Optimized test regimes and workflows for the certification and troubleshooting of an cabling infrastructure found in today’s data centers

Maximize ...
Optimize ...
Protect ...

Christian Schillab
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What makes testing in the data center different from testing cabling in the commercial building?

- Adapted fiber test regimes for the data center
- Adapted copper test regimes for the data center
Data Centre vs. Commercial Building Cabling Infrastructure
Differences Affect Test Regimes

Larger number of links

- Testing time
- Consolidation
- Labeling / ID Mgmt.
**800+ Installers VOCs:**
Top eight problems (hours wasted)

<table>
<thead>
<tr>
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Average amongst all respondents in the previous 30 days
Top eight problems:
Wrong Configuration (Limit, IDs, Standard, .....)

Average amongst all respondents in the previous 30 days
**Step 1: Project Definition**

- **Create ProjX™**
- **Inspect & Clean**
- **Basic Tests**
  - EXT. Tests: no
  - all or conditional
- **Trouble Shoot**
- **Extended Tests**
  - EXT. Tests: no
  - all
- **Grade End faces**
- **Monitor & Document**
Project Definition

- Limits, Cable Types, Cable ID are best known by the planner/project-manager
- New relaxed ISO limits do not reflect what is possible and/or needed to be future ready → **Custom Limits**
ID Lists .... Sources

- Limits
- Cables
- Cable ID

...many more
Data Centre vs. Commercial Building Cabling Infrastructure
Differences affecting test regimes

Larger number of links

Larger share of fiber vs. copper

- Testing time
- Consolidation
- Labeling / ID Mgmt.

Source: BSRIA 2015

Germany 61M$: 53% Value, 26% Cable, 12% Connectivity

UK 58M$: 57% Value, 20% Cable, 12% Connectivity

France 25M$: 34% Value, 38% Cable, 16% Connectivity
Data Centre vs. Commercial Building Cabling Infrastructure
Differences affecting test regimes

Larger number of links

Larger share of fiber vs. copper

“Zoned” Data Centers
Low channel loss budgets
Low loss connectors

• Testing time
• Consolidation
• Labeling / ID Mgmt.

• Little room for measurement error
Testing – “Zoned” Data Centers

- After the installation only the links can be tested
- The “Patched Channel” is configured by the network user during the operational phase

<table>
<thead>
<tr>
<th>Link</th>
<th>Budget #1</th>
<th>Budget #2</th>
<th>Budget #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>10GB… 2.6dB or 40 or 100G… 1.5dB (OM4…150m) / 1.9dB (OM3…100)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- There is very little room for error!
Step 2: Inspect & Clean Fibers

- **Create ProjX™**
- **Inspect & Clean**
- **BASIC Tests**
  - Inspect
  - Clean
- **EXTENDED Tests**
  - EXT. Tests
  - Doc. Endf.
- **Grade End faces**
- **Trouble Shoot**
- **Monitor & Document**

...Optional / Conditional Testing
Dirt will transfer

Conclusion: Clean measurement cord after every mating
Step 2: Inspect & Clean

- Prevent dirt from causing poor/incorrect Test Results
- Prevent dirt from spreading
- Prevent abrasive dust on test cords damaging ports
- Prevent abrasive dust on ports from damaging valuable test cords
**Step 3: BASIC Tests**

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>Tier 2</th>
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<tbody>
<tr>
<td>BASIC</td>
<td>EXTENDED</td>
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- **BASIC Tests**
  - Create ProjX™
  - Inspect & Clean
  - Trouble Shoot
- **EXTENDED Tests**
  - Monitor & Document
  - Grade End faces

*Optional / Conditional Testing*

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BICSI MEA - Cape Town Oct.2017  V1.0  (C) FlukeNetworks
Being certain of loss uncertainty
Set Reference & TRC verification

- A wizard guides through the correct process
- TRC verification stored as part of project
- A TRC verification test should be run with regular intervals
Why was the EF STANDARD NEEDED?

- Different light sources may have different launch conditions
- A EF compliant source reduces the error from 50% to 10%
## Normative Requirement
- ANSI/TIA-526-14-B
- ISO 1180 → ISO/IEC 14763-3 Ed.1 62
- EN 50173 → IEC IEC 61280-4-2

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<table>
<thead>
<tr>
<th>Why?</th>
<th>How?</th>
</tr>
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<tbody>
<tr>
<td>1. It helps to prevent...</td>
<td></td>
</tr>
<tr>
<td>2. It helps...</td>
<td></td>
</tr>
<tr>
<td>1. Less expensive</td>
<td></td>
</tr>
<tr>
<td>2. Smaller than a mandrel</td>
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</table>

It is highly recommended by almost all manufacturers in particular when testing highest grade components for very demanding limits.
If BASIC Tests **FAIL** ...

Step 3B: Trouble Shoot

---

...Optional / Conditional Testing
800+ Installers VOCs:
Top eight problems (hours wasted)

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OTDRs are not only for “Gurus”

- Event Maps simplify the presentation
- Overall (Link) limits complement component limits
- Launch & Tail fibers are automatically excluded
Step 4: Extended Test

Create ProjX™

BASIC Tests

Inspect & Clean

Trouble Shoot

EXTENDED Tests

Monitor & Document

Grade End faces

Endf.

Grade

...Optional / Conditional Testing
Why EXTENDED Testing?

- Identify, locate and eliminate unnecessary bottlenecks in otherwise compliant links
  - Further increase performance margin
- Identify connectors with excessive reflectance
- Document the state of the installation
- Bi-Directional testing and averaging is essential
Bi-Directional Testing with a SMART Loop

- > 9 out of 10 OTDR tests are performed incorrectly. The list of reasons is long
  - No Bi-Directional test and/or averaging
  - No tail fiber
  - Incorrect handling of launch and tail fiber
  - Adaption with hybrid cords
  - etc.

- A SMART Loop concepts forces the user to perform the test correctly

- Multiple remote loops support operation by 1 technician
ACCELERATED EXTENDED Testing with a SMART Loop

- A built in experts verifies the integrity of the test setup
- The testing time reduced by > 50%
Internal Bi-Directional Averaging

Bi-directional Average

EventMap

- Fiber Length: 51.18 m
- Overall Loss: 0.10 dB
- Tail at 51.18 m
- Loss: -0.20 dB
- Reflectance: -44.34 dB

Fiber Type: OM4 Multimode 50
Test Limit: *FNET MM*
Step 5: Fiber End Face Grading & Documentation

Create ProjX™

Inspect & Clean

Trouble Shoot

BASIC Tests

EXTENDED Tests

Grade End faces

Moniter & Document

...Optional / Conditional Testing

Inspect & Clean

Trouble Shoot

Create ProjX™

BASIC Tests

EXTENDED Tests

Grade End faces

Moniter & Document

...Optional / Conditional Testing
Without inspection equipment, you will never know if the connector is clean or not

Even with inspection equipment, there are arguments as to what is acceptable for a fiber connector

IEC 61300-3-35 defines levels of acceptable scratches and debris on the end faces of fiber connectors

Automated field inspection is something to consider

Images can be stored and made part of the documentation
Fiber Testing Best Practices

Create ProjX™

BASIC Tests

EXTENDED Tests

EXT. Tests no
all or conditional

Doc. Endf. no
all

Grade End faces

Inspect & Clean

Trouble Shoot

...Optional / Conditional Testing

Monitor & Document

Fiber Testing Best Practices
Data Centre vs. Commercial Building Cabling Infrastructure

Differences affecting test regimes

- Larger number of links
  - Testing time
  - Consolidation
  - Labeling

- Larger share of fiber vs. copper
  - "Zoned" Data Centers
  - Low channel loss budgets
  - Low loss connectors
  - Little room for measurement error

- Copper testing in the Data Centre
  - 10GBASE-T / Cat.6_A dominant
  - Shielded systems
  - Future Cat.8 systems
  - An Extended Test Regime is beneficial
Step 1A: Basic (Minimum) Test Regime

BASIC Tests

EXTENDED Tests

Trouble Shoot

CREATE ProjX™

Monitor & Document

...Optional / Conditional Testing
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
What makes a Cat.5e, -6, -6A, -8.1 Connector Work?

Note: Above is shown for the most critical pair 3,6/4,5 at 100MHz
Comparing PERMANENT LINK Results
Permanent Link Adapter with a “CENTERED” Test Plug for the „Heavy Duty Field Use“
Step 1B: Extended Test Regime

**Create ProjX™**

**BASIC Tests**

**EXTENDED Tests**

**Trouble Shoot**

...Optional / Conditional Testing

**Monitor & Document**
### Why EXTENDED Testing?

#### Copper Certification to ISO/IEC 11801

<table>
<thead>
<tr>
<th></th>
<th>Reference Conformance Testing</th>
<th>Installation Conformance Testing</th>
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<tbody>
<tr>
<td>Wire Map</td>
<td>✓</td>
<td>✓</td>
</tr>
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<td></td>
</tr>
<tr>
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</tr>
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<td></td>
</tr>
<tr>
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<td>✓</td>
</tr>
<tr>
<td>DC Resistance Unbalance</td>
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<td>Insertion Loss</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>NEXT, PS NEXT</td>
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<td>✓</td>
</tr>
<tr>
<td>Return Loss</td>
<td>✓</td>
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<tr>
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<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>
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1) Class E<sub>u</sub> only
## Why EXTENDED Testing?

<table>
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<tr>
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<th>ANSI/TIA-568-C.2 (Cabling System)</th>
<th>ANSI/TIA-1152 (Minimum Field Test)</th>
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1) Category 6A only
WHAT IF ...

TCL / ELTC TL is not compliant
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.
Mode Conversion – Real World Example

GOOD vs. BAD Drum of Cable

- 18km cable of identical type was installed
- 30% of the links don’t carry 1000BASE-T
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!
• Difference in Resistance between wires in the pair

• Example:

1.87 Ω

1

1.85 Ω

2

Resistance = 3.7 Ω

Resistance Unbalance = 0.02 Ω

<table>
<thead>
<tr>
<th></th>
<th>RESISTANCE VALUE (Ω)</th>
<th>RESISTANCE UNBALANCE VALUE (Ω)</th>
<th>LIMIT (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2</td>
<td>3.7</td>
<td>0.02</td>
<td>0.15</td>
</tr>
<tr>
<td>3,6</td>
<td>3.7</td>
<td>0.02</td>
<td>0.15</td>
</tr>
<tr>
<td>4,5</td>
<td>3.7</td>
<td>0.01</td>
<td>0.15</td>
</tr>
<tr>
<td>7,8</td>
<td>3.6</td>
<td>0.01</td>
<td>0.15</td>
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<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**
  
  Poor contacts may further degrade over time
Shield Integrity

... Opinions

Opinion A:
Even when the shield is open at the both ends the requirements for 10GBASE-T are met

Opinion B:
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 1 tester 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
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
Standards Compliant Cat.8 Field Testing...

- Standards defined requirements for field testers
- Manufacturer endorsed Cat.8 Field Testers
- Testing Cat.8 links is no more complex than Cat.6
Step 6: Project Monitoring & Documentation

Create ProjX™

BASIC Tests

EXTENDED Tests

Inspect & Clean

Trouble Shoot

Monitor & Document

Grade End faces

...Optional / Conditional Testing
Monitoring & Documentation

• Progress
• Results
• Unexpected

Try it... www.linkwarelive.com
user: c.puller@mailinator.com
Password: Versisv4u
Fiber Testing Best Practices
The VERSIV Family cover it....

...Optional / Conditional Testing
Qualified instruments and personnel paired with an efficient work flow ensures ...

• “Next Generation Readiness” by maximizing performance margins
• ensures a profitable certification of fiber optic or copper cabling systems
THANK YOU
FOR YOUR ATTENTION!

Questions?

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