VERSIV USERS REPORT:

**10% INCREASE IN PROFITS**

**66% REDUCTION IN TESTING AND REPORTING PROBLEMS**

**WORLD’S FIRST TRUE CATEGORY 8 FIELD TESTER**

4,200,000 VERSIV TEST RESULTS UPLOADED TO LinkWare Live (...AND COUNTING)

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

13 SERVICE CENTERS WORLDWIDE (THAT CAN CALIBRATE A DSX)

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

36 CABLE TESTING U.S. PATENTS

112 CABLE TESTING NERDS EMPLOYED

233 NEW PROJECTS DAILY IN LINKWARE LIVE

THE TOP 10 FORTUNE 500 CORPORATIONS ARE REGISTERED OWNERS

24/7 DOWNTIME WITH GOLD SUPPORT

1,051 KNOWLEDGE BASE ARTICLES

14 BICSI CREDITS (TWO DAYS OF CCT)

10,208 CERTIFIED TECHNICIANS CCT

REPRESENTED ON OVER 30 STANDARDS BODIES

APPROVED BY 29 CABLE MANUFACTURERS
Maximize ...  
Optimize ...  
Protect ...  

Realize the Value in modern Copper Optic Infrastructure

Rikard Momme, Distribution Account Manager  
Denmark, Poland, Finland, Greece and Romania  
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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.

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
Our History of Innovation

1992
- Fluke Enters Networking Industry
- Fluke Networks Formed

1993
- Centric PLA
- Intellitone LAN Toner and Probe

1995
- Fluke Networks Acquired

1998
- DTX Compact OTDR

2000
- CableIQ Qualification Tester

2002
- DTX CableAnalyzer Fault Info

2004
- Omnistar (Microtest) Cat 5 Field Tester

2005
- MicroScanner Cable Troubleshooter
- Centered PLA

2007
- DTX CableAnalyzer Fault Info

2012
- DTX CableAnalyzer Fault Info

2013
- Fluke Telecommunications

2014
- TempAlert (Microtest) Cat 6 Field Tester

2015
- Enterprise LAN Meter Portable Network Tester
- CertiFiber Pro EN 61280-4-100-compliant OTDR

2016
- OptiFiber® Pro with SmartLoop® Practical Bidirectional OTDR Test

2017
- FI-500 FiberInspector® Micro Port-Bright Illumination
- Third Party Integration with LinkWare Live
- FI-7000 FiberInspector® Pro Fiber and loss grading that fully integrates with certification reports

Trusted in the Field Since 1992
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
Copper Testing Best Practices

Create ProjX ™ -> BASIC Tests

EXTENDED Tests

Trouble Shoot

Monitor & Document

Optional / Conditional Testing
Copper Testing Best Practices

Create ProjX™

BASIC Tests

EXTENDED Tests

Trouble Shoot

Monitor & Document

...Optional / Conditional Testing

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Step 1: Project Definition

- Create ProjX™
- Optional / Conditional Testing
- BASIC Tests
- EXTENDED Tests
- Trouble Shoot
- Monitor & Document

...Optional / Conditional Testing

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800+ Installers VOCs:
Top eight problems (hours wasted)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Hours Wasted</th>
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</thead>
<tbody>
<tr>
<td>Wrong Copper Limit</td>
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<td>2.8</td>
</tr>
<tr>
<td>Negative Loss</td>
<td>2.8</td>
</tr>
<tr>
<td>Troubleshoot Copper</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Average amongst all respondents in the previous 30 days
**Top eight problems:**

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

- **Wrong Copper Limit**: 4.3
- **Incorrect Cable IDs**: 3.2
- **Consolidating Results**: 3.1
- **Setting Up Copper Test**: 2.9
- **Evaluating OTDR Trace**: 2.9
- **Wrong Fiber Limit**: 2.8
- **Negative Loss**: 2.8
- **Troubleshoot Copper**: 2.7

Average amongst all respondents in the previous 30 days
Project Definition

- Limits, Cable Types, Cable ID are best known by planner/project-manager
ID List Import (NEW Since Dec. 2015)

- Limits
- Cables
- Cable ID

...many more

AutoCAD
Excel
Visio
NETDOC
LW
Wi-Fi

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Step 1A: Basic (Minimum) Test Regime

Create ProjX™

EXT. Tests

no

yes

BASIC Tests

EXTENDED Tests

Trouble Shoot

Monitor & Document

...Optional / Conditional Testing
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 the cable
- **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

\[ V_{\text{diff in}} \]

\[ V_{\text{diff out}} \]

- Caused by:  
  - Badly made / damaged cable  
  - Not maintaining the twist of the pair in the connector  
  - Incorrect test limit / category of cable

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**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

Application

CHANNEL

LINK
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
Permanent Link Adapter for the „Heavy Duty Field Use“

Test Plug Adapter

Test Plug Interface (proprietary)

Test Plug “Centered Plug”
Permanent Link Adapter
for the „Heavy Duty Field Use“ – Strain Relieve

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

Return Loss should be 10+ dB better than PL limit
Step 1B: Extended Test Regime

Create ProjX™

BASIC Tests

EXTENDED Tests

Trouble Shoot

EXT. Tests

no

yes

Optional / Conditional Testing
## Why EXTENDED Testing?

### Copper Certification to ISO/IEC 11801

<table>
<thead>
<tr>
<th></th>
<th>Reference Conformance Testing</th>
<th>Installation Conformance Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Map</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Length</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
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<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Delay Skew</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>DC Loop Resistance</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>DC Resistance Unbalance</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>NEXT, PS NEXT</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Return Loss</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ACR-N, PS ACR-N</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ACR-F, PS ACR-F</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>TCL, ELTCTL</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>PS ANEXT, PS AACR-F 1)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

1) Class EA only
Why EXTENDED Testing?

<table>
<thead>
<tr>
<th></th>
<th>ANSI/TIA-568-C.2 (Cabling System)</th>
<th>ANSI/TIA-1152 (Minimum Field Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Map</td>
<td>✓</td>
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</table>

1) Category 6A only
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

Drum #2
**TCL (Transverse Conversion Loss)**

- **Transverse Conversion Loss** 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.**

![Diagram showing differential signal applied and common mode voltage measured](image-url)
WHAT IF ...

TCL / ELTCTL is not compliant

Resistive Unbalance is not compliant

Shield Integrity is not given

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

<table>
<thead>
<tr>
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<th>RESISTANCE UNBALANCE</th>
</tr>
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<tbody>
<tr>
<td>1,2</td>
<td>3.7</td>
<td>0.02</td>
</tr>
<tr>
<td>3,6</td>
<td>3.7</td>
<td>0.02</td>
</tr>
<tr>
<td>4,5</td>
<td>3.7</td>
<td>0.01</td>
</tr>
<tr>
<td>7,8</td>
<td>3.6</td>
<td>0.01</td>
</tr>
<tr>
<td>LIMIT</td>
<td>21.0</td>
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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
Even when the shield is open at the both ends the requiremens for 10GBASE-T are met

1.) Experiments prove it (both opinions)
2.) The EMI gets significantly worse

Requirements for 10GBASE-T are not met if the shield is open (floating)
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 the left end
• 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

Example Alien Crosstalk:

Shield Open / Connected

SHIELD TERMINATED

SHIELD OPEN
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)

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Average amongst all respondents in the previous 30 days
Trouble diagnosing Cat 6A/Class E<sub>A</sub> 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

- Create ProjX™
- BASIC Tests
- EXTENDED Tests
- Optional / Conditional Testing
- Troubleshooting
- Monitor & Document

EXT. Tests:
- no
- yes
Monitoring & Documentation

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

- Progress
- Results
- Unexpected

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Documentation: Copper & Fiber
Documentation: Copper & Fiber
Coper Testing Best Practices
... The VERSIV Family covers it!

Create ProjX™

BASIC Tests

EXTENDED Tests

EXT. Tests

no

yes

Monitor & Document

Trouble Shoot

...Optional / Conditional Testing
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
THANK YOU FOR YOUR ATTENTION!

Questions?

Rikard.Momme@FlukeNetworks.com
Back Up Slides