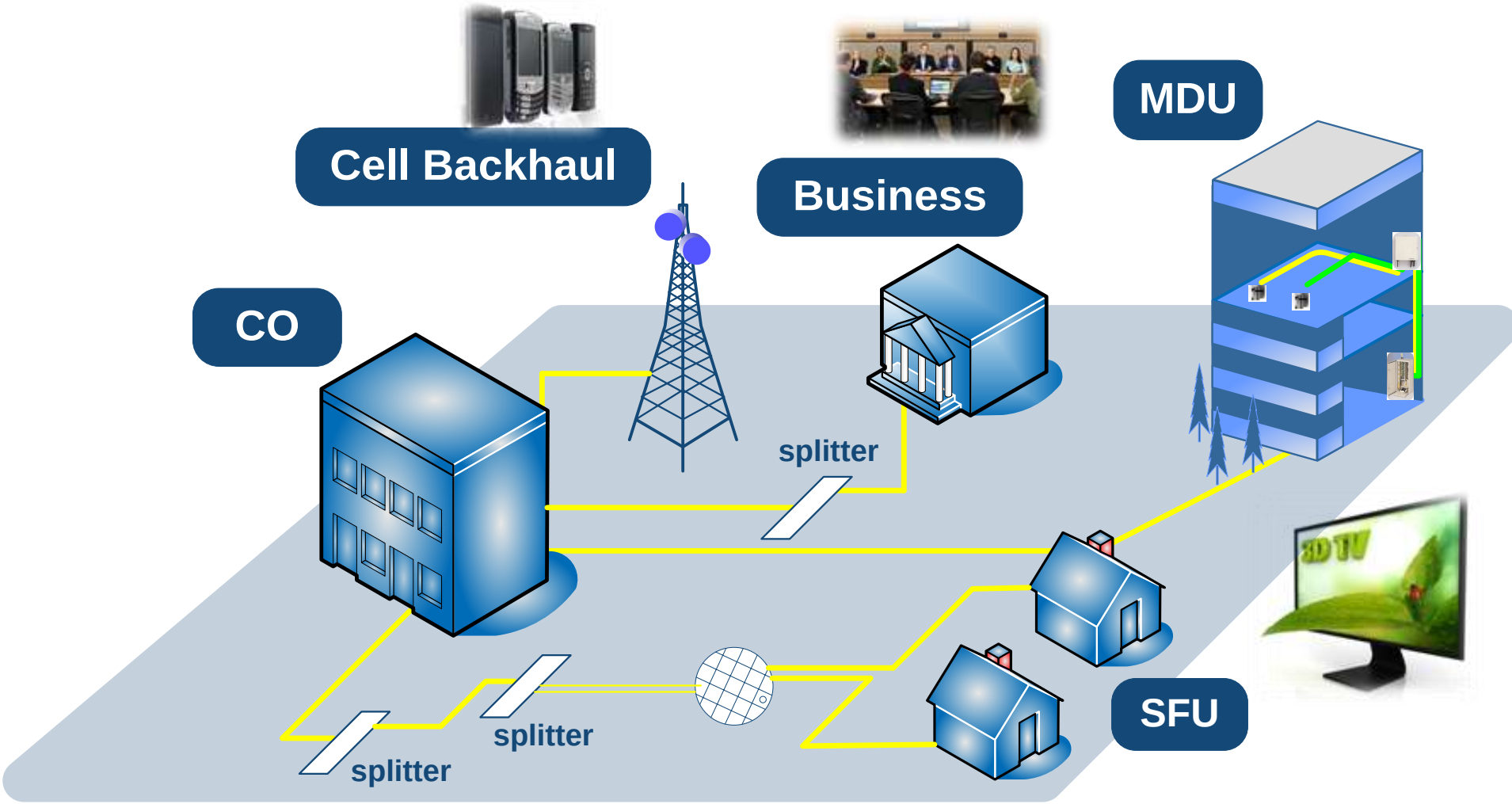
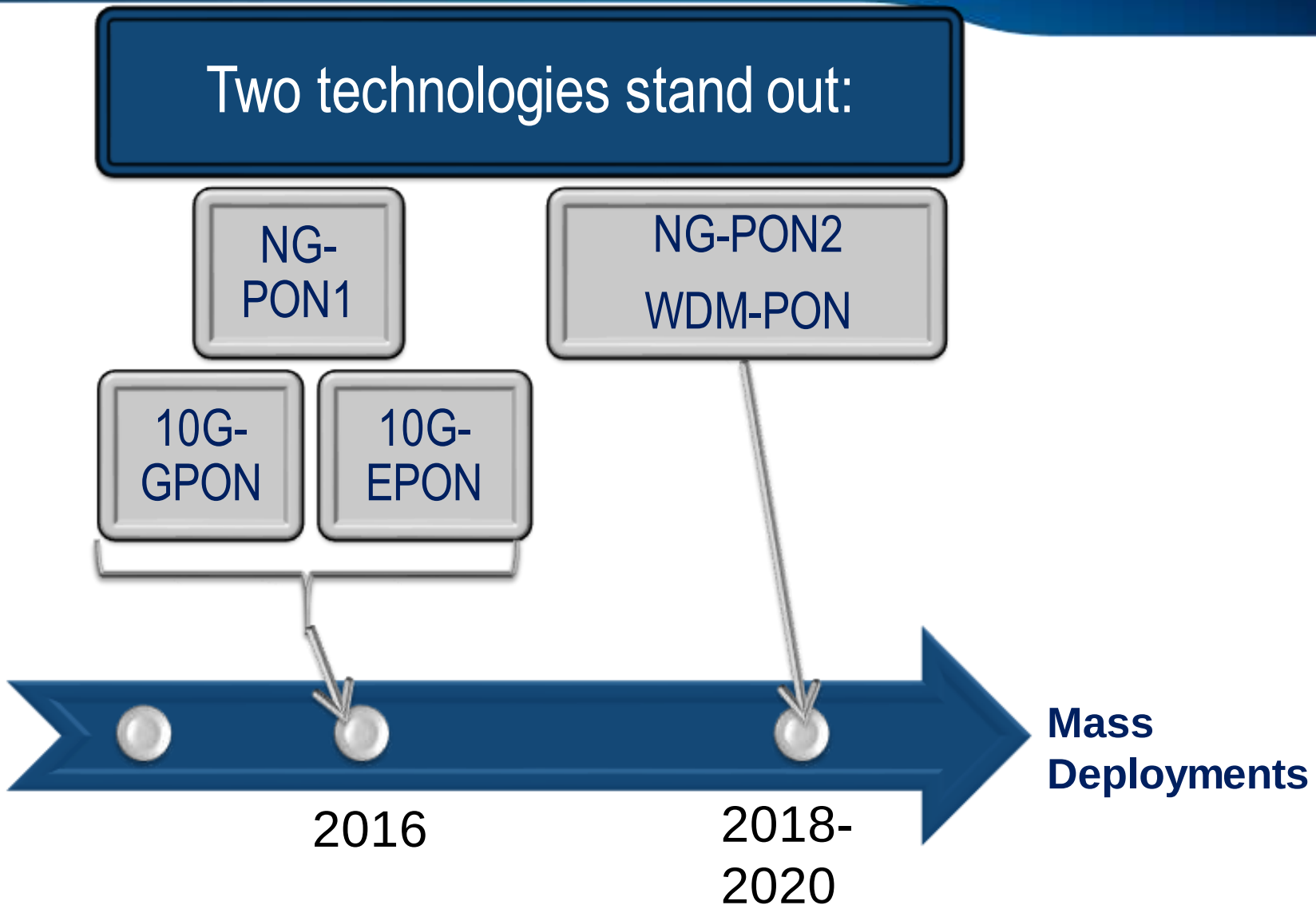
Fiber Distribution Hub
FDH

FTTH : The evolution

FTTH Next Gen PON

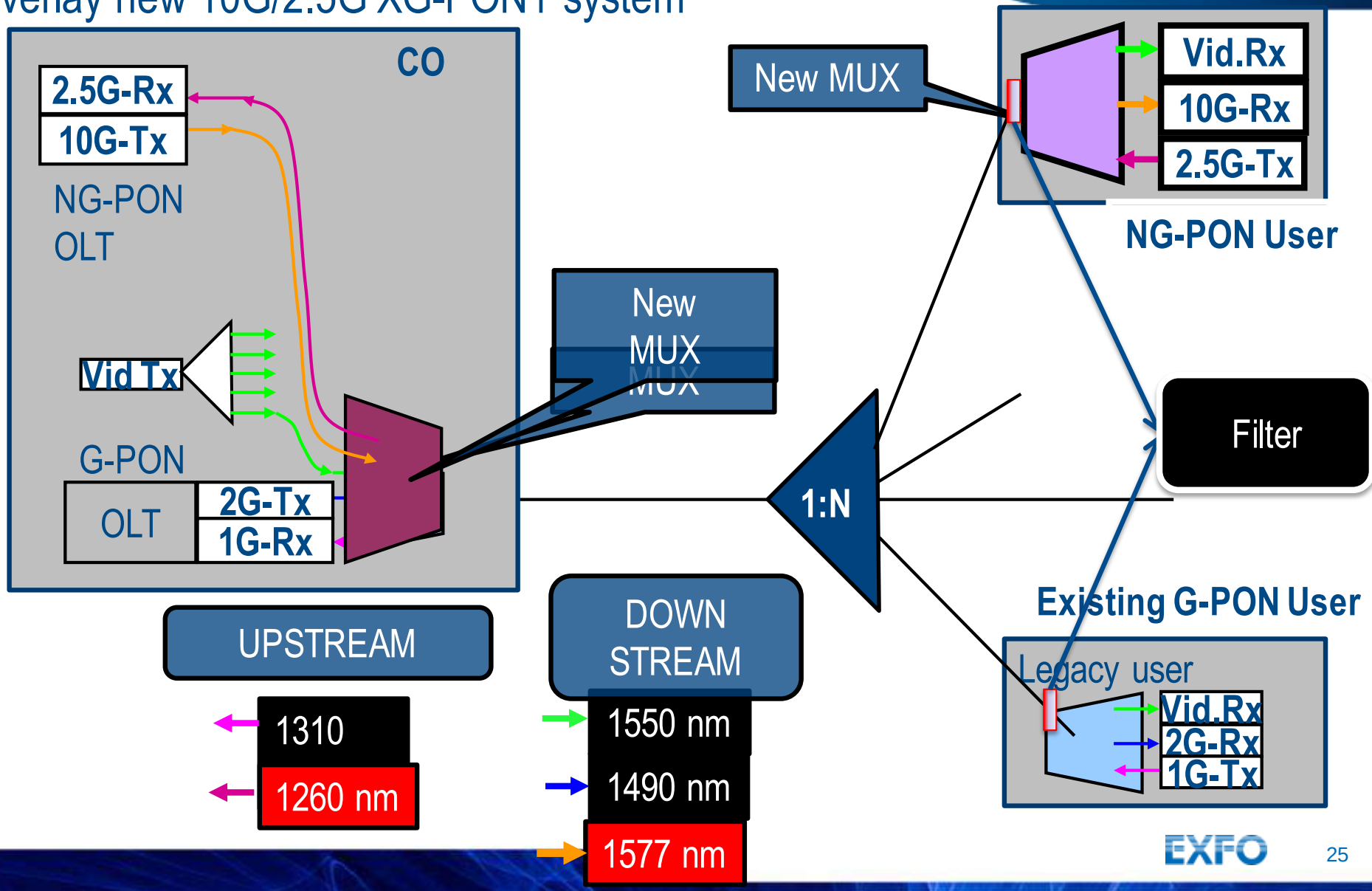


FTTH Next Gen PON



FTTH Next Gen PON

Overlay new 10G/2.5G XG-PON1 system

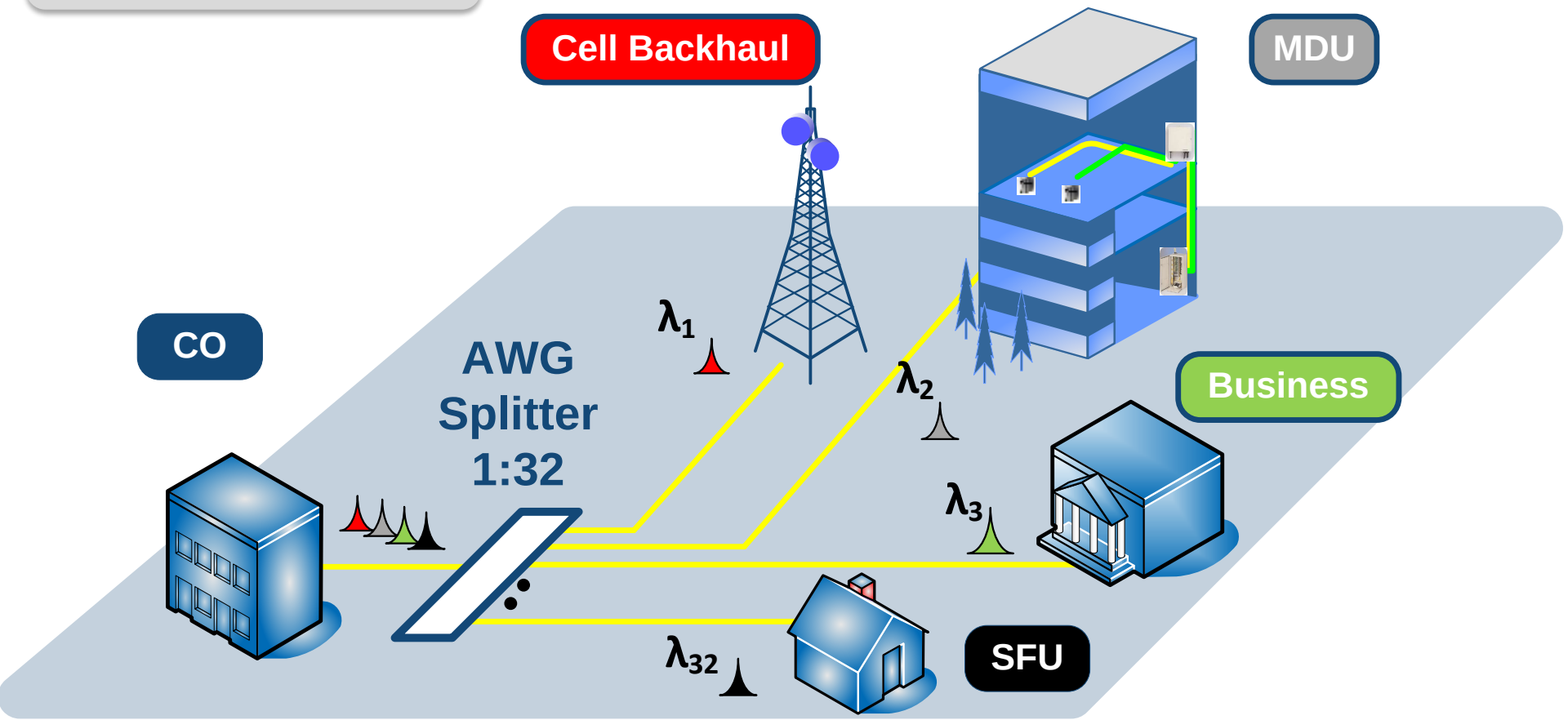


FTTH Next Gen PON

Items	EPON IEEE 802.3av	GPON ITU G.987
Upstream speed	•1 Gbit/s (asymetric) •10 Gbit/s (symmetric)	•2.5 Gbit/s XG-PON1 •10 Gbit/s XG-PON2 is for future study
Downstream speed	10 Gbit/s	10 Gbit/s
Loss budget	20 dB to 29 dB	29 dB to 31 dB (Nominal class)
Wavelengths	Down: •10 Gbit/s transmission using 1575 to1580 nm Up: •1 Gbit/s band spreads from 1260 to 1280 nm	Down: •10 Gbit/s transmission using 1575 to1580 nm Up: •2.5 Gbit/s band spreads from 1260 to 1280 nm
Split ratio	Up to 1:32	1:32 / 1:64 (1:128)
Fiber distance	20 km	20 km

FTTH Next Gen PON

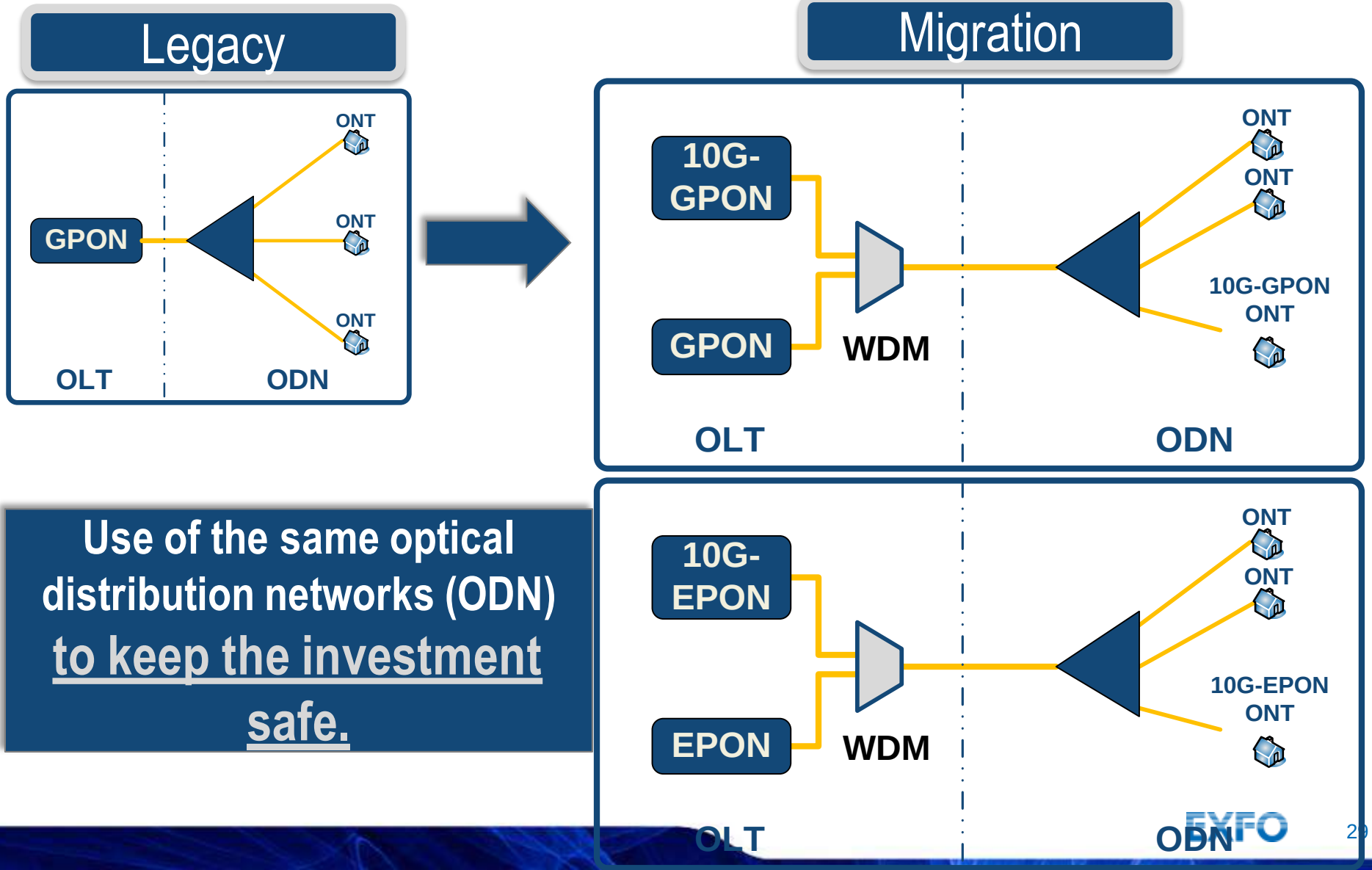
WDM-PON



FTTH Next Gen PON

Items	WDM-PON
Upstream speed	Virtually no limits E.g., 1 Gbit/s per user
Downstream speed	Virtually no limits E.g., 1 Gbit/s per user
Loss budget	T.B.C
Wavelengths	T.B.C E.g., DWDM in C-Band
Split ratio	T.B.C E.g., 1x32
Fiber distance	T.B.C. E.g., 50 km
Standard	Possibly 1 to 2 years from now

FTTH Next Gen PON



Use of the same optical distribution networks (ODN) to keep the investment safe.

FTTH Network construction

Different requirements

Your challenges – We know.

TESTING CHALLENGES

Copper to fiber migration

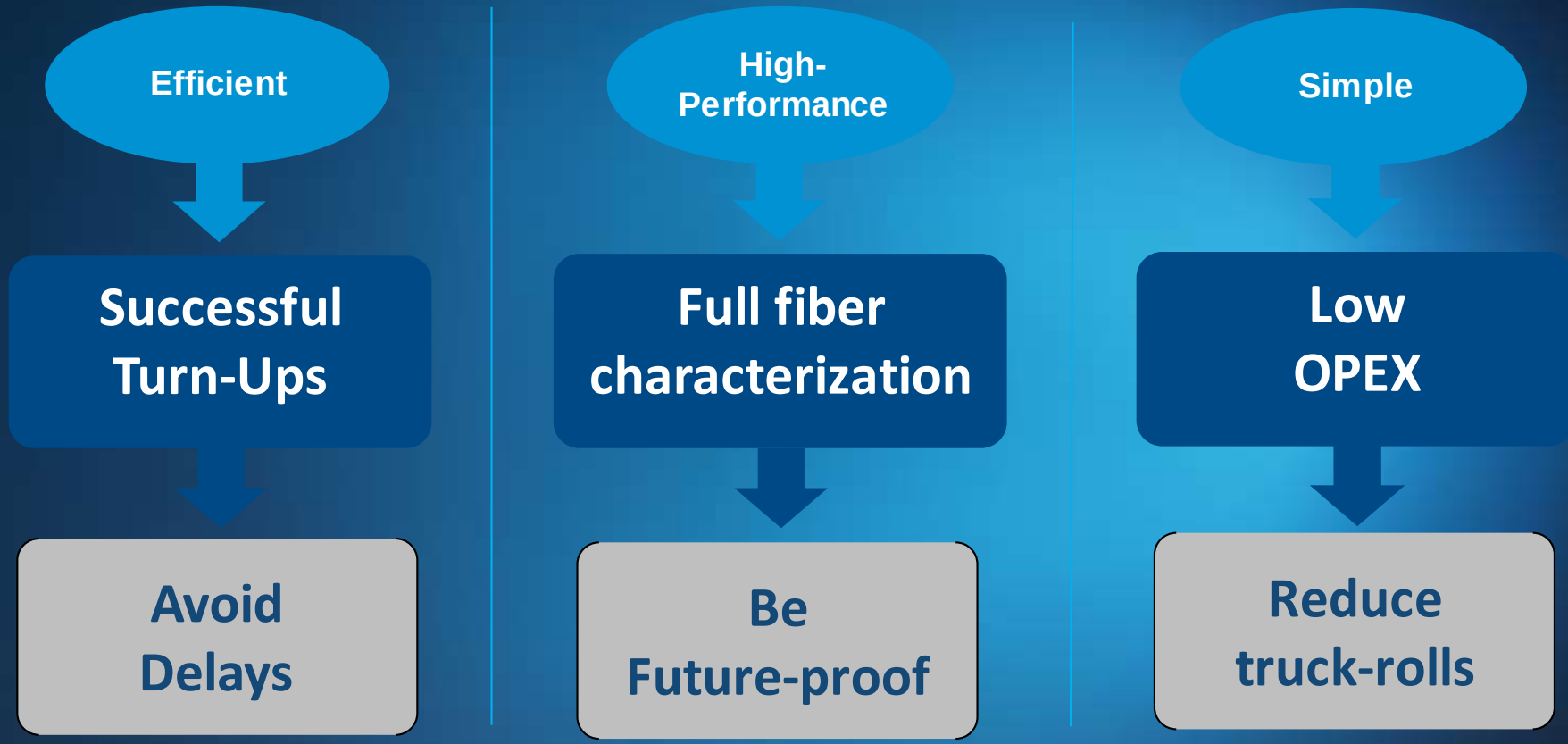
Expertise level

Mix of contractors

High OPEX

Limited Budget

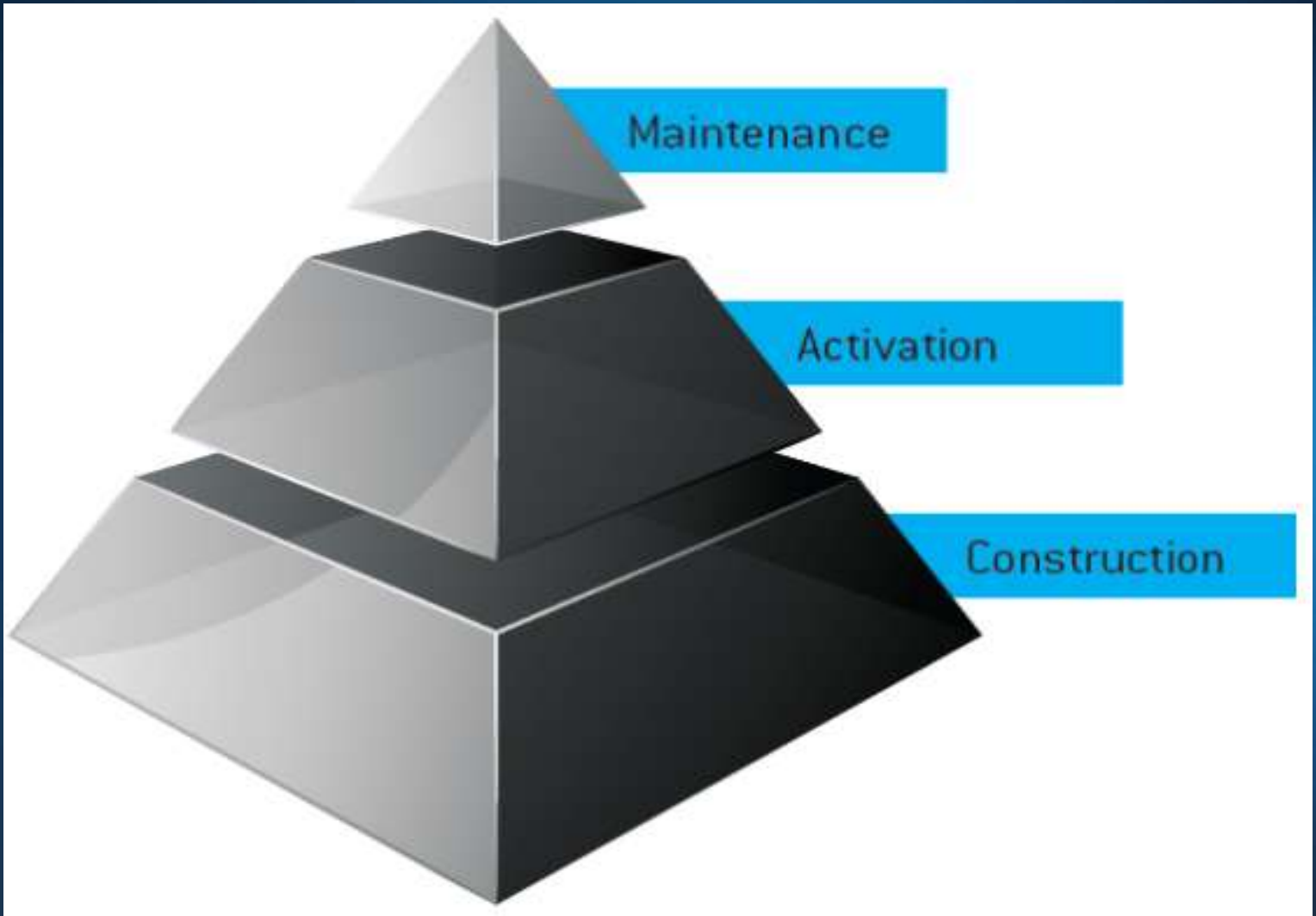
TESTING OBJECTIVES



Avoid the pitfalls!

- "It's plug'n play !"
  - NSPs are told there is no need to test
- "We had No problems in trials !"
  - controlled environment, known technicians, field trials with aware clients/employees
- "We don't know what's next !"
  - Invest today in deploying healthy networks and be future-proof

3 phases



What needs to be tested?

- optical power budget (end-to-end loss)
- Optical power levels at ONT
- Connectors cleanliness
- Componant insertion loss (IL)
- ORL and reflectance
- Macrobends

Why testing in construction ?

- To qualify the outside plant section of the network and document for future references
- To make sure it meets transmission-system requirements (standards)
- To avoid delays and costly repairs when the system is turned-up

Why testing in service activation?

- Power Level Assessment of active components
- Service Activation Reporting
- Ensure Quality of Experience (QoE) and successful turn-ups

Why testing ORL ?

- **Strong fluctuations in laser output power**
- **Potential permanent damage to the OLT**
- **Higher bit-per-error rate (BER) in digital systems**
- **Distortions in analog video signals**

Important:
Measure ORL in the same direction as the transmission of the 1550 nm video signal.
ORL is direction dependant

Testing at 1490nm in FTTx

1490 increases CAPEX and OPEX without ROI

- Very low added-value with 1310/1550 results (CAPEX ++)
- 1625 nm measurement in construction is a added-value when used in template mode for troubleshooting
- 1490nm has lower dynamic range and requires more averaging time (OPEX ++)
- Management of three wavelengths test data (OPEX ++)

Troubleshooting a live network

- **When 1 customer is connected to FTTH, all outputs are active with signals**
- **OTDR SM Live port using 1625nm or 1650nm (out-of-band)**
- **Filtered port to block the incoming signal**
- **Does not interfere with the other active users on the network**

Troubleshooting a live network

FiberFinder TM

- No need to change heads, self-adjusts the bending radius; No risk of creating excessive loss and cut signal
- Guaranteed IL below 1dB; Safe to use on PON or high speed network
- Self adjustment to fiber size and type (G652 & G657A)

Here is why testing is required!

A real case study from a FTTH service provider in China
In one month, 600 000 home passed in a dense city area

Problem types	Qty	Qty12M	Notes
ONU failures			
OLT failures			
ODN failures (fiber related)			

Here is why testing is required!

A real case study from a FTTH service provider in China
In one month, 600 000 home passed in a dense city area

54%

- **FAILURES ON SPLICES AND CONNECTORES**

characterize properly during construction

16%

- **FAILURES FROM SPLITTERS**

importance of testing through the splitter

Connector inspection

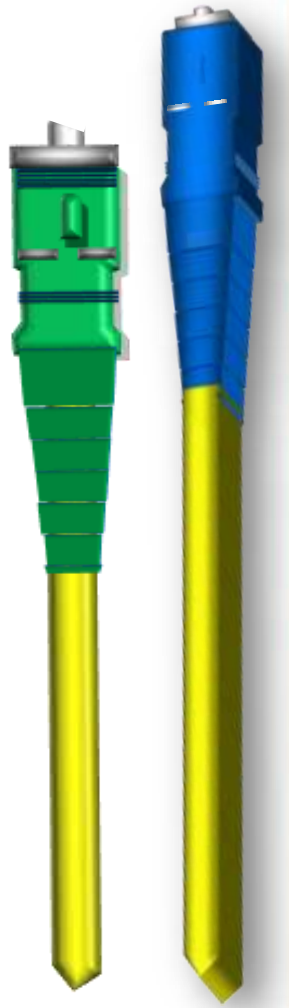
No. 1 cause of network failures is contaminated connectors

- *NTT-Advanced Technology Research, 2010*

80% of network problems are due to connectors!

Connector inspection

- Connector inspection requires a great amount of judgment
- Should I change/clean this connector or not?



Connector Issues

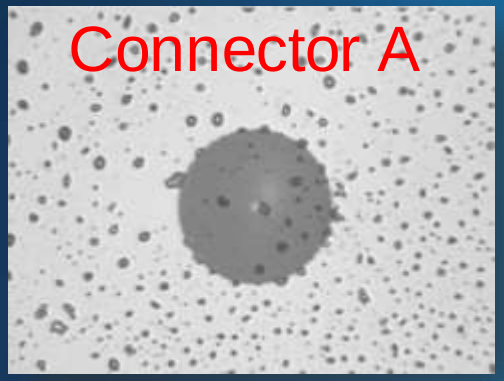
Did you know ?

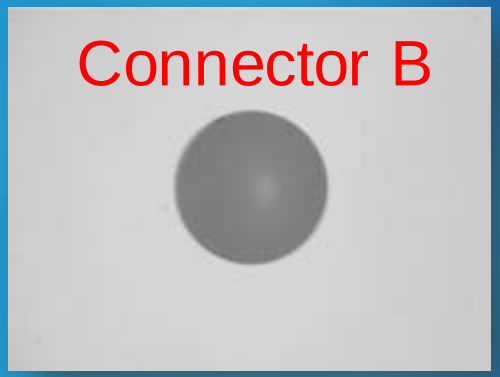
Dust/dirt residues transfer:

- If not cleaned properly:

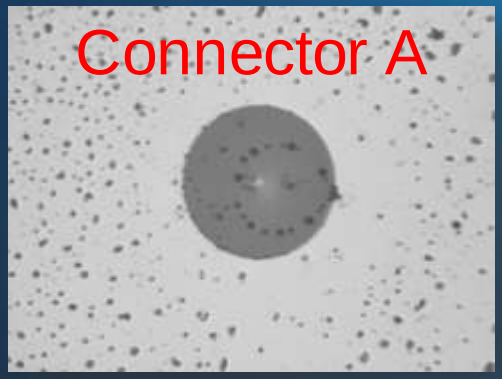
  Residues will transfer and may create permanent damage when mating

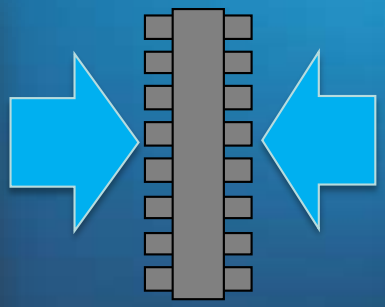
Before mating:





After mating:

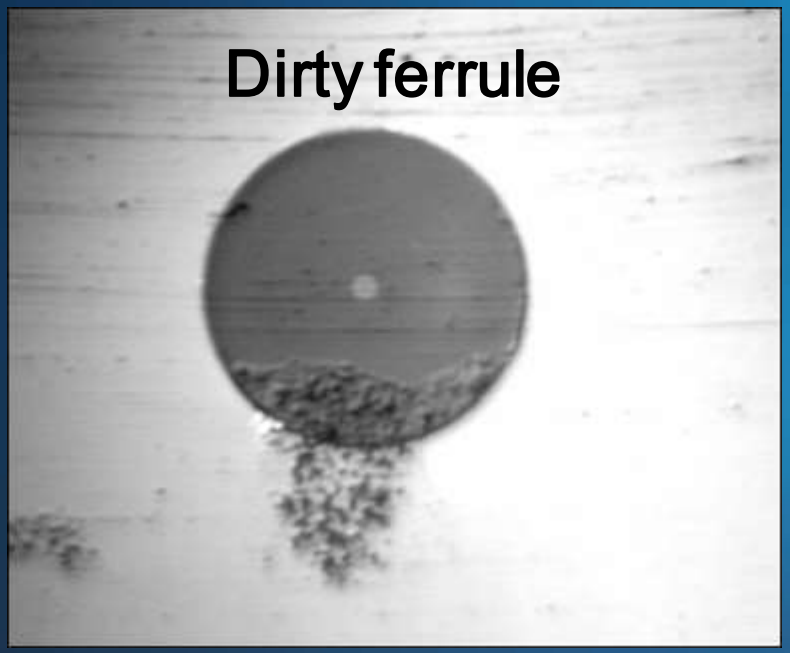


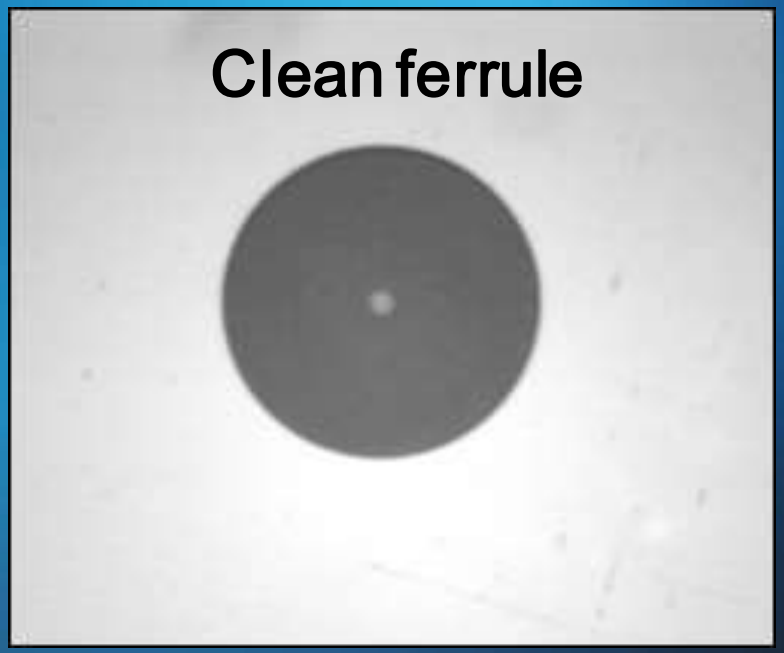


Connector Cleaning

Two cleaning techniques are mainly followed in the field

1. Dry Method
2. Wet/Dry method





Connector Cleaning

Dry method

- An efficient technique for removing light contaminants
- Often considered the technique of choice in a controlled manufacturing environment where speed and ease of use are important factors

Advantages	Disadvantages
Convenience of readily available tools	Can possibly create electrostatic charges
Fast and easy	Not effective in removing all contaminant types

Example of dry cleaning supplies:

- Specialized lint free wipes and swabs
- Mechanic cleaning devices

Connector Cleaning

Combination method (hybrid)

- Combination cleaning is a mix of the wet and dry cleaning methods
- The first step in hybrid cleaning is to clean the connector end-face with a solvent and to dry any remaining residue with either a wipe or a swab

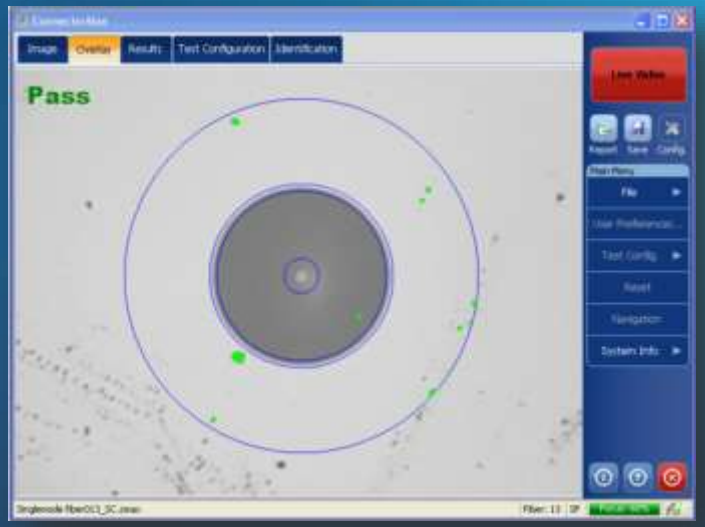
Advantages	Disadvantages
Cleans all soil types	Requires multiple products
Reduces potential static field soil accumulation	
Automatically dries moisture and solvent used in the cleaning process	
Captures soil in wiping material as an integrated aspect of cleaning procedure	
Not expensive	

Example of combination cleaning supplies:

- Specialized wipes and solvents

Do you know for sure if your connector is clean ?

- Subjectivity in the field is unreliable
- Interpretation errors can cause big problems in the future
- Cleaning standards developed by the IEC and IPC



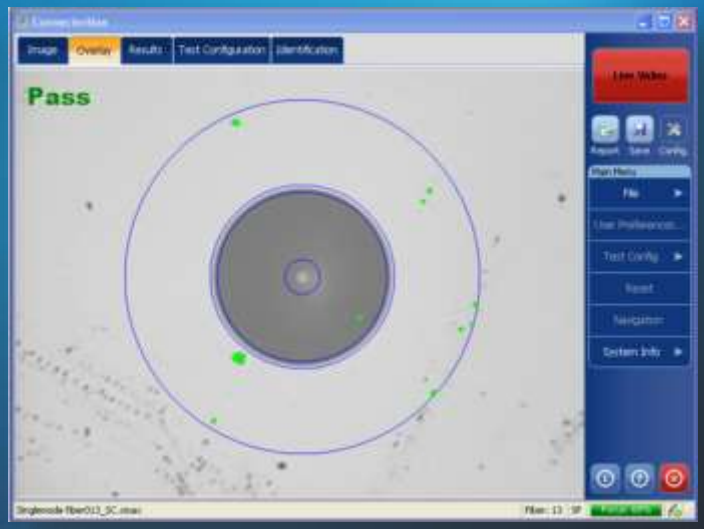
ConnectorMax ANALYSIS SOFTWARE

ELIMINATE GUESSWORK

Guarantee a uniform level of acceptance:

- Between users within an organization
- Between suppliers and customers
- Between contractors and network owners

- Facilitate decision process by removing subjectivity



ConnectorMax ANALYSIS SOFTWARE

CERTIFY YOUR WORK

Automatically certify connectors against standards

- Reporting capabilities for record keeping
- Proof of compliance to IEC or IPC standards
- Detailed defect analysis

NEXT GENERATION INSPECTION

THERE WAS BEFORE…
- Manual process
- Subjective
- Time consuming

AND THERE IS NOW.
- Automated
- Accurate
- Quick and Easy

Manual

CONNECT
CENTER
FOCUS
CAPTURE
ANALYSE

Automated

CONNECT
CENTER
FOCUS
CAPTURE
ANALYSE

100%

AUTOMATED

THE MAX-FIP

Compact integrated and dependable solution

Optical Plug ‘n Play Options (VFL, Power meter)

Rubber bumpers

Rugged focus mechanism

- Integrated GUI with power meter, VFL & inspection
- 11h Rechargeable battery
- Wi-Fi & Bluetooth
- 2GB built-in storage
- Two USB ports

Only 42mm in thickness

THE ONLY 100% AUTOMATED PROBE

SPEED-UP YOUR INSPECTION TEST SEQUENCE BY **MINIMUM**

50%

Show time!

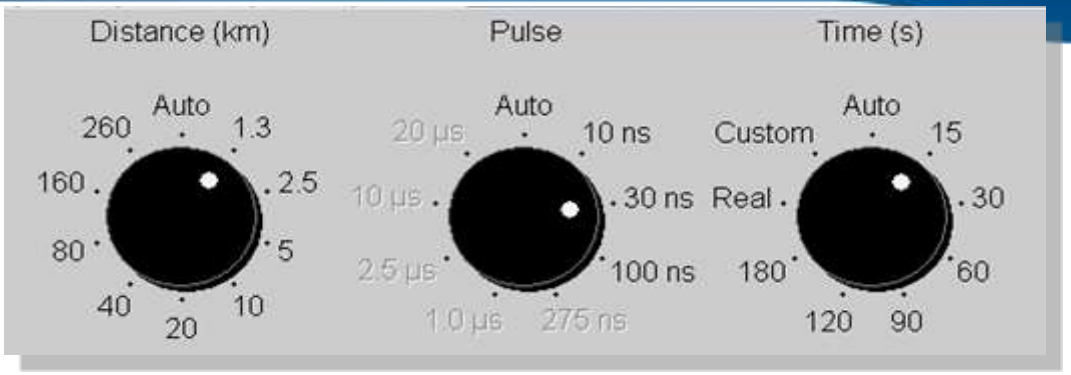
OTDR Testing

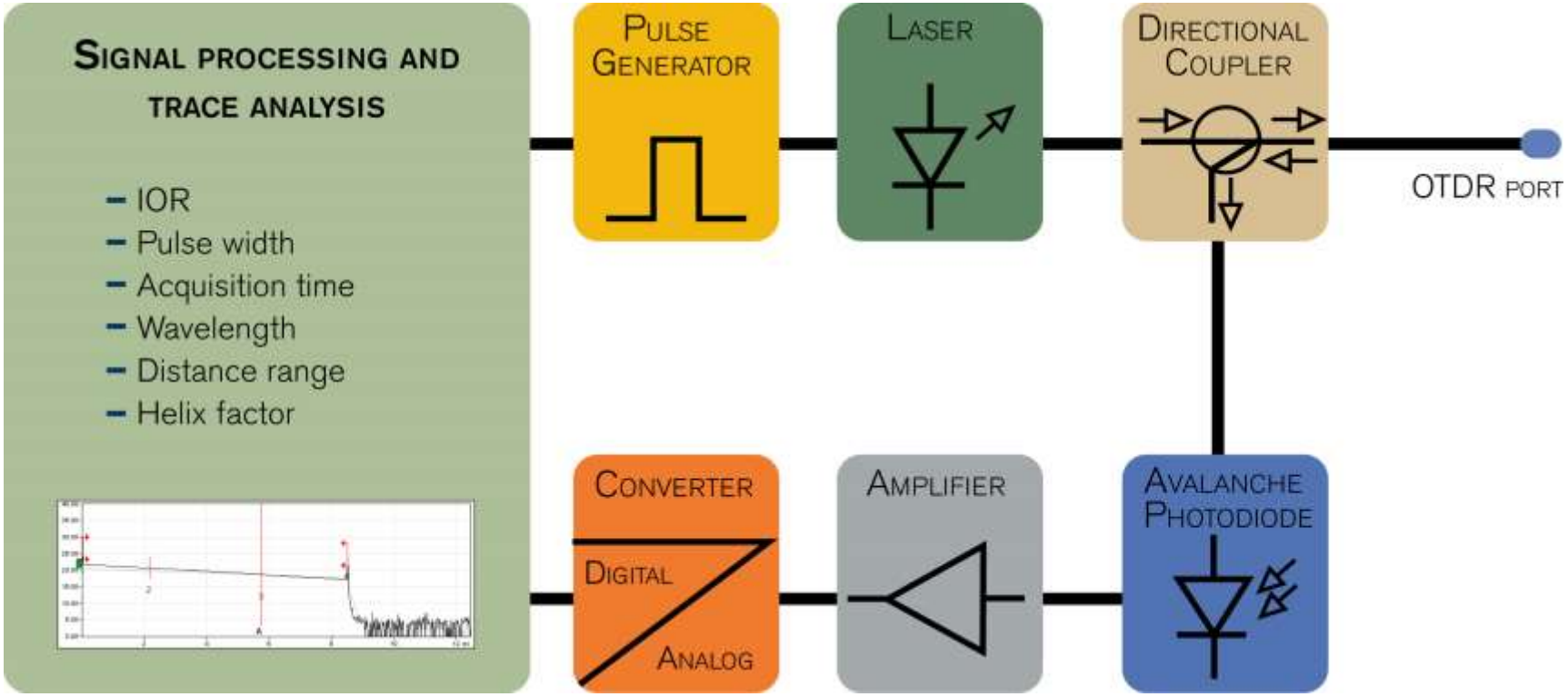
Simplified OTDR

➢ The OTDR launches a pulse of LASER light into the optical fiber.

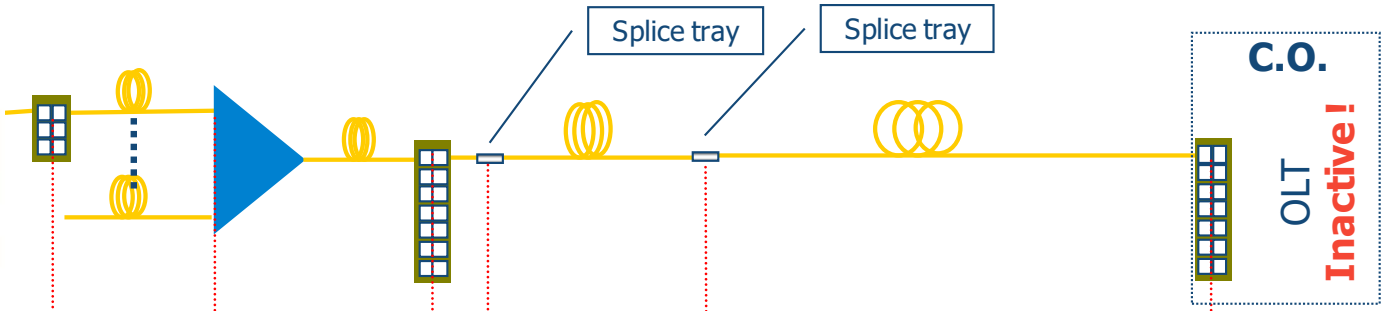
➢ Reflections return to the OTDR from connectors, splices and other irregularities within the fiber.

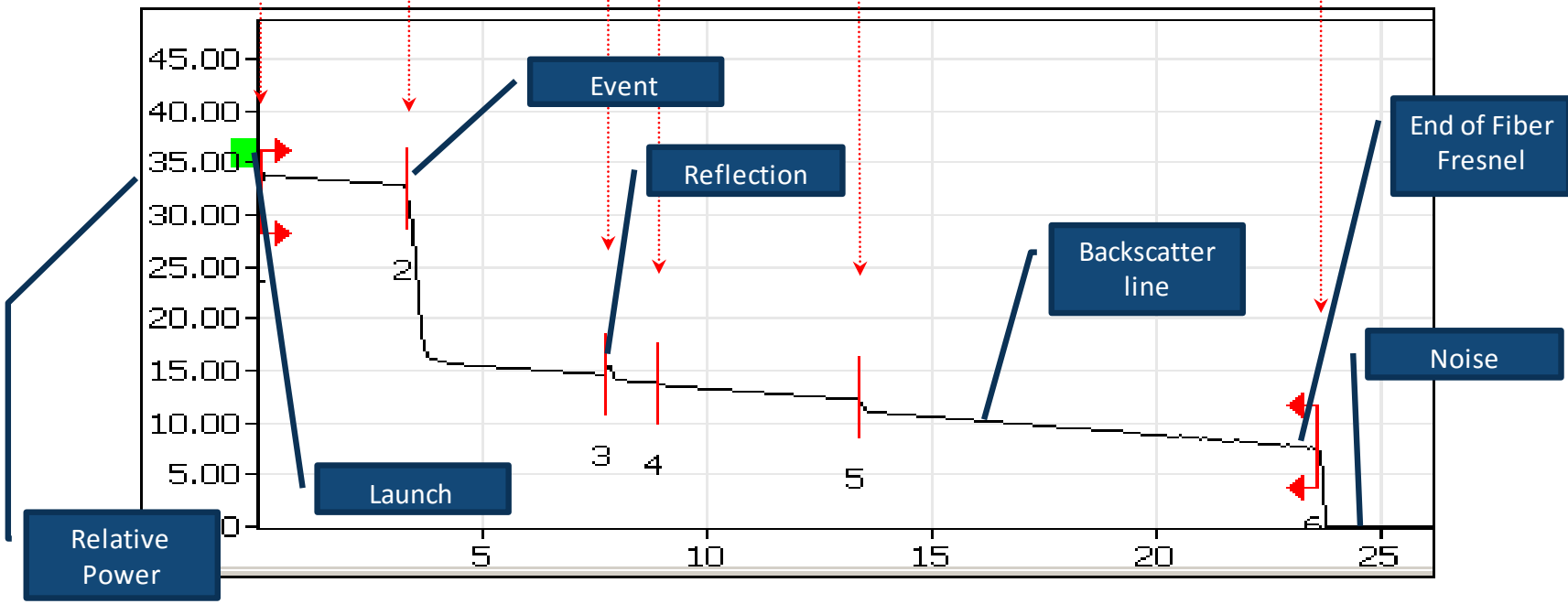
Reflectometry Theory





OTDR Trace Terminology

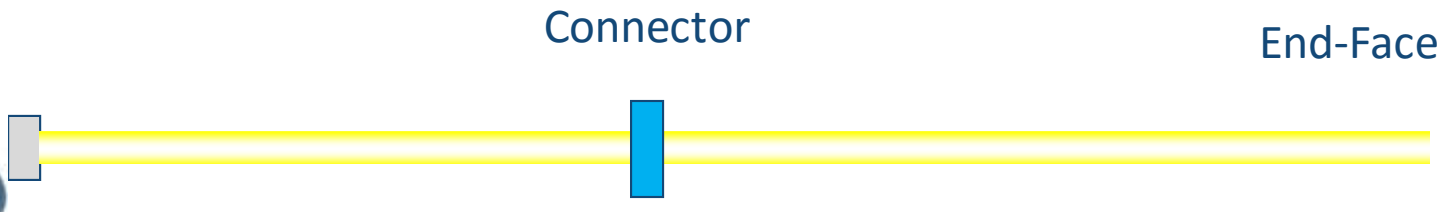




OTDR -- Basic parameters

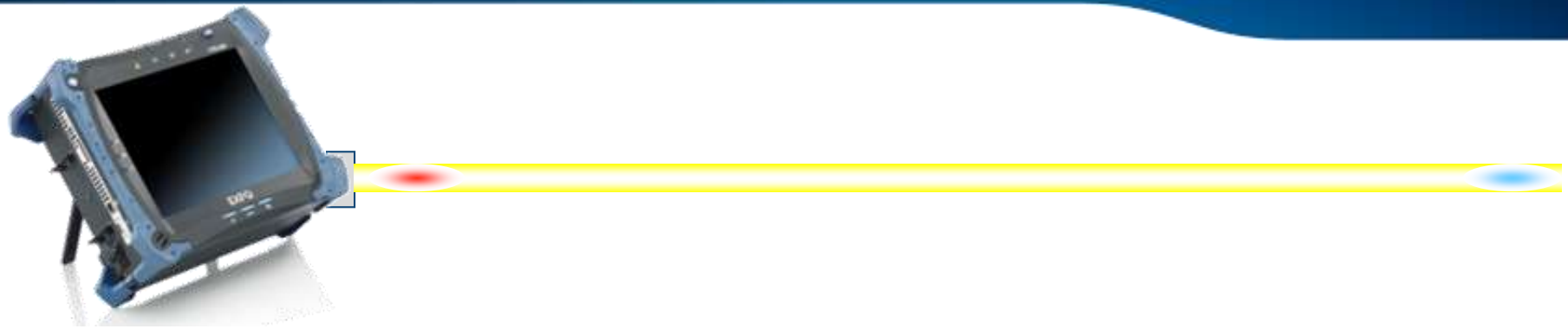
- OTDRs deal with multiple parameters that all interact with each other
- OTDRs are a matter of trade-offs : gain this, loose that.
- There are multiple recipies to get a good OTDR trace, as well as a bad one!

OTDR -- Basic parameter: Average Time



- By the time the primary pulse reaches the end of a relatively long optical fiber, most of its energy has been dissipated.
- The OTDR records the results of the first pulse then launches another and then another. It 'averages' the results of multiple pulse launches to give the operator a clean trace
- The more averaging time, the more dynamic range

OTDR -- Basic parameter: Pulse Width



- Pulse width is the parameter that has the greatest impact on OTDR performance. In fact, adjusting PW will impact both dynamic range and resolution in very predictable ways.
- Put simply, the longer the LASER stays on the more energy is injected into the fiber and the greater the effective range.
- Counter side is the resolution of the pulse is reduced and increases the dead zones

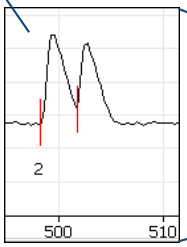
OTDR -- Basic parameter: Pulse Width

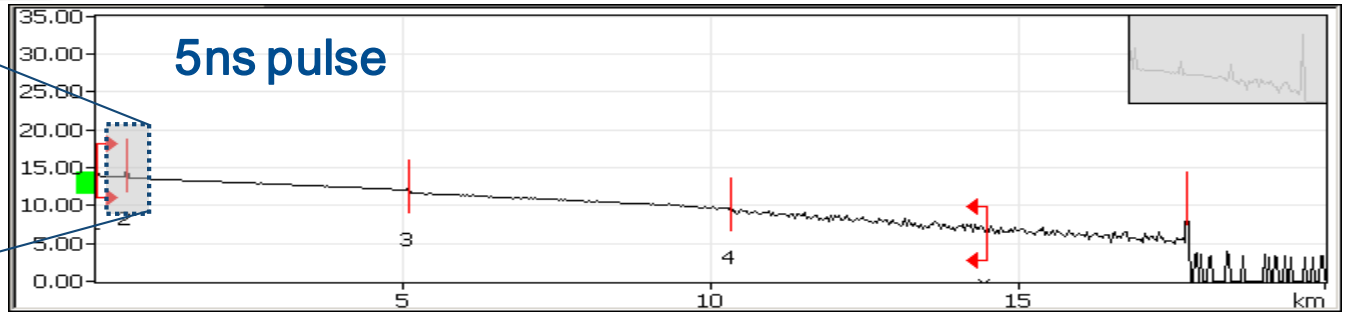
Short pulses will give a better resolution but less dynamic range:

Two connectors 3 meters apart

End of link (patch panel)

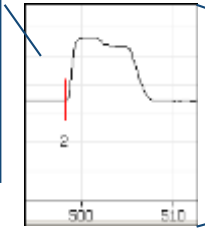
Connectors are measured for distance and marked as separate events

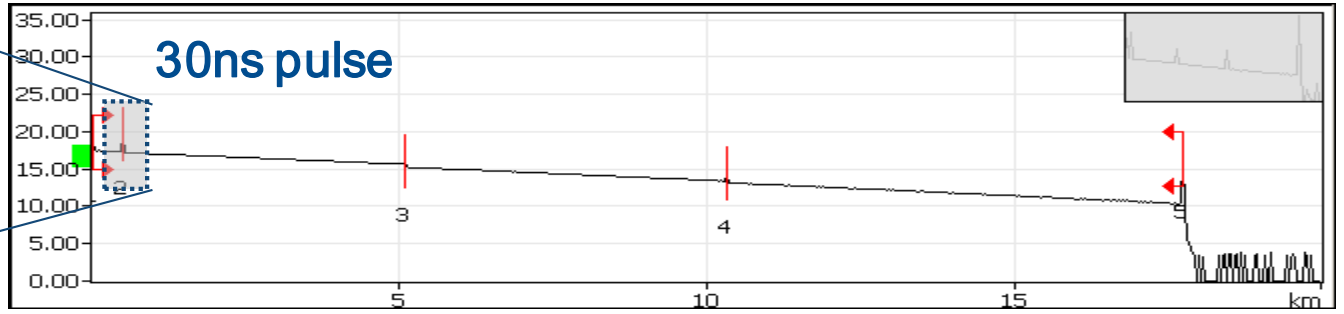




Long pulses will give a better dynamic range but less resolution:

Connectors are « merged » and identified as one event



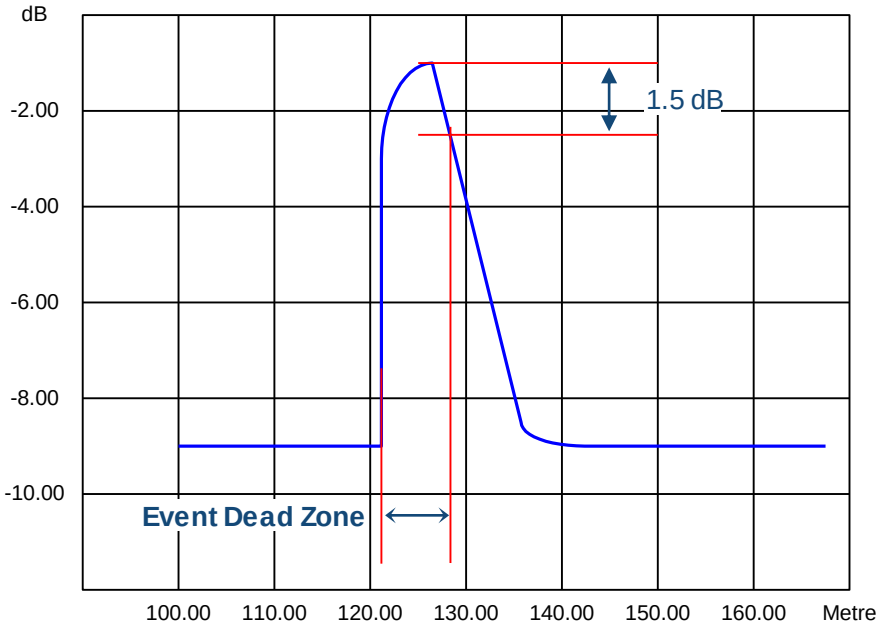


OTDR -- Basic parameter: Pulse Width

Event dead zone

- The event represents the minimum distance between the beginning of a reflective event and the point where a consecutive reflective event should clearly be recognized.
- Dead zone concerns only reflective events

It is the distance between:
The beginning of the events
the -1.5 dB point on the falling edge

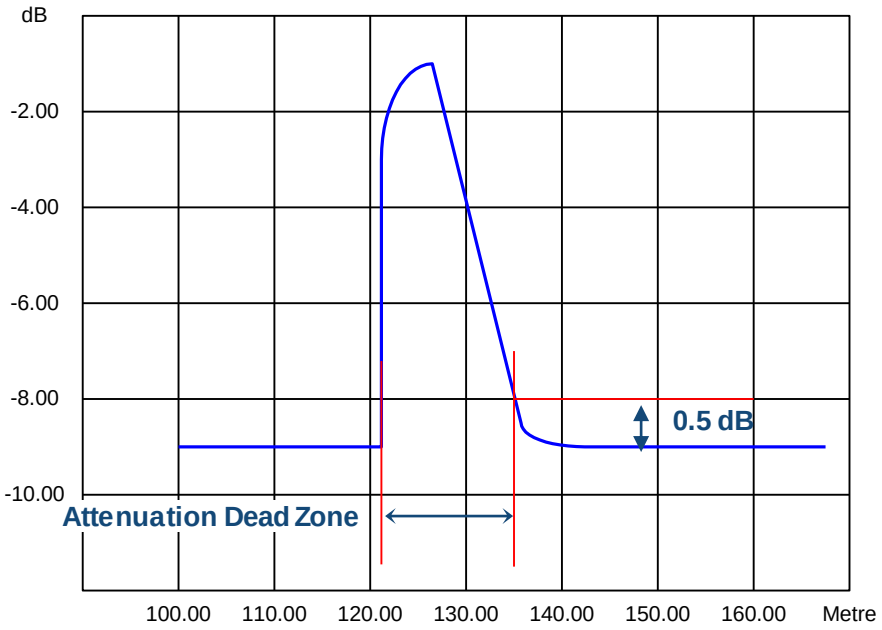


OTDR -- Basic parameter: Pulse Width

Attenuation dead zone

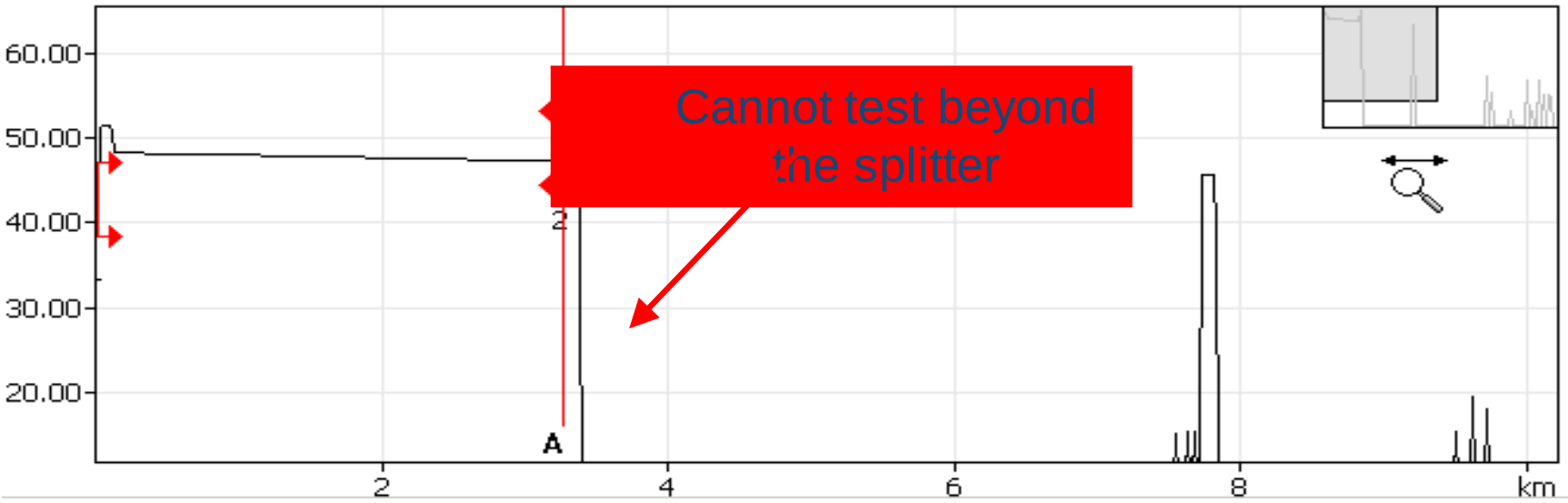
- The minimum distance between two consecutive reflective or non-reflective event in order for the OTDR to perform loss measurement.

It is the distance between:
The beginning of the events the point on the falling edge where the receiver sees a value around ±0.5dB from the normal backscatter trace

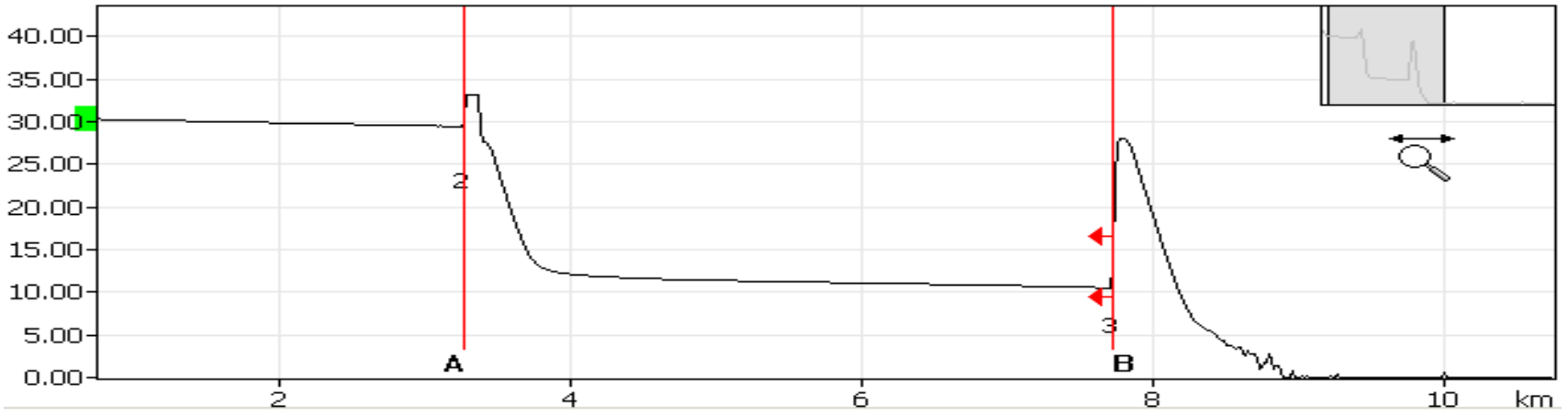


PON Testing with an OTDR

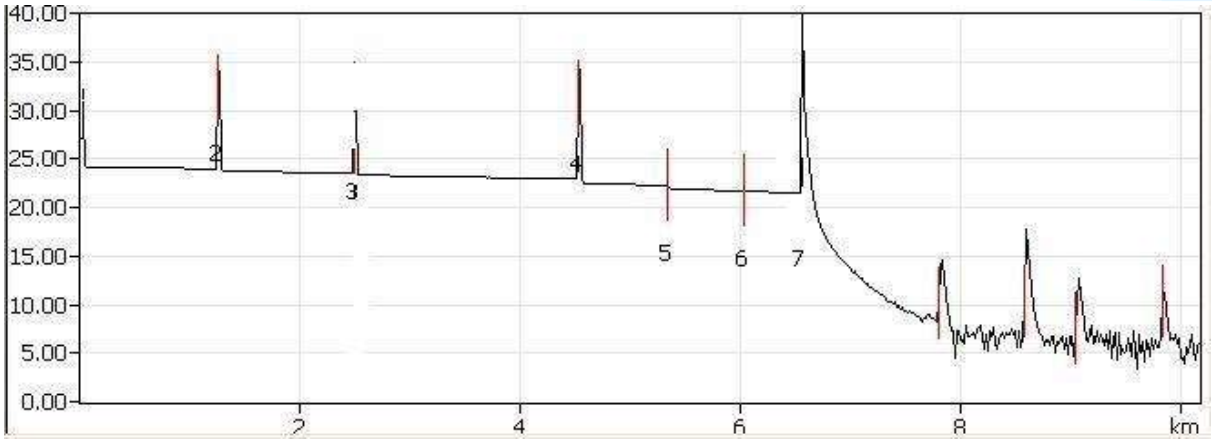
Standard OTDR:



PON-optimized OTDR:



OTDR – A tool of choice, WHY?



It reveals:

- Total Loss
- Optical return Loss
- Fiber Length

It is use for:

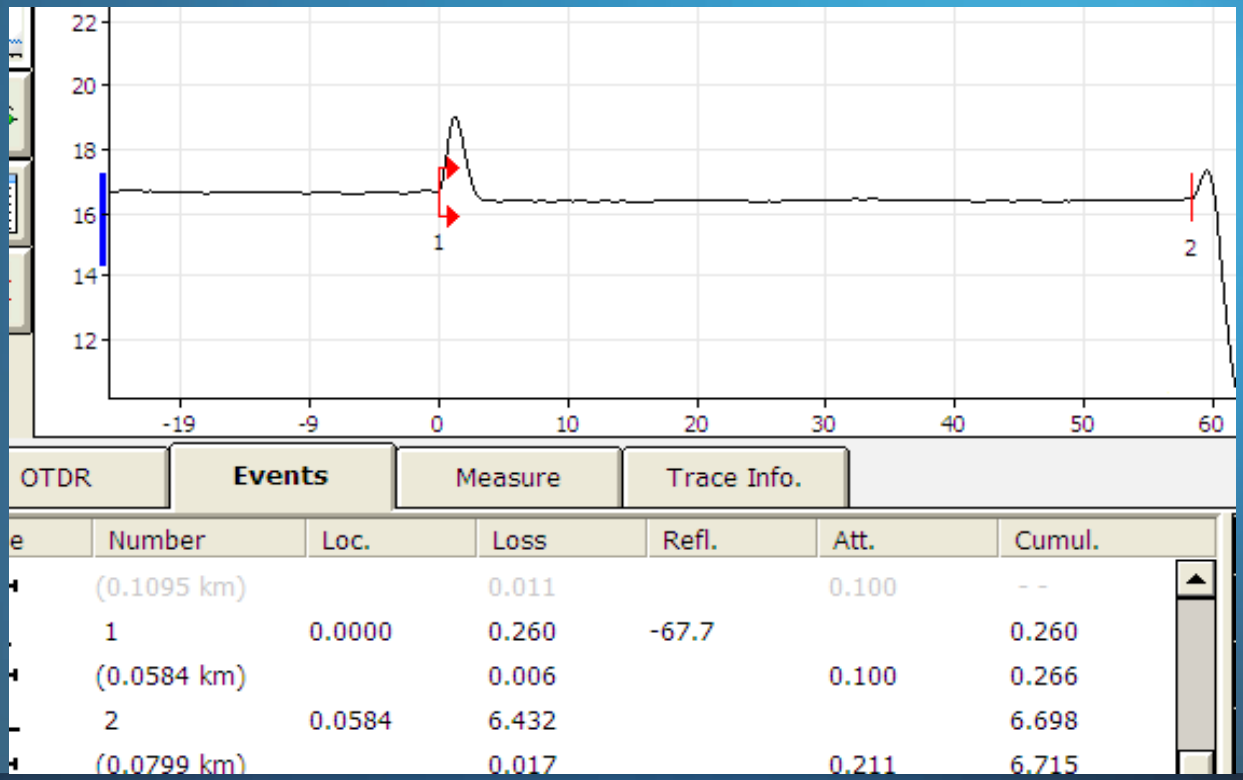
- Characterize the link components
- Highlight a potential problem
- Locate a fault

PON-Optimized OTDR characteristics

- High dynamic range:
  - Must exceed the PON loss budget by a reasonable margin to perform End-to-End loss
  - Minimum requirement is 37 db.
- Optimized dead zones:
  - Critical to characterize closely spaced events after the splitter
- Out of band testing port at1625nm for troubleshooting and maintenance
  - In-line power meter allows to measure downstream power before OTDR test

Procedimiento Recomendado con OTDR

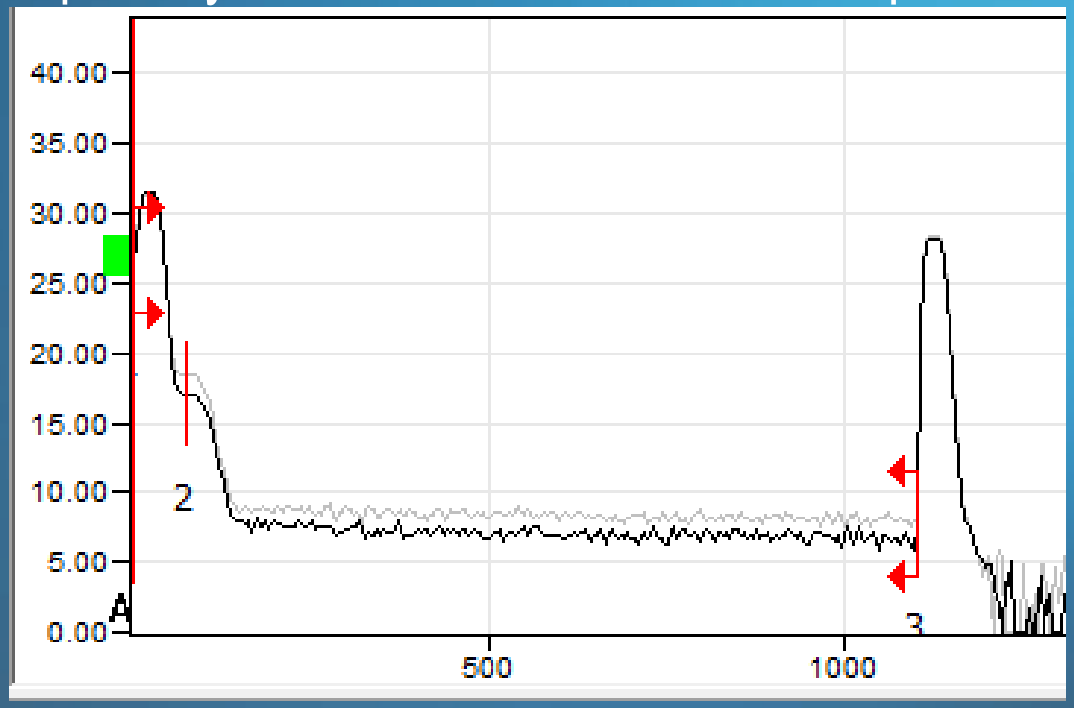
- Comenzar con un pulso corto (5 a 10 ns) para calificar la primera parte del enlace, probablemente hasta el splitter únicamente para asegurar que el primer conector y los primeros eventos (en caso que existan) se encuentran dentro de especificaciones



e	Number	Loc.	Loss	Refl.	Att.	Cumul.
	(0.1095 km)		0.011		0.100	- -
	1	0.0000	0.260	-67.7		0.260
	(0.0584 km)		0.006		0.100	0.266
	2	0.0584	6.432			6.698
	(0.0799 km)		0.017		0.211	6.715

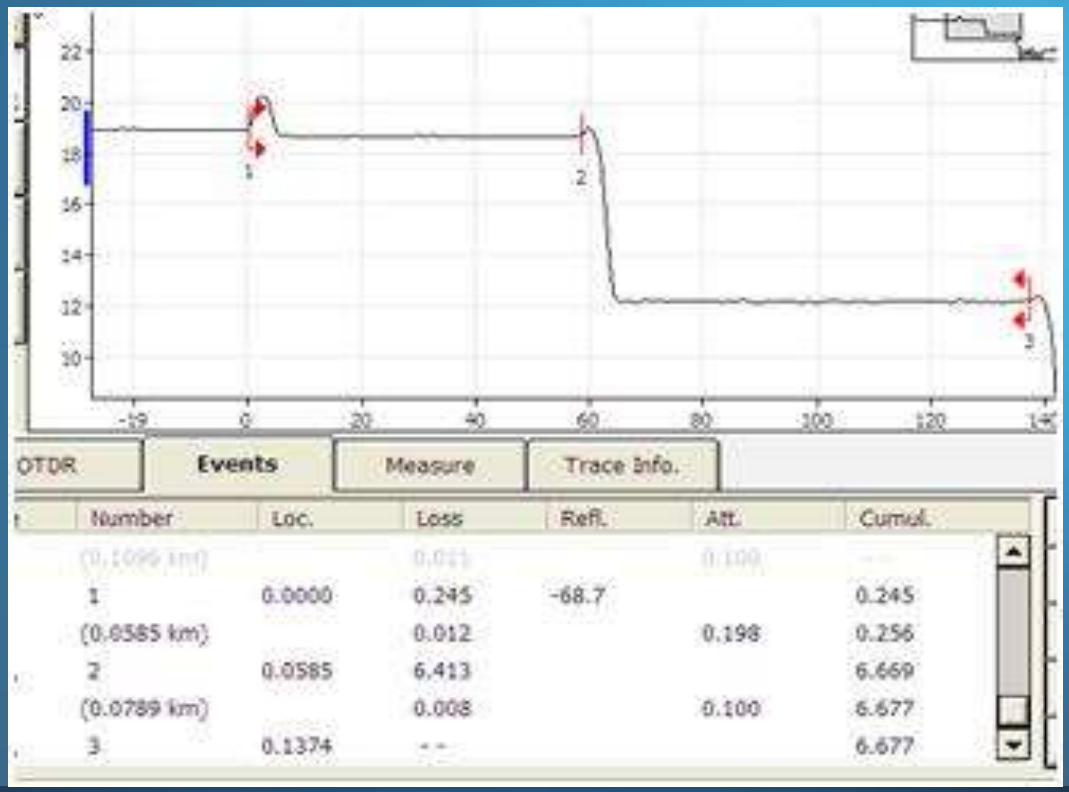
Procedimiento Recomendado con OTDR

- Realizar una segunda adquisición con un pulso un poco mas largo (aprox 30 a 100 ns) para calificar la gráfica en el primer splitter. De ser posible se debe realizar la medición a 2 longitudes de onda 1310/1550 nm para comparar ambas gráficas y si hay mayor pérdida a 1550 nm quiere decir que hay un macrodoblez cerca del splitter



Procedimiento Recomendado con OTDR

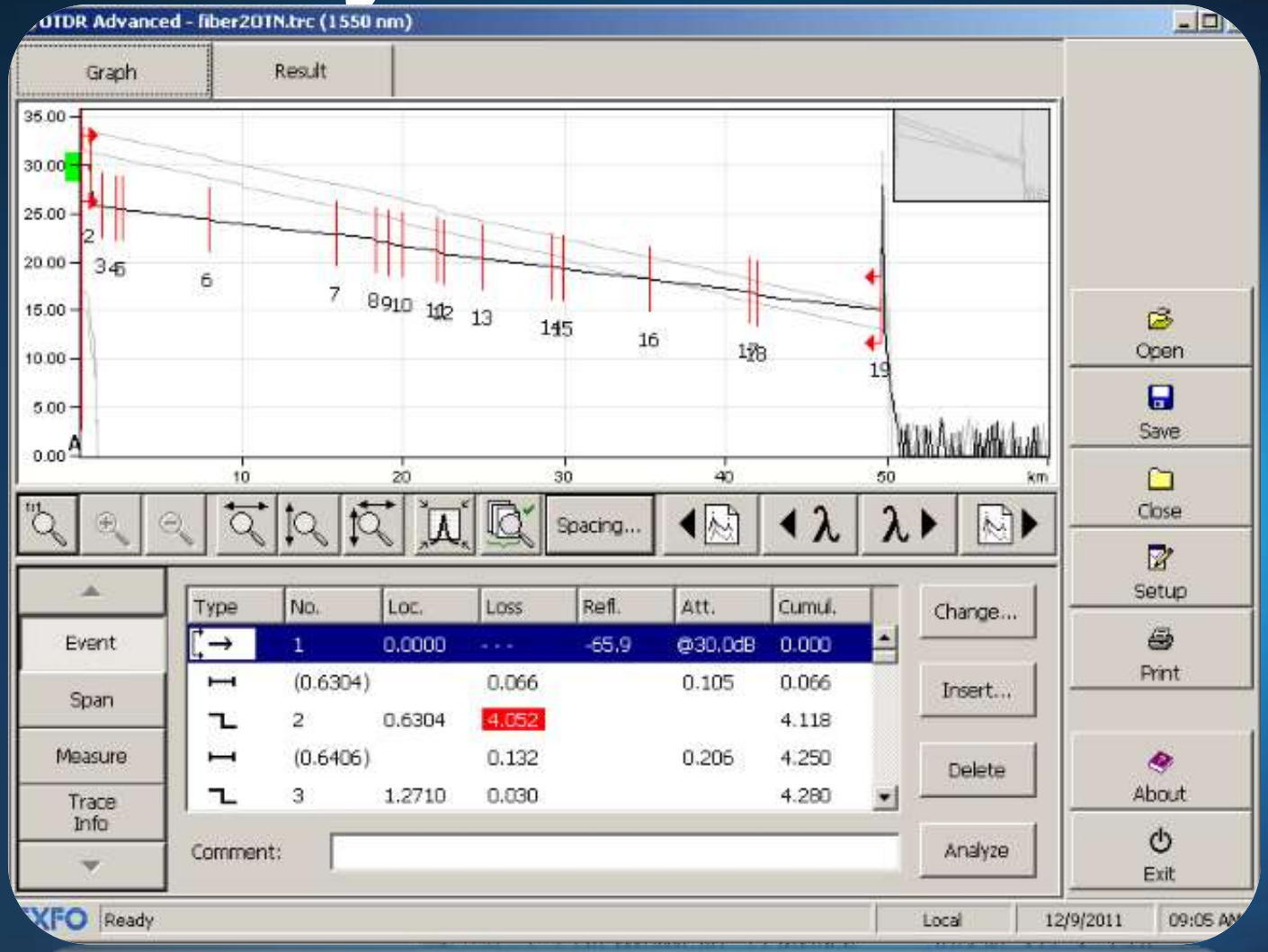
- Realizar una tercera adquisición con un pulso mas largo (aprox 275 ns) para calificar la porción después del primer splitter y antes del segundo splitter. Un técnico especializado tendrá hasta este momento todas las armas para caracterizar el link hasta el segundo splitter



OTDR Testing

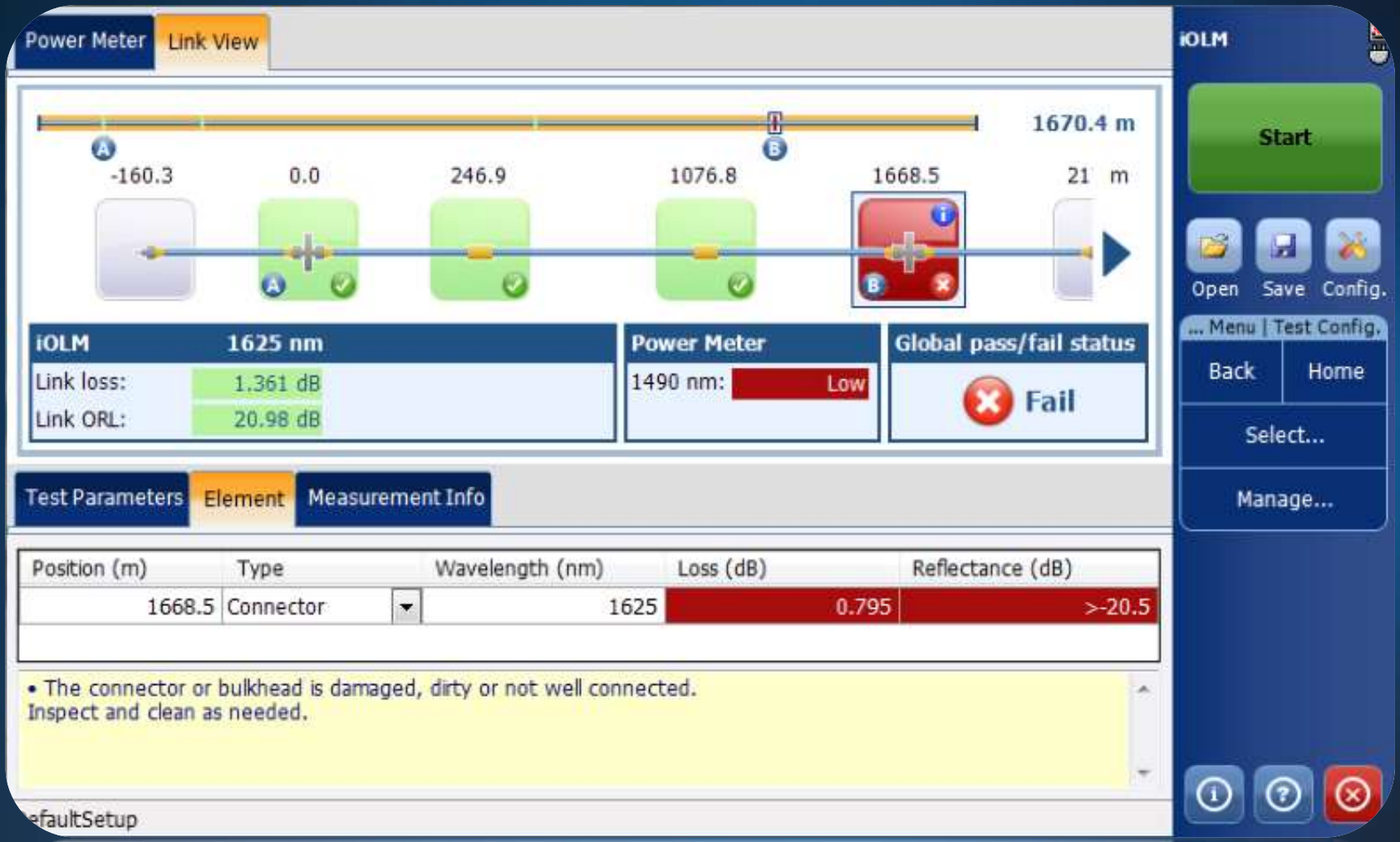

CHANGE
AHEAD

Can you read this?



Traditional OTDR

And can you read this?

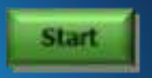


Intelligent OTDR

QUESTIONS | FOR FTTH DEPLOYMENTS

WOULD YOU LIKE AN OTDR THAT ALL FIELD TECHS COULD OPERATE?

WOULD YOU LIKE A SIMPLIFIED TEST PROCEDURE, IN A ONE BUTTON OPERATION?



WOULD YOU LIKE A TOOL THAT PROVIDES UNDOUBTFUL PASS/FAIL RESULTS?

WOULD YOU LIKE TO REPLACE THE TRACE ANALYSIS WITH COLORED ICONS INSTEAD?

iOLM

WOULD YOU LIKE AN OTDR THAT CAN REDUCE TESTING TIME BY 85%?

EXFO

iOLM

POWERED BY LINK AWARE™ TECHNOLOGY

INTELLIGENT OPTICAL LINK MAPPER

Advanced algorithms with automated multiple pulse widths and wavelengths to display the link with clear icons

EXFO

A revolution | HOW DOES IT WORK

Dynamic multipulse acquistions

↓

Intelligent trace analysis

↓

Combine all results into a single link view

LINK AWARE™ TECHNOLOGY

↓

Display clear pass/fail with comprehensive diagnosis

EXFO

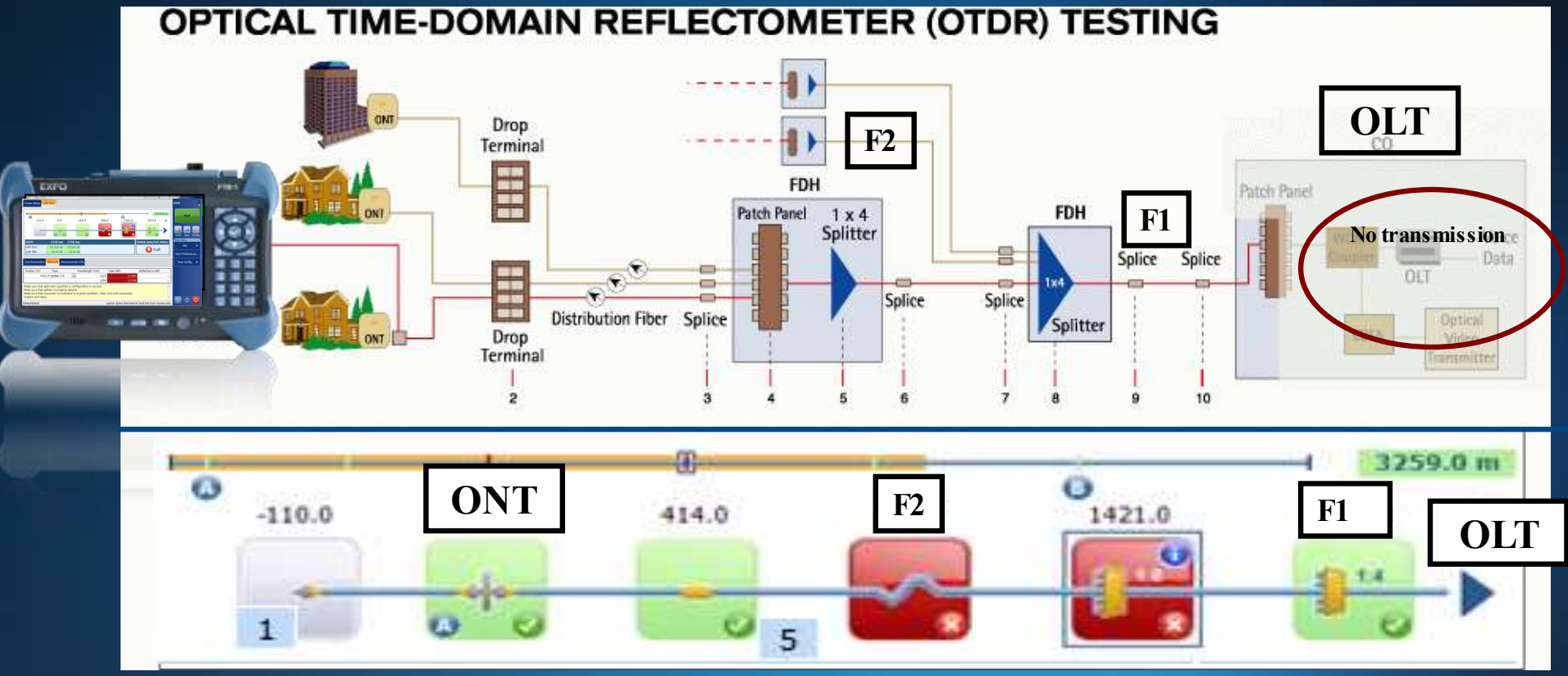
How it works?

In the background

What you see!

iOLM test results

Complete fiber characterization



- Using a multi-pulse approach, all sections are accurately characterized.
- No trace analysis, icons recall the network plans with split ratio associated

DON’T CHANGE WHAT YOU DO

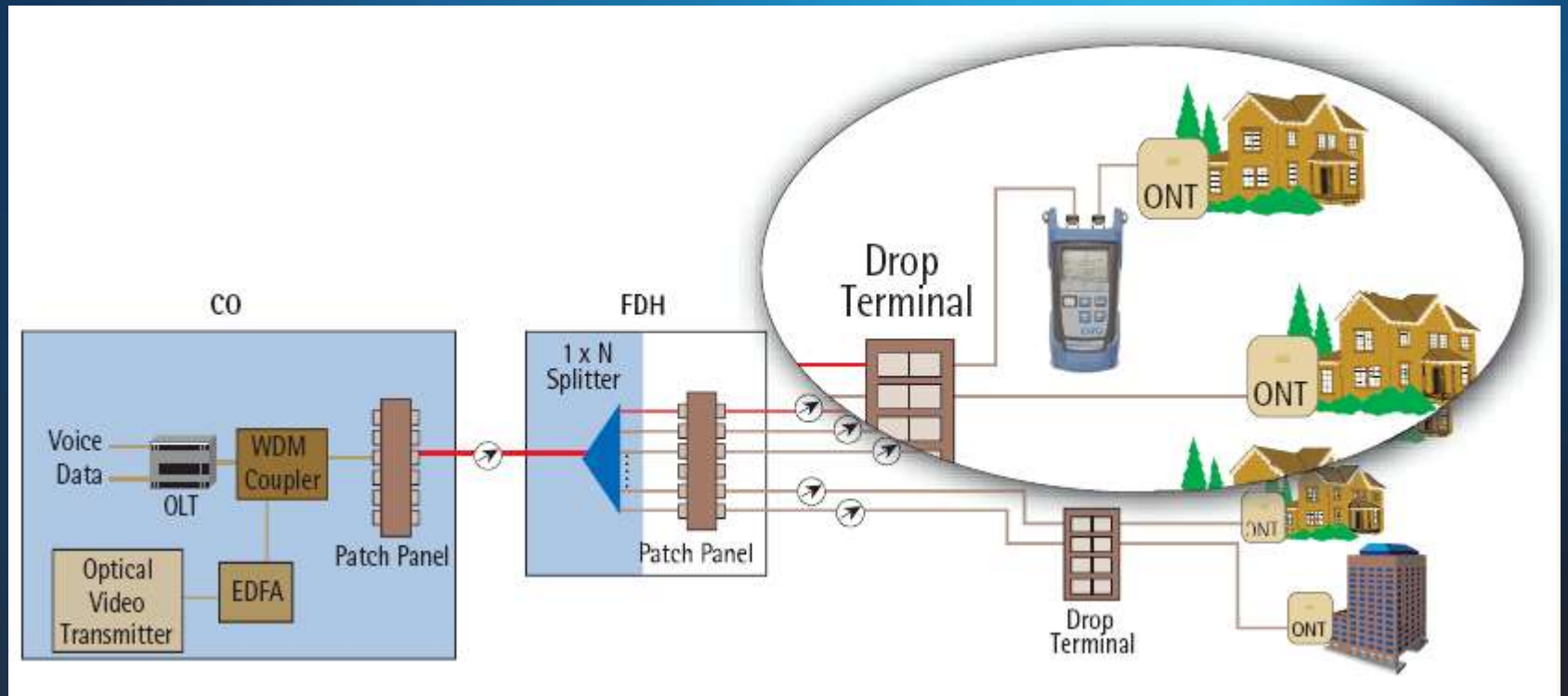
- OTDR-based
- PON/FTTH or P2P
- iOLM file results and report
- OTDR file in .SOR format

Service activation testing

Pruebas de activación de servicio

Pruebas de red en funcionamiento con el Medidores de Potencia “inline”

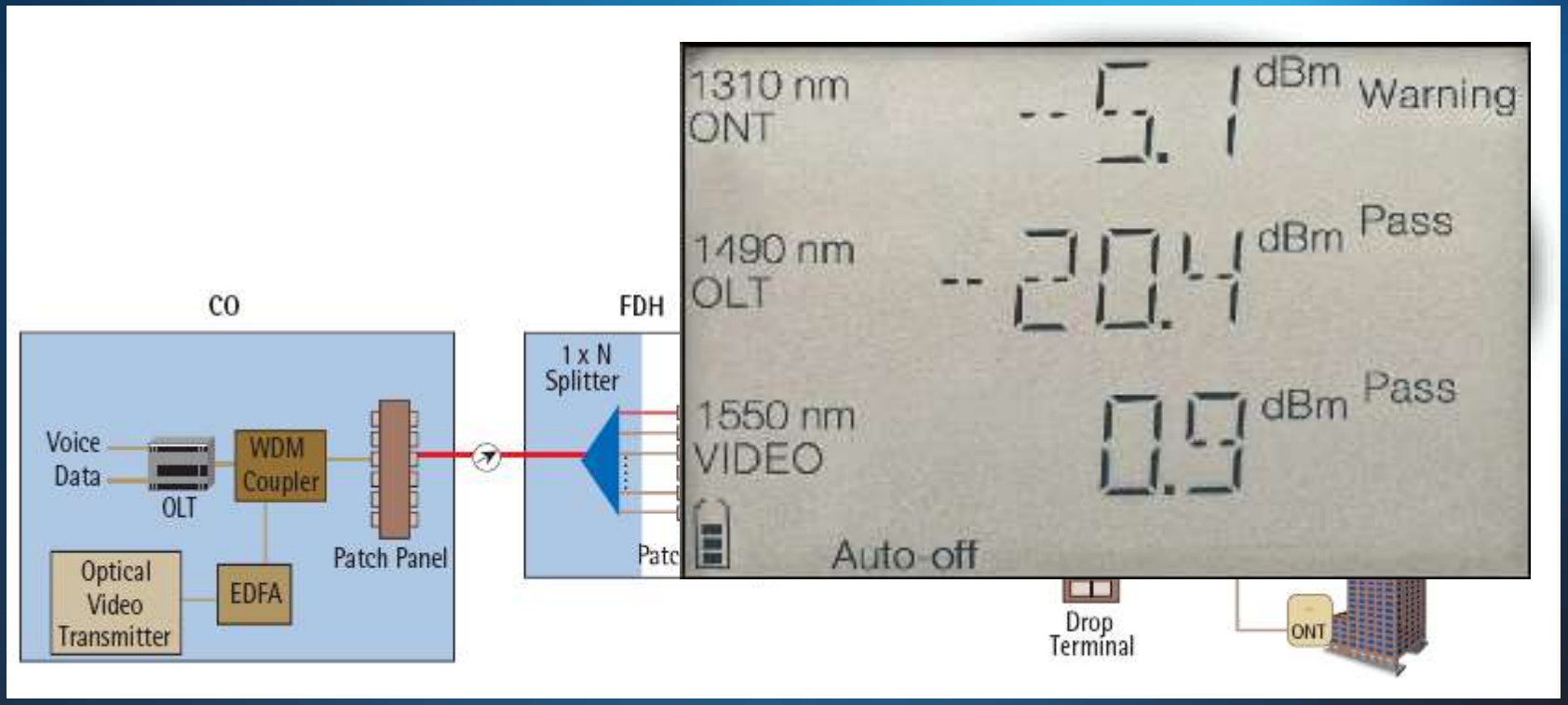
- Se requiere comunicación entre la OLT & ONT para medir la potencia de upstream (1310nm)
  - PPM-350B permite pruebas « pass through »
  - Se requieren lecturas simultaneas de upstream y downstream



Activación de servicio

« Pass-through » testing with the PPM-350B

- Se requiere comunicación entre la OLT & ONT para medir la potencia de upstream (1310nm)
  - PPM-350B permite pruebas « pass through »
  - Se requieren lecturas simultaneas de upstream y downstream



APPLICATIONS – IP TESTING

EXpert IP TEST TOOLS (DATA TESTING)

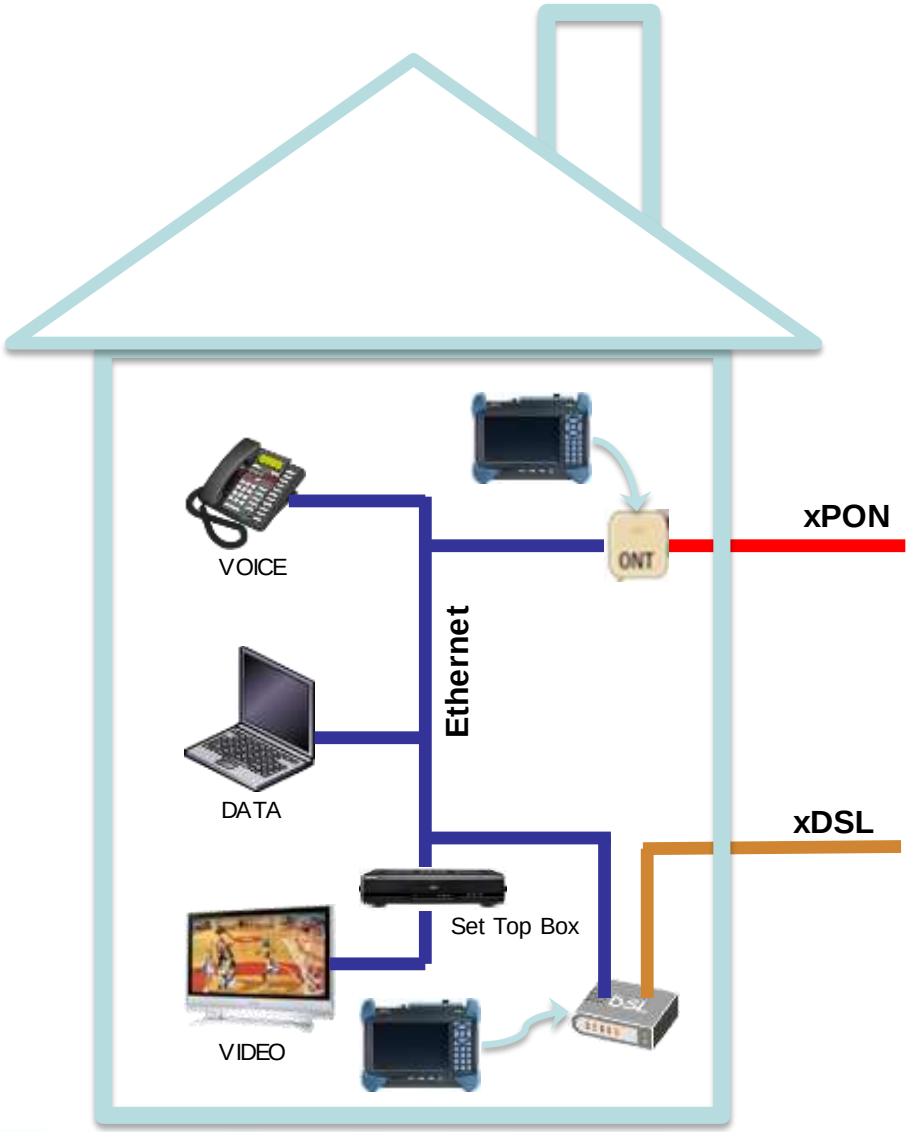
- Connectivity test
- Throughput measurement
- Response time, download and upload times

EXpert VoIP TEST TOOLS (VOICE TESTING)

- Live calls
- Measure VoIP metrics: MOS, RTP, Latency

EXpert IPTV TEST TOOLS (VIDEO TESTING)

- Emulate set top box
- View video streams
- Measure video and audio metrics



Pruebas en FTTH: Conclusión

•Probar desde la instalacion disminuye quejas y problemas de parte de clientes.

•Los OTDRs ayudan a prevenir, identificar y corregir problemas antes de la activación de servicio.

• Un power meter PON y un OTDR filtrado son las mejores herramientas para realizar pruebas en una red en servicio.

•¿Podemos soportar tener una red/cliente sin servicio por conectores sucios?

What about the test results?

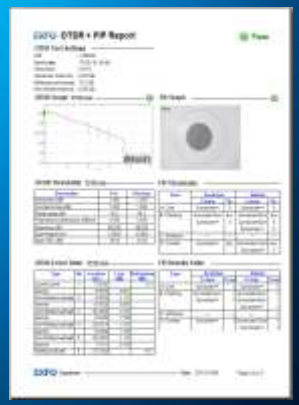
Post-processing and reporting

... Today I will get **hundreds** of field **measurements** ...

EDIT

ANALYZE

DOCUMENT



Post-processing and reporting

FastReporter 2

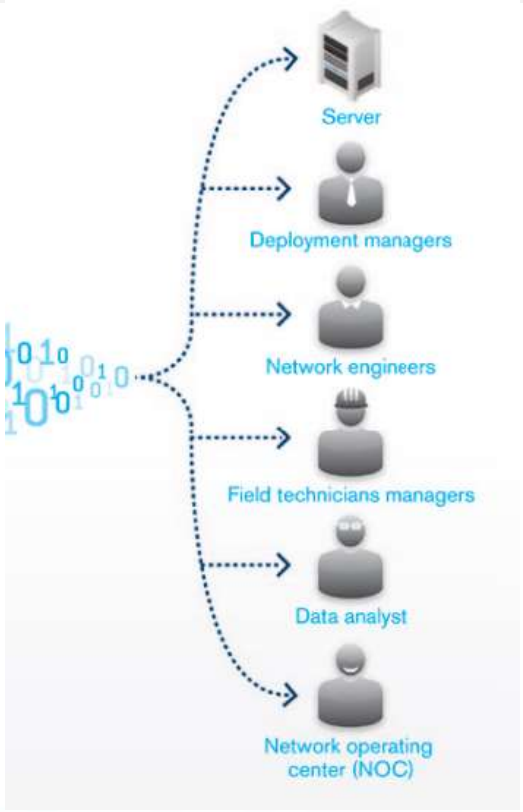
- Post-processing optical measurements software (OTDR, CD, PMD, iOLM, ConnectorMax, etc)
- Report in various format: PDF, Excel and HTML
- Simplify bi-directional iOLM analysis
- Compatible Bellcore v1 et v2
- **And more …**

Data Post-Processing

FastReporter 2

FR2 on FTB-1

- Close job on the spot and get paid faster
- Flexible reporting (XLS, PDF, custom)



EXFO Connect

Make your data mean business.

First Cloud-based Field Test Management Solution for Network Operators to

REDUCE OPEX

THE CONNECTED EXPERIENCE

› Better Methods and Procedures

› Better Asset Control

› Better “Business Intelligence”

Thank you

Jimmy.gagnon@exfo.com

