OUR NUMBERS HELP YOU MAKE YOUR NUMBERS

VERSIV™
Cabling Certification System

VERSIV USERS REPORT:

10% INCREASE IN PROFITS

66% REDUCTION IN TESTING AND REPORTING PROBLEMS

FLUKE networks 25 YEARS OF TRUST AND PARTNERSHIP 1992-2017

14 BICSI CREDITS
(TWO DAYS OF CCTT)

CABLE TEST TECHNICIAN — FLUKE networks — CERTIFIED PROFESSIONAL

1,051 KNOWLEDGE BASE ARTICLES

WORLD'S FIRST TRUE CATEGORY 8 FIELD TESTER

13 SERVICE CENTERS WORLDWIDE
(THAT CAN CALIBRATE A DSX)

162 YEARS OF CABLE TESTING EXPERIENCE
TECH SUPPORT (US + EMEA)

10208 CERTIFIED TECHNICIANS
CCTT

CCTT AVAILABLE IN **50** COUNTRIES

REPRESENTED ON OVER **30** STANDARDS BODIES

4,200,000 VERSIV TEST RESULTS UPLOADED TO LINKWARE LIVE
(...AND COUNTING)

LinkWare Live

112 CABLE TESTING NERDS EMPLOYED

36 CABLE TESTING U.S. PATENTS

ZERO DOWNTIME WITH GOLD SUPPORT

GOLD

25 LINKS TESTED EVERY SECOND OF EVERY BUSINESS DAY
(ESTIMATE)

THE **TOP 10** FORTUNE 500 CORPORATIONS ARE REGISTERED OWNERS

24h **233 NEW** PROJECTS DAILY IN LINKWARE LIVE

APPROVED BY **29** CABLING MANUFACTURERS

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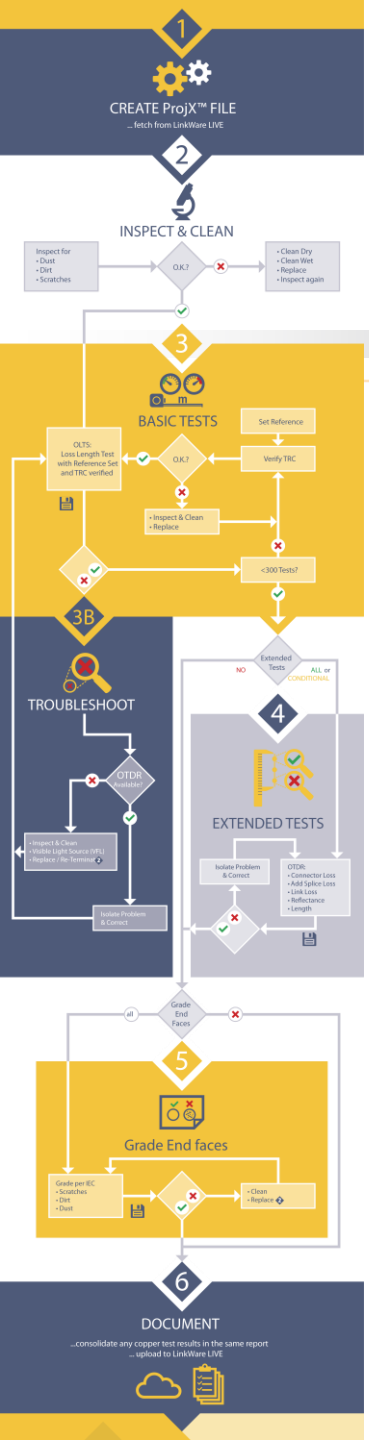

Maximize …
Optimize …
Protect …

Realize the Value in modern Copper Optic Infrastructure

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FORTIVE

Professional Instrumentation

Field Solutions*

FLUKE

QUALITROL

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Product Realization*

Tektronix

Invetech

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Sensing Technologies

Gems Sensors & Controls

setra

ANDERSON-NEGELE

Industrial Technologies

Transportation Technologies

GILBARCO VEEDER-ROOT

TELETRAC NAVMAN

Automation & Specialty

KOLLMORGEN
Because Motion Matters™

THOMSON

Portescap

Jacobs Vehicle Systems™

Franchise Distribution

MATCO TOOLS

AMMCO coats
Hennessy Industries

FLUKE networks

Who We Are

Fluke Networks is the worldwide leader in certification, troubleshooting, and installation tools for professionals who install and maintain critical network cabling infrastructure. From installing the most advanced data centers to restoring service in the worst weather, our combination of legendary reliability and unmatched performance ensure jobs are done efficiently.

Datacom Contractors

Datacenter / Network Managers

Communications Service Technicians

Customer Segments

- Electrical/ Datacom Contractors
- Datacenter Operators
- Service Providers
- Private Network Owners
- Structured Cabling System Manufacturers

Technologies

- Twisted Pair Copper
- Single- / Multi-Mode Fiber
- Coaxial Copper
- POTS (Telephony)
- Database Management
- Cloud (LinkWare Live)

Applications

- Installation Certification / Qualification
- Troubleshooting

Products

Datacom Certification

Datacom Fiber Optic Testing

Datacom Copper Testing

Communication Service Tools

FLUKE networks

Our History of Innovation

Trusted in the Field Since 1992

FLUKE networks 25 YEARS OF TRUST AND PARTNERSHIP 1992-2017

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Agenda

- Defining the scope of the project
  - VOC from 800+ customers
  - ProjX the tool for concurrent projects
  - LinkWare Live
- Basic Test Regime
  - Test Interfaces
  - Test Adapters with a “centered” Test Plug
  - Fundamentals: IL, RL, NEXT, FEXT, …..
- Driving forces for an extended Test Regime
  - Resistance Unbalance: (POE, Intermittent Contact, CCA)
  - Mode Conversion and Balance (TCL, ELTCTL)
  - Screen Integrity
- Project Monitoring and Reporting
  - Linkware Live
  - LinkWare PC

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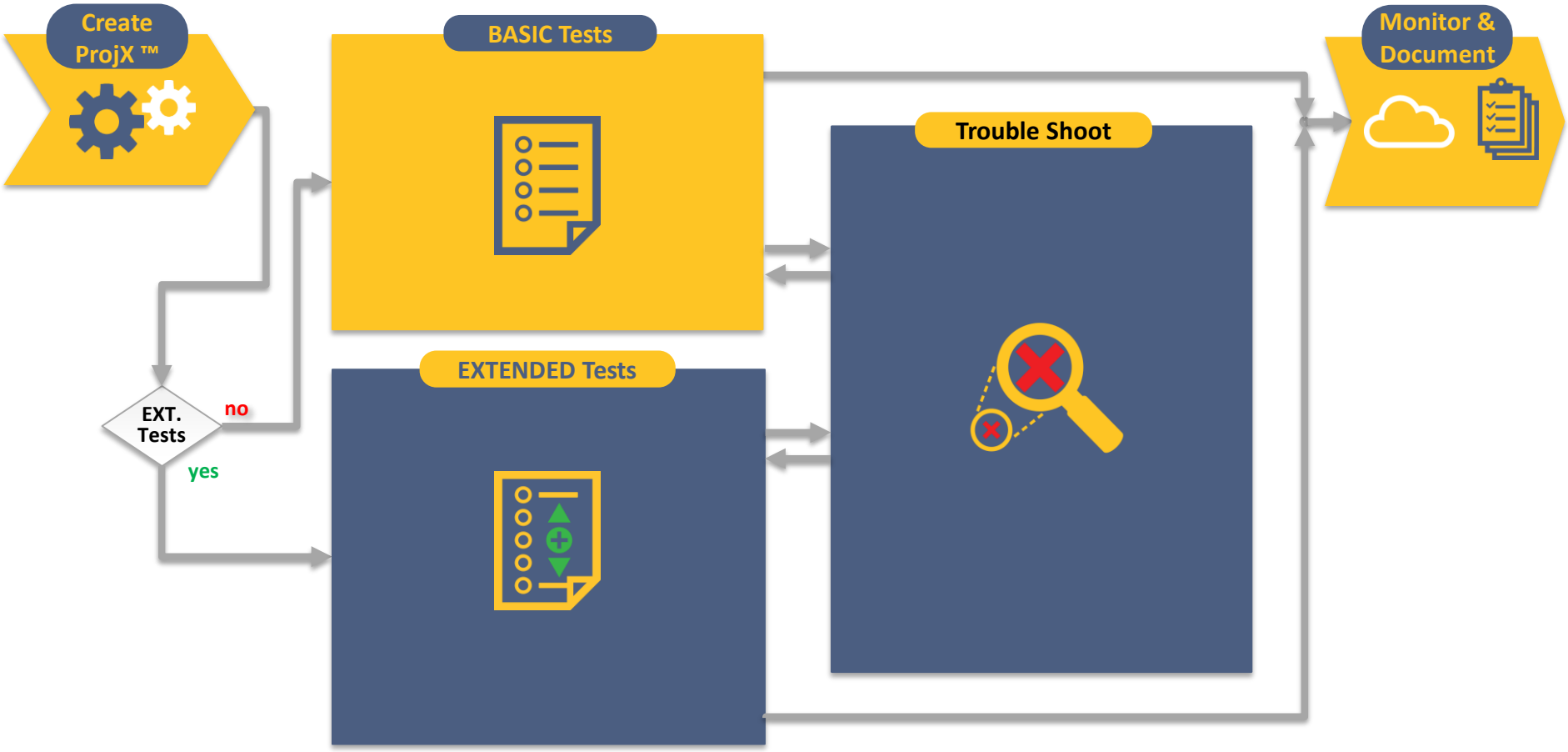
Copper Testing Best Practices



…Optional / Conditional Testing

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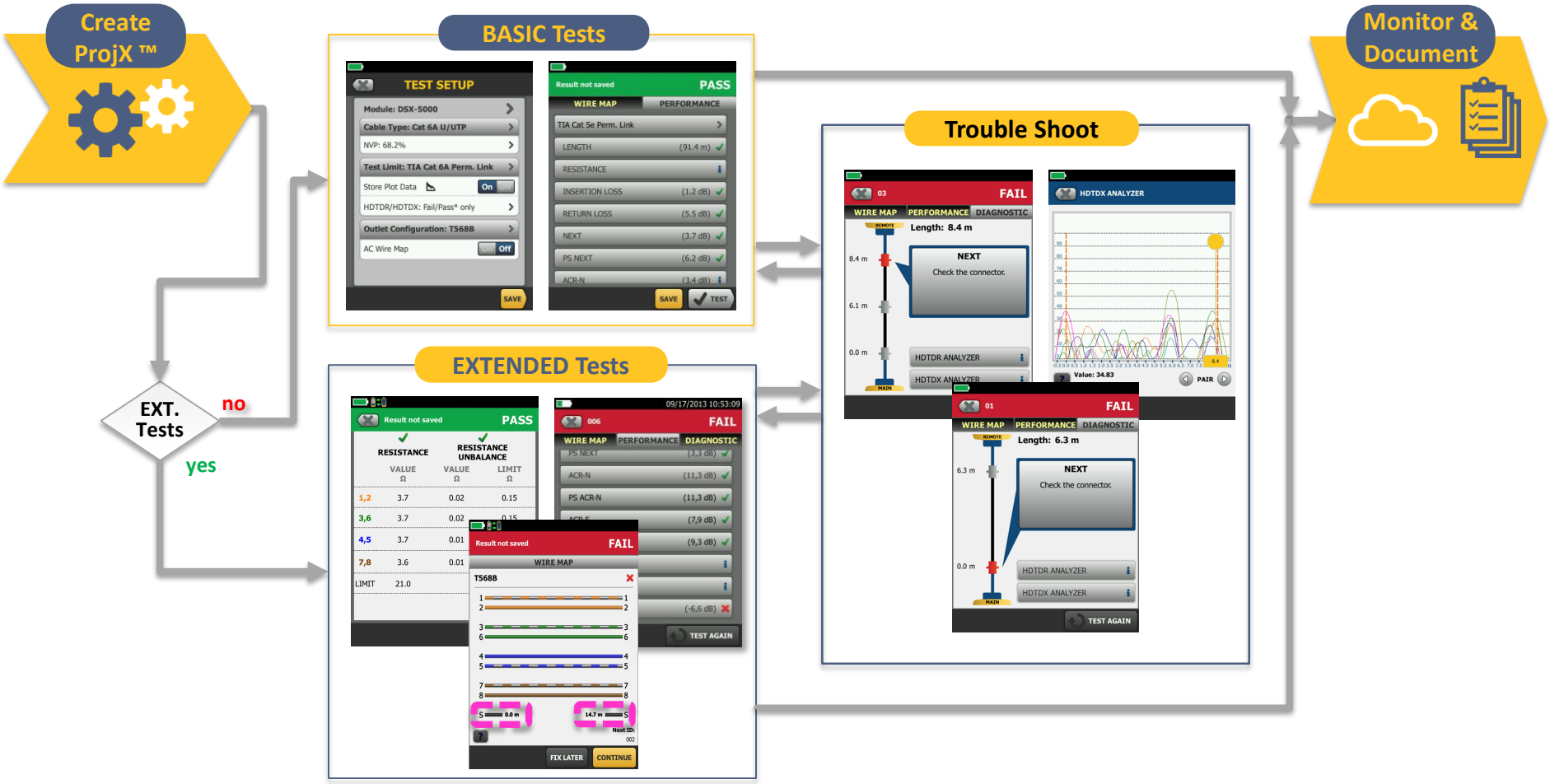
Copper Testing Best Practices



…Optional / Conditional Testing

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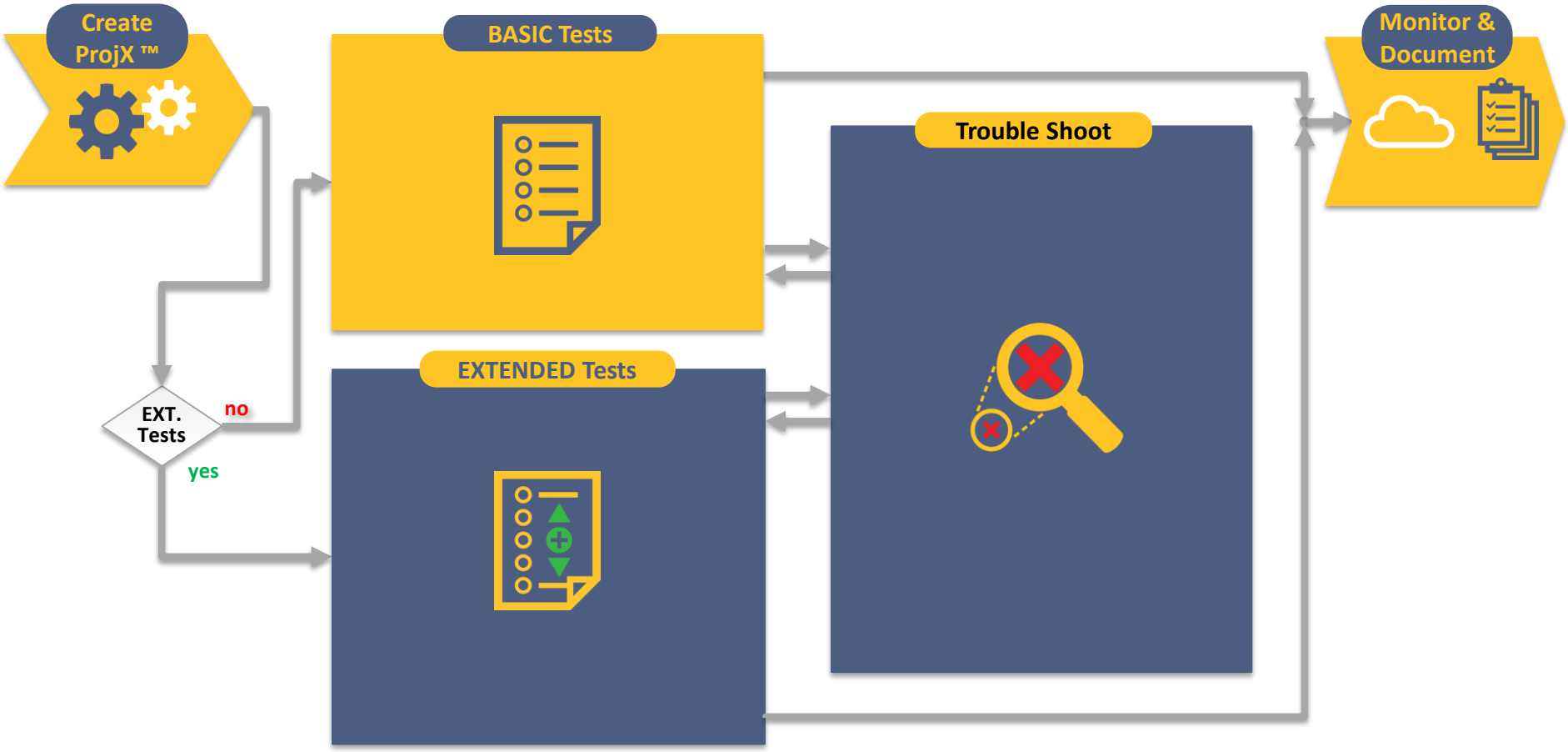
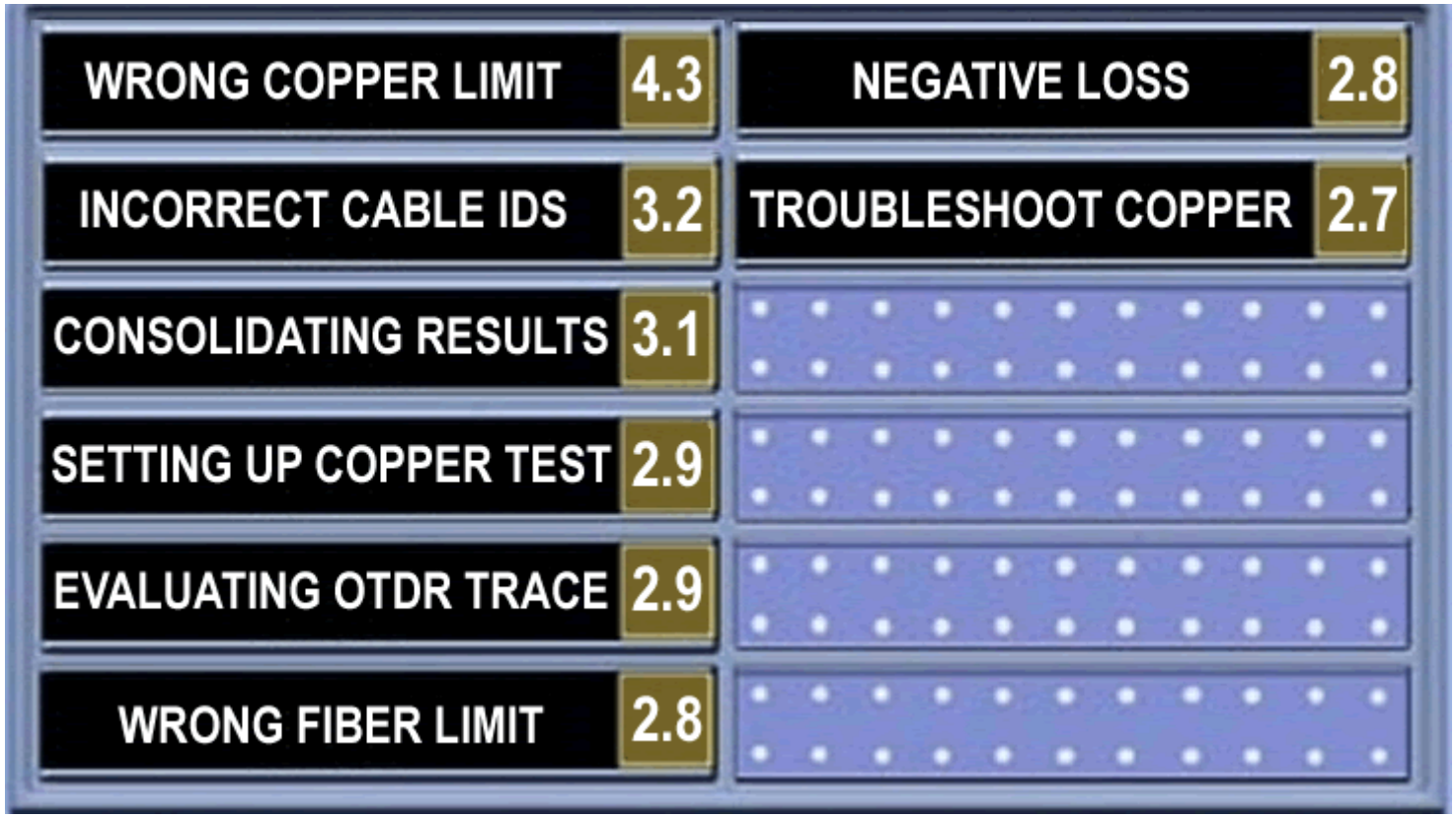
Step 1: Project Defintion



…Optional / Conditional Testing

800+ Installers VOCs:

Top eight problems (hours wasted)



Average amongst all respondents in the previous 30 days

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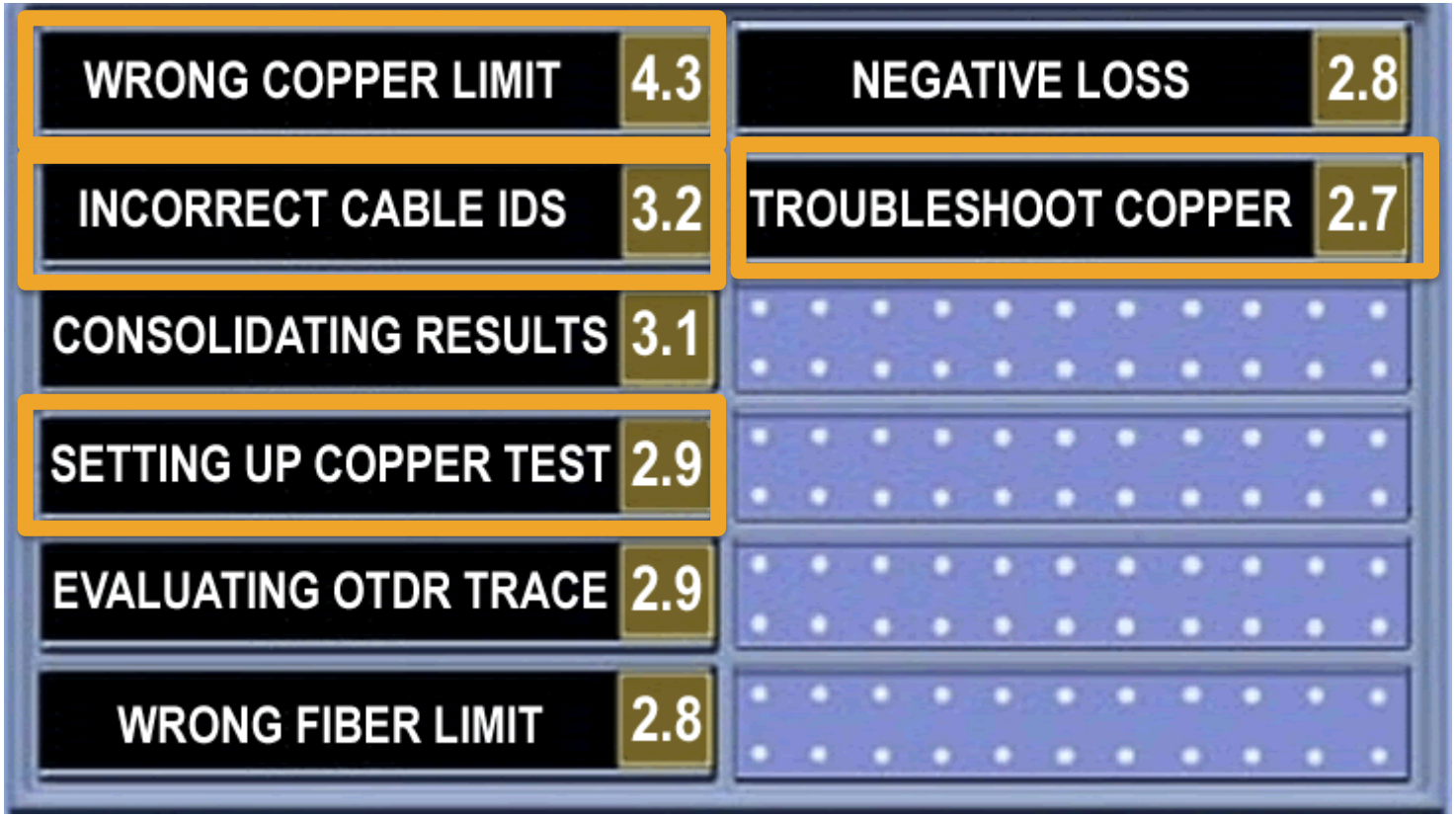
Create ProjX ™

Top eight problems:

Wrong Configuration (Limit, IDs, Standard, …..)



Average amongst all respondents in the previous 30 days

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Project Definition

Create ProjX ™

- Limits, Cable Types, Cable ID are best known by planner/project-manager

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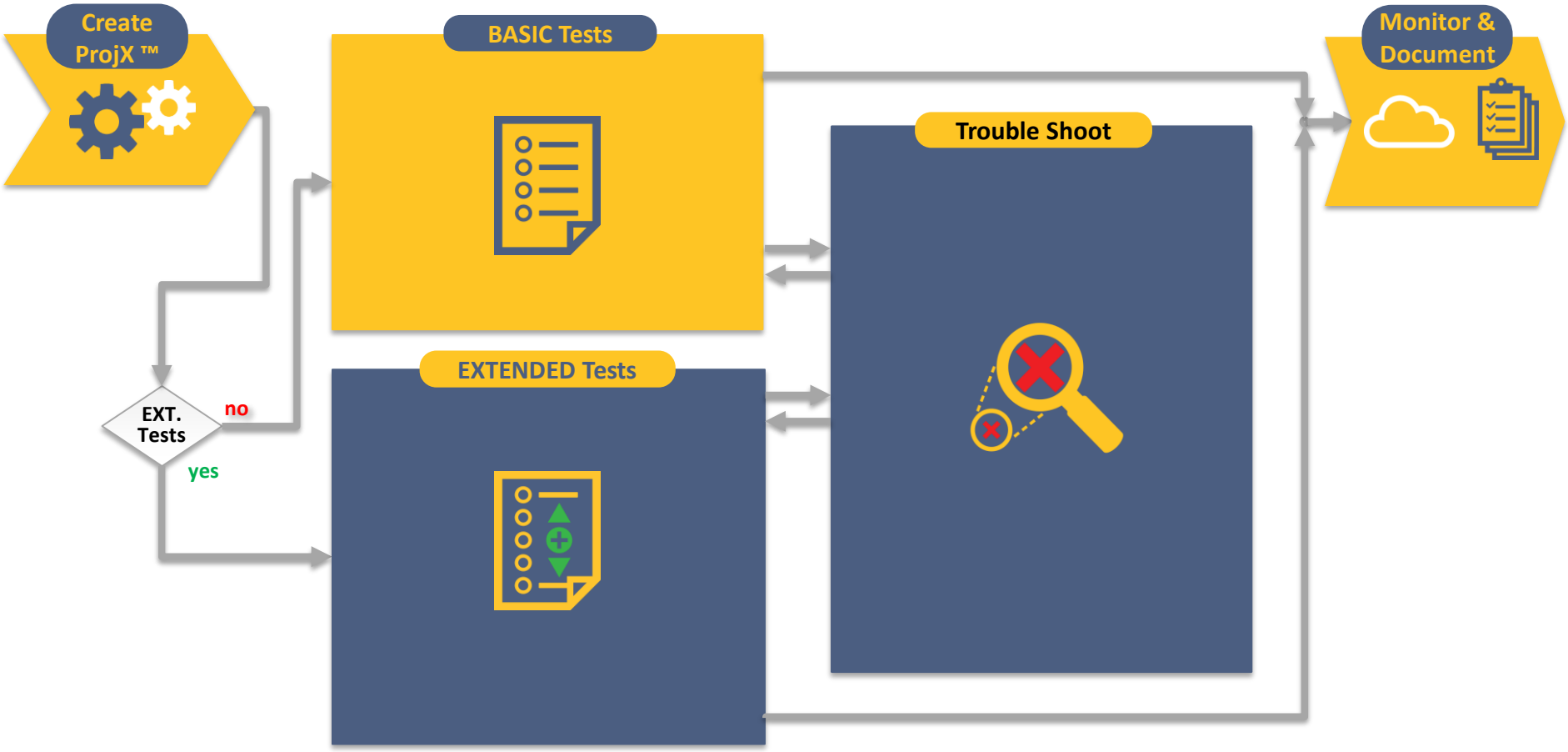
ID List Import *(NEW Since Dec.2015)*

Step 1A: Basic (Minimum) Test Regime



…Optional / Conditional Testing

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Copper Testing: Basic Parameters

Measured

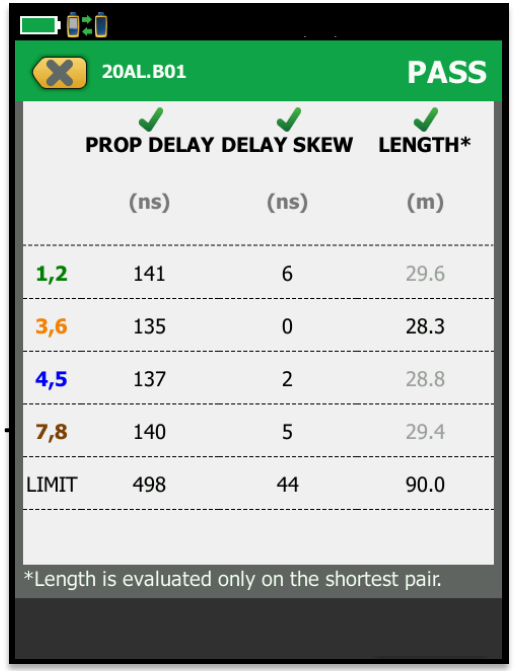
- Length
- Insertion Loss
- NEXT
- FEXT

Calculated from measured

- PS NEXT
- ACR-N
- PS ACR-N
- ACR-F
- PS ACR-F

Length

- Tap **Length** to see:
  - Length, Propagation Delay & Delay Skew
- Length
  - Only the shortest pair is evaluated
  - No PASS/FAIL for ISO/IEC standards
- Propagation Delay
  - Time it takes to send a 10 MHz signal down
- Delay Skew
  - Difference in delay between the pairs



- Go back to the summary screen

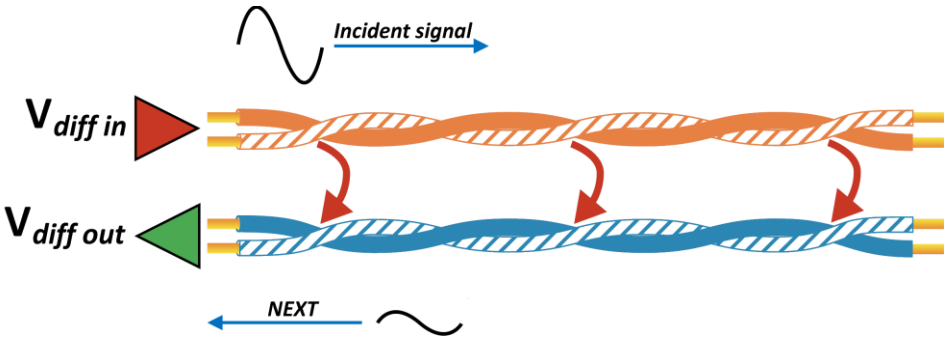
Insertion Loss

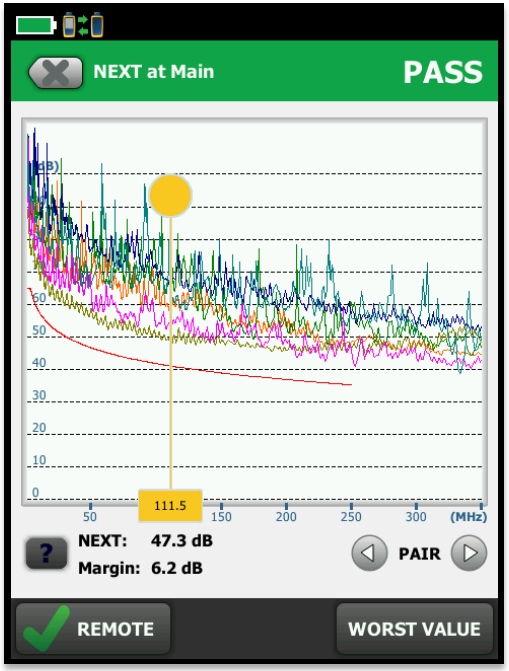
- Tap **Insertion Loss**:
  - In dB, the signal loss down the cable

- Causes of failure
  - Over length
  - Incorrect test limit / category of cable
  - Pulling lubricant

NEXT (Near-end Xtalk)

- Tap **NEXT**:
  - In dB, the disturbed signal on an adjacent pair

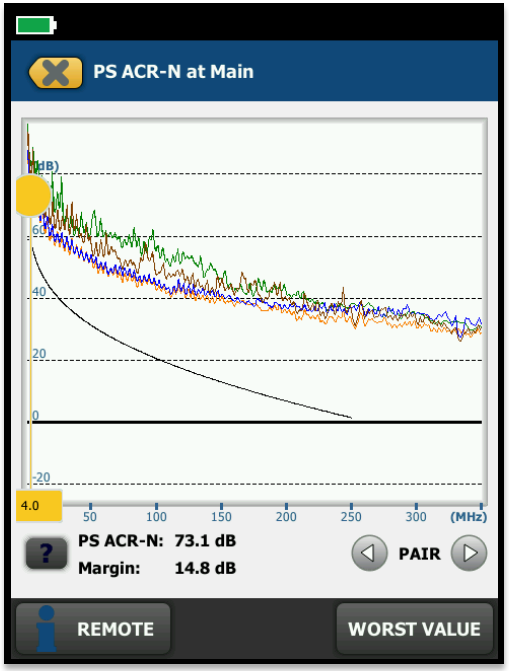




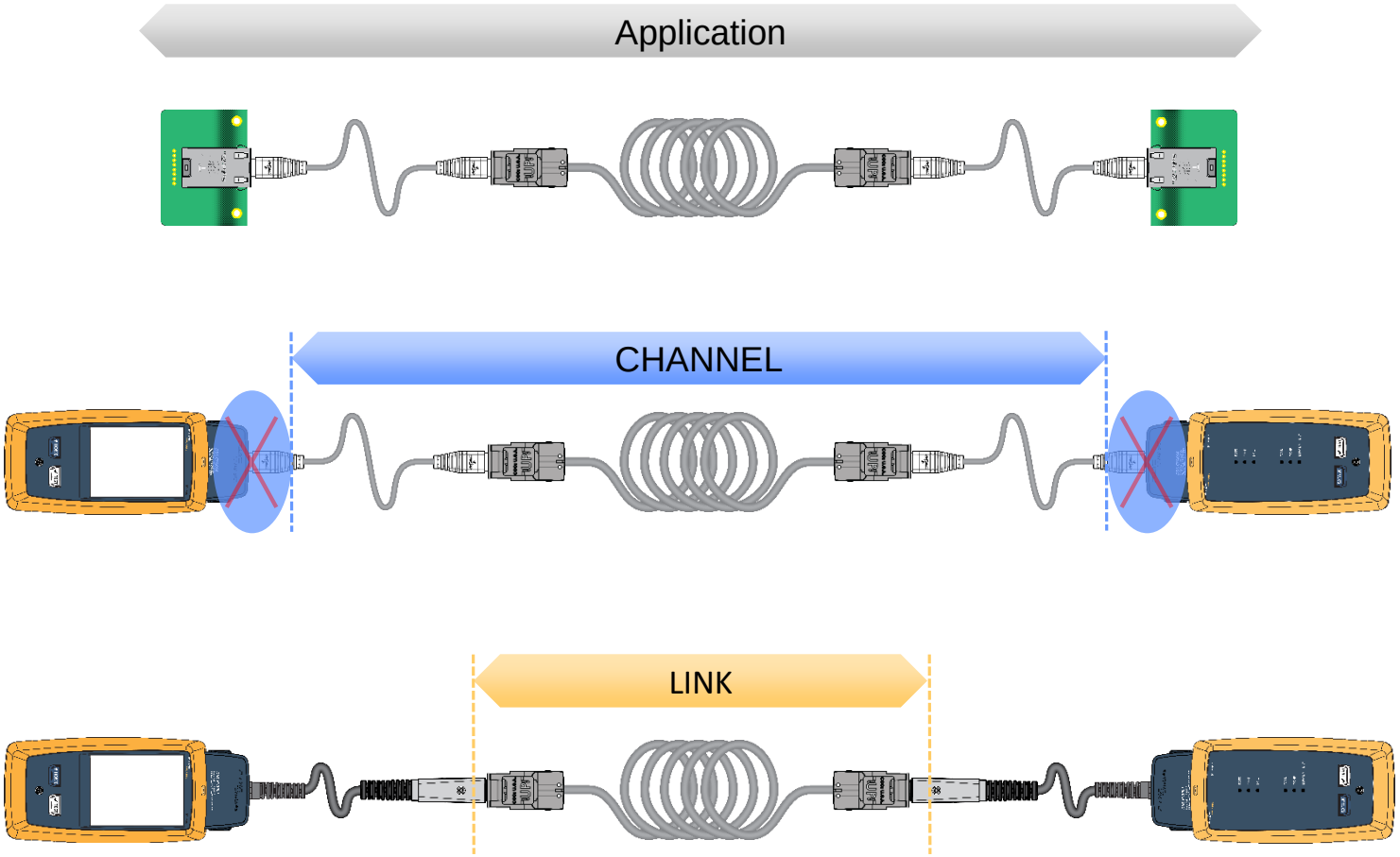
- Causes of failure
  - Badly made / damaged cable
  - Not maintaining the twist of the pair in the connector
  - Incorrect test limit / category of cable

PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-end)

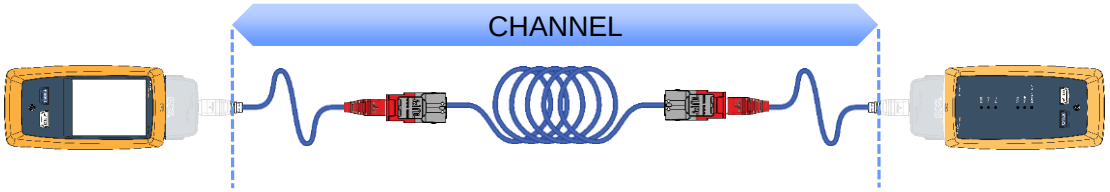
- **PS ACR-N**:
  - In dB, shows how the amplitude of signals received from
    a far-end transmitter compares to the combined
    amplitudes of crosstalk produced by near-end transmissions on the other wire pairs
- Not required in TIA, so you will/would see an
- Causes of failure
  - Over length
  - Badly made / damaged cable
  - Not maintaining the twist of the pair in the connector
  - Incorrect test limit / category of cable



Test Interfaces & Reference Planes

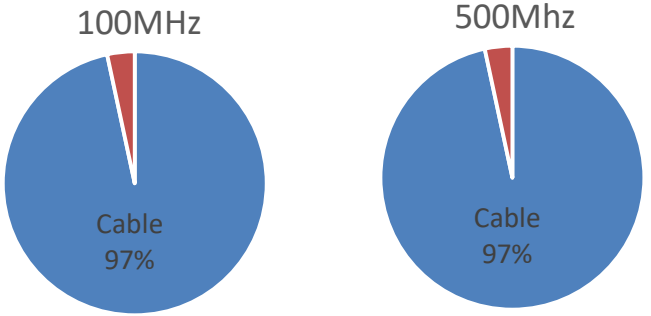


What Limits The Bandwidth more … Connectors or Cable ?

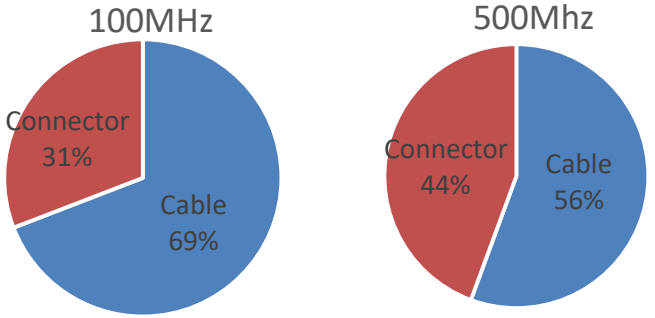


Example: 30m Link

- Insertion Loss (IL)



- Near End Cross Talk (NEXT)



…An inch at either end affects results noticeable

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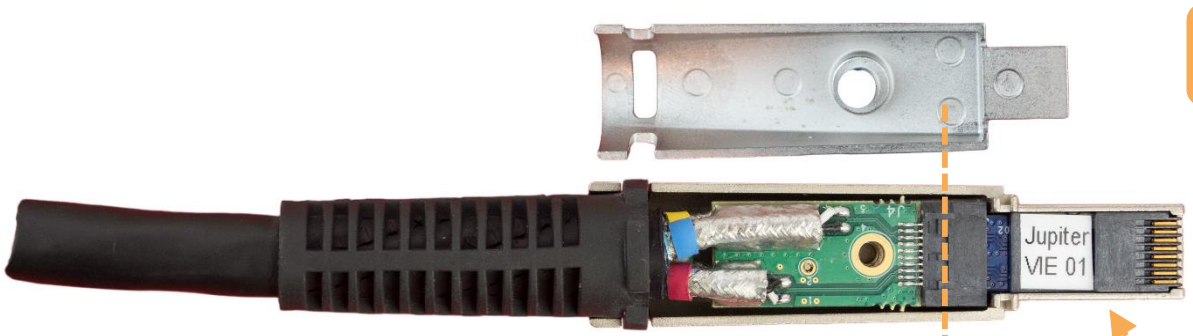
Permanent Link Adapter for the „Heavy Duty Field Use“



Consumable

Test Plug Adapter

Test Plug Interface (proprietary)

Test Plug “Centered Plug”

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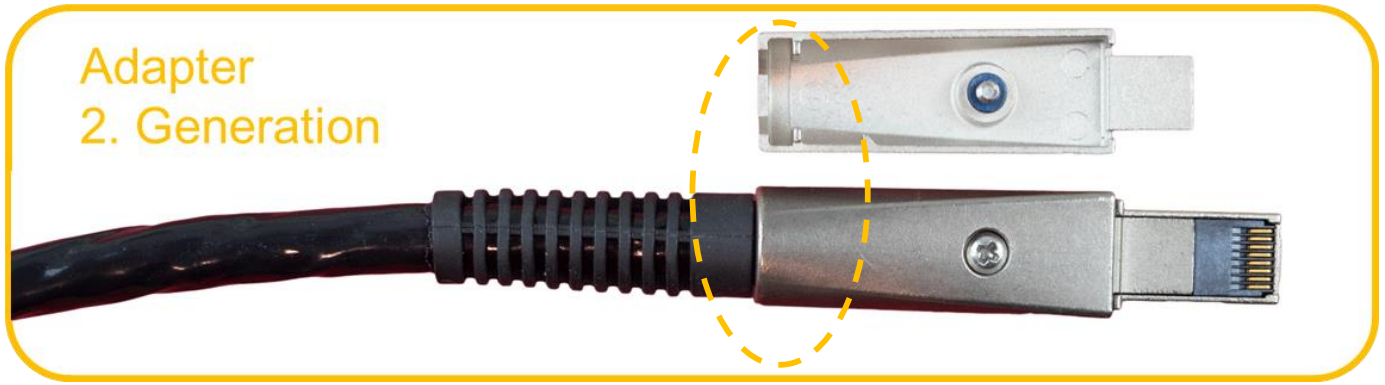
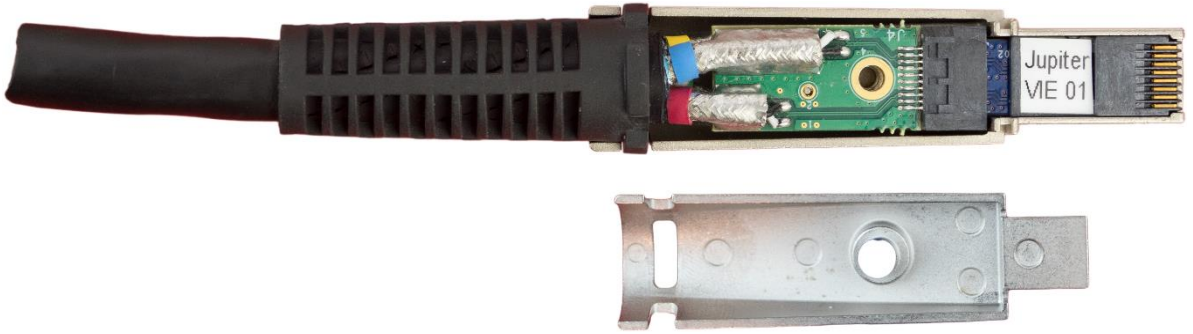
Permanent Link Adapter for the „Heavy Duty Field Use“ – Strain Relieve





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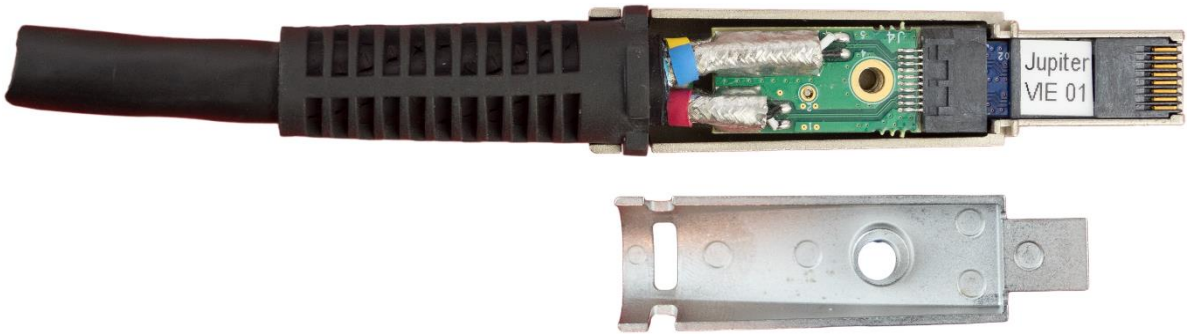
Permanent Link Adapter for the „Heavy Duty Field Use“ – Cable

Return Loss should be 10+ dB better then PL limit



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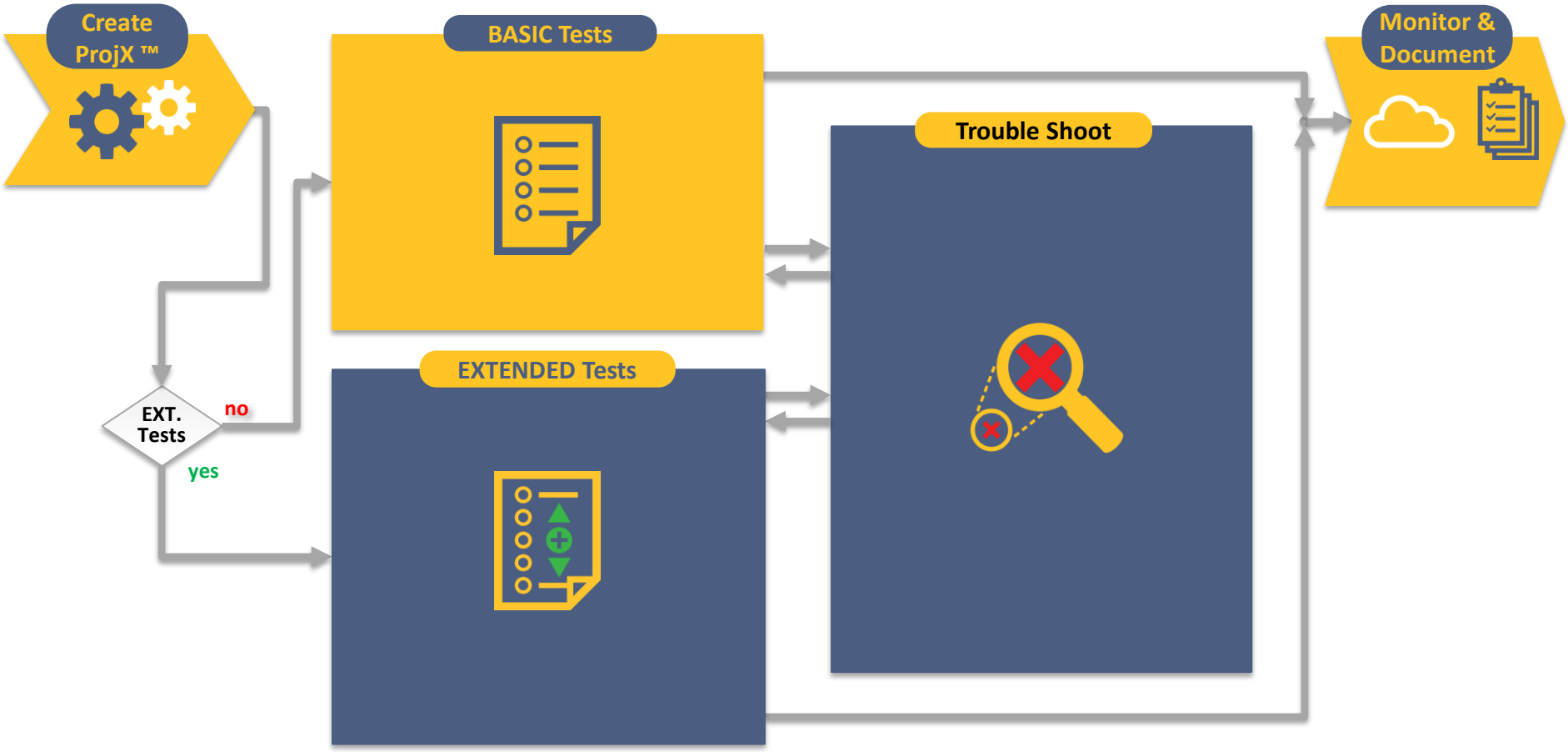
Step 1B: Extended Test Regime



…Optional / Conditional Testing

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Why EXTENDED Testing ?

	Copper Certification to ISO/IEC 11801	
	Reference Conformance Testing	Installation Conformance Testing
Wire Map	✓	✓
Length	✓	
Propagation Delay	✓	✓
Delay Skew	✓	✓
DC Loop Resistance	✓	✓
DC Resistance Unbalance	✓	
Insertion Loss	✓	✓
NEXT, PS NEXT	✓	✓
Return Loss	✓	✓
ACR-N, PS ACR-N	✓	✓
ACR-F, PS ACR-F	✓	✓
TCL, ELTCTL	✓	
PS ANEXT, PS AACR-F 1)	✓	✓

1) Class E_A only

Why EXTENDED Testing ?

ADVANCING GLOBAL COMMUNICATIONS

	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	✓	
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

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WHAT IF …

TCL / ELTCTL is not compliant

Example 2:

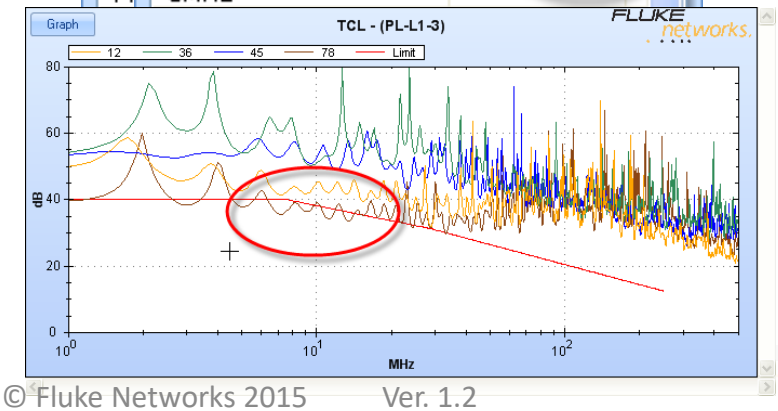
GOOD vs. BAD Drum of Cable

- 18km cable of identical type was installed
- 30% of the links don't carry 1000BASE-T

Drum #1

Tests

Insertion Loss	26.2 dB
NEXT	8.4 dB
PS NEXT	8.2 dB
ACR-N	18.1 dB
PS ACR-N	18.0 dB
ACR-F	20.2 dB
PS ACR-F	20.6 dB
RL	8.7 dB
TCL	-4.7 dB
CMRL	



Drum #2

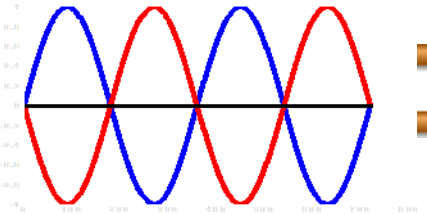
Tests

Insertion Loss	38.6 dB
NEXT	6.9 dB
PS NEXT	7.5 dB
ACR-N	23.3 dB
PS ACR-N	23.1 dB
ACR-F	17.3 dB
PS ACR-F	19.4 dB
RL	8.1 dB
TCL	5.7 dB
CMRL	
CDNEXT	
ELTCTL	21.9 dB
Length	22.2 m
Prop. Delay	102 ns
Delay Skew	2 ns
Resistance	3.4 ohms

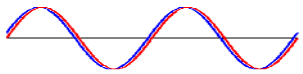
TCL (Transverse Conversion Loss)

- **T**ransverse **C**onversion **L**oss is the ratio (in dB) of a common-mode voltage measured on a wire pair relative to a differential-mode voltage applied to the same end of the pair. **The TCL value shows you how well the impedances of the pair's conductors are balanced.**

Differential Signal Applied



Common Mode Voltage Measured

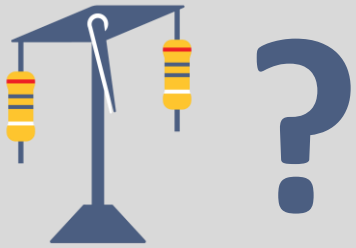


WHAT IF …

TCL / ELTCTL is not compliant

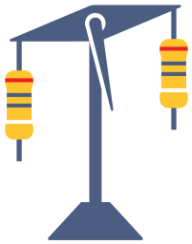
Even a legacy application like 1000Base-T may not work on an otherwise compliant Cat.6/6A system !

Resistive Unbalance is not compliant



Shield Integrity is not given

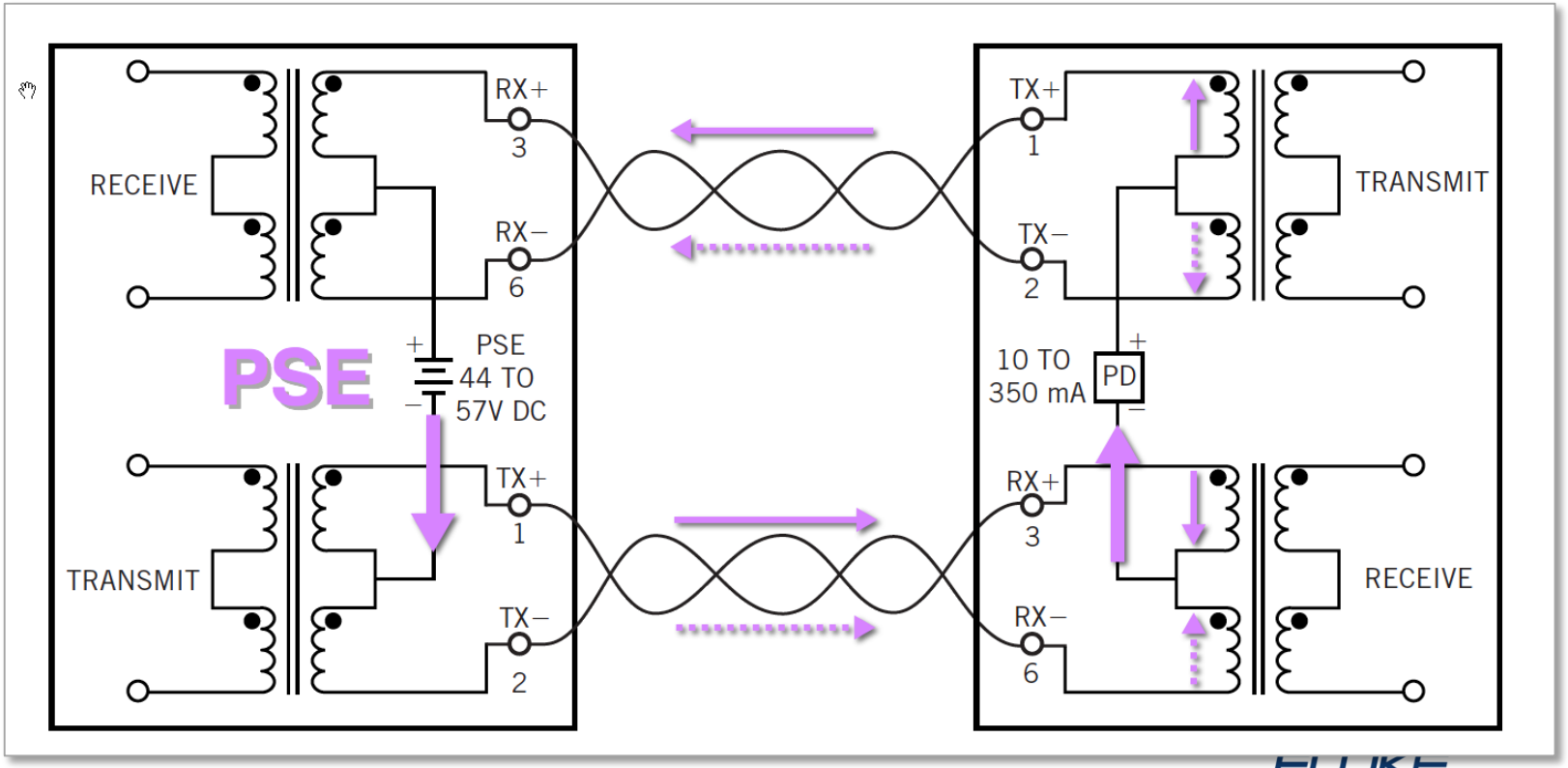
Power Over Ethernet



- New WLAN Standards IEEE 802.11n (450Mb/s) and IEEE 802.11ac (300, 450, 867 and 1.333 Mb/s) demand a 1000Base-T or better link
- 1000Base-T uses 4 Duplex wire pairs / POE shares 4 pairs with data
- Phantom Power Feeding in IEEE 802.3af (15Watt) & IEEE 802.3at (25.5/51Watt) defines more demanding requirements for the DC balance in the channel

1GB/s / POE demands Balance

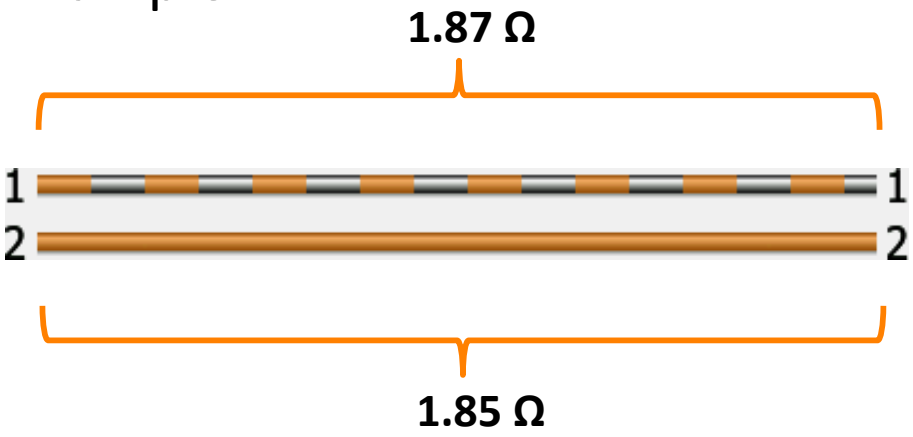
- Unbalance in the DC resistance causes the transformers to saturate
- **Balance was was no requirement for 10/100Mb/s POE**
  - 2 pairs used for data and 2 for power



Resistance Unbalance

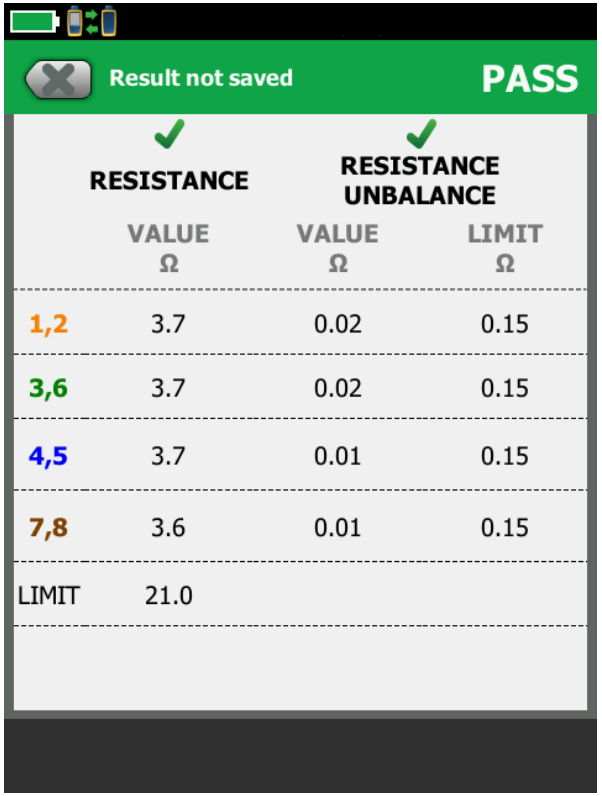
- Difference in Resistance between wires in the pair

- Example:

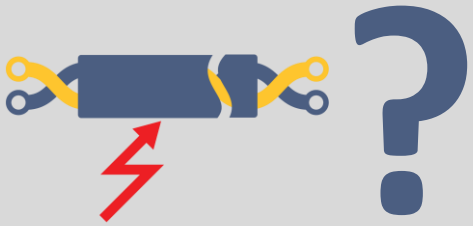


Resistance= 3.7 Ω

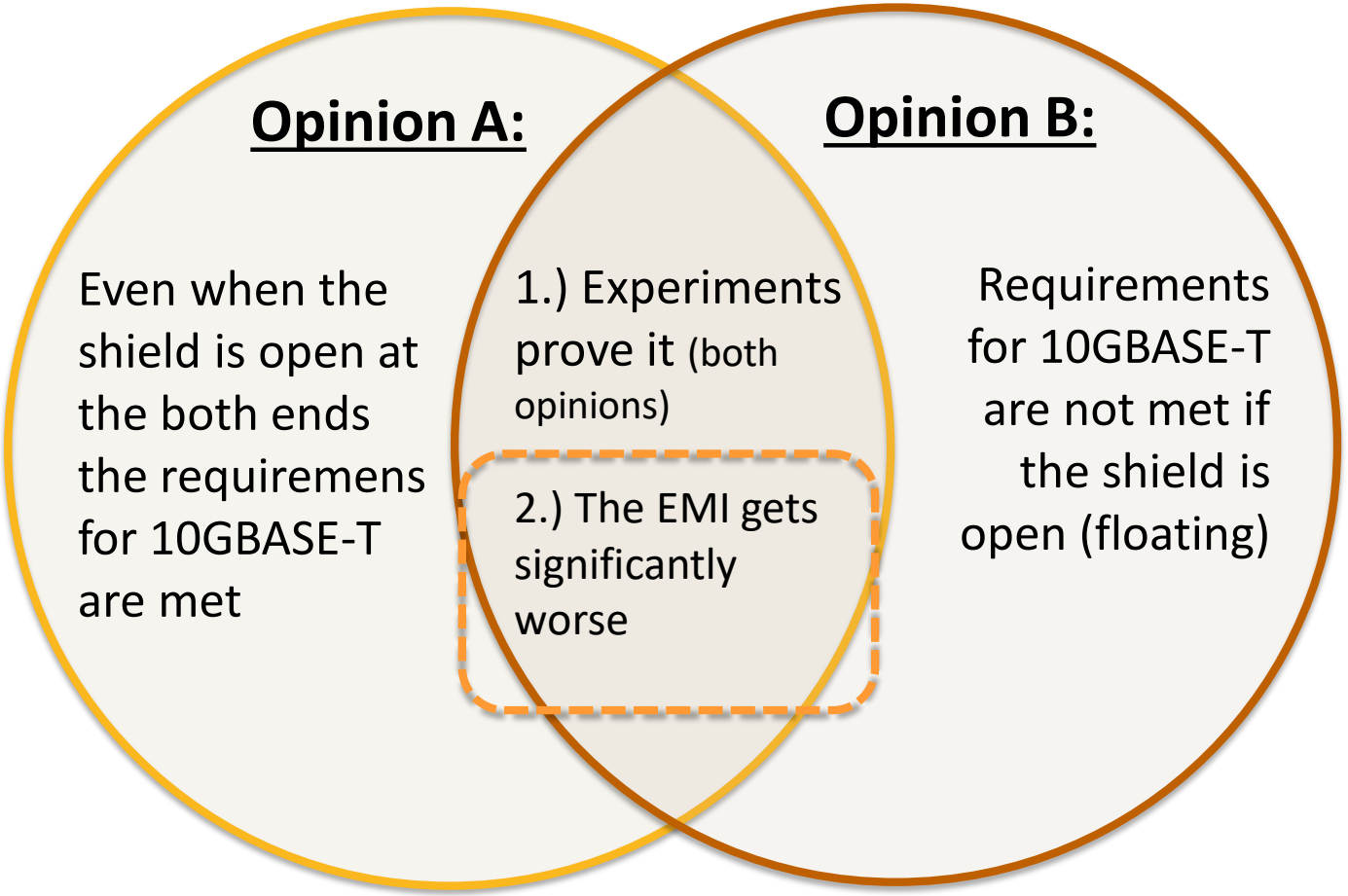
Resistance Unbalance = 0.02 Ω



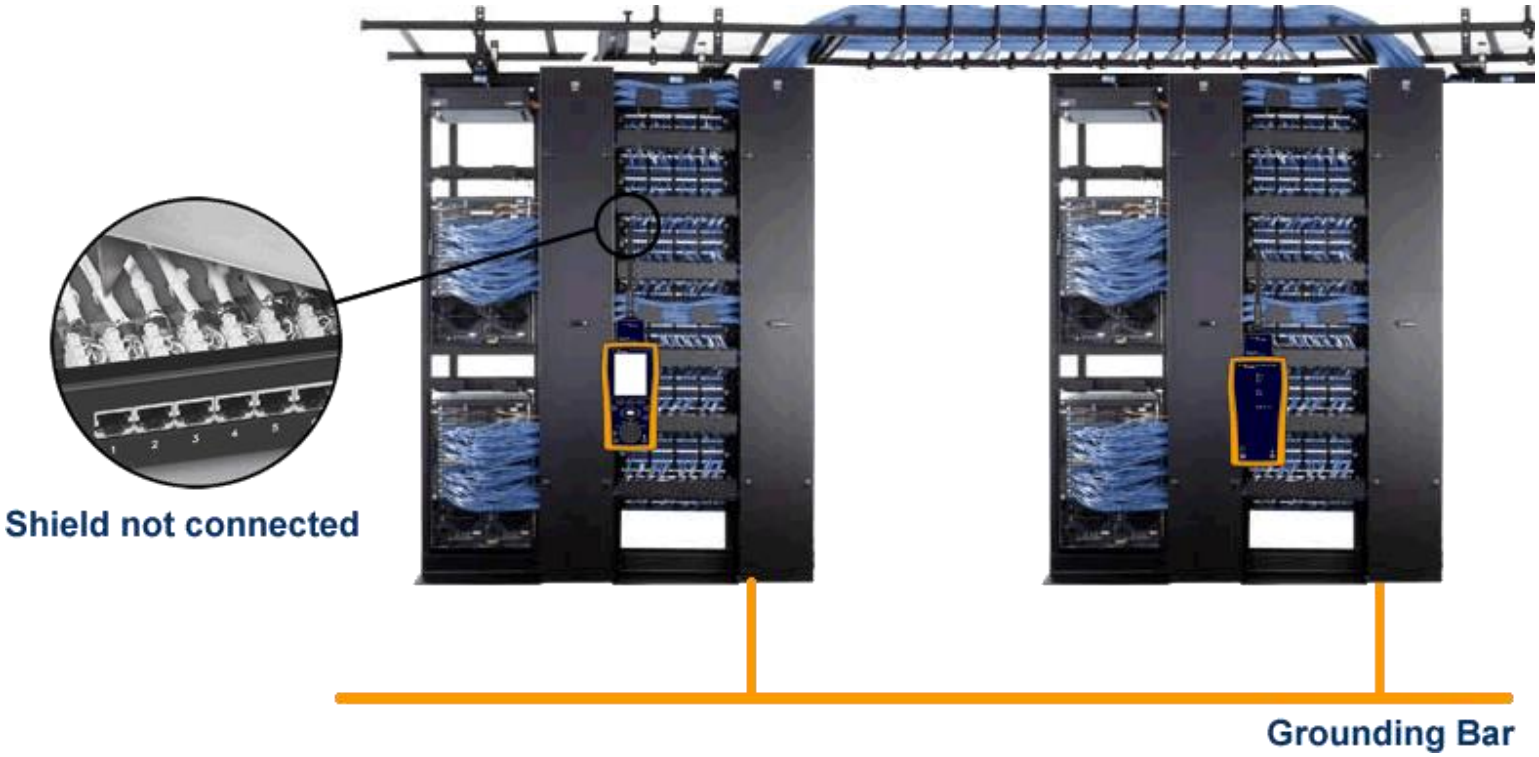
WHAT IF …

TCL / ELTCTL is not compliant	Even a legacy application like 1000Base-T may not work on an otherwise compliant Cat.6/6A system !
Resistive Unbalance is not compliant	POE operation is at risk during maximum load Poor contacts may further degrade over time
Shield Integrity is not given	

Shield Integrity … Opinions



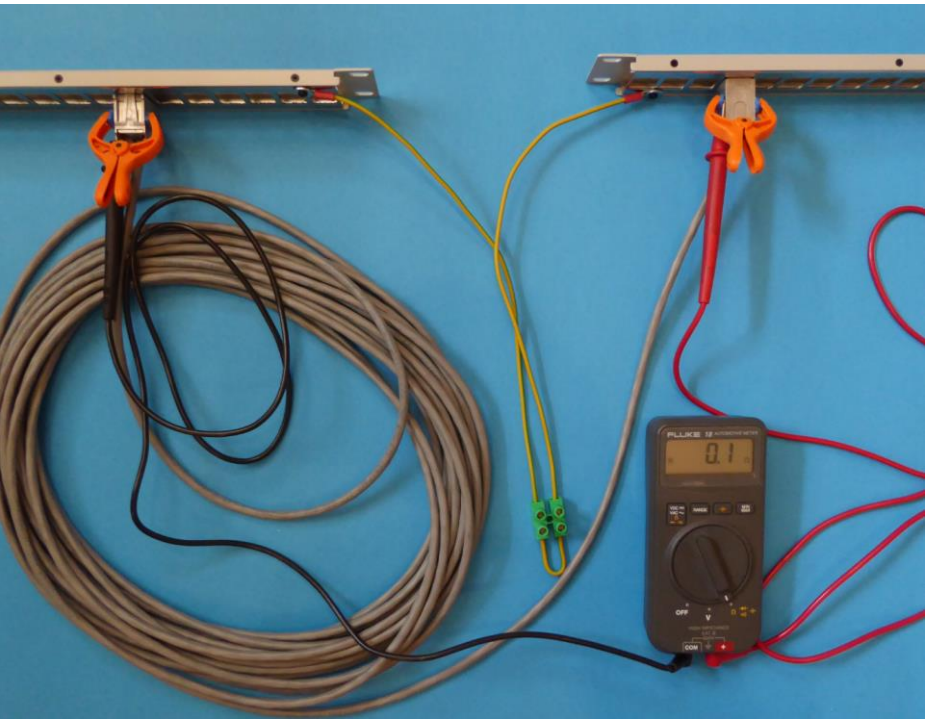
Shield Integrity

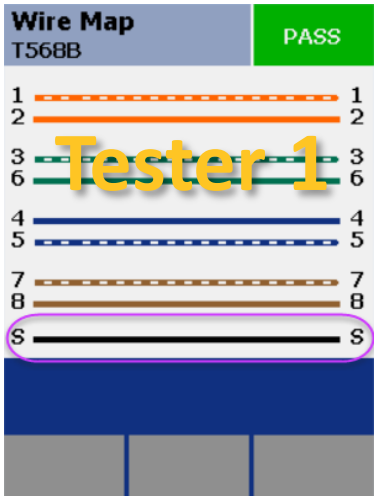


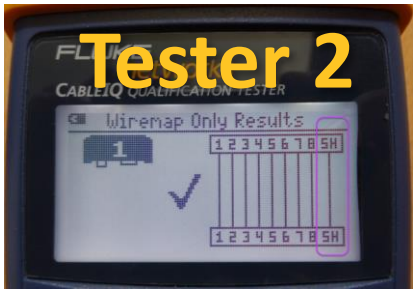
In The Past:

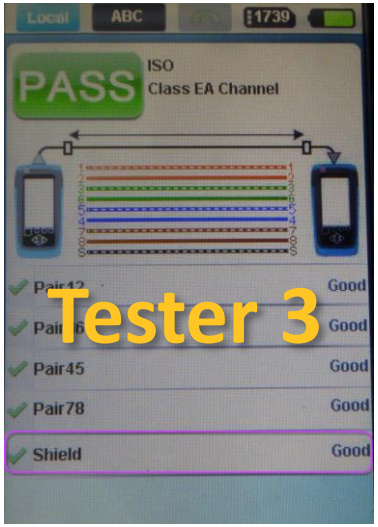
- Field testers could only verify that there is DC Continuity
- DC Continuity is given by grounding and earth
- Any open shields/ends could not be detected

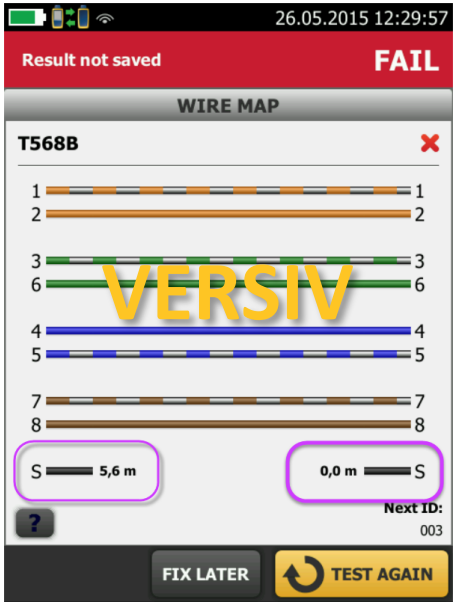
Let's test a UTP cable between shielded patch panels…







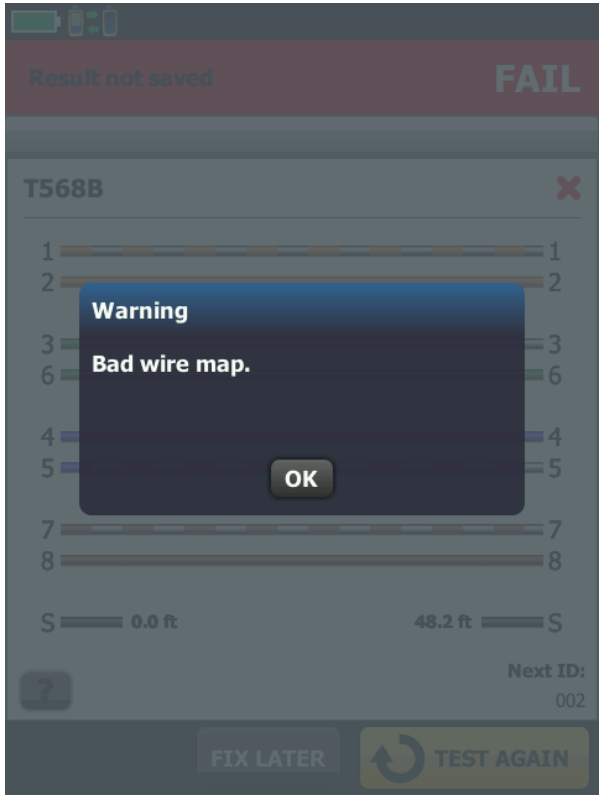


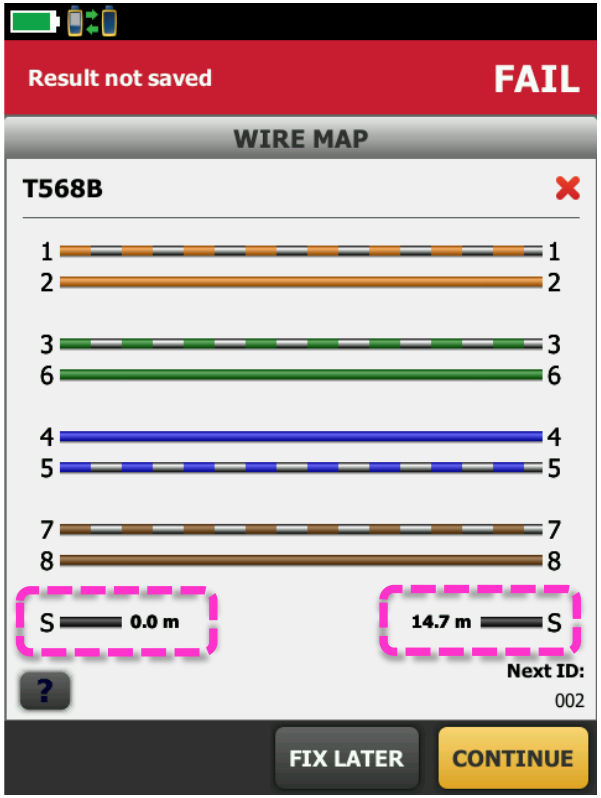


- **Only DSX will detect the lack of a shield**
- NOTE: In special applications it may be essential to verify that the shield is open on a defined end
  - e.g: Building to Building and non-perfect grounding

Shield Test – Re-Engineered

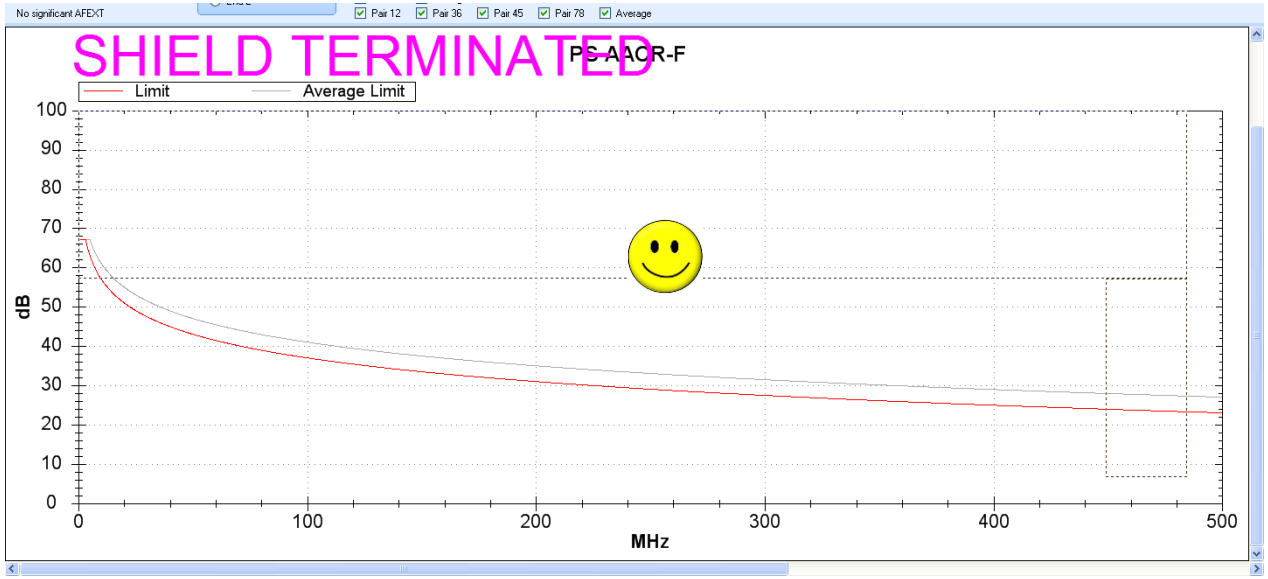
- Example:
  15m Link … the shield is not connected at he left end



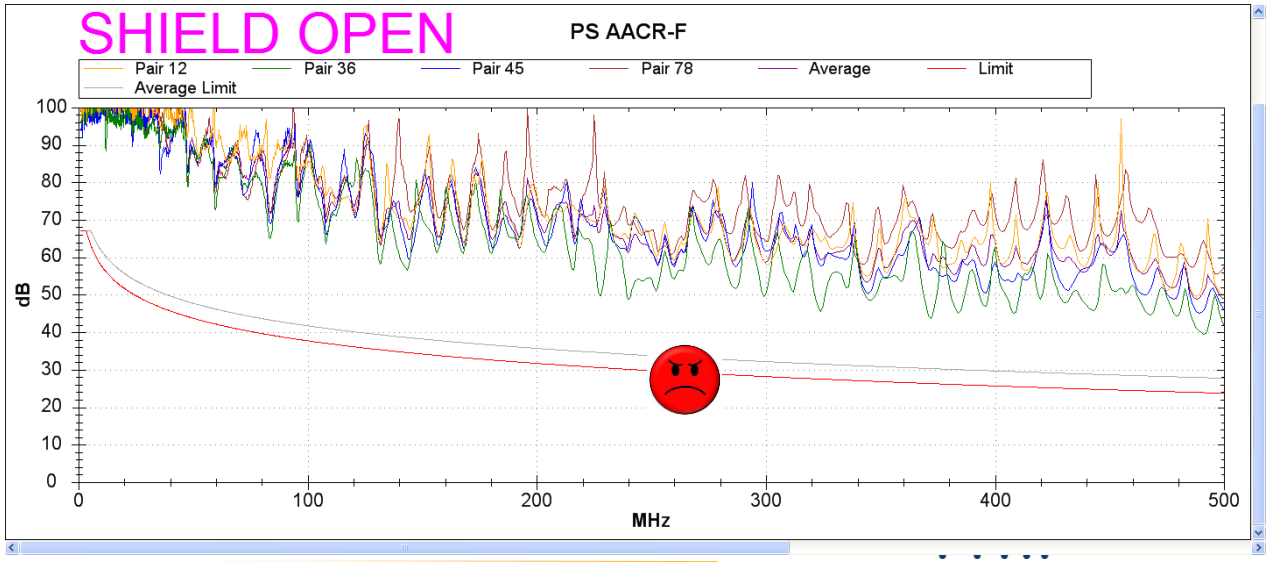


Example Alien Crosstalk: Shield Open / Connected

- For this high end cable the Alien Crosstalk is below the testers significance level



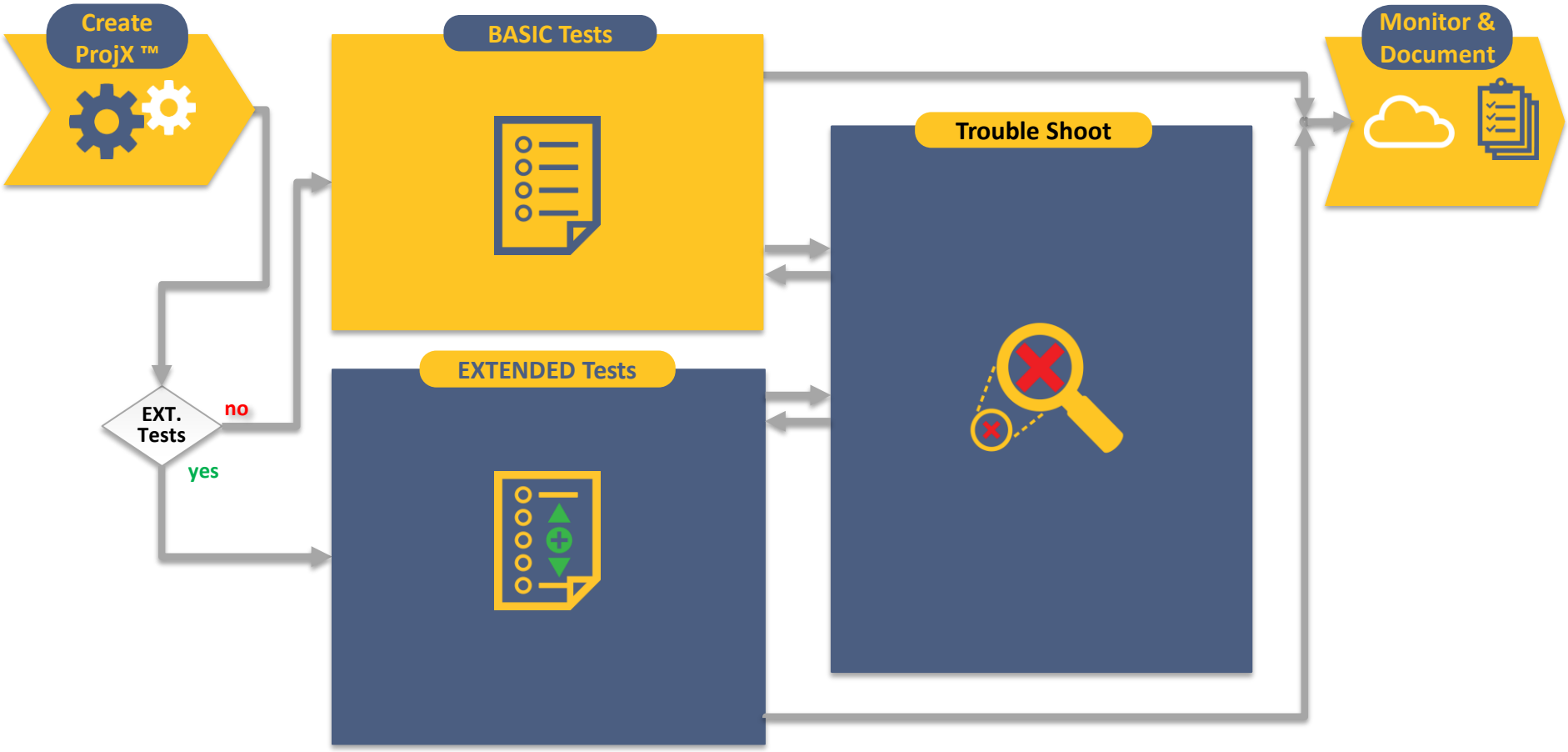
- The same cable show a > 20dB worse Alien Crosstalk
- A major portion of the EMI (Electromagnetic Immunity) was lost



WHAT IF …

TCL / ELTCTL is not compliant	Even a legacy application like 1000Base-T may not work on an otherwise compliant Cat.6/6A system !
Resistive Unbalance is not compliant	POE operation is at risk during maximum load Poor contacts may further degrade over time
Shield Integrity is not given	10 or 20 dB of electromagnetic immunity (EMI) is lost. Alien Crosstalk may become non-compliant

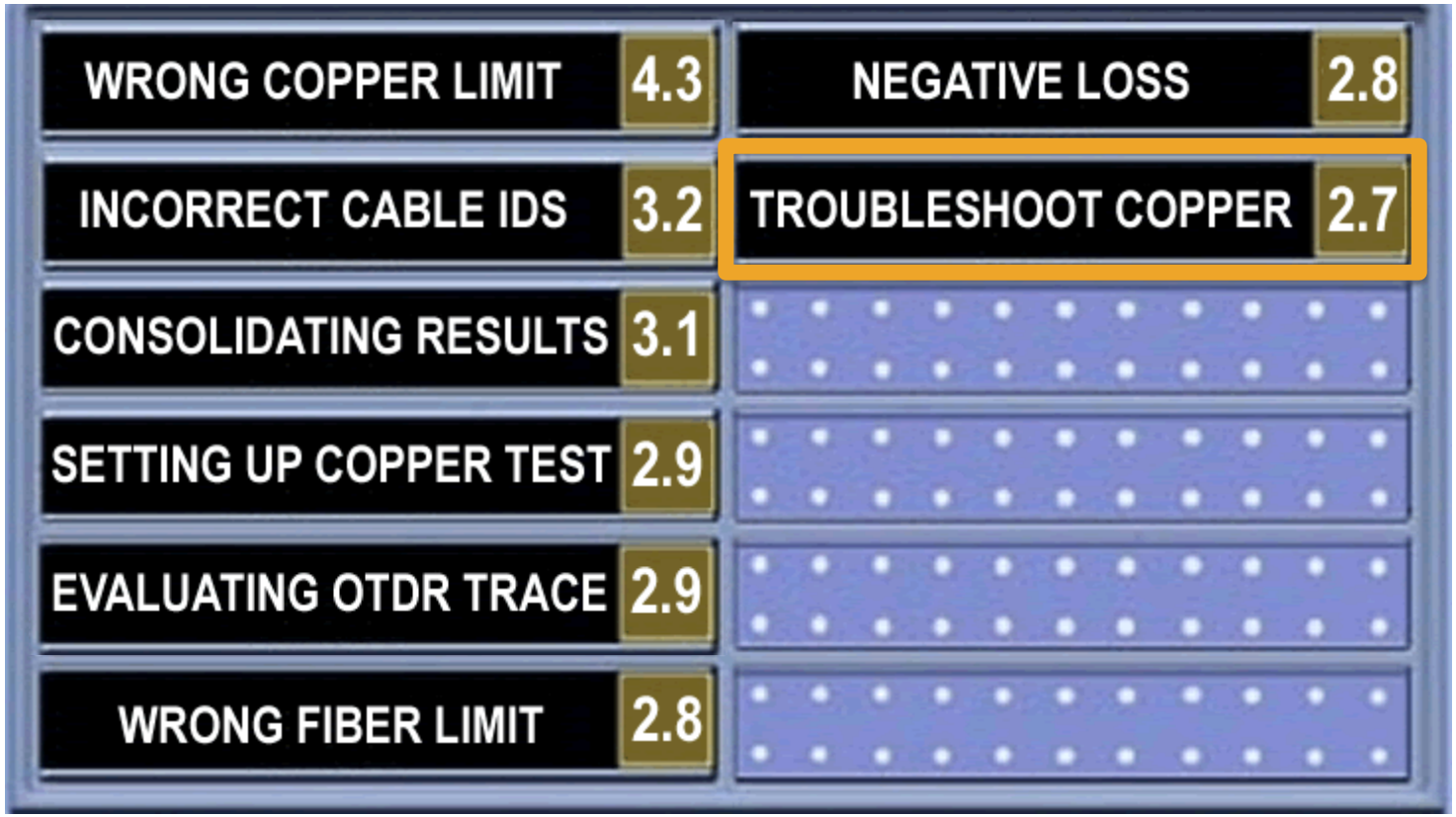
Step 3: Trouble Shooting



…Optional / Conditional Testing

800+ Installers VOCs:

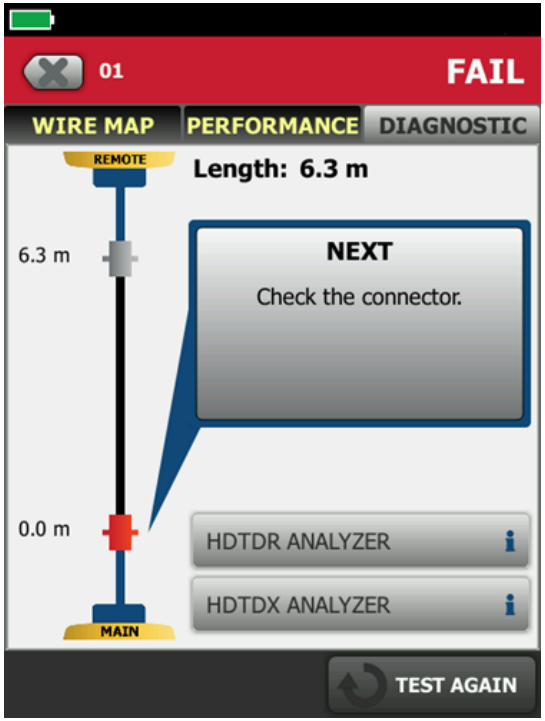
Top eight problems (hours wasted)

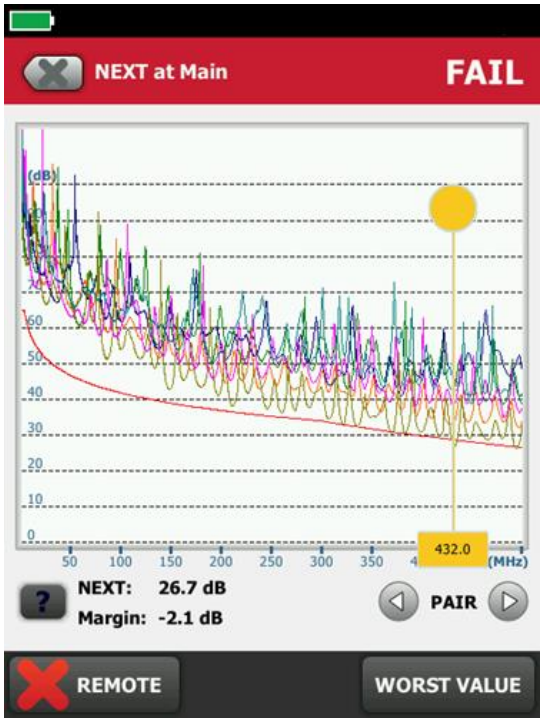


Average amongst all respondents in the previous 30 days

Trouble diagnosing Cat 6A/Class E_A links?

- DSX can resolve high frequency failures (where DTX could not)

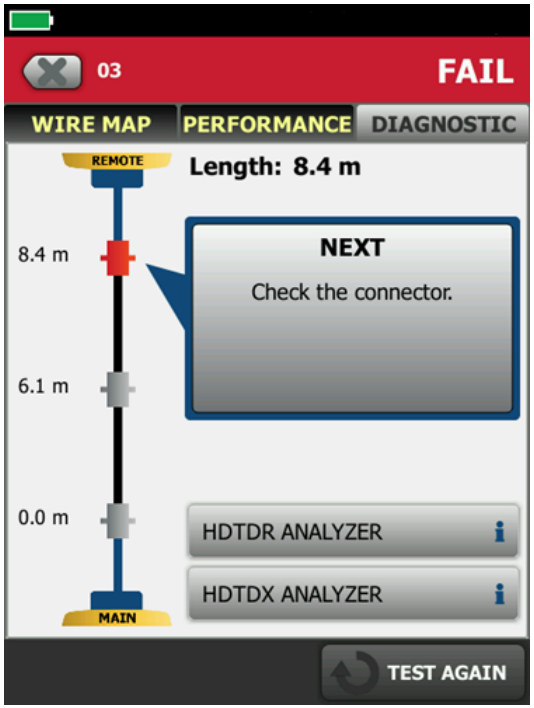


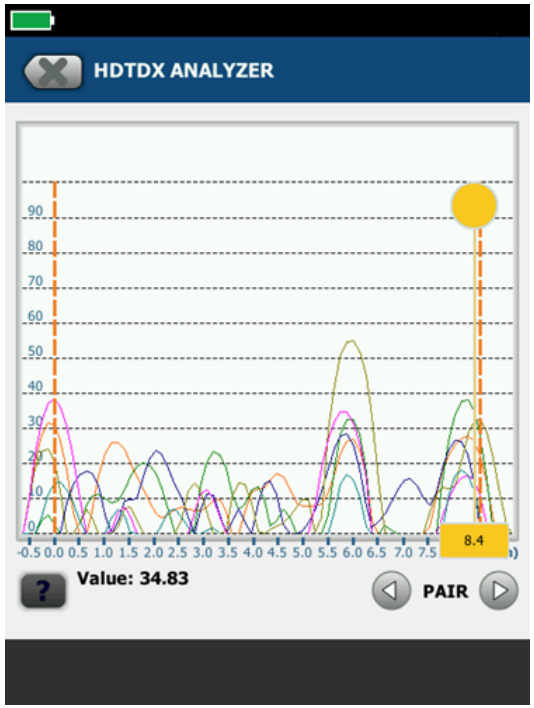


- **No more guessing why the link failed**

Reliably detect connectors…

- DSX uses patent pending technology to reliably detect connectors

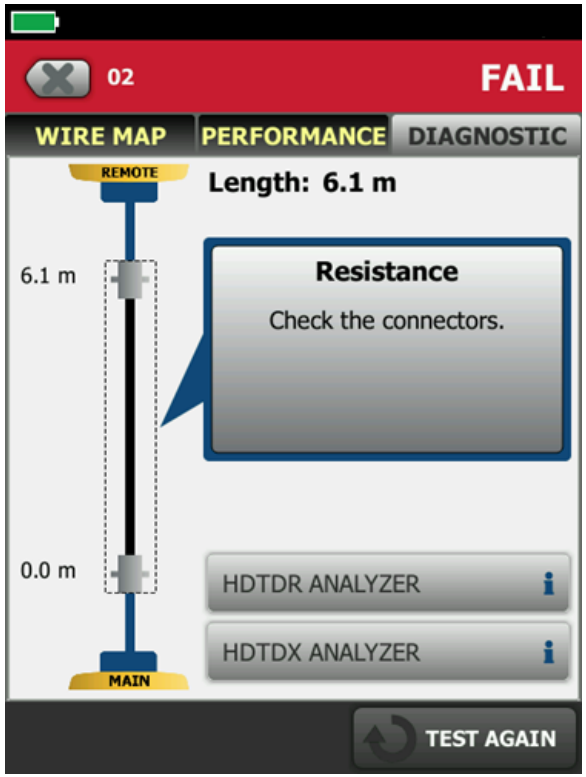


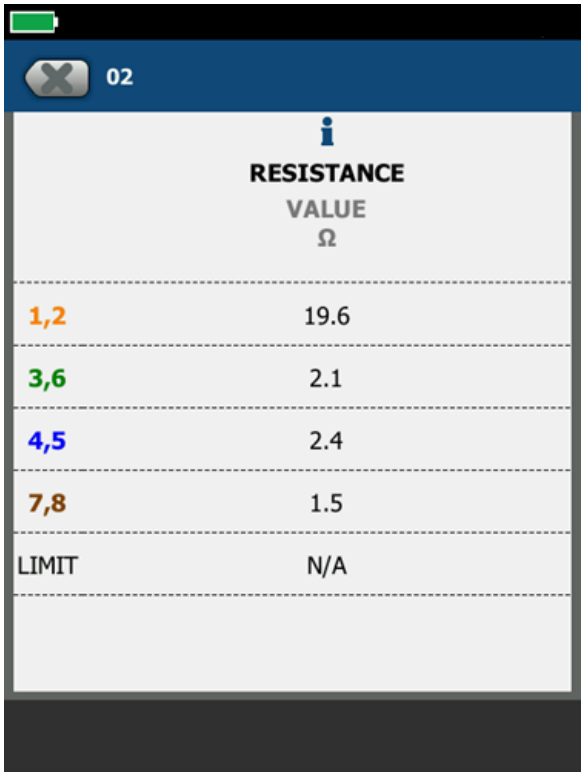


- **DSX empowers you to make better decisions in the field**

DSX's built in Expert

- DSX uses our experience of the last 10 years to better diagnose links and suggest corrective actions

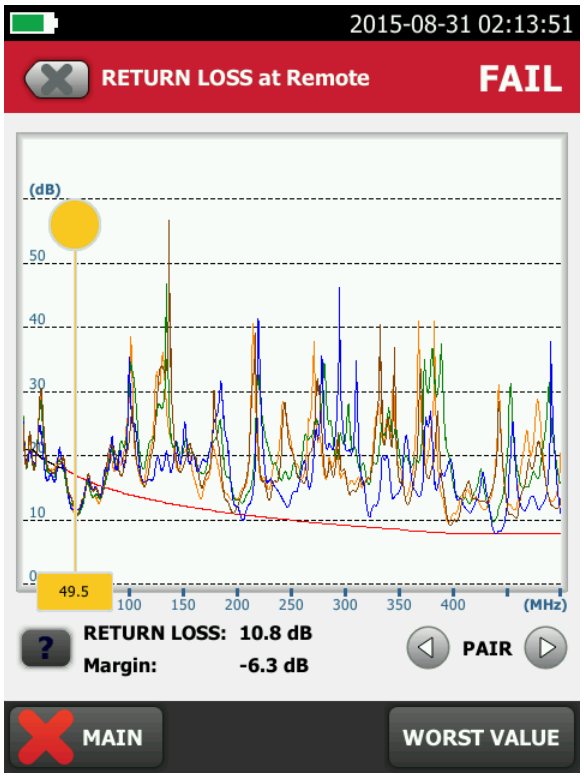


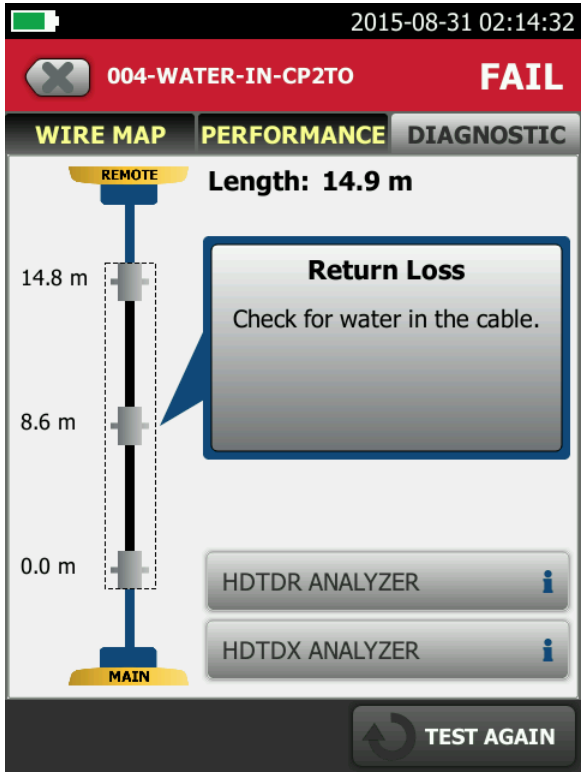


- **Example shows a high resistance make RL fail**

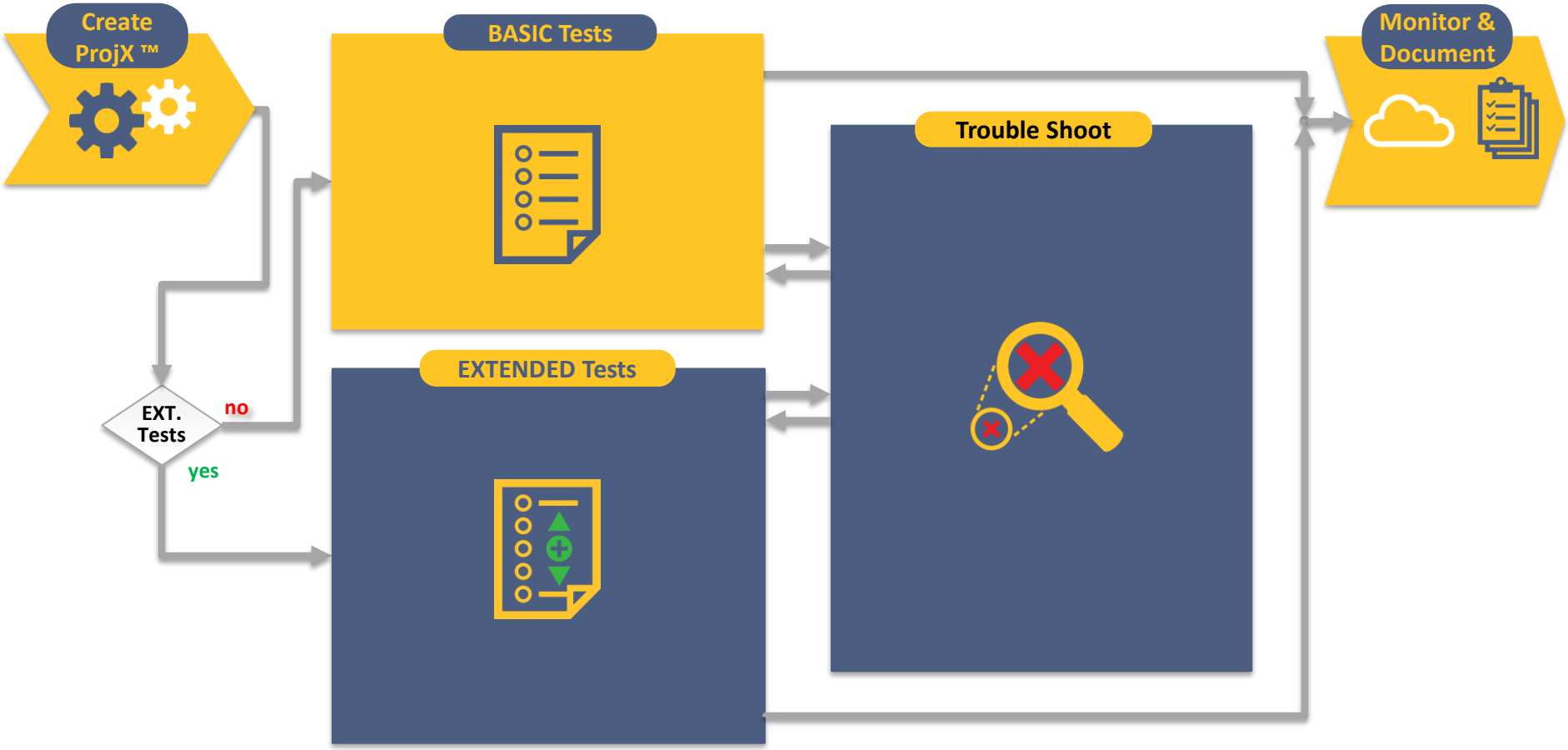
Water in the CP to TO cable

- Not many experts will be able to recognize the problem and the cause





Step 6: Project Monitoring & Documentation



…Optional / Conditional Testing

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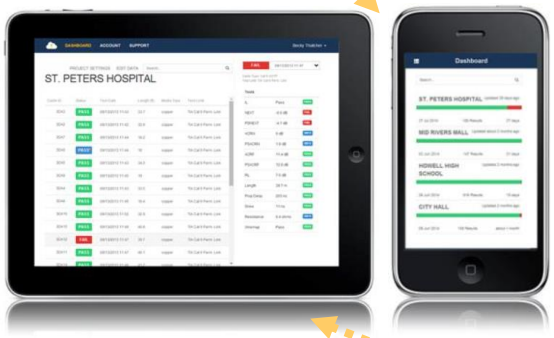
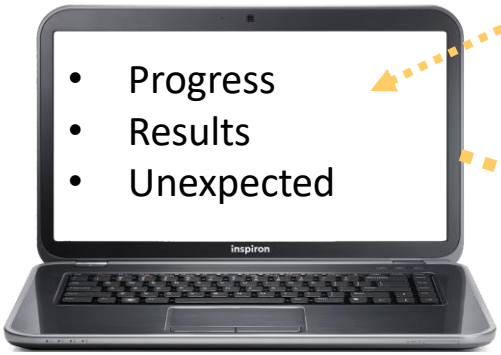
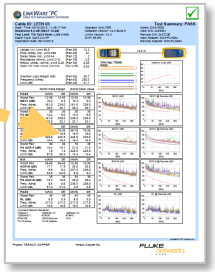
Monitoring & Documenation

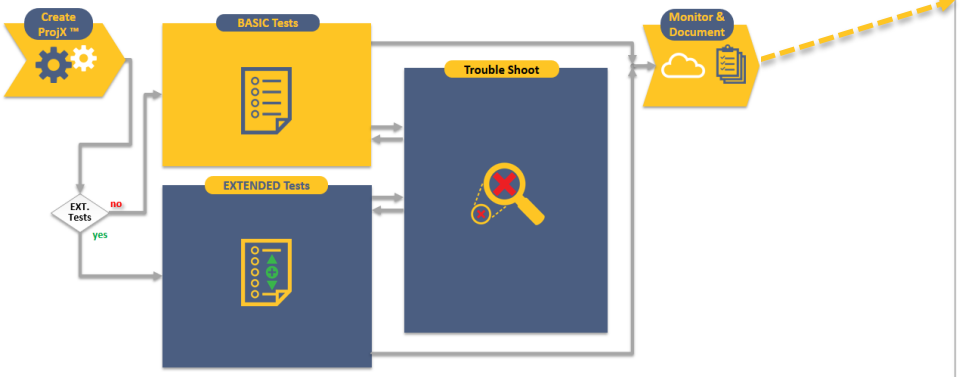
Try it… www.linkwarelive.com
user: c.puller@mailinator.com
Password: Versisv4u

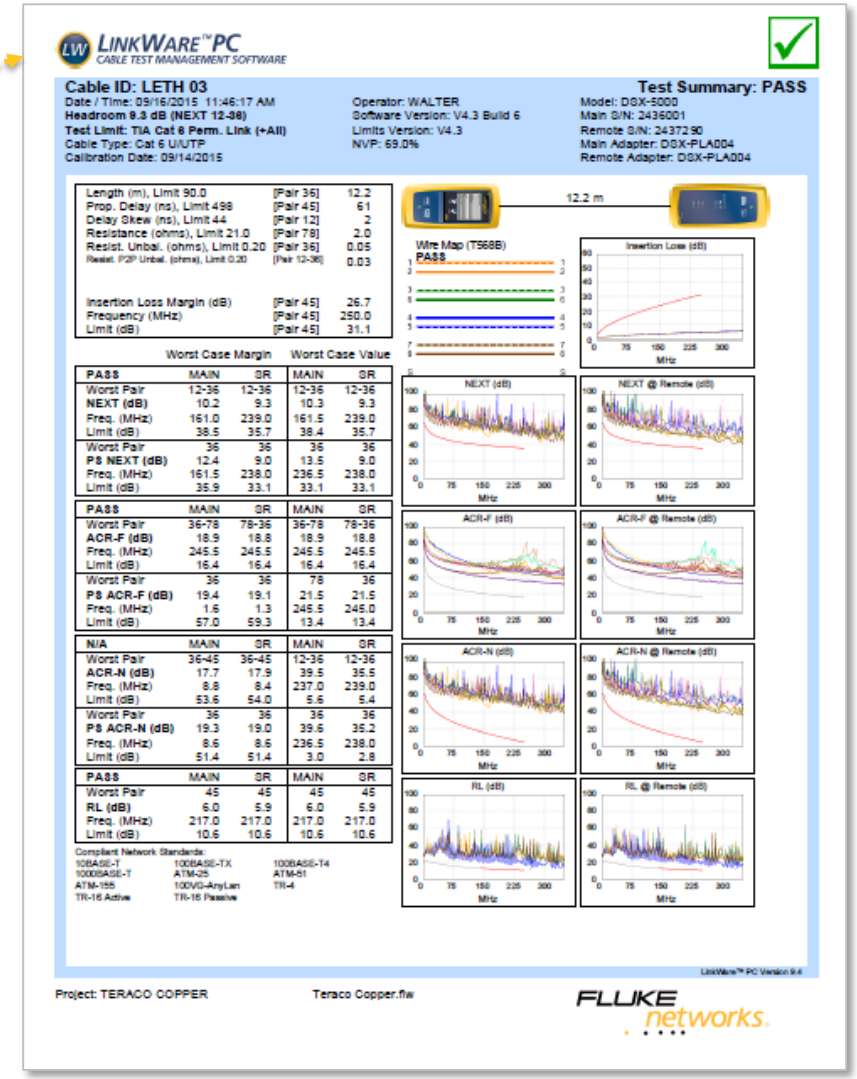






Documentation: Copper & Fiber





LINKWARE™PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: LETH 03 — **Test Summary: PASS**

Date / Time: 09/16/2015 11:46:17 AM
Headroom 8.3 dB (NEXT 12-36)
Test Limit: TIA Cat 6 Perm. Link (+All)
Cable Type: Cat 6 U/UTP
Calibration Date: 09/14/2015

Operator: WALTER
Software Version: V4.3 Build 6
Limits Version: V4.3
NVP: 69.0%

Model: DSX-5000
Main S/N: 2436001
Remote S/N: 2437290
Main Adapter: DSX-PLA004
Remote Adapter: DSX-PLA004

Length (m), Limit 90.0	[Pair 36]	12.2
Prop. Delay (ns), Limit 498	[Pair 45]	61
Delay Skew (ns), Limit 44	[Pair 12]	2
Resistance (ohms), Limit 21.0	[Pair 78]	2.0
Resist. Unbal. (ohms), Limit 0.20	[Pair 36]	0.05
Resist. P2P Unbal. (ohms), Limit 0.20	[Pair 12-36]	0.03
Insertion Loss Margin (dB)	[Pair 45]	26.7
Frequency (MHz)	[Pair 45]	250.0
Limit (dB)	[Pair 45]	31.1

12.2 m

Wire Map (T568B)
PASS

Insertion Loss (dB)

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	12-36	12-36	12-36	12-36
NEXT (dB)	10.2	9.3	10.3	9.3
Freq. (MHz)	161.0	239.0	161.5	239.0
Limit (dB)	38.5	35.7	38.4	35.7
Worst Pair	36	36	36	36
PS NEXT (dB)	12.4	9.0	13.5	9.0
Freq. (MHz)	161.5	238.0	236.5	238.0
Limit (dB)	35.9	33.1	33.1	33.1
PASS	MAIN	SR	MAIN	SR
Worst Pair	36-78	78-36	36-78	78-36
ACR-F (dB)	18.9	18.8	18.9	18.8
Freq. (MHz)	245.5	245.5	245.5	245.5
Limit (dB)	16.4	16.4	16.4	16.4
Worst Pair	36	36	78	36
PS ACR-F (dB)	19.4	19.1	21.5	21.5
Freq. (MHz)	1.6	1.3	245.5	245.0
Limit (dB)	57.0	59.3	13.4	13.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	36-45	36-45	12-36	12-36
ACR-N (dB)	17.7	17.9	39.5	35.5
Freq. (MHz)	8.8	8.4	237.0	239.0
Limit (dB)	53.6	54.0	5.6	5.4
Worst Pair	36	36	36	36
PS ACR-N (dB)	19.3	19.0	39.6	35.2
Freq. (MHz)	8.6	8.6	236.5	238.0
Limit (dB)	51.4	51.4	3.0	2.8
PASS	MAIN	SR	MAIN	SR
Worst Pair	45	45	45	45
RL (dB)	6.0	5.9	6.0	5.9
Freq. (MHz)	217.0	217.0	217.0	217.0
Limit (dB)	10.6	10.6	10.6	10.6

NEXT (dB) | NEXT @ Remote (dB) | ACR-F (dB) | ACR-F @ Remote (dB) | ACR-N (dB) | ACR-N @ Remote (dB) | RL (dB) | RL @ Remote (dB)

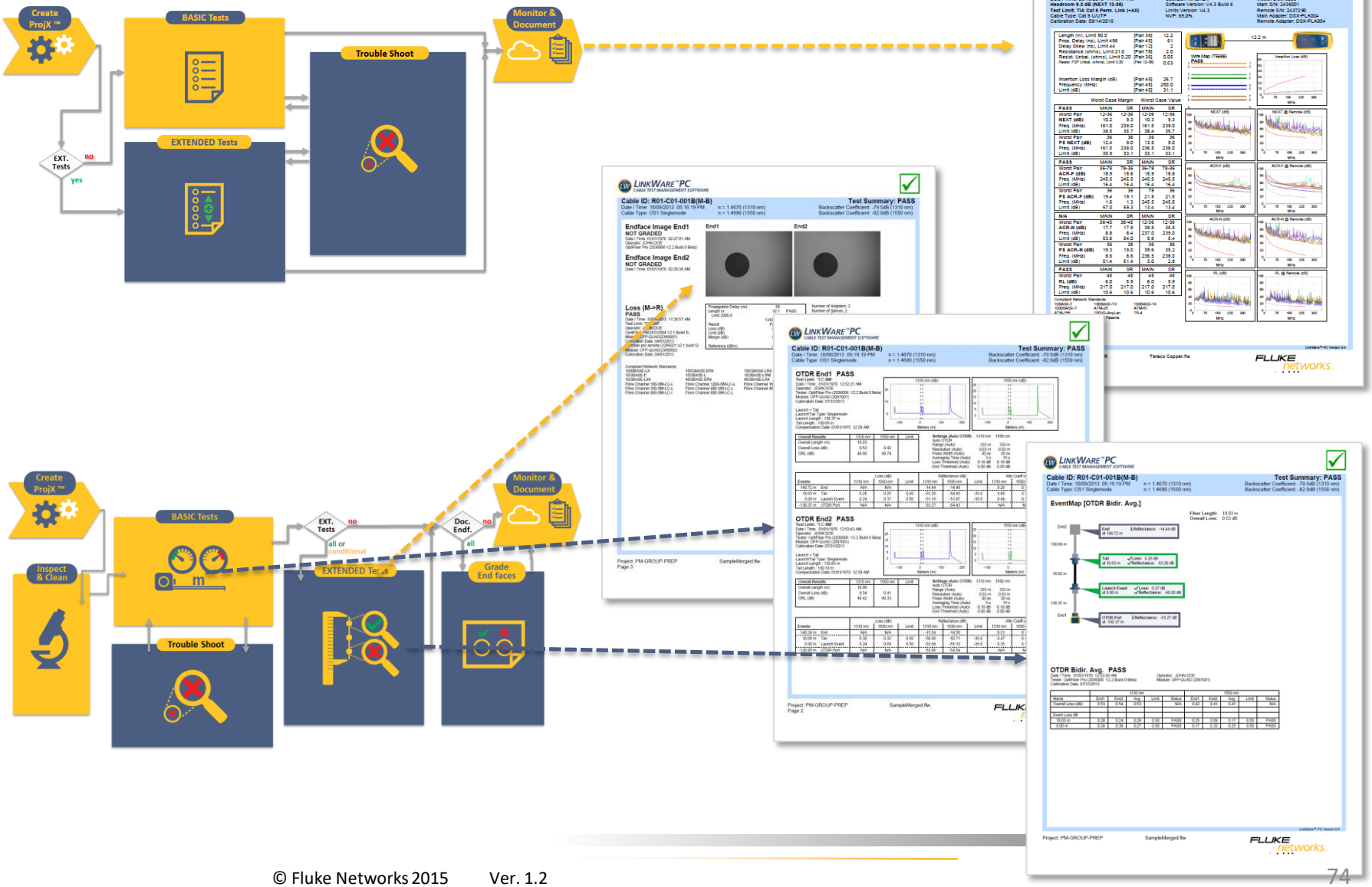
Compliant Network Standards:
10BASE-T, 100BASE-TX, 100BASE-T4, 1000BASE-T, ATM-25, ATM-51, ATM-155, 10DVG-AnyLan, TR-4, TR-16 Active, TR-16 Passive

LinkWare™ PC Version 9.4

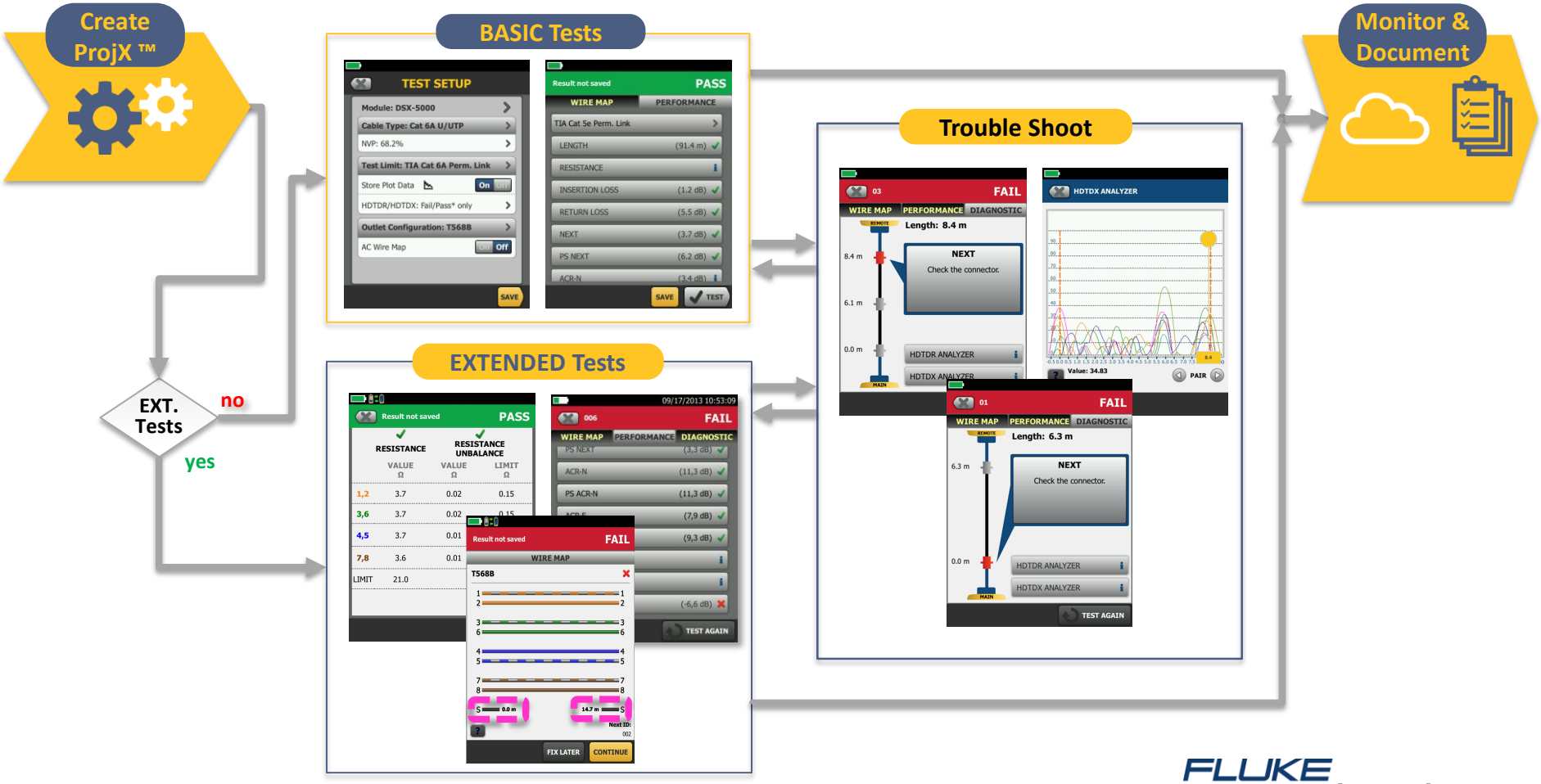
Project: TERACO COPPER — Teraco Copper.flw

FLUKE networks

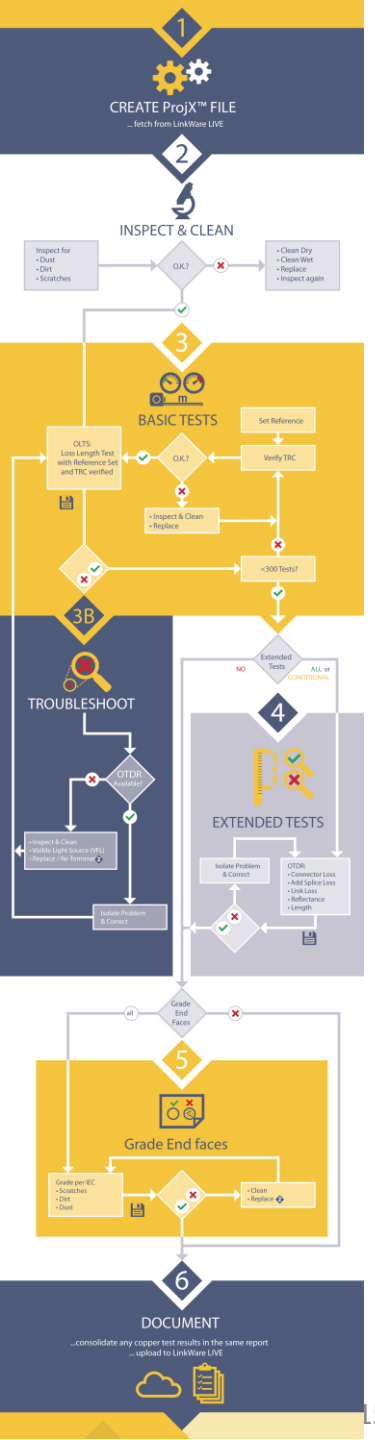
Documentation: Copper & Fiber



Coper Testing Best Practices
… The VERSIV Family covers it!



…Optional / Conditional Testing



Conclusion

Qualified instruments and personnel paired with an efficient work flow ensures …

- … “Next Generation Readiness” by extending the certification to all parameters specified for a cabling system
- … a profitable certification of twister pair cabling systems

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THANK YOU
FOR YOUR ATTENTION !

Questions?

Rikard.Momme@FlukeNetworks.com

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