Análisis del Cableado Estructurado en un Centro de Datos

¿Quienes Somos?

Fluke Networks es líder mundial en fabricación de equipos de ***diagnóstico, certificación y herramientas de instalación*** *para profesionales que realizan mantenimiento de la infraestructura de red en el Centro de Datos.*

Ayudamos a los profesionales de networking asegurando el ***performance y la confiabilidad*** *de nuestro* ***mundo conectado****.*

Datacom
Contratistas

Datacenter /
Administradores de Red

Communications
Service Technicians

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Soluciones

Certificación

- Versiv: DSX-5000, OptiFiber Pro, CertiFiber Pro, FI-7000
- LinkWare Live / PC
- MultiFiber Pro

Cobre Qualificacion / Verificacion

- MicroScanner
- CableIQ

Fibra Qualification / Verification

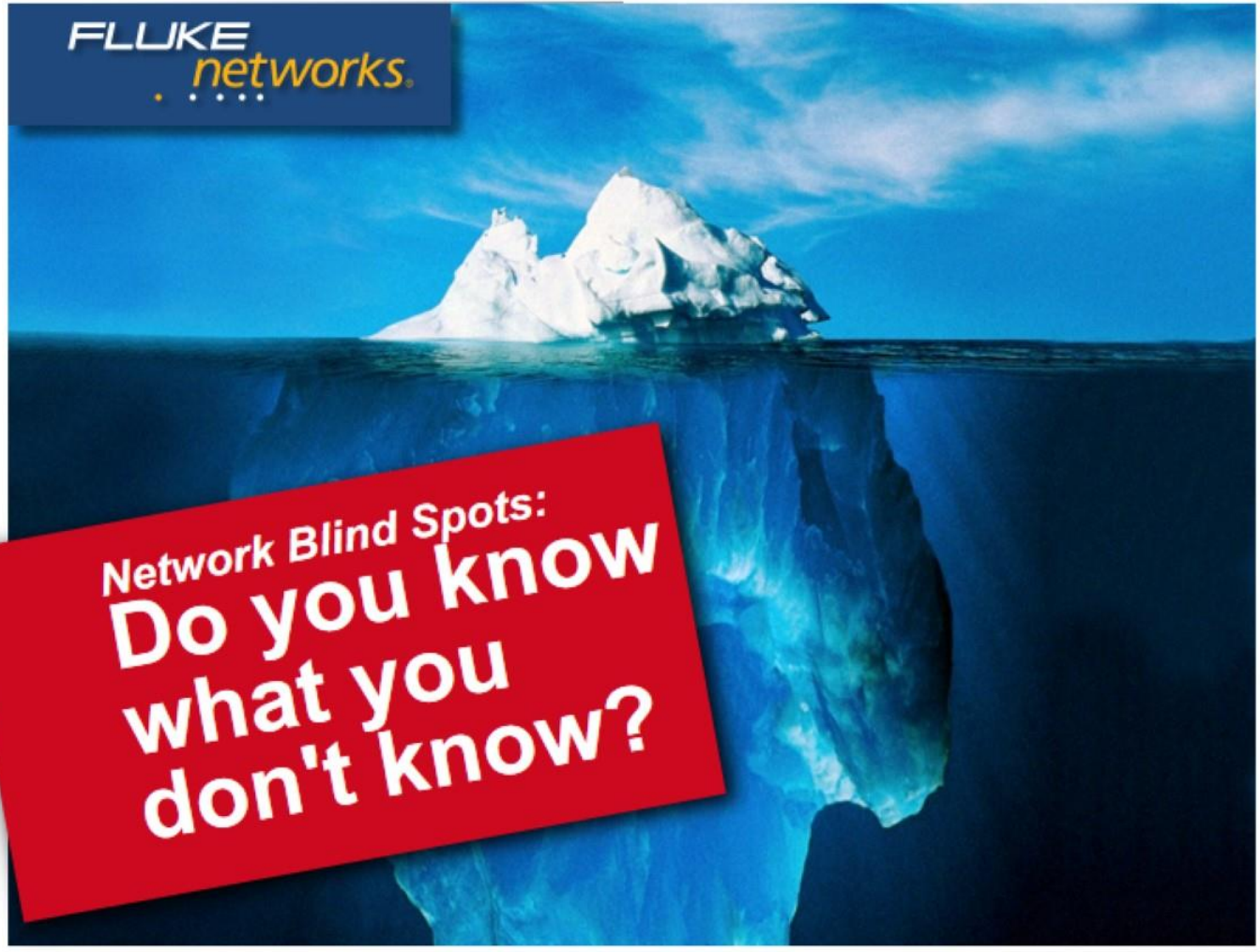
- SimpliFiber
- Inspection and Cleaning

Herramientas

- Buttsets
- Hand Tools

AGENDA

- ¿Qué problemas del cableado estructurado afectan a los switches?
- Pruebas en el cableado para garantizar funcionamiento de dispositivos PoE.
- Certificar y Analizar el cableado, como ganar más con las auditorías de cableado.



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El costo de lo que no se puede ver . . .

The State of the Data Center

Mission Critical

- Pressure for New Technologies and Apps Need to be Up ASAP
- Isolating root cause of performance issues is urgent priority

Constant Change

- Expansion
- Consolidation
- New applications and services
- Virtualization

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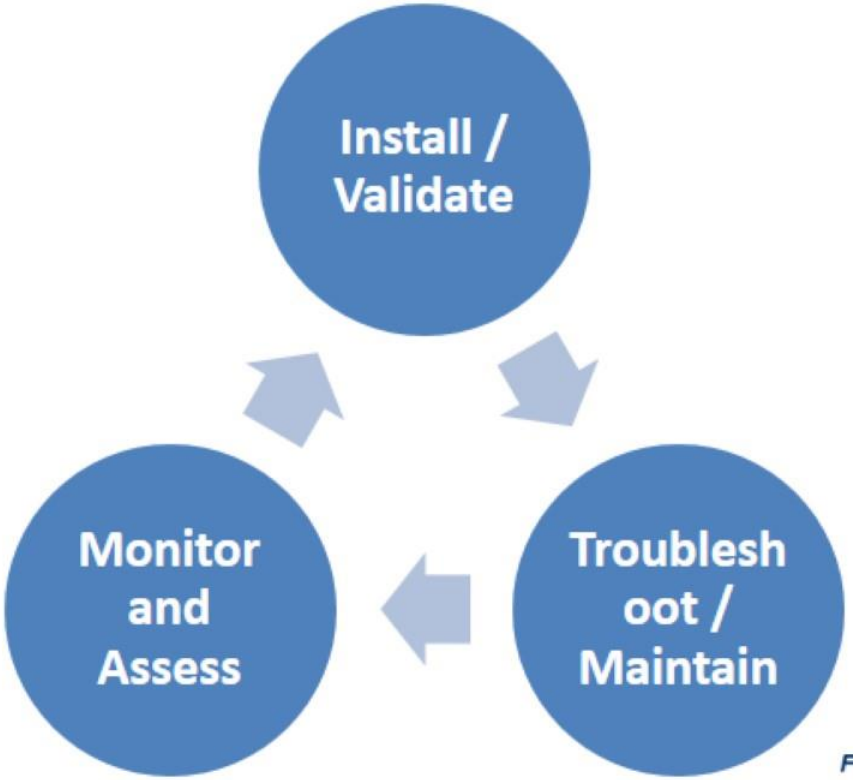
Datacenter Lifecycle

- Manage Continuous Change Within a Lifecycle



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Stage	Assess	Install/Validate	Troubleshoot/Maintain
Needs	• Evaluate current environment • Evaluate flexibility and scalability of infrastructure • Identify, research necessary changes • Evaluate potential impacts of changes	• Configure and install new, or reconfigure current systems • Validate performance of change • Train staff on new systems/technology	• Troubleshoot - Prove it's not the network and root cause analysis • Manage Changes • Optimize
Tasks	• Inventory • Topology • Performance Baseline • Documentation	• Validate ports and cabling • Measure throughput of new infrastructure • Measure response times, resources and processes • Measure link utilization • Documentation	• Problem investigation • Examine bandwidth usage • Identify paths from client to server, server to server • Infrastructure health • Application flow analysis • Packet analysis • Documentation

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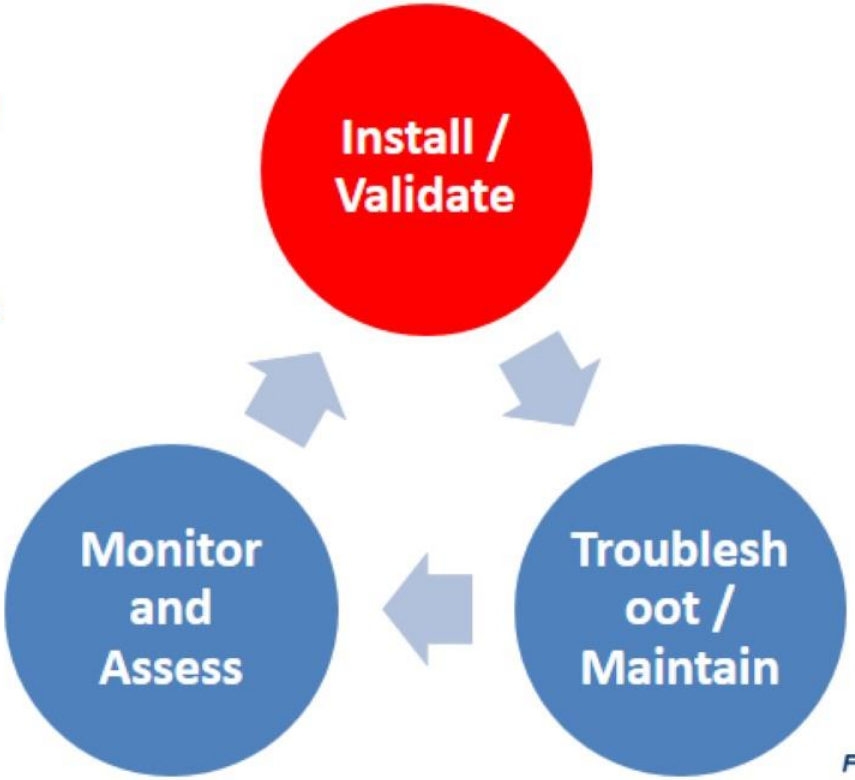
Picking a Starting Point

- Just Starting to Build Out?
- Assessed your needs and ready to go?



2. Installation and Validation

Cable and Fiber Testing

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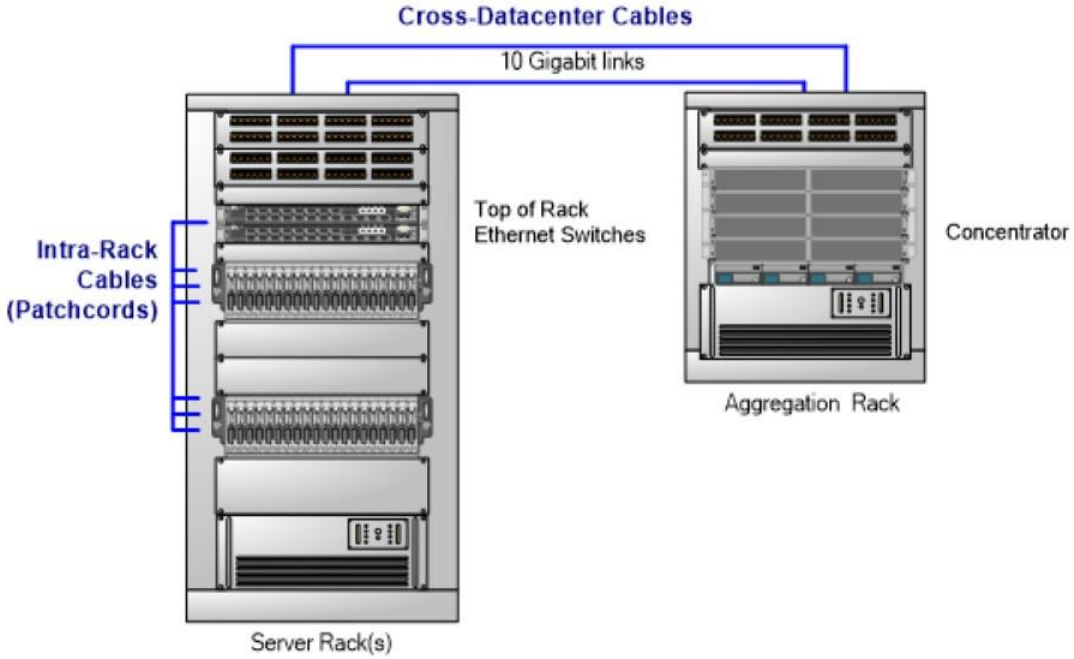
- Today's Datacenter
  - Changes, options, standards
- Copper testing and troubleshooting
- Verifying fiber continuity, polarity, and cleanliness
  - (PMLS, VFL, End-Face Inspection)
- Tier 1 fiber(Basic) Certification (OLTS)
- Tier 2 fiber (Extended) Certification OTDR)
- Finding fiber Faults
  - (FQM)
- Advanced Troubleshooting (OTDR)
  - Finding poor components within a channel
  - Reflectance issues

Today's Datacenter

- Virtualization Demands on the Datacenter Network
  - More bandwidth!
  - More flexibility!
  - How?
  - Two architectures for cable infrastructure:
    - Top-of-Rack
    - End-of-Row

Networks for a Virtualized Datacenter

Top-of-Rack



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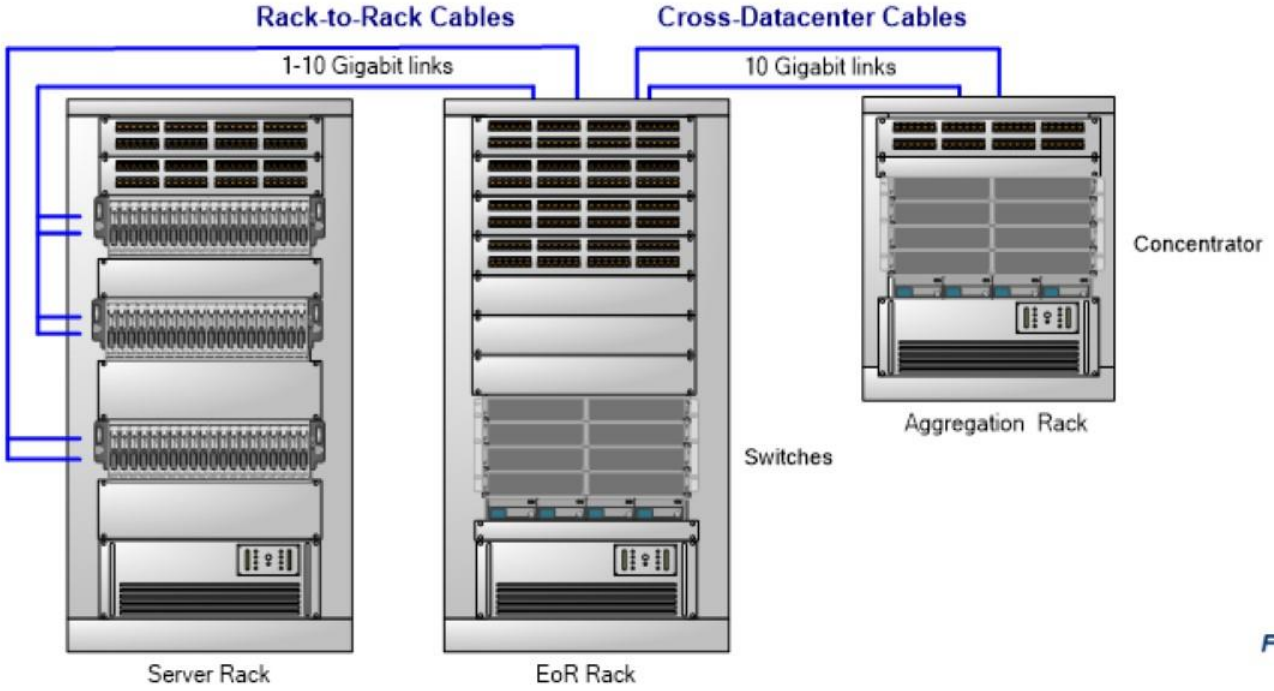
End-of-Row



Networks for a Virtualized Datacenter

- Cabling Choices
  - Assume at least 10 Gbps everywhere
    - Futureproof to support any application
  - Copper Options
    - Twinax — Intra-Rack only
    - Unshielded Twisted Pair — All classes
    - Shielded Twisted Pair — Rack-to-Rack & Cross-Datacenter
  - Fiber Options
    - 850/1300 Multimode — Rack-to-Rack & Cross-Datacenter
    - 1310 Single Mode — Rack-to-Rack & Cross-Datacenter
  - A mix of copper and fiber is common

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Networks for a Virtualized Datacenter

- The Case for 10GBASE-T
  - 10 Gbps over Unshielded / Shielded Twisted Pair (Cat 6A)
  - 40 Gbps over Shielded Twisted Pair (Cat 8)
  - Inexpensive cables/connectors
  - Backward-compatible with Ethernet standards
  - Supported by all switch manufacturers
  - Declining cost of silicon
  - Increasing port densities
  - Supports all needs in Top-of-Rack and End-of-Row architectures

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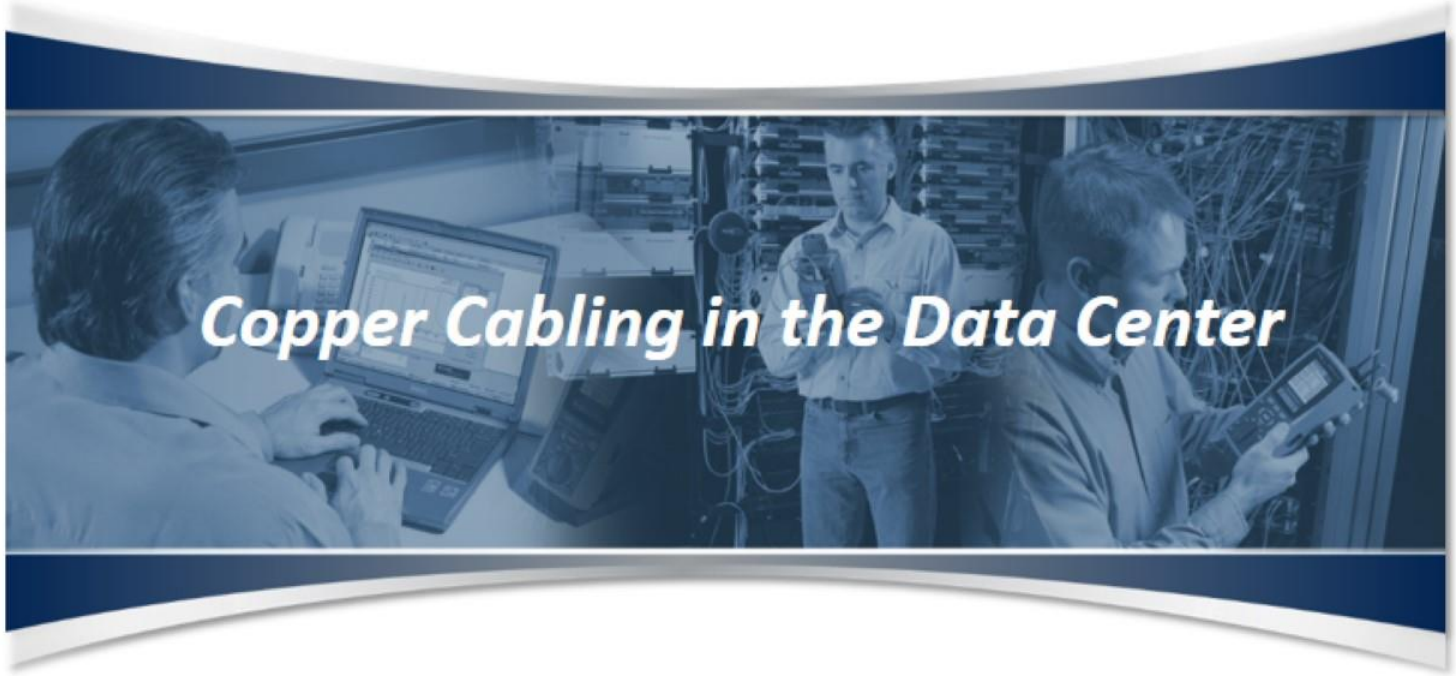

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Networks for a Virtualized Datacenter

- Ensuring Success
  - Always certify every cable
    - Warranties end
    - Warranties do not cover workmanship
    - Problem prevention is cheaper than repair
  - Certifying copper for 10/40 Gbps is easy
    - The VERSIV family has certified over 1 billion copper links
    - DSX CableAnalyzer will test to industry standard parameters and give quick pass/fail results
  - Certifying fiber can also be simple
    - Clean, inspect and test
  - Always, always document test results
    - Proof of quality is the baseline for resolving later problems

Example: Copper Applications

Type	Media	Max. length
10BASE-5	Coax	500 m
10BASE-2	Coax	185 m
10BASE-T	Twisted Pair	100 m
100BASE-TX	Twisted Pair	100 m
1000BASE-T	Twisted Pair	100 m
10GBASE-T	Twisted Pair	100 m*

* Dependent up on Alien Crosstalk results if using Category 6 cable

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TIA Categories for UTP components and links

- Category 3 (16 MHz)
  - 10BASE-T & Voice
- Category 4 (20 MHz)
  - Obsolete, 10BASE-T, 16Mb Token Ring
- Category 5 (100 MHz)
  - Obsolete; 10BASE-T, 100BASE-TX, 1000BASE-T subject to TSB-95
- Category 5e (100 MHz)
  - 10BASE-T, 100BASE-TX, 1000BASE-T
- Category 6 (250 MHz)
  - 10BASE-T, 100BASE-TX, 1000BASE-T, 10GBASE-T*
- Category 6A (500 MHz)
  - 10BASE-T, 100BASE-TX, 1000BASE-T, 10GBASE-T

* Dependent up on Alien Crosstalk results if using Category 6 cable

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Standards also provide specifications for test methods and accuracy of field test equipment

- TIA-1152 specifies three levels of accuracy for field testers
  - Category 5e: Level IIe
  - Category 6: Level III
  - Category 6A: Level IIIe

- IEC 61935-1
  - Class D: Level IIe
  - Class E: Level III
  - Class E_A: Level IIIe
  - Class F: Level IV
  - Class F_A: Level IV

Plugs and standards

- ANSI/TIA-568-C.2 has done an amazing job in specifying the test plug

Pair	Frequency range (MHz)	Return loss magnitude (dB)[1]	Return loss phase (degrees)[2]
1,2	10-500	≥ 33.5 – 20log(f/100)	Negative phase
3,6	10-500	≥ 33.5 – 20log(f/100)	Positive phase
4,5	10-500	≥ 33.5 – 20log(f/100)	Negative phase
7,8	10-500	≥ 33.5 – 20log(f/100)	Negative phase

1) The phase requirement does not apply when the measured magnitude is greater than 35-20log(f/100).
2) Calculations that result in return loss requirements greater than 40 dB shall revert to a requirement of 40 dB minimum.

Pair Combination	FEXT loss magnitude range (dB)[1]	phase (degrees)[2]
3,6-4,5	46-20log(f/100) ≥ FEXT loss ≥ 56-20log(f/100)[3]	-90 ± (30.f/100)[1,3]
1,2-3,6	46-20log(f/100) ≥ FEXT loss ≥ 56-20log(f/100)[3]	-90 ± (30.f/100)[1,3]
3,6-7,8	46-20log(f/100) ≥ FEXT loss ≥ 56-20log(f/100)[3]	-90 ± (30.f/100)[1,3]
1,2-4,5	FEXT loss ≥ 55-20log(f/100)[4]	Any phase
4,5-7,8	FEXT loss ≥ 55-20log(f/100)[4]	Any phase
1,2-7,8	FEXT loss ≥ 55-20log(f/100)[4]	Any phase

1) When the measured test plug FEXT loss is greater than 70 dB, the phase requirement does not apply.
2) Phase limits apply over the frequency range from 50 MHz to 500 MHz.
3) When upper limit FEXT loss calculations result in values greater than 70 dB, there shall be no upper limit for FEXT loss.
4) When lower limit FEXT loss calculations result in values greater than 70 dB, the lower limit FEXT shall revert to a limit of 70 dB.

Pair Combination	NEXT loss magnitude range (dB)[1]	NEXT loss phase range (degrees)[2]
3,6-4,5	36.3-20log(f/100) ≥ NEXT loss ≥ 39.5-20log(f/100)[3]	50 – 100 MHz: (-90 + 1.5× f/100) ± 1 100 – 500 MHz: (-90 + 1.5 f/100) ± f/100
1,2-3,6	46.8-20log(f/100) ≥ NEXT loss ≥ 49.5-20log(f/100)	(-90 +1.5 f/100) ± 3. f/100
3,6-7,8	46.8-20log(f/100) ≥ NEXT loss ≥ 49.5-20log(f/100)	(-90 +1.5 f/100) ± 3. f/100
1,2-4,5	NEXT loss ≥ 57-20log(f/100)[4]	90 ± (30+ f/100)[3]
4,5-7,8	NEXT loss ≥ 57-20log(f/100)[4]	90 ± (30+ f/100)[3]
1,2-7,8	NEXT loss ≥ 46-20log(f/100)[4]	Any phase

1) Magnitude limits apply over the frequency range from 10 MHz to 500 MHz.
2) Phase limits apply over the frequency range from 50 MHz to 500 MHz.
3) When the measured test plug NEXT loss magnitude is greater than 70-20log(f/100) or 70 dB, the phase limit does not apply.
4) When the NEXT loss magnitude limit calculation results in a value greater than 70 dB, the limit shall revert to 70 dB.
5) When Future NHFOGS DPRIT described in annex H is used, the magnitude high limit for pair combination 36-45, 39.5-20log(f/100), shall be 39.5-20log(f/100) + 0.5(f/100)/200 for the frequency range from 300 MHz to 500 MHz.

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Alien Crosstalk (AxTalk) testing:

- Values are found in ANSI/TIA-568-C.2 for the Perm. Link and Channel

- Methodology is found in the new ANSI/TIA-1152
  - Myth: "You do not have to do Alien Crosstalk testing if it is a shielded cabling system"
  - Fact: Neither standard makes a distinction between UTP/FTP/STP when it comes to Alien Crosstalk testing
  - Experience: Our experience shows that shielded cabling systems can fail Alien Crosstalk requirements if not installed correctly

- AxTalk is a sample test of the installation
  - ANSI/TIA does not specify the sampling plan
  - IEC 61935-1 no longer specifies 1% or 5 links whichever is the greatest
  - Sampling instructions can be found in the new IEC 14763-2

How is it measured?

- A Disturber cable is picked (which one?)
  - ANSI/TIA-568-C.2 and TIA-1152 give little guidance; “short and long link”
  - IEC 61935-1 provides better information:

    - **5.4.8.2 Selection of disturbing links**
      - Disturbing links shall include both of the following:
        - » all of the links that are in the same cable bundle or the most consistently positioned relative to the disturbed link as disturbing links;
        - » those that occupy adjacent positions to the left, right, above and below connections on the disturbed link on patch panels or multiple outlets.

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Networks for a Virtualized Datacenter

- Cabling Choices
  - Assume at least 10 Gbps everywhere
    - Futureproof to support any application
  - Copper Options
    - Twinax — Intra-Rack only
    - Unshielded Twisted Pair — All classes
    - Shielded Twisted Pair — Rack-to-Rack & Cross-Datacenter
  - Fiber Options
    - 850/1300 Multimode — Rack-to-Rack & Cross-Datacenter
    - 1310 Single Mode — Rack-to-Rack & Cross-Datacenter
  - A mix of copper and fiber is common

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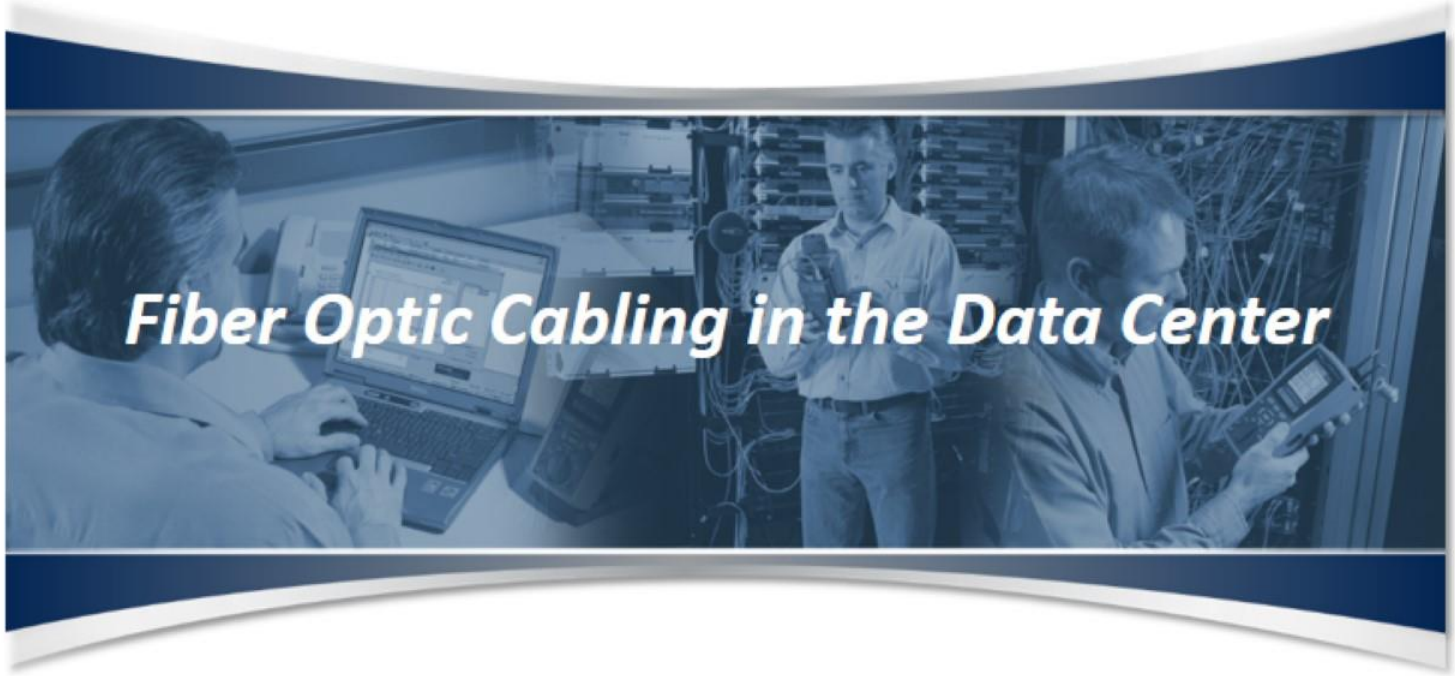

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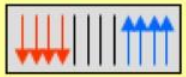
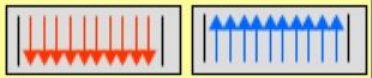
IEEE 802.3ba 40/100G Ethernet

	10G	40G	100G
Approach	10G	10G x4	10G x10
Laser Type	VCSEL	VCSEL Array	VCSEL Array
Fiber Type	OM3/OM4	OM3/OM4	OM3/OM4
Connector	LC x2	MPO	MPO x 2
# of Fibers	2	12 	24 
Transceiver Tolerances	Tight	Relaxed (to lower cost)	Relaxed (to lower cost)
Maximum Distance	OM3: 300m OM4: 400m	OM3: 100+ m OM4: 125 – 150 m*	OM3: 100+ m OM4: 125 – 150 m*

* 150 meters with OM4 requires low loss connectors

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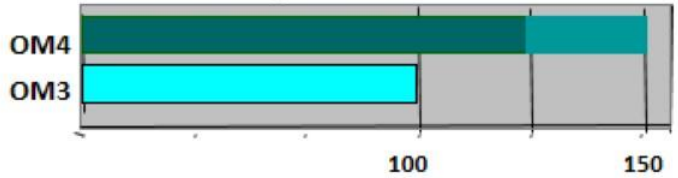
OM4 goes farther! Do you need it?

40 & 100 Gb/s 850 nm, 16GB FC

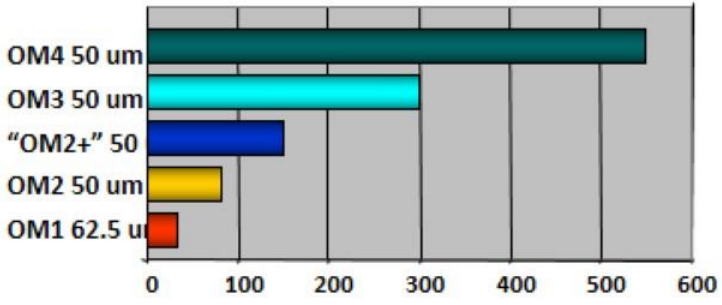


OM1, OM2, and OM2+ do not support

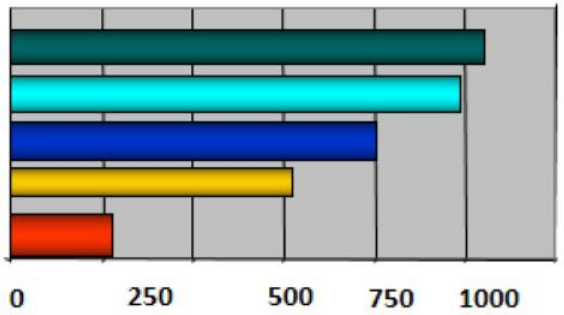
Only OM3, OM4, and SM are relevant for systems speeds above 10G

Low Loss Connectivity is required > 125 meters

10 Gb/s 850 nm, OIF STM-64 & 10 G FC



1 Gb/s 850 nm Ethernet or FC



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Data Center Evolution

- Growth rates of 40 Gbps in data centers expected to grow by more than 175% by 2016*
- Migrating from 10 GbE toward 40/100 GbE backbone
  - Very Low Link Loss Budget
  - Standardizing on Multimode OM3/4
  - Leveraging MPO backbones with cassettes
  - Pre-terminated assemblies becomes de facto

Pre-terminated MPO Cable

*Cisco Market Need for 40 Gigabit Ethernet Report, 2012

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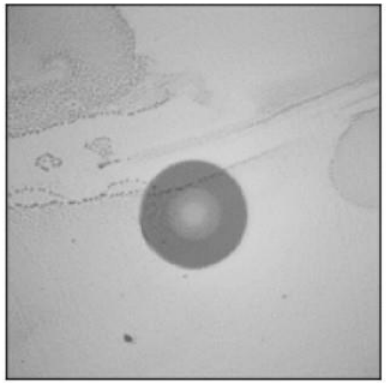
Verification -Inspecting and Cleaning

- This is what happens when the technician has no inspection equipment



- Cleaning wipe was saturated with IPA
- Technician did not wipe it dry with a lint free wipe

Verification with a VFL

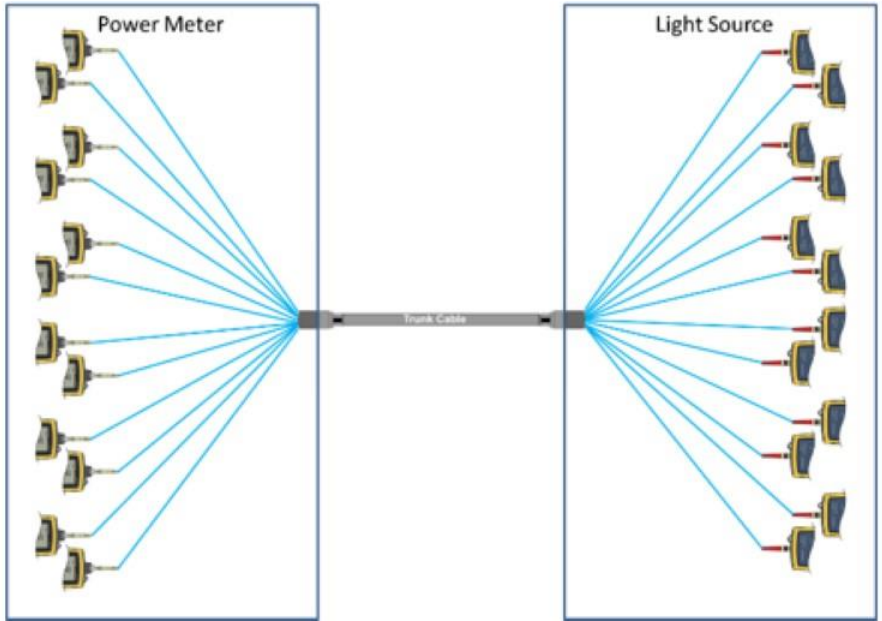
- Quality cannot be determined with a VFL.

12 dB Loss!

0.5 dB Loss!

What is needed …

- Measure the performance of all 12 trunk fibers in a single
  - Test loss
  - Validate polarity



Introducing MultiFiber™ Pro

- The industry's first MPO fiber trunk tester that validates the performance of all 12 trunk fibers in a single test – reducing testing time by nearly 95%*

- Simple & efficient
  - Measures loss on all 12 fibers
  - Tests against user-configurable loss limits
  - Validates polarity

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*According to Fluke Networks research of standard competitive products and processes.

Prepare the meter for testing

- Set the loss limit as desired
  - Press SELECT to enter the loss limit set up mode
  - Press F1 to decrease the limit
  - Press F2 to increase the limit
  - Press and hold MENU
  - Release when the meter returns to normal measurement mode

Application Budgets At 850nm		OM2	OM3	OM4
1000BASE-S	Loss Budget (dB)	3.6	4.5	4.8
	Length m (ft)	550 (1804)	550 (1804)	550 (1804)
10GBASE-S	Loss Budget (dB)	2.3	2.6	2.9
	Length m (ft)	82 (269)	300 (984)	400 (1312)
40GBASE-SR4	Loss Budget (dB)	---	1.9	1.5
	Length m (ft)	---	100 (328)	150 (492)
100GBASE-SR10	Loss Budget (dB)	---	1.9	1.5
	Length m (ft)	---	100 (328)	150 (492)

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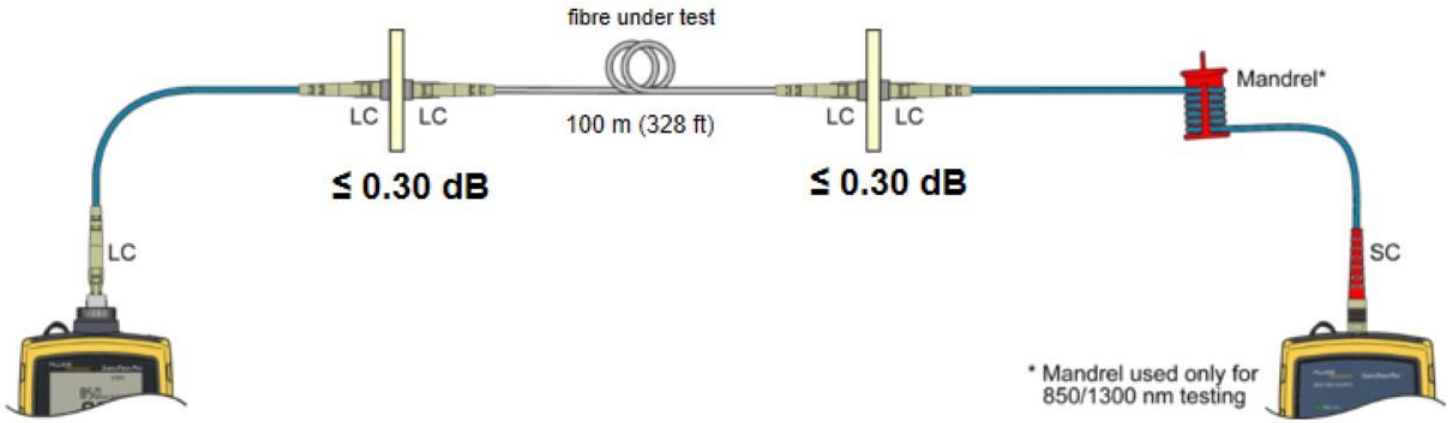
≤ 0.35 dB @ 850 nm
≤ 0.15 dB @ 1300 nm



Loss budget @ 850 nm = 0.30 dB + 0.35 dB + 0.30 dB
= 0.95 dB

Loss budget @ 1300 nm = 0.30 dB + 0.15 dB + 0.30 dB
= 0.75 dB

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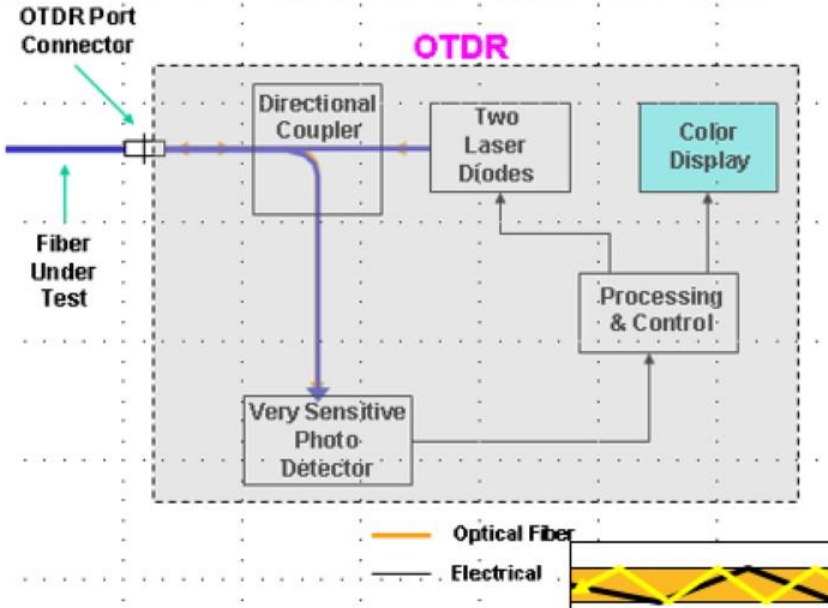
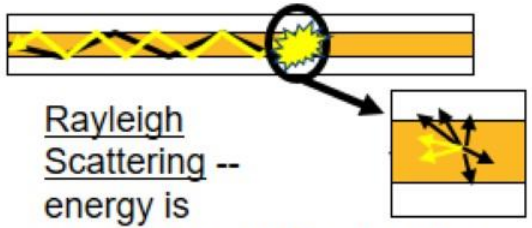
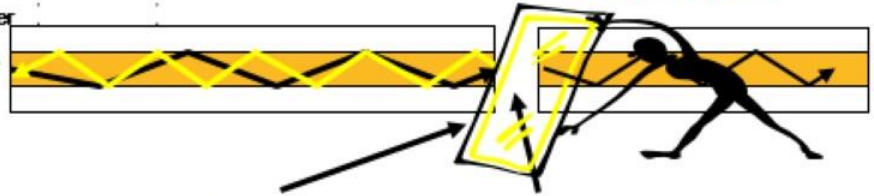
How does an OTDR work?





Rayleigh Scattering -- energy is released in all directions.

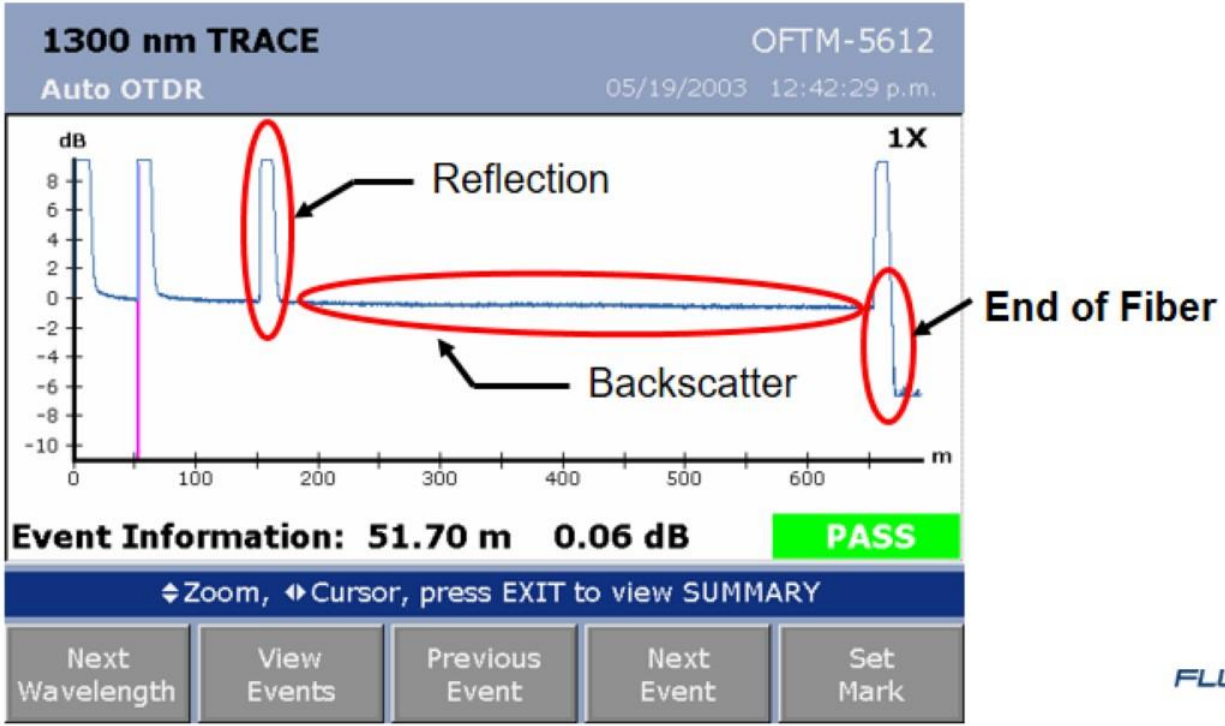
Backscatter -- about one millionth of the light that goes out is reflected back to the OTDR.



Fresnel Reflection -- Occurs when light traveling in one material encounters a different density material (like air).

Coupling loss -- Air gap causes loss of transmitted light

Simple OTDR Trace



Datacenter OTDR requirement #1

- **The industry's shortest multimode deadzones**

  Event: 0.5 meters

  Attenuation: 2 meters at 850nm, 3 meters at 1300, 1310 and 1550nm

- **Ideal for Top-of-Rack and End-of-Row architectures with short links with many connectors**

- **OptiFiber Pro ensures reliability of virtualized datacenters and SANs**

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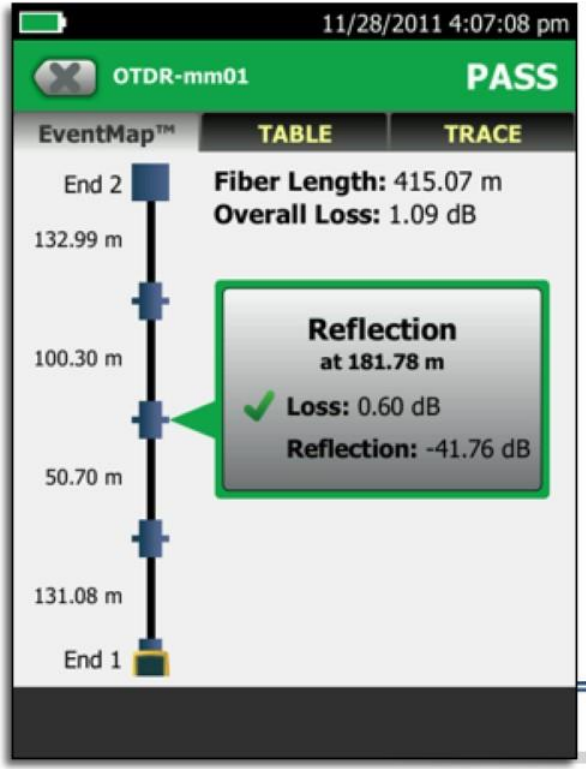
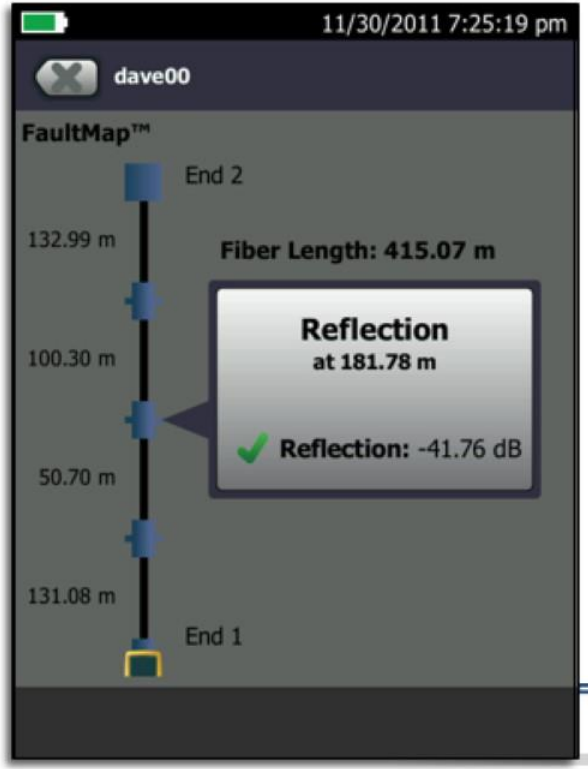
Datacenter OTDR requirement #2

- **Event Map: Alternative to trace presentation of link topology**
- **Reduces need for OTDR expertise**
- **Icons designate the type of fiber event**
- **One-tap gives access to all event details**



Datacenter OTDR requirement #3

- Reflectance: The silent bandwidth thief
- FaultMap is the fastest way to find reflectance and eliminate insidious reliability problems
- Icons designate large and small reflectance
- One-tap access to event details



Datacenter OTDR requirement #4

- **The industry's fastest trace time**

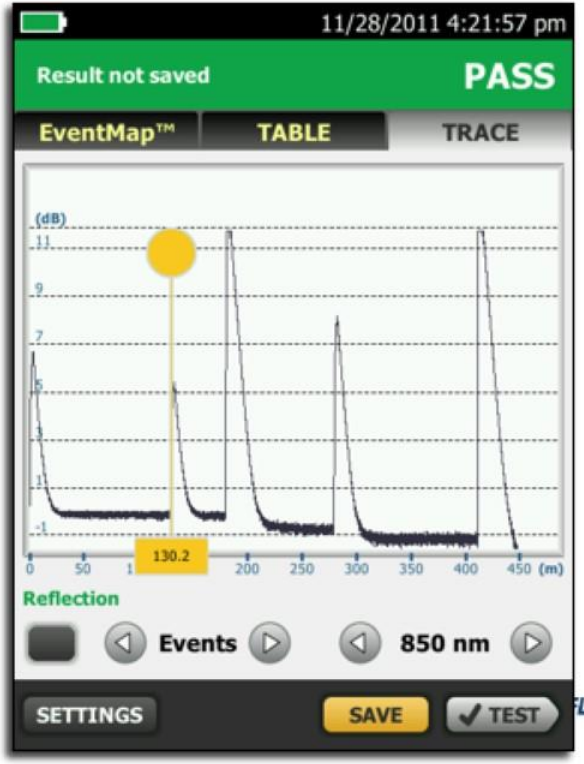
  QuickTest: 2 seconds*

  DataCenter: 2 seconds typical*

  Auto OTDR: 5 seconds typical*

- **Because you don't have time to waste**

*- Per wavelength



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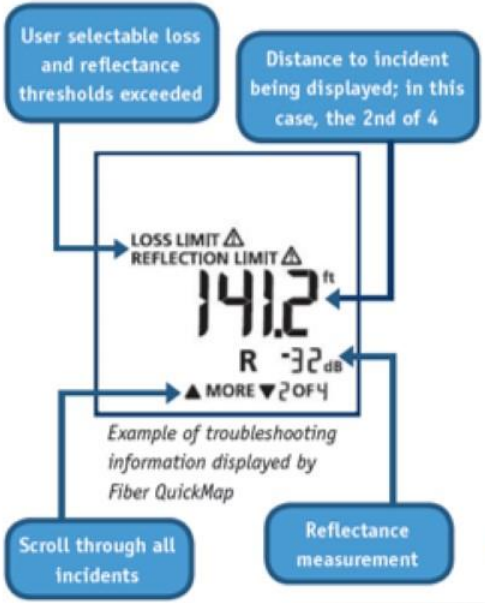
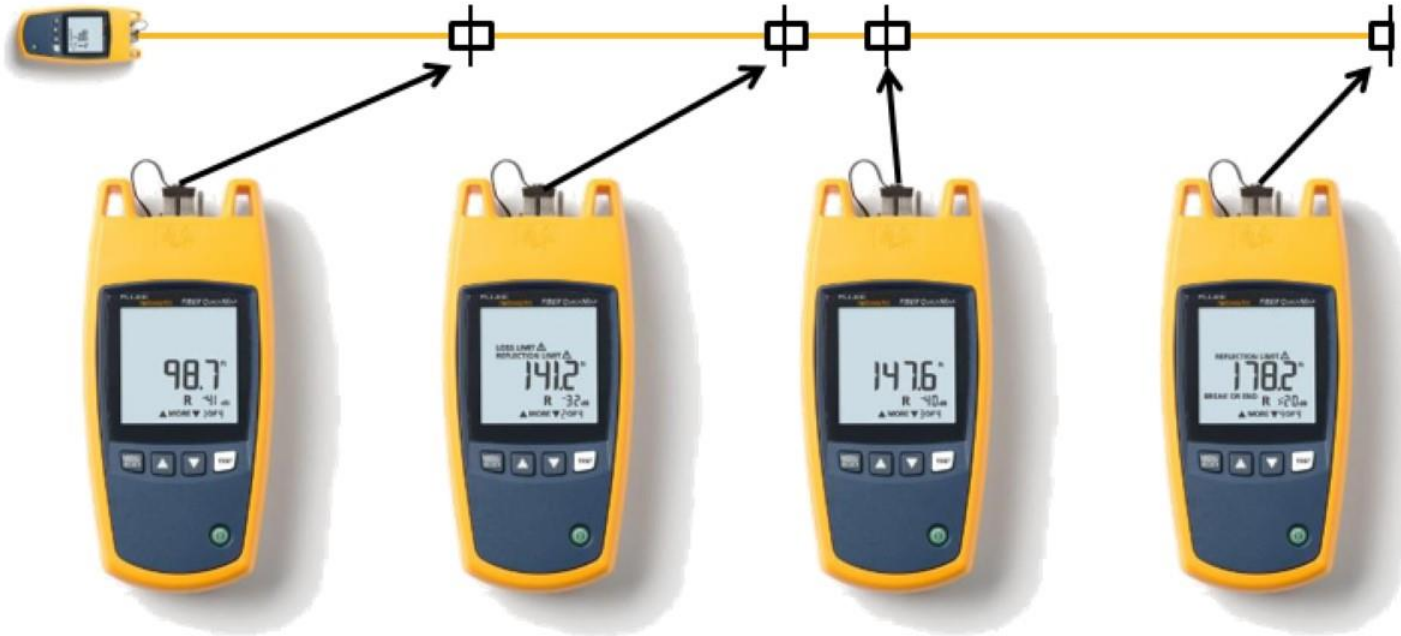
Tools To Measure Reflectance

- Optical Fiber Troubleshooter
- Not your father's "fault finder"
  - Locates multiple reflective and/or loss incidents
  - No setup required
  - Test times = 6 seconds
  - Numeric read-out



Testing With An Optical Fiber Troubleshooter



FLUKE networks

Comparación de Rendimiento

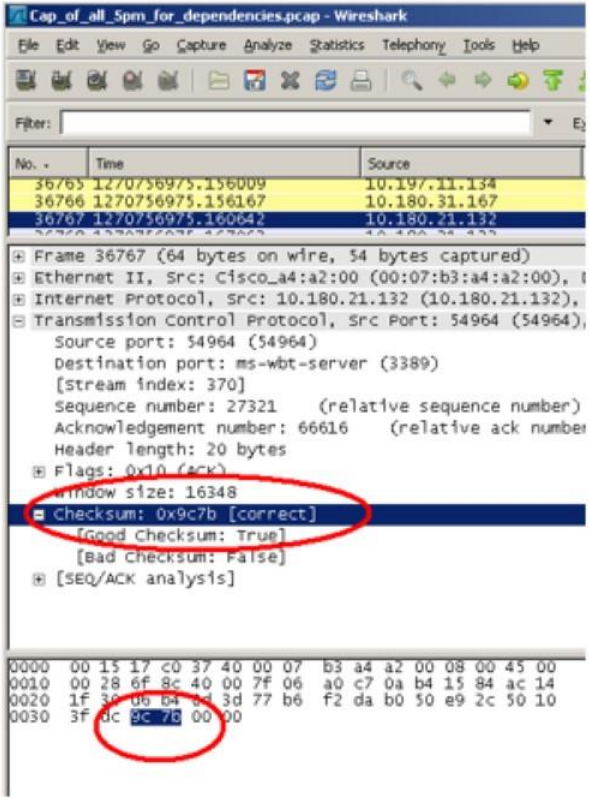
	Cat 5e	Cat 6
	Cat 5 Mejorada	Cat 6
Rango Frecuencia	1 – 100 MHz	1 – 250 MHz
Retardo de Propag.	Igual que TSB95	Igual que TSB95
Diferencia retardos	Igual que TSB95	Igual que TSB95
Atenuación	Igual que Cat 5	43% más fuerte
NEXT	41% más fuerte	337% más fuerte
PSNEXT	Especificado	216% más fuerte
ELFEXT	5% más fuerte	104% más fuerte
PS ELFEXT	Same as TSB95	95% más fuerte
Pérdida de Retorno	26% más fuerte	58% más fuerte

OK garantizado para 1000Base-T

Rendimiento grandemente mejorado

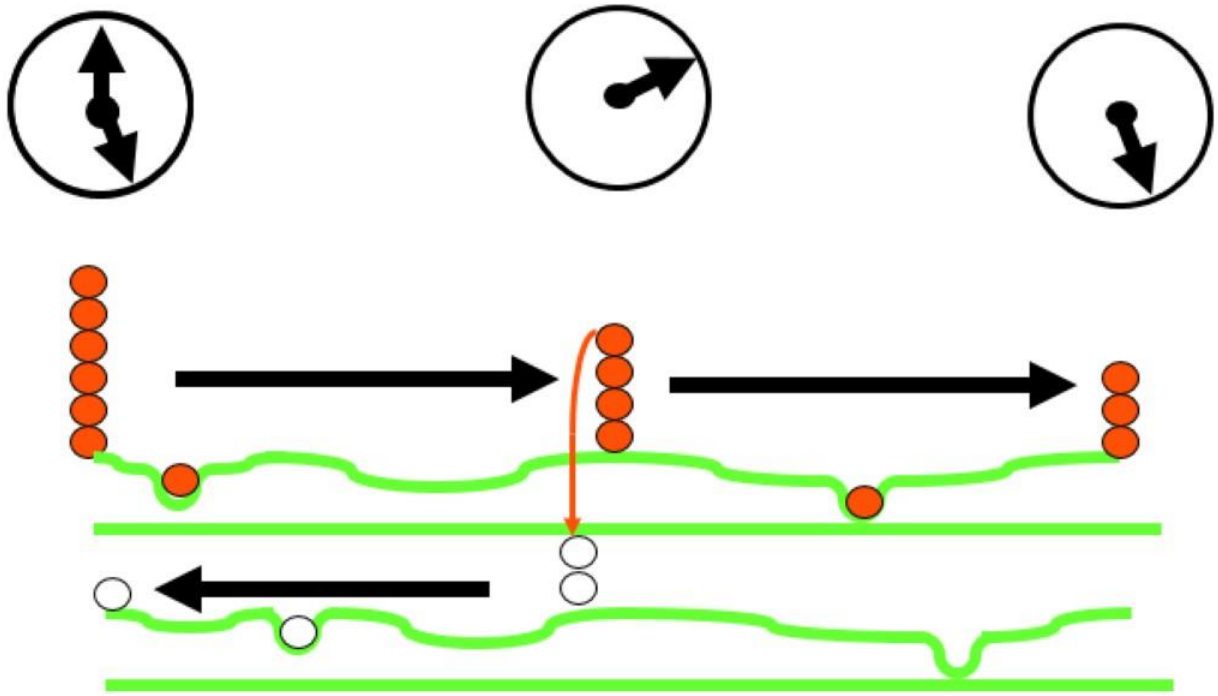
FLUKE networks.

Poor ACR (and NEXT problems)can lead to FCS and CRC errors and – Retransmissions!



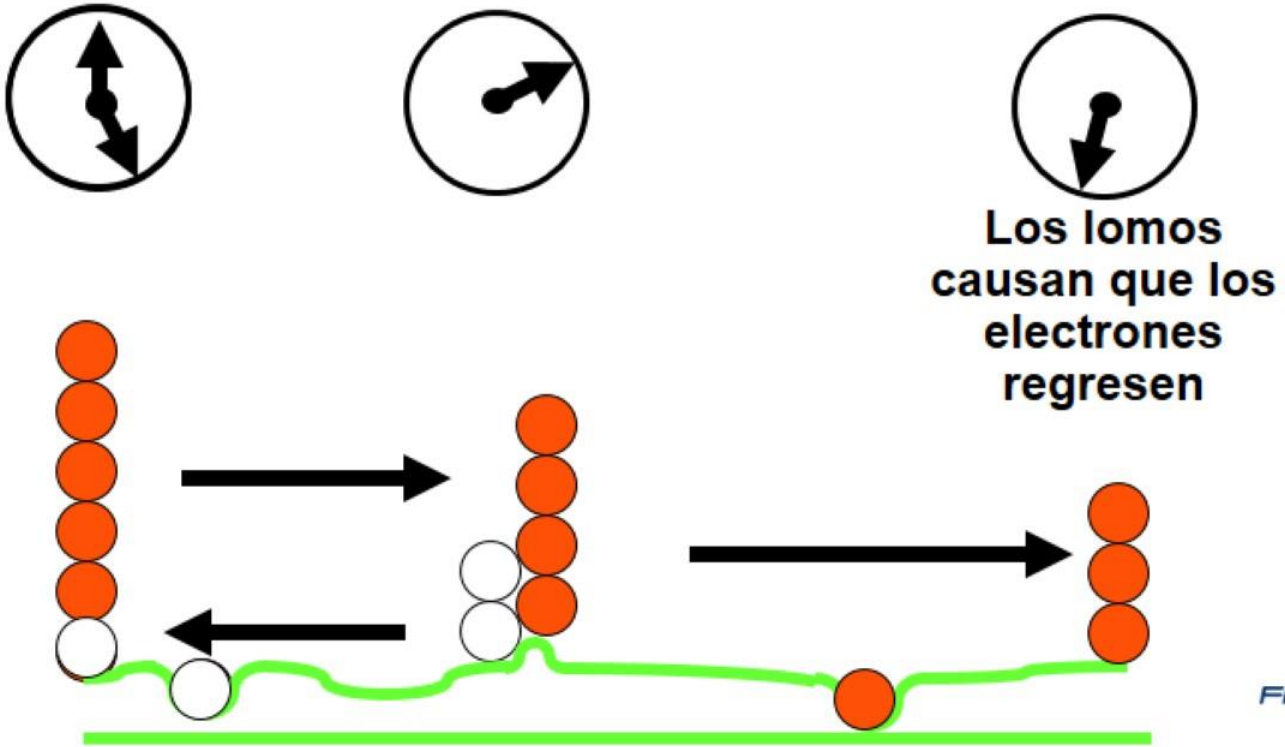
Bad Cabling = Slow Network

Near End Crosstalk (NEXT)

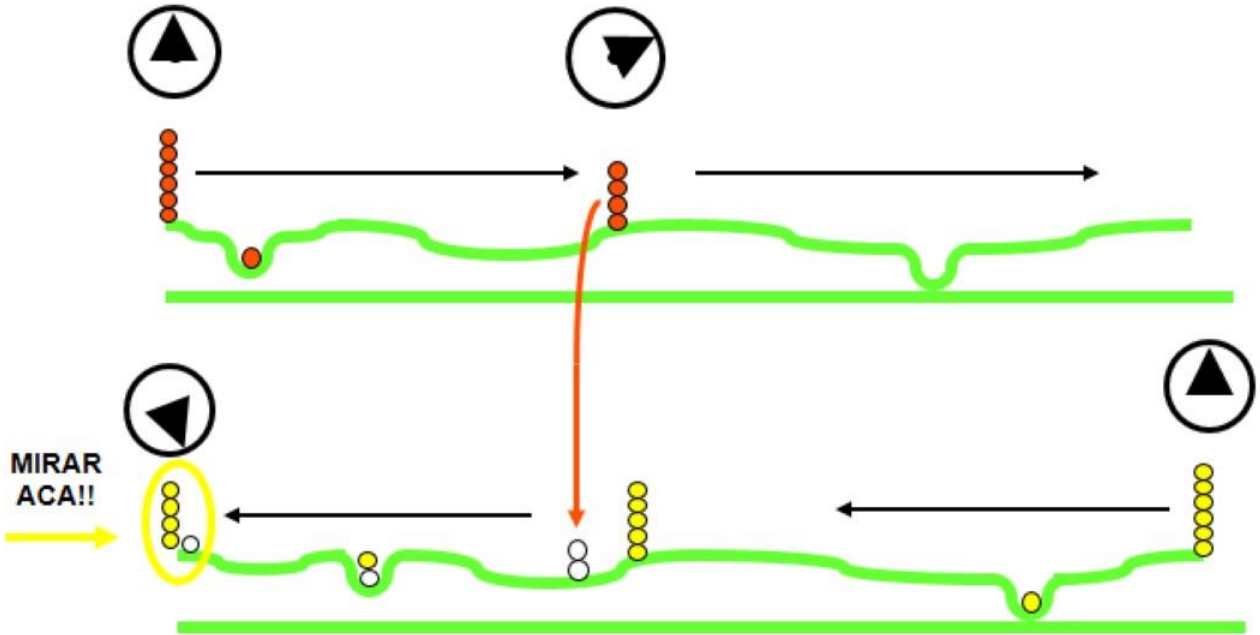


Near End Crosstalk Next son los electrones que vuelven al origen

También tenemos lomos….. Perdida de retorno



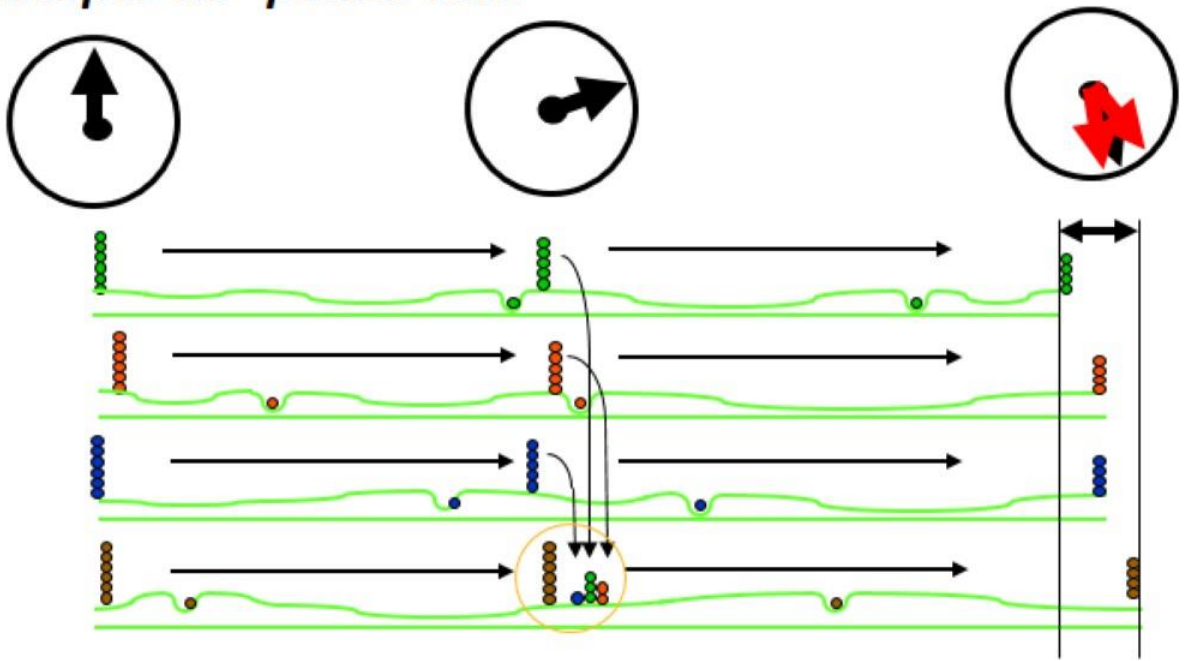
Combinando 2 efectos: atenuación y NEXT:
S/N = ACR



En el receptor necesitamos mas señal atenuada que ruido del par vecino

FLUKE networks.

El concepto de "power sum"



Señales en diferentes pares afectan simultáneamente a los pares vecinos.

Por qué Certificar?

- Para asegurar que el Cableado instalado cumple con los requerimientos por los que el usuario está pagando.

- La experiencia dice que las redes certificadas tienden a tener menores errores en las transmisiones de datos, lo cual se convierte en una red confiable y rentable para el usuario final.

- Hay que tener mucho cuidado con quien ofrece una instalación más económica por no certificar , el ahorro no está en ahí, el ahorro real para el cliente es contar con una red CONFIABLE para el presente y el futuro.

FLUKE networks.

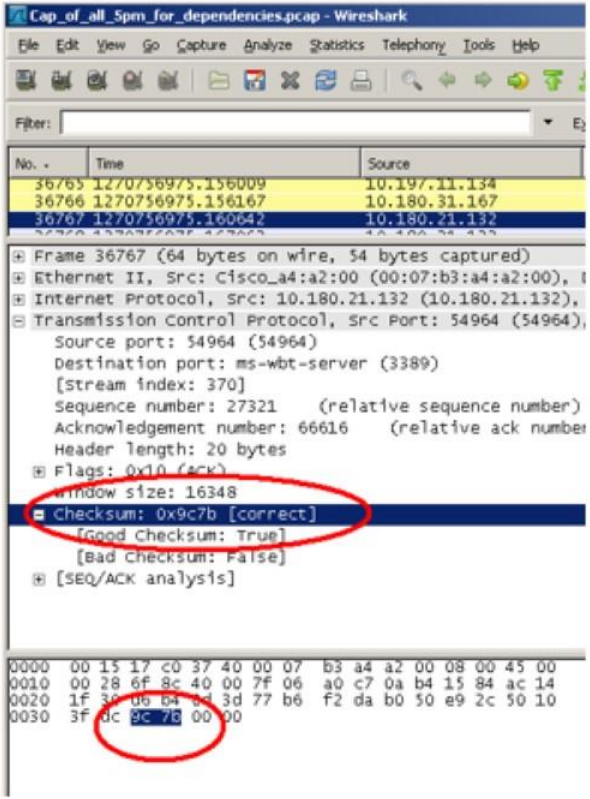
ANSI/TIA requirements

	Copper Certification	
	ANSI/TIA-568-C.2 (Cabling System)	ANSI/TIA-1152 (Minimum Field Test)
Wire Map	✓	✓
Length	✓	✓
Propagation Delay	✓	✓
Delay Skew	✓	✓
DC Loop Resistance	✓	1152-A (Draft)
DC Resistance Unbalance	✓	
Insertion Loss	✓	✓
NEXT, PS NEXT	✓	✓
Return Loss	✓	✓
ACR-F, PS ACR-F	✓	✓
TCL, ELTCTL	✓	
PS ANEXT, PS AACR-F 1)	✓	✓

1) Category 6A only

FLUKE networks.

Poor ACR (and NEXT problems)can lead to FCS and CRC errors and – Retransmissions!



Bad Cabling = Slow Network

Versiv: Una plataforma de comprobación de estructuras para todo

Certificación OTDR
OptiFiber Pro

Certificación de fibra
Certifiber Pro

Certificación de cobre
DSX-8000

FLUKE networks.

LinkWare Live supports DSX-8000

- Need to upgrade to newest version of LinkWare PC

Auditoria de Cableado

Diagnóstico del NEXT (HDTDX)

Diagnóstico del RL (HDTDR)

DSX-5000

FLUKE networks.

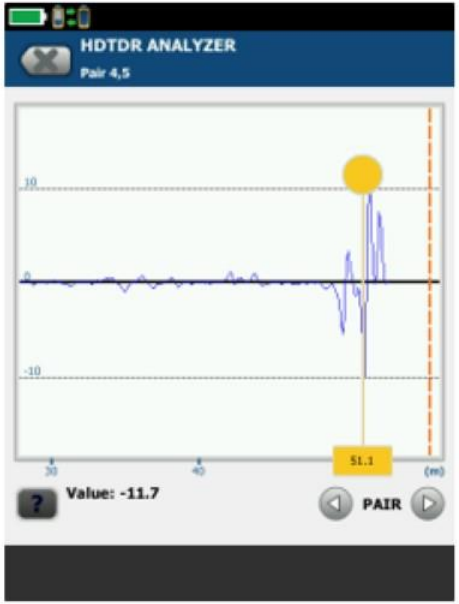
Fallo de NEXT #1

- Veamos la conexión cercana
- Con un valor de 37.4%, excede nuestra recomendación de35% por un poco
- Vale la pena notar que la terminación tampoco es buena en este extremo
- Es posible que estos conectores no sean realmente de Categoria 6

Fallo de Pérdida de Retorno #1

- Analicemos la gráfica HDTDR
- Desde la pantalla de RESULTADOS, presione:
  - **DIAGNÓSTICO**
  - **ANALIZADOR HDTDR**
  - **Elija y acerque** en los eventos
  - **Seleccione el par más corto**
  - **Mueva el cursor al evento más grande**

- Cuando vemos un evento mayor que -6%, significa un cambio severo en la impedancia y es consistente con un problema de agua en el cable

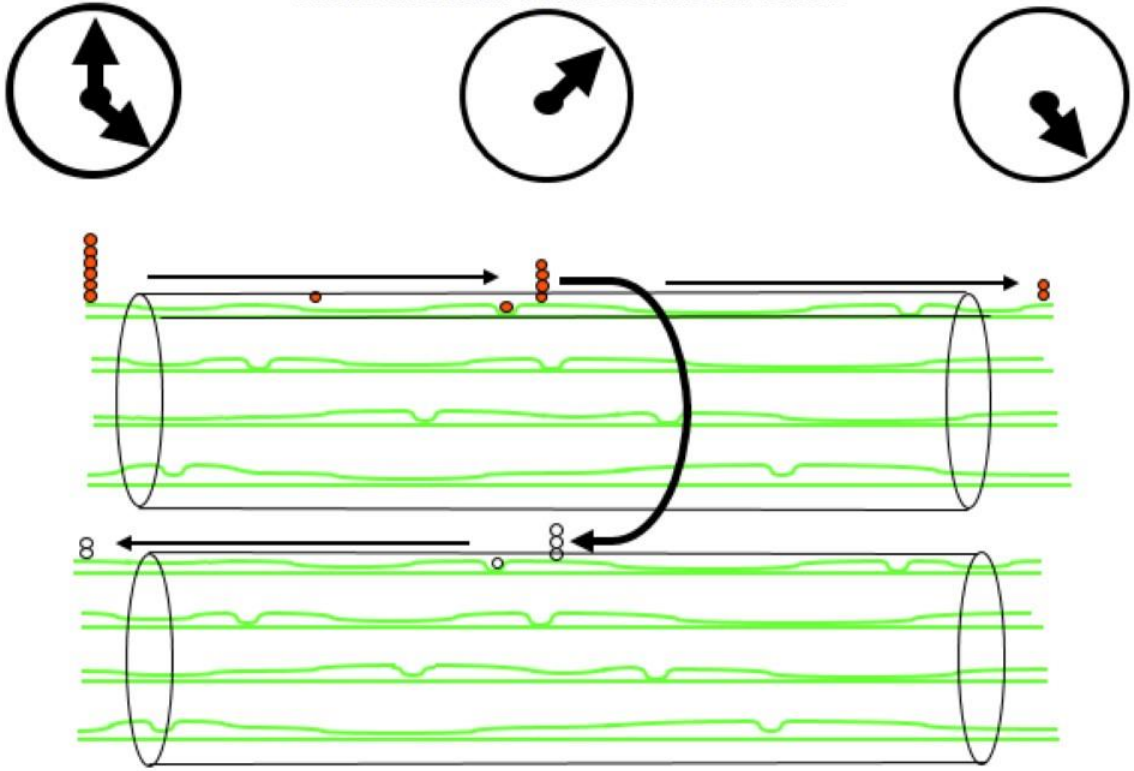


Alien Crosstalk

(Crosstalk Exógeno)

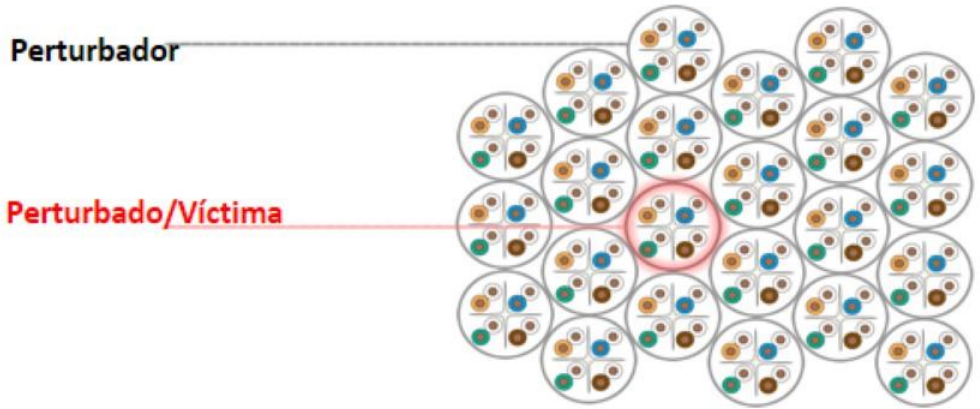
Alien Crosstalk

Alien crosstalk occurs between cables

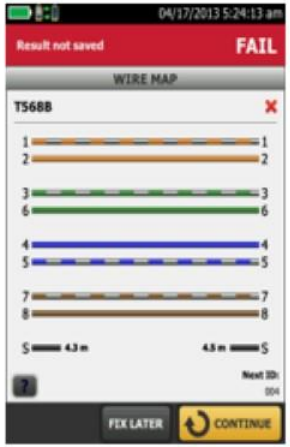


¿Qué es Alien Crosstalk?

- Alien crosstalk es el ruido acoplado de un enlace a otro
- Cuando un cable está rodeado por otros cables, el ruido de estos cables impactará su capacidad de transmisión – a eso lo llamamos Alien Crosstalk
- El cable afectado que probaremos se conoce como Víctima, y los cables adyacentes son llamados Perturbadores

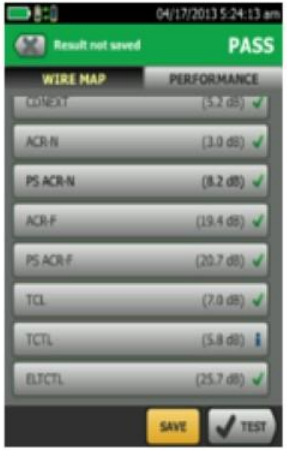


Ready for Today's and Tomorrow's Requirements



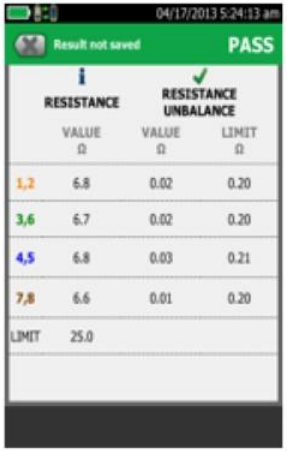
Shield integrity

- Shield continuity historically is a DC measurement.
- The DSX-5000 reports distance to shield integrity issues using a patented AC measurement technique.
- Addresses the issue that grounded racks in a data center will show the shield connected, even when it isn't.



TCL, TCTL, ELTCTL, CDNEXT, CMRL balance measurements:

- Specified in ANSI/TIA-568-C.2 & TSBs.
- Specified in ISO/IEC 11801:2010
- Important for successful 10GBASE-T.



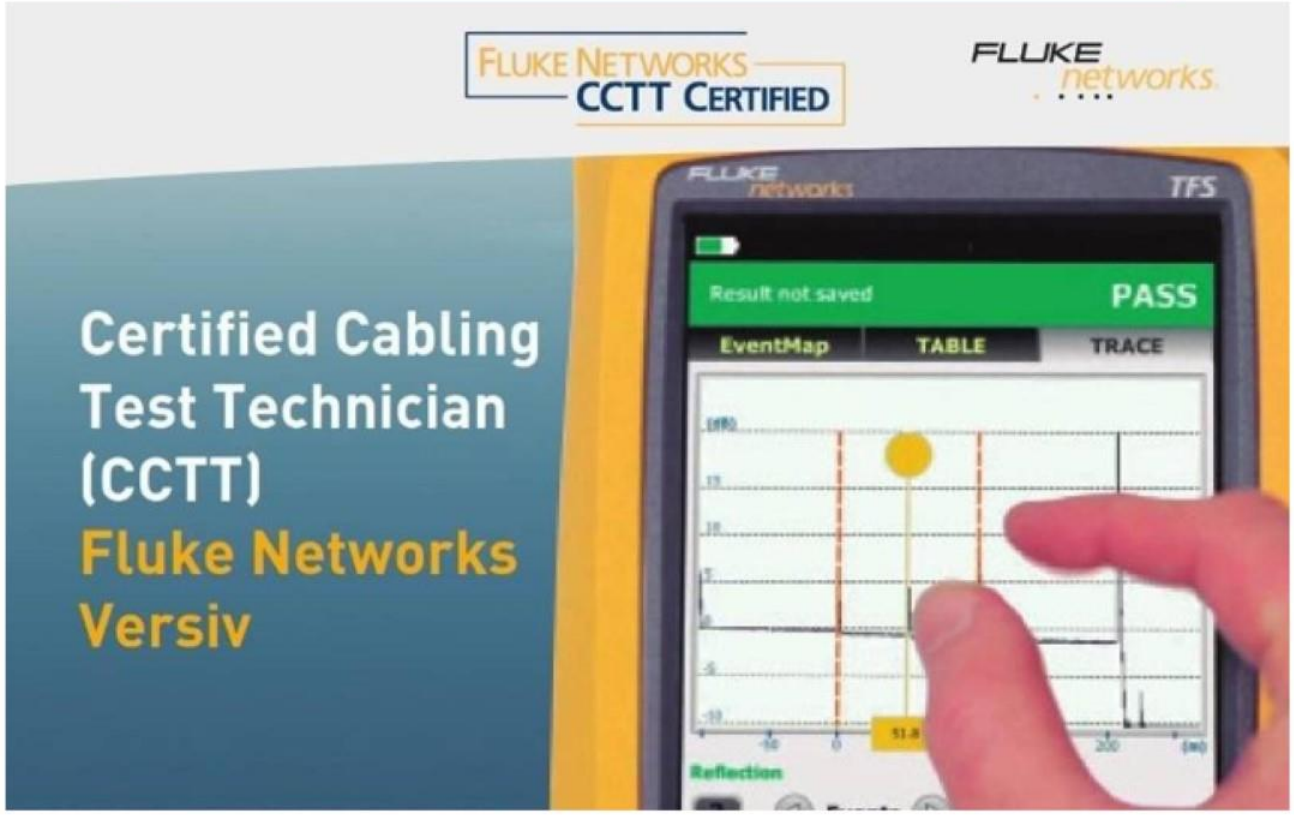
Resistance Unbalance:

- Specified in IEEE 802.3af and IEEE 802.3at.
- Specified in ANSI/TIA-568-C.2.
- Specified in ISO/IEC 11801:2010.
- Important for successful PoE operation.

These measurements are currently not specified as a field measurement because industry experts thought it could never be done in the field.
The **DSX-5000** CableAnalyzer is the **FIRST FIELD TESTER** to measure them!

FLUKE networks.

http://www.networks.pe/cctt



FLUKE networks

https://www.facebook.com/Networks.Peru

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We know networks.

FLUKE networks.

NETWORKS

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