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

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

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Agenda

- What makes testing in the data centre different from testing cabling in the commercial building?
- Adapted fiber test regimes for the data centre
- Adapter copper test regimes for the data centre
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)
Top eight problems:
Wrong Configuration (Limit, IDs, Standard, .....

<table>
<thead>
<tr>
<th>Problem</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrong Copper Limit</td>
<td>4.3</td>
</tr>
<tr>
<td>Incorrect Cable IDs</td>
<td>3.2</td>
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<tr>
<td>Consolidating Results</td>
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<td>2.9</td>
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Average amongst all respondents in the previous 30 days
Step 1: Project Definition

Create ProjX™

Inspect & Clean

BASIC Tests

EXTENDED Tests

Trouble Shoot

Monitor & Document

Grade End faces

Create ProjX™

Inspect & Clean

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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**

- Limits
- Cables
- Cable ID
ID Lists .... Sources

- Limits
- Cables
- Cable ID

...many more

Create ProjX™
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% Cable, 26% Fibre Cable, 12% Fibre Connectivity)
- UK: 58M$ (57% Cable, 20% Fibre Cable, 12% Fibre Connectivity)
- France: 25M$ (34% Cable, 38% Fibre Connectivity)
Data Centre vs. Commercial Building Cabling Infrastructure
Differences affecting test regimes

Larger number of links

• Testing time
• Consolidation
• Labeling / ID Mgmt.

Larger share of fiber vs. copper

• Little room for measurement error

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

Total Budget: 10GB... 2.6dB or 40 or 100G... 1.5dB (OM4...150m) / 1.9dB (OM3...100)

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

Create ProjX™

Inspect & Clean

BASIC Tests

EXTENDED Tests

Trouble Shoot

End faces

...Optional / Conditional Testing

Monitor & Document

Doc. Endf.

Grade End faces

EXT. Tests

all or conditional

no

no
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>
</tr>
</thead>
<tbody>
<tr>
<td>BASIC</td>
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- **Create ProjX™**
- **Inspect & Clean**
- **Trouble Shoot**
- **Monitor & Document**
- **EXTENDED Tests**
  - EXT. Tests
  - Doc. Endf.
- **Grade End faces**

...Optional / Conditional Testing
Being certain of loss uncertainty

- Power Meter Performance
- Light Source Performance
- 1-Jumper Reference
- Encircled Flux and Test Reference Cords

Significance
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%
In the past …

- Expensive & Bulky
- Revenue at risk
- Reputation at risk

Today …

- Less expensive
- Smaller than a mandrel
- Highly recommended by almost all manufacturers in particular when testing highest grade components for very demanding limits

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<table>
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<tr>
<th>Why?</th>
<th>How?</th>
</tr>
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<tbody>
<tr>
<td>Normative Requirement</td>
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<tr>
<td>• ANSI/TIA-526-14-B</td>
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<tr>
<td>• ISO 1180 → ISO/IEC 14763-3 Ed.1 62</td>
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<tr>
<td>• EN 50173 → IEC IEC 61280-4-2</td>
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</table>
If BASIC Tests **FAIL** ...

**Step 3B: Trouble Shoot**

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

BASIC Tests

EXTENDED Tests

...Optional / Conditional Testing

Create ProjX™

Monitor & Document

Inspect & Clean

Grade End faces

Trouble Shoot
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**
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%

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**Internal Bi-Directional Averaging**

**Phase #1:**
- Launch Fiber
- End 1
- Fiber A
- Fiber B
- End 2

**Phase #2:**
- Tail Fiber
- Launch Fiber

**Bi-directional Average**

**EventMap**
- 1 Fiber Length: 51.18 m
- Overall Loss: 0.10 dB
- End 2
- 104.08 m
- 51.18 m
- 103.98 m

**Table**
- Fiber Type: OM4 Multimode 50
- Test Limit: *FNET MM*

**Trace**
- Tail at 51.18 m
- Loss: -0.20 dB
- Reflectance: -44.34 dB

**PASS**

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Step 5: Fiber End Face Grading & Documentation

Create ProjX™

BASIC Tests

Inspect & Clean

Trouble Shoot

EXTENDED Tests

Grade End faces

Monitor & 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

BASIC Tests

EXTENDED Tests

Inspect & Clean

Create ProjX™

Trouble Shoot

Monitor & Document

Grade End faces

EXT. Tests no all or conditional

Doc. Endf. no all

...Optional / Conditional Testing
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

Copper testing in the Data Centre

10GBASE-T / Cat.6A dominant
Shielded systems
Future Cat.8 systems

Testing time
Consolidation
Labeling

Little room for measurement error

An Extended Test Regime is beneficial
Step 1A: Basic (Minimum) Test Regime

Create ProjX™
BASIC Tests
EXTENDED Tests
Trouble Shoot
Monitor & Document

...Optional / Conditional Testing
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
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

NEXT: 37dB ...14mV

Cat.6, Cat.6A, Cat.8.1 ...“Mated NEXT”
> 54dB ... < 1.9mV
Comparing PERMANENT LINK Results

For the permanent link test configurations, the length of the cable between the modular connector on the patch panel and the test connector shall be 40.0 ± 1.0 m (129 ± 3.2 ft) measured. The instrument connector should be a type that makes direct the high-quality measurement part of the test connector as shown in Figure 18. Some methods used by field testers for permanent link measurements rely on special calibrator features that are associated to a manufacturer’s LIS certified patch panel. The permanent link configuration can be looked up from the LIS adapter is physically modified or a test is run without valid calibration features. Contact the LIS adapter manufacturer for any special instructions.

Figure 18 - Special patch cord for permanent link test configuration

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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**

**Decision Points:**
- EXT. Tests
  - no
  - yes

**Flow:**
- Create ProjX™ → BASIC Tests → EXTENDED Tests → Trouble Shoot
- Optional/Conditional Testing

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Why **EXTENDED** Testing?

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<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>
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<tr>
<td>Length</td>
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<tr>
<td>Propagation Delay</td>
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<td>Delay Skew</td>
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<tr>
<td>DC Loop Resistance</td>
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<td>DC Resistance Unbalance</td>
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<tr>
<td>NEXT, PS NEXT</td>
<td>✓</td>
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</tr>
<tr>
<td>Return Loss</td>
<td>✓</td>
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</tr>
<tr>
<td>ACR-N, PS ACR-N</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ACR-F, PS ACR-F</td>
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<td>✓</td>
</tr>
<tr>
<td>TCL, ELTCTL</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>PS ANEXT, PS AACR-F 1)</td>
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<td>✓</td>
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1) Class E_A only
## Why **EXTENDED** Testing?

### Copper Certification

<table>
<thead>
<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 / ELTCTRL 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

Drum #1

Drum #2
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!
Resistance Unbalance

• Difference in Resistance between wires in the pair

• Example:

Resistance $= 3.7 \, \Omega$
Resistance Unbalance $= 0.02 \, \Omega$
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!**

**POE operation is at risk during maximum load**

**Poor contacts may further degrade over time**
Opinion A: Even when the shield is open at the both ends the requirements for 10GBASE-T are met.

Opinion B: Requirements for 10GBASE-T are not met if the shield is open (floating).

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

Even when the shield is open at the both ends the requirements for 10GBASE-T are met.
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
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.6A
Step 6: Project Monitoring & Documentation

- Create ProjX™
- BASIC Tests
  - Monitor & Document
  - EXTENDED Tests
    - Doc. Endf.: all or conditional
    - EXT. Tests: no
- Inspect & Clean
- Trouble Shoot
- Grade End faces
- Optional / Conditional Testing
Monitoring & Documentation

- Progress
- Results
- Unexpected
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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