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)

- **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
**Top eight problems:**

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

<table>
<thead>
<tr>
<th>Problem</th>
<th>Average</th>
</tr>
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<tbody>
<tr>
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Average amongst all respondents in the previous 30 days
Step 1: Project Definition

- Create ProjX™
- Inspect & Clean
- Trouble Shoot
- Monitor & Document

BASIC Tests

EXTENDED Tests

EXT. Tests

Doc. Endf.

Grade End faces

all or conditional

no

no

all
**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

- AutoCAD
- Visio
- NETDOC
- Microsoft Excel
- LW
- Limits
- Cables
- Cable ID

...many more

Create ProjX™

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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

**Value**

- Germany 61M$: 53% Cu Cable, 26% Fibre Cable, 12% Fibre Connectivity
- UK 58M$: 57% Cu Cable, 20% Fibre Cable, 12% Fibre Connectivity
- France 25M$: 34% Cu Cable, 38% Fibre Cable, 16% Fibre 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

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**
- **Trouble Shoot**
- **EXTENDED Tests**
- **Endfaces**
- **Optional / Conditional Testing**
- **Monitor & Document**
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>
<td>EXTENDED</td>
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**BASIC Tests**

- Create ProjX™
- Inspect & Clean
- Trouble Shoot
- Monitor & Document

**EXTENDED Tests**

- Grade End faces

*Optional / Conditional Testing*

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Being certain of loss uncertainty

- Power Meter Performance
- Light Source Performance
- 1-Jumper Reference
- Encircled Flux and Test Reference Cords
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%
<table>
<thead>
<tr>
<th>Why?</th>
<th>How?</th>
</tr>
</thead>
</table>
| Normative Requirement  
- ANSI/TIA-526-14-B  
- ISO 1180 → ISO/IEC 14763-3 Ed.1 62  
- EN 50173 → IEC IEC 61280-4-2 |   |
If BASIC Tests **FAIL** …

**Step 3B: Trouble Shoot**

- **Create ProjX™**
- **Inspect & Clean**
- **Trouble Shoot**

The diagram shows a flowchart with various stages:

1. **BASIC Tests**
   - EXT. Tests: no, all or conditional
   - Doc. Endf.: no, all

2. **EXTENDED Tests**
   - Grade End faces

3. **Optional / Conditional Testing**

The flowchart illustrates the process of diagnosing and troubleshooting issues during 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 – Basic Tests

Trouble Shoot – Ext. Tests

EXTENDED Tests

Grade Endf.

Monitor & Document

...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*
Testing with a \textit{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 expert verifies the integrity of the test setup
- The testing time reduced by >50%

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Internal Bi-Directional Averaging

Bi-directional Average

EventMap: Fiber Length: 51.18 m
Overall Loss: 0.10 dB
End 2

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**
- **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

Create ProjX™

BASIC Tests

EXTENDED Tests

EXT. Tests

Doc. Endf.

Inspect & Clean

Trouble Shoot

Grade End faces

...Optional / Conditional Testing

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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.6A dominant
 Shielded systems
 Future Cat.8 systems

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

Create ProjX™

BASIC Tests

EXTENDED Tests

Trouble Shoot

Monitor & Document

EXT. Tests

...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

NEXT: 37dB ...14mV

Cat.6, Cat.6A, Cat.8.1 ...“Mated NEXT”
> 54dB ... < 1.9mV
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™**
  - EXT. Tests
    - no
    - yes

- **BASIC Tests**

- **EXTENDED Tests**

- **Trouble Shoot**

- **Monitor & Document**

...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>
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<tbody>
<tr>
<td>Wire Map</td>
<td>✓</td>
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<tr>
<td>Length</td>
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<tr>
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<tr>
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<tr>
<td>DC Resistance Unbalance</td>
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<td></td>
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<tr>
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<tr>
<td>NEXT, PS NEXT</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Return Loss</td>
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<td>✓</td>
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<tr>
<td>ACR-N, PS ACR-N</td>
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</tr>
<tr>
<td>ACR-F, PS ACR-F</td>
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<tr>
<td>TCL, ELTCTL</td>
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<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<sub>A</sub> only
Why **EXTENDED** Testing?

<table>
<thead>
<tr>
<th>Copper Certification</th>
<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 / ELTCTL 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

1.85 Ω

Resistance = 3.7 Ω
Resistance Unbalance = 0.02 Ω

<table>
<thead>
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<th>RESISTANCE UNBALANCE</th>
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<tbody>
<tr>
<td>1,2</td>
<td>3.7</td>
</tr>
<tr>
<td>3,6</td>
<td>3.7</td>
</tr>
<tr>
<td>4,5</td>
<td>3.7</td>
</tr>
<tr>
<td>7,8</td>
<td>3.6</td>
</tr>
<tr>
<td>LIMIT</td>
<td>21.0</td>
</tr>
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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:

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
For this high-end cable, the Alien Crosstalk is below the tester's significance level.

The same cable showed 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 the Cat.6A
Step 6: Project Monitoring & Documentation

- Create ProjX™
- Inspect & Clean
- Trouble Shoot
- BASIC Tests
- EXTENDED Tests
- Monitor & Document
- 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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